

Connecting Informal STEM Experiences to Career Choices: Identifying the Pathway

A literature review produced by the

ITEST Learning Resource Center

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Introduction

There is a growing concern that the United States does not have sufficient numbers of skilled technology workers entering careers in Information Technology, and Science, Technology, Engineering and Mathematics (STEM). For success in a global economy, America depends on a robust and reliable pipeline of scientists, technicians, engineers and mathematicians. Current research shows that 80% of the fastest growing fields are in science and technology areas (Coble and Allen 2005) and 50% of the current workforce is approaching retirement (Business Roundtable 2005). However, domestic universities are preparing only half enough computer workers for the 1,500,000 technology jobs expected by 2012 (NCWIT 2005). Although more and more jobs will require post-secondary degrees (Bureau of Labor Statistics 2004), according to CRESPAR (Center for Research on the Education of Students Placed At Risk), there is epidemic academic under-preparedness on the part of students (Balfanz, Legters et al. 2004).

In response to these challenges, there has been an enormous investment by foundations, government (notably the National Science Foundation), universities and research institutions to increase the number of people entering and succeeding in STEM fields. This investment starts with middle and high school interventions and continues through college and graduate studies. The National Science Foundation's (NSF) Information Technology Experiences for Students and Teachers (ITEST) initiative is one of these major investments. In direct response to the concern about shortages of information technology workers in the United States, "ITEST is designed to increase the opportunities for students and teachers to learn about, experience, and use information technologies within the context of science, technology, engineering, and mathematics (STEM), including Information Technology (IT) courses. Supported projects are intended to provide opportunities for both school-age children and for teachers to build the skills and knowledge needed to advance their study, and to function and contribute in a technologically rich society" (NSF 2005).

In order to better understand the pathway for students from early exposure to STEM experiences to pursuing a STEM career, the ITEST Learning Resource Center at Education Development Center commissioned a review of the literature. What are the links between informal educational experiences in the STEM (science, technology, engineering and mathematics) fields and the career decisions of the interventions' participants? What do we know about the ways that these informal STEM experiences, diverse as they are, influence young people to envision themselves, for example, as scientists or information technologists and put themselves on a pathway toward a STEM career?

The focus of this literature review is out-of-school time activities in informal environments, a "vastly understudied" set of experiences (Carnegie Council on Adolescent Development 1992), and the role these experiences can have in shaping the direction of youth to pursue STEM careers. By understanding the research base on this topic we can better understand the ways that interventions can lead to more young people choosing STEM professions. Our goal is to contribute to these infrastructure building

efforts by synthesizing the relevant research for ITEST project staff, NSF Program Officers and others in the ITEST community and others concerned about the future of the STEM workforce. This literature review is the first in what will be a series of literature reviews targeting topics of interest and concern to the ITEST community.

Although it can be challenging to identify the ways that interventions make a difference to youth, the literature points to six key factors that connect the informal STEM experiences to the choice to pursue future STEM work: 1) Decision to pursue a STEM career; 2) Academic preparation and achievement; 3) Identification with STEM careers; 4) Self-efficacy; 5) External environmental factors which are barriers or supports; and 6) Motivation, interest and enjoyment. In the following pages, we discuss each factor separately, with the understanding that in young people's lives, these factors are intertwined. By examining the factors individually, we are able to highlight the links between informal STEM experiences and young people's career choices.

What is Informal STEM Education?

