



**The Role of High School Research Experiences in the Development of Undergraduate Students' Research Self-Efficacy**

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*Paper presented at the  
Annual Meeting of the American Educational Research Association  
April 2013, San Francisco, CA*

The data used in this study was part of a larger project commissioned by the International Baccalaureate Organization (IBO). All representations, assertions, and errors, however, are solely attributed to the authors and not the IBO.

### **The Role of High School Research Experiences in the Development of Undergraduate Students' Research Self-Efficacy**

Policy makers have focused on research-based learning for undergraduate students since the 1990s when the Boyer Commission (1998) as well as funding agencies and organizations recommended research-based learning as a way of promoting both greater interaction with faculty members and student-centered learning experiences (Kuh, 2008; National Research Council, 1999; National Science Foundation, 2003). Undergraduate research programs subsequently gained widespread popularity and have been shown to confer a host of benefits upon students including stronger retention and persistence (Banta, 2004), greater likelihood of pursuing graduate education (Bauer & Bennett, 2003; Hathaway, Nagda & Gregerman, 2002; Russell, Hancock & McCullough, 2007), and development of career interests (Hunter, Laursen & Seymour, 2006; Lopatto, 2004). While the effects of undergraduate research participation are well documented, less is known about students' pathways into undergraduate research participation. The association between postsecondary outcomes and pre-college achievement in particular subjects (Betz & Hackett, 1983; Pajares & Miller, 1995; Tai, Liu, Maltese & Fan, 2006), however, suggests that achievement in pre-college research experiences may similarly pave the way for students' participation in undergraduate research.

#### **Purpose of the Study**

The International Baccalaureate Organization commissioned a study to examine the research experiences of undergraduates and possible influences of the International Baccalaureate (IB) curriculum on those experiences. The IB curriculum is divided into six subject areas and includes an Extended Essay (EE) requirement, for which students must conduct an original research project under the supervision of someone at their high school.

This research examines whether students' development of research self-efficacy in high school strongly influences their interest and participation in undergraduate research. Specifically, this study examines the research skills that students developed through their involvement in the IB Extended Essay project, their perceptions of this high school research experience, and outcome expectations – as well as college-level outcomes -- associated with the development of research skills. Research questions for this study include:

- 1) How does the IB Extended Essay project, a high school research experience, shape students' research self-efficacy, interest, and undergraduate research participation?
- 2) What is the nature of students' undergraduate research participation, and how do they make meaning of these experiences?
- 3) How do students' cumulative research experiences shape their educational and career goals?

This mixed-method study is based on data collected during the 2011-2012 academic year at one institution from first-year through senior undergraduate students who participated in the International Baccalaureate (IB) program in high school.

## **Literature Review**

### **Self-Efficacy**

Bandura (1977) defined self-efficacy as the conviction that one can successfully perform the behavior required to produce an outcome. In his social cognitive theory of human behavior, he argued that individuals' choice of activities, the amount of effort they are willing to expend, and the length of time they will persist in stressful situations are all influenced by perceived self-efficacy. Sources of efficacy expectations include performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. The effect that the information drawn

from these sources has on efficacy expectations depends upon how it is cognitively appraised. Bandura wrote that these appraisals, in turn, are mediated by contextual factors, including the social, situational, and temporal circumstances under which events occur.

Research self-efficacy, therefore, is an individual's confidence in his or her ability to successfully perform the tasks involved in conducting research (Forester, Kahn & Hesson-McInnis, 2004). Studies show that research self-efficacy beliefs directly predict research productivity (Hollingsworth & Fassinger, 2002; Kahn, 2001) and indirectly predict research interest (Bieschke, 2006; Bieschke, Bishop & Garcia, 1996; Kahn, 2001) among students at the graduate level. Research self-efficacy is thus an important consideration when examining research interest and outcome expectations among students at the undergraduate level.

### **Undergraduate Research**

Undergraduate research can be defined in a variety of ways. For the purposes of this study, we used Stocks et al.'s (2003) definition of undergraduate research as research, scholarly, or artistic activities that lead to the production of original work. By this definition, undergraduate research includes a range of educational experiences and can result in output such as a collection of poetry, an agricultural field experiment, or an analysis of archival materials (Kinkead, 2003).