While in-school curricula and teacher professional development should not be ignored, a host of programs and activities exist outside of the classroom and are receiving increased attention for their role in children's lives. Together, in-school and out-of-school learning experiences can "form a two-pronged approach to learning," (Rosser 1997 p.271) as they inspire and enable STEM achievement. These activities are grouped under the wide umbrella of informal education¹. The National Science Foundation defines a broad vision for informal education: "Informal learning happens throughout people's lives in a highly personalized manner based on their particular needs, interests, and past experiences. This type of multi-faceted learning is voluntary, self-directed, and often mediated within a social context (Falk 2001; Dierking, Ellenbogen et al. 2004); it provides an experiential base and motivation for further activity and subsequent learning"(NSF 2006). The National Science Teachers Association (NSTA), noting the enrichment orientation, ability to spark further learning and the basis of lifelong learning in the sciences, lists the types of informal education as those "programs and experiences developed outside the classroom by institutions and organizations that include: children's and natural history museums, science-technology centers, planetariums, zoos and aquaria, botanical gardens and arboreta, parks, nature centers and environmental education centers, and scientific research laboratories; media, involving print, film, broadcast, and electronic forms; and community-based organizations and projects, including youth organizations and community outreach services" (NSTA 1999).

Methods

To compile this literature review, we searched primarily on four databases (Academic Search Premier, ERIC, PsychINFO, and Education Abstracts) using the search terms in

¹ "Informal education," used throughout this review, is the most commonly used term within the field and the distinctions between it and other terms are subtle and semantic. We have used "informal" to include all of those activities and experiences that happen outside of the school setting.

Appendix A. We went directly to organizations that publish on informal science (for example the NSF, American Academy for the Advancement of Science) and to university evaluation centers (such as the Evaluation Center at Western Michigan State University). We attempted to find evaluations of known, high-quality programs by searching the evaluator or program web sites, and to on-line repositories of evaluations (such as Harvard Family Research Project and InformalScience.org). Highly relevant articles' bibliographies were mined for further citations. To be included, an article needed to appear in a peer reviewed journal or conference, be a published book, or be a publicly available report or a white paper by a nationally-known organization; discuss career and achievement results from informal (rather than in-school) STEM activities; concern United States participants; and be published between 1990 and 2005. We did include some references that did not meet every criterion if it had an otherwise high degree of relevance to this study. The method of evaluation or research was not a criteria for inclusion. This report cites 63 articles, book chapters, conference papers and program evaluations; about 200 were reviewed. We did not include informal learning for adults connected to the youth programs (such as mentors themselves or other volunteers) or adult students in secondary education programs.

The Informal STEM Education and Career Connection

Careers in the STEM fields include large sectors of our society, and hold roles for people who complete various levels of formal education. Two-year college degrees can lead to careers as technicians in computer manufacturing, and graduate diplomas in bio-engineering can lead to careers in cutting edge biomedical and biotechnology research. However, unlike non-technical fields, STEM careers require a path of achievement that starts with high school courses in math and science (AAUW 1999); these courses are known as gatekeepers to advancement. In fact, students need to leave high school academically prepared, with a sense of self-efficacy, motivation and commitment to persist until graduation in a STEM area major (Clewell and Campbell 2002).

While academic preparedness generally depends on a strong secondary school academic program (Rosser 1997), non-classroom experiences with STEM, the attitudes of family and peers, and young people's personal qualities contribute to students' persistence in STEM. For example, young people need parents who are encouraging; a peer network that supports achievement; and mentors or counselors who can explain the meaning of the choices that students face (Alston and Hampton 2000; Jodl, Michael et al. 2001; Madill, Ciccocioppo et al. 2004; Cleaves 2005; Scott and Mallinckrodt 2005). Experiences such as internships, hands-on afterschool programs and opportunities to participate in projects that build knowledge and excitement for learning recharge the subject matter with relevancy and excitement (NSTA 1999). As they mature from children into adolescents and adults, students need motivation to persist through college and beyond, a clear sense of self-efficacy and an enjoyment of the subject matter (Rosser 1997; Darke, Clewell et al. 2002).

The factors we discuss in this literature review have been identified as important elements of successful pathways to STEM careers. However, these pathways are not

necessarily or always direct, and determining the link between interventions and career choices is still a challenge for the research community. For example, Darke and Clewell (2002) found evidence of the effectiveness of informal activities for improving outcomes for women in STEM, but they conclude that “it is difficult to determine how widespread the use of effective interventions have been, or to trace the effectiveness of these approaches and strategies on the status of girls and women in SMET [sic]” (p.21). They also agree with Fennema’s (Fennema n.d.) conclusion that “interventions can make a difference” since lessening the performance and test-taking gaps in the pre-college years are attributed, at least in part, to these interventions. While few articles show direct links between the informal intervention and career outcomes, and even longitudinal studies are challenged to explain direct links (Fadigan and Hammrich 2004), some connections can be found in the literature between informal experiences and youth decision making in the STEM fields (Diamond, St. John et al. 1987; Van Tassel-Baska and Kulieke 1987).

Although our literature review topic is informal STEM education and career choice, most of the studies do not follow students all the way to employment. Instead, they focus on young people’s stated career aspirations and expectations. We believe their views are an appropriate proxy for career choice, since students’ declarations of intended STEM study are very good indicators of their actual career choices further in the future (Lent, Brown et al. 2005).

Two large program evaluations have helped to identify the major elements of significance in the connection between careers and informal experiences. Clewell and Darke (2000) evaluated the National Science Foundation’s Program for Women and Girls (PWG), investigating 119 programs that ran between 1993 through 1996. The PWG aimed to build knowledge capital, social capital, and human capital in order to address and lessen the achievement gap between females and males. Over those years the funded programs reached 31,500 participants directly in formal and informal settings, and an additional 15,000 through replications. Eighty-two percent of projects reported that the young women who participated gained an enhanced attitude and self-confidence in STEM courses, increased interest in STEM courses and careers, and mastery of STEM content. Seventy-three percent of programs used collaborations between formal and informal institutions to achieve their goals. Half of programs surveyed used out-of-school programming, about 30% used mentors, almost 25% held summer camps, and 20% ran parent-child Saturday workshops. These were all found by the evaluators to be effective strategies to help girls persist in STEM. They believe that it was the mix of strategies that was responsible for the benefits to participants (Similarly, Van Tassel-Baska, 1987). It was through these strategies that participants showed gains in the six factors that we have identified as leading to pursuing a career.

Starting in 1991, ASTC (Association of Science and Technology Centers) was funded by the Wallace-Reader’s Digest Fund to seed high-quality and comprehensive youth internships in 72 science-oriented museums, such as aquaria, nature centers, and zoos. The YouthALIVE! Program reached over 7000 young people, mostly children of color and those from low-income communities. In their roles as junior museum staff, 89% were explainers, 66% worked as demonstrators, 57% staffed afterschool sessions for

younger kids, and 57% participated in enrichment classes, among other roles (YouthALIVE! 2001). Career counseling, pre-employment training and relationships with mentors were part of each program. In a summary of the program, its evaluations and articles about the program showed repeated findings that the program had direct impact on the six factors that we have identified. They found an increase in participants' connection to school courses (academic achievement); interest in learning about science (motivation); exposure to mentors (positive external factor) and role models (identification); sense of "ownership" about science content (identification); development of life skills such as communication and patience with young children—i.e., the visitors to a museum (self-efficacy); awareness of careers in the sciences and science education (decision to pursue a career); and an overall excitement about science (motivation). In short, "a theme of *life-changing* experiences emerges. Many of the participants were introduced to new, unimagined opportunities, to a new way of perceiving the world, to exciting opportunities that have transformed their perception of themselves and their place in the world" (Hein, Baum et al. 2000 p.22, in YouthALIVE!, 2000, italics original).

Six factors that contribute to students' pursuit of STEM careers

1. Career Awareness and Decision to pursue a STEM career

If post-secondary STEM education and training depend upon secondary school academic achievement, and young people's choice to pursue elective and advanced STEM coursework in high school depends on initial commitment to pursuing a STEM career, what influences young people to make that commitment? Many of the investigations into student career decision-making that we discuss in this literature review are grounded in one or more of the following theories: Super's Career Development Theory (Super 1957), Possible Selves Theory (Markus and Nurius 1986), Social Cognitive Career Theory (Lent, Brown et al. 1994), Farmer's Model of Career and Achievement Motivation (Farmer 1985), and the Eccles et al. Model of Achievement-Related Choices (Eccles (Parsons), Adler et al. 1983). These theories are described briefly below.