Much of the literature on undergraduate research participation has focused on specific types of educational experiences and outcomes associated with these experiences (Bauer & Bennett, 2003; Campbell & Skoog, 2008; Ishiyama, 2002; Joyce, 2003). Many of these studies focus on educational experiences at a single institution. One such study (Campbell & Skoog, 2004) examined career and personal development outcomes (e.g., gains in self-confidence, increased motivation to pursue a science career, preparation for graduate school) associated with

female students' participation in a biology undergraduate research program. Another (Joyce, 2003) explored outcomes reported by participants in a social science undergraduate research program, and found that students experienced gains in areas such as self-confidence and critical thinking. Indeed, the outcomes reported in these single institution studies have been borne out in national studies, as well. Studies show, for example, that alumni of undergraduate research programs are significantly more likely to attend graduate school than peers with similar academic characteristics (Bauer & Bennett, 2003; Hathaway, Gregerman & David, 2004). In terms of career development, 68 percent of participants in science, technology, engineering and mathematics (STEM) undergraduate research programs reported an increased interest in pursuing careers in STEM fields (Russell, Hancock & McCullough, 2007).

National studies that included students from multiple disciplines provide more insight into the relationships between research experiences and outcomes. Analyses of National Survey of Student Engagement (NSSE) data showed that students who gained significantly in critical thinking and oral communication skills were more likely to have taken part in particular kinds of research tasks such as contributing to research design, reviewing related research, interpreting findings, and collecting data (Buckley, Korkmaz & Kuh, 2008). In addition, students who analyzed data and interpreted findings were more likely to engage in higher order thinking (NSSE, 2007). Students were also more likely to engage in integrative thinking if they contributed to study design, reviewed related literature, analyzed data, interpreted findings, wrote up findings, or submitted a paper or product (NSSE, 2007).

### **Theoretical Framework**

Social Cognitive Career Theory (SCCT) (Lent, Brown & Hackett, 1994), which is based on Bandura's (1977, 1986) social cognitive theory, provides a model for understanding students'

learning experiences and educational decision-making processes related to conducting research. SCCT highlights human agency, while also acknowledging the many personal and environmental factors that can affect human agency with respect to career development (Lent, 2005). The key mechanisms through which people are able to exercise personal agency, according to SCCT, are three central variables: self-efficacy, outcome expectations, and personal goals (Lent, Brown & Hackett, 1996). Lent, et al. (1994) conceptualized career-related interest, choice, and performance within three interlocking process models, as illustrated in Figure 1.

The interest and performance models are particularly useful in exploring the students' experiences with research as they move from high school to college. According to SCCT's interest model, self-efficacy and outcome expectations about particular activities exert a direct effect on the formation of career interests. Lent, Brown and Hackett (1994) posited that individuals are more likely to develop an enduring interest in an activity if they view themselves as competent at it and anticipate that performing the activity will produce valued outcomes (Lent, Brown & Hackett, 1996; Lent, 2005). Emergent interests lead to goals for sustaining or increasing involvement in particular activities, and these goals subsequently increase the likelihood of activity practice (Lent et al., 1996; Lent, 2005). Attainments that accrue through practice of an activity (e.g., awards, grades) revise self-efficacy and outcome expectations, forming an ongoing feedback loop (Lent et al., 1996; Lent, 2005).

The SCCT performance model is concerned with the factors that affect academic and career-related performance (Lent, 2005). In the model, Lent, Brown and Hackett (1996) emphasize the "interplay among ability, self-efficacy, outcome expectations, and goals in determining performance outcomes" (p. 394). Ability, based on indicators of aptitude, achievement, or past performance, affects an individual's performance attainment level both

directly, through task knowledge and performance strategies, and indirectly, affecting self-efficacy and outcome expectations (Lent et al., 1996; Lent, 2005). In turn, self-efficacy and outcome expectations affect the level of performance goals that individuals set for themselves (Lent et al., 1994, 1996; Lent, 2005). Thus, a student who did well on high school research projects might enter college with a prior understanding of the principles involved in conducting research, feel optimistic about her ability to take on a research project, pursue research opportunities outside of class, and aspire to educational or career goals that involve conducting research.

### **Methods**

Data for this study were drawn from a mixed-method project conducted at a mid-sized public research university in the Mid-Atlantic region. The quantitative portion of the study consisted of a combination of a survey to current undergraduate students at the public research university, as well as a student records analysis of the students selected for the survey. The qualitative portion of the study included interviews and focus groups of a sub-section of students who responded to the survey. The study's design was a sequential, exploratory mixed-methods design (Creswell, 2008b; Tashakkori & Teddlie, 2003). Sequentially, the quantitative portion of the study preceded the qualitative portion. In addition, for the purposes of this study, the quantitative data analysis provided baseline, descriptive information that informed and guided the more in-depth and thick description in the qualitative portion of the study.