Super's Career Development Theory (1957) divides career development into stages roughly corresponding to age. Young people pass from the Growth stage into Exploratory stage during their teenage years, and eventually into the Establishment stage. While this theory provides a helpful framework, Super's stages have been criticized for being based only on the experiences of white, middle class boys and men and therefore being less suitable for use with people from lower socioeconomic backgrounds, people of color, and women (Farmer 1992; Crozier 1999).

As young people begin to make choices about their futures, one way to make sense of their decisions is Possible Selves Theory (Markus and Nurius 1986). "Possible selves" are positive and negative visions of what one might become; people tend to make decisions in order to work toward what they would like to be, and to avoid what they fear. Possible Selves theory is particularly relevant to young people's career development because adolescence is a time when students actively make choices that either close doors on various visions, or keep them open. If girls and boys cannot envision themselves as

scientists or engineers, they will not make the choices necessary to pursue STEM fields (like enrolling in advanced mathematics, for example).

Social Cognitive Career Theory (Lent, Brown et al. 1994), which is based on Bandura's (1986) social cognitive theory and expands on Hackett and Betz' (1981) career self-efficacy model, suggests that three personal factors—self-efficacy, outcome expectations, and interests—operate together and interact with external barriers and supports to inform a person's career goals and actions. Self-efficacy is a measure of how successful a person believes he or she will be at completing a particular task or meeting a goal. One frequently used measure when studying young people's STEM persistence is their math self-efficacy. Outcome expectations are the risks and rewards that a person associates with a course of action. Lastly, interests are just that: what subjects, topics, and types of activities a person enjoys.

Two other models that should be mentioned are the Farmer Model of Career and Achievement Motivation (1985) and the Eccles et al. Model of Achievement-Related Choices (1994). Both have roots in social cognitive theory and include the concept of self-efficacy. They were developed to take into account the fact that, due to gender role socialization, the same career choice may have different risks and rewards depending on the chooser. The Farmer model combines demographic information with cognitive and environmental factors and past behavior to predict STEM choices. The Eccles model proposes that self-efficacy, goals, notions of gender roles, and perceived risks and rewards are all key to conscious and unconscious achievement-related decisions.

Young people cannot choose a specific STEM career or field of study if they do not know of its existence: lack of knowledge of STEM careers may be one reason why students choose non-STEM careers. Studies show that students have a limited understanding of the variety of STEM work available and the qualifications needed to do that work (Bieber, Marchese et al. 2005; Cleaves 2005). In response, several research studies conclude with a call for active STEM career guidance on the part of educators (Alston and Hampton 2000; Madill, Ciccocioppo et al. 2004; Cleaves 2005). STEM-specific career guidance can broaden students' awareness of STEM career opportunities and help them see how their talents and interests make them suited to pursue those opportunities.

Informal STEM activities are one venue for increasing young people's familiarity with the many career options available. For example, after interviewing career counselors at sixteen diverse British schools, Munro and Elsom (2000) conclude that educators can have a major influence on students' decision to pursue science careers through extracurricular activities, providing information about post-16 experiences and tips on surviving college courses. A museum-based enrichment program tracked past participants who had completed least one year of the program between 1992 and 1997, and found that for the people pursuing careers in health and other STEM fields, mentors and exposure to job skills were key elements (Fadigan and Hammrich 2004).

2. Academic Preparation and Achievement

Persistence in post-secondary STEM education and training depends on solid academic preparation. While informal STEM educational opportunities cannot replace school curricula, they can augment curricula and prepare young people for greater school achievement. For example, a strong math-science component of the out-of-school enrichment program, GEAR-UP, has been successful in increasing grades, persistence, graduation and college admissions rates (Heisel 2005). Another example is the retrospective study of past participants of the San Francisco Exploratorium's Explainer Program (Diamond, St. John et al. 1987). Over 800 alumni were asked about the program's impact on their lives, and a third traced their experiences at the Exploratorium to their seeking out related books, media or classes. Participants who already had an interest in science were encouraged by their experience to pursue science classes (in high school or college). Also, while not specifically about learning science, the opportunity to interact with museum exhibits increased the students' "generalized learning and thinking skills" (p.644) that supported their future success in course work.

Students need this kind of informal STEM exposure to motivate them to study and excel in STEM coursework at school. Enrollment and achievement in STEM courses is an excellent predictor of young people's persistence in STEM (Farmer, Wardrop et al. 1999). Specifically, Farmer and Wardrop found that enrollment is a good predictor for young women's persistence, while GPA is a good predictor for young men's persistence. Furthermore, enrollment may be a less significant factor for boys because they encounter greater social expectation to take additional STEM coursework than do girls.

Research has shown that that enrollment in advanced mathematics and elective science courses in high school serves as a gatekeeper for STEM occupations (AAUW 1999). This understanding has led educators to focus on convincing students to take courses in order to keep future career options open. However, as several other studies point out, students' motivation for enrolling in these courses comes from already existing, if nascent, career decisions (Catsambis 1994; Farmer, Wardrop et al. 1999; Thompson and Lewis 2005). If students do not believe that STEM courses are important to their career goals, indeed, if they have already decided on career goals outside of STEM, they have no incentive to enroll in advanced STEM courses. In contrast, career awareness and goals can inspire students to seek out new academic opportunities (Thompson and Lewis 2005).

What happens when young people's schools do not offer strong academic STEM programs? Informal STEM opportunities can help fill in the gaps. For example, museums and other similarly structured enrichment programs provide potential academic supplements that are hands-on and inquiry- based, like the opportunity to conduct research with high quality lab equipment (Schenkel 2002).

Informal STEM activities, whether consisting of one-time exposure to equipment or concepts or longer term enrichment programs, can influence students' academic achievement. Stake and Mares (2005) found that students who had completed a summer science enrichment program reported increased science confidence and motivation

months after returning to their regular high schools. The students also reported feeling more confident in their abilities to pursue science careers.

3. Identification with STEM Careers

Possible Selves theory suggests that young people will not decide in favor of a career (STEM or otherwise) unless they can envision themselves in that professional role. What enables young people to picture themselves succeeding in a STEM career? Although there is little consensus as to the relative importance, having role models, developing relationships with mentors and gaining job experience all are mentioned as possible positive factors in the literature (Hill, Pettus et al. 1990; Packard and Nguyen 2003; Madill, Ciccocioppo et al. 2004; Tisdal 2005).

Packard and Nguyen (Packard and Nguyen 2003) found that developing relationships with STEM mentors through a math/science high school summer program had significant, positive impacts on the decisions of first generation college women to pursue STEM careers. In contrast, mentors were not as important to the career decisions of young women whose parents had attended college.

Hill, Pettus, & Heddin (Hill, Pettus et al. 1990, as cited in VanLeuvan, 2004) and Madill, Ciccocioppo, and Stewin, Armour & Montgomerie (2004) found relationships between youth and STEM professionals of similar backgrounds to be an important factor in students' career decisions. In another study, parents and teachers of students with physical disabilities agreed, citing the lack of visible STEM role models with disabilities as a key problem for their students making career decisions (Alston and Hampton 2000). On the other hand, in their case study of a successful African American mathematics student, Thompson and Lewis (2005) propose that a dearth of role models of the same race or gender as students can be frustrating for young people, but not enough to deter them from enrolling in advanced math courses if the courses are available and the young people already believe the courses are necessary preparation for their chosen careers.