#### **Quantitative Methods**

This study utilizes a sub-section of data from a larger study regarding high school and college research experiences. For the larger study, all former IB students enrolled as undergraduates at the institution (n=1,045) were selected for participation. This included students

who matriculated in the fall of 2008, 2009, 2010, and 2011. To form a comparison sample of students with similar accelerated academic preparation and motivation, we selected 1,046 currently enrolled undergraduates at the same institution who participated in an Advanced Placement (AP) curriculum while in high school. Thus, the total number of students selected (both IB and AP alumni) for the study was 2,091. Institutional records (e.g., semester enrollment, first semester and cumulative GPA, gender, race, Pell eligibility) of the 2,091 students were obtained from the institution's research office; institutional data was merged with survey responses for those participants who responded. A total of 1,008 students responded to the survey from the pool of 2,091 students; however, after removing duplicate files and unusable data, the total number of respondents was reduced to 953, resulting in a 46 percent response rate for the useable data.

The data used for this study include only the IB sample (n=470). The majority (63 percent) of IB respondents were female and diverse by racial ethnic background: 64 percent White/Caucasian, 14 percent Asian Pacific American, three percent Black/African American, five percent Hispanic/Latino, three percent Multi-racial or ethnic, four percent resident alien, and seven percent unknown. The average high school GPA of the IB respondents was 4.24 (weighted), and the average cumulative SAT score was 2000. Additionally, the IB respondents aspired to a high level of educational attainment: 79 percent aspired to a master's degree or higher. Thus, the academic profile of the sample in this study is rather high, but this is also indicative of the postsecondary institution that these students attend, which is highly competitive.

The survey instrument included 29 questions in four sections: 1) background information; 2) high school research experience with the IB Extended Essay; 3) college research experiences in a variety of contexts; and 4) writing, mentorship, and resource usage in relation to research



projects. Background information collected included socio-economic status, perceptions of prior academic preparation, educational major, and career aspirations. College research experiences queried included research conducted as part of a class, as part of a cumulative project such as a senior thesis, in conjunction with a job or internship, as part of a professor's ongoing research, and as an independent endeavor.

A preliminary version of the survey instrument was pilot tested for face validity by a few undergraduates (n=5) in late-January 2012. Their feedback and suggestions for revision were taken into account, and the final version of the questionnaire was completed in mid-February. The final version was fielded to the entire sample from late-February to mid-March via an Internet survey using QuestionPro software. Incentives to participate included the opportunity to win one of the following: one of two iPads or one of eight \$25 gift cards.

### **Qualitative Methods**

At the end of the survey instrument, respondents were asked to describe a research project of which they were particularly proud, and indicate whether they would be willing to participate in an interview or focus group. Sixty-three IB alumni indicated that they would participate in an interview or focus group. All 63 students were asked to indicate their availability for a group interview and 39 students responded to this request after two reminders.

Interview participants were purposefully selected from this group based on several criteria, including the settings and disciplines in which their described EE or undergraduate research projects were conducted and their academic year in college. Two students participated in individual interviews and 19 students took part in focus group interviews comprised of three to six participants each. Of these 21 participants, 16 were female and 5 were male. Nine

participants were seniors, five were juniors, five were sophomores, and two were first-year students.

Interviews and focus groups were conducted by a trained postdoctoral researcher and doctoral student in April 2012. We conducted individual interviews with students who indicated on the survey that they were most proud of their EE projects. With the remaining students, who indicated on the survey that they were most proud of research projects they had conducted in college, we felt that the dialogue would be richer if the focus groups were composed of students conducting research in a similar field and/or in a similar context (e.g., working with a professor). We therefore assembled four different focus groups: the first focus group (n=4) included students who indicated that they had only conducted a research project as part of a class assignment; the second (n=5) included students who indicated that they had conducted multiple research projects in a social science research context; the third (n=3) included students who indicated that they had conducted multiple research projects in a science, technology, engineering, or mathematics context; and the final focus group (n=7) included students who had performed research in a variety of contexts. Individual interviews each lasted approximately one hour, while focus group interviews each lasted about 90 minutes. Interview questions were related to topics such as students' experiences with the EE, changes in students' understanding of the research process over time, and students' experiences with research in college.

All individual and focus group interviews were recorded and subsequently transcribed verbatim. In order to facilitate the process of storing, organizing, and searching the data (Creswell, 2008a), transcribed interviews were uploaded into the qualitative data analysis software program QSR NVivo 9.0. Coding, used to summarize segments of data, was