Work experiences and internships expand students' abilities to see themselves as professionals in STEM disciplines (Packard and Nguyen 2003; Tisdal 2005). Through such activities, young people have the opportunity to carry out STEM tasks themselves and to meet professionals in the field.

A few program evaluations of informal STEM programs point to the effectiveness of gaining hands-on experience. For example, the Girls Creating Games program found that game design and pair programming increase girls' technical skills, their ability to envision themselves as creators of technology and combat the stereotype of computer work as a solitary endeavor (Denner, Werner et al. 2005). Kerr and Robinson Kurpius (2004) found that minority and low-income girls who attended a day of guidance intervention activities, including conversations with women scientists, increased their exploration of STEM careers, and that the intervention's activities and follow-up mentoring raised the girls' achievement and self-efficacy.

4. Self-Efficacy

Self-efficacy is the lynchpin within Social Cognitive Career Theory (Lent, Brown et al. 1994). Young people's internal beliefs and experiences combine to influence their ideas and expectations about their own capabilities with respect to STEM (Lent, Brown et al. 2005). Ultimately, in order to persist in STEM, young people must believe that they are capable of successfully completing the required education and training and carrying out the job duties once in the field. How can this self-efficacy be fostered?

According to our review, informal education activities can increase young people's STEM self-efficacy. Sixty six percent of the surveyed alumni of the Exploratorium's Explainer Program reported that their experiences at the Exploratorium led to "gaining confidence that they could understand science" (Diamond, St. John et al. 1987 p.650). The explainer model allowed youth who were not as successful in school to be experts in front of teachers, parents or peers (Gottfried 1980, quoted in Rennie, 2005). Diamond (1987) concluded that the social context of exhibit visiting at museums allows for interactions between people who might be as valuable as the content of the exhibit itself. Similarly, in an evaluation of the FIRST Robotics program, participants report an increased self-confidence (89%) and an increased motivation to do well in school (70%) (Melchior, Cohen et al. 2005). Raising students' levels of self-efficacy is particularly important when trying to keep girls in the STEM career pipeline. Math self-efficacy is a significant predictor of the likelihood of young women's persistence in STEM (Farmer, Wardrop et al. 1999).

5. External Environmental Factors (Barriers and Supports)

Social Cognitive Career Theory (Lent, Brown et al. 1994) models a person's goals and actions as outcomes of the interaction between internal attitudes and beliefs and external environmental factors. In other words, factors such as working with an excellent mentor, experiencing a hostile laboratory climate, having supportive parents, or socializing with siblings and peers who value sports over mathematics all work together to raise or lower a young person's feelings of self-efficacy with respect to STEM. Within this view, informal STEM educational programs are themselves external supporting factors. For this reason, many studies focus on specific external factors (such as family and peer relationships or the availability of enrichment opportunities) in order to determine how much of a supportive or deterring effect the factors have on young people's decisions.

The literature frequently mentions the importance of high levels of family involvement and support in young people's STEM persistence (Cleaves 2005; Russell and Atwater 2005). Jodl, Michael, Malanchuk, et al. (2001) found that the career goals of African American and white youth can be predicted based on parents' values, such as importance of taking math and science classes, going to college and, in general, the value put on academic achievement versus the value put on other interests, such as sports (Jodl, Michael et al. 2001). Stake and Mares (2005) found, in a study of a summer science enrichment program, that encouragement from significant people (e.g. family, teachers, peers) was an important link between students' attitudes toward science and their science

abilities. The authors hypothesize that the absence of such involvement and support can reduce students' feelings of science self-efficacy. In another study of science self-efficacy, researchers found that lack of support from fathers had negative effects on young women's tendency to choose STEM as a career (Scott and Mallinckrodt 2005).

6. Interest, Enjoyment and Motivation

Professionals in STEM careers, particularly those with careers in the physical sciences, attribute their early decisions to take high school STEM electives and choose a college major to positive childhood experiences with science (Roe, 1952, as cited in Joyce and Farenga 1999). Informal STEM activities help maintain students' positive attitudes about STEM throughout middle school and high school (Hofstein 1990, as cited in VanLeuvan, 2004; Rennie 2005; Tisdal 2005). For example, Coventry (1997) found that students studying the sciences in college were more likely to have visited science museums than other students (80% vs. 64%).

Different experiences result in different outcomes. Joyce and Farenga (1999) found that physical science experiences motivated boys to enroll in more physical science courses, and life science experiences motivated girls to enroll in more life science courses; they suggest that early socialization affected the types and intensity of the girls' and boys' science exposure. Furthermore, they found that students expressed attitudes about whether a STEM career was a viable choice by age nine.

When explaining why they would or would not wish to pursue a STEM career, girls cited "doing the mathematics, the hard work required, and lack of interest or enjoyment" as cons, while "learning or discovery involved, enjoyment or intrinsic interest, and use of mathematics" were the most frequent pros (VanLeuvan 2004, p. 253). Furthermore, older girls reported that they saw STEM careers as solitary work and therefore unattractive. Informal STEM activities can combat this attitude. Madill, Ciccocioppo, Stewin, et al. (2004) found that applications of STEM to real-world problems help sustain students' interest and engagement in STEM coursework, and ultimately their persistence in post-secondary STEM study.

Gender is not the only factor that affects young people's motivation for and enjoyment in STEM. Studies have shown that the construction of achievement identity differs among youths by race, gender, and socioeconomic status (Brickhouse 2001). When exploring the educational and career plans of Mexican American girls, McWhirter, Hackett, and Bandalos (1998) found that degree of acculturation, partly due to amount of time spent in the U.S., was a particularly significant variable in predicting girls' career expectations. In complementary studies of African American middle school and college students, Oyserman, Ager, and Gant (1995) found that "for [African American] females, viewing achievements as part of a socially contextualized identity improves performance. For [African American] males, it is the ability to visualize the self as achieving or failing to achieve that is particularly motivating" (p.1229).

Summary

This literature review outlines the factors, as culled from research articles, program evaluations and reports, that connect informal STEM educational experiences to the choice to pursue a career in a STEM-related field. Although the link is not always direct, this review can assist the ITEST community in connecting program outcomes that demonstrate these important factors to persistence in STEM classes and STEM career choice.

As most reviews of research literature end with a call for more research, so do we. Indeed, if we are to understand the complex interactions between young people and the physical, sociocultural and personal influences that contribute to their decisions about their futures, we need improved research and perspectives. Dierking and Falk describe a rich view into the processes that we aim to understand: “One needs to pan the camera back in time and space so that one can see the individual learner across a larger swath of his life and can view the experience within the larger context of the community and society” (Dierking and Falk 2001, p.8). Research needs to articulate and make explicit the connection between these informal experiences and the paths young people take post-intervention. As suggested by Dykeman, Wood, et al (2003), rather than trying to connect the whole field to multiple student outcomes, studying individual programs, their outcomes, dosage and long term effects is a place to start.

The NSF ITEST program is investing in such research—led by the ITEST Learning Resource Center—across the 51 currently funded ITEST projects. This research will contribute to understanding the ways in which these six factors—Decision to pursue a STEM career; Academic preparation and achievement; Identification with STEM careers; Self-efficacy; External barriers and supports; and Motivation, interest and enjoyment—are influenced by students’ experiences in ITEST projects. As a funded program, ITEST expects to be able to link the ITEST experience to future STEM career choice, and therefore support the building of a national infrastructure for a robust STEM pipeline.

Appendix: Search Terms

We used the following key words for the search of published relevant research. Asterisk indicates a truncation.

Career, mentor*, job*, pipeline

Science, STEM, technology, engineer*, math*

Informal, out-of-school, after school, enrichment, extracurricular, club*, supplement*

Attitude*, persist*, achievement, courses, enrollment, efficacy, self-efficacy

Student*, adolesc*, youth,

US, domestic, americ*

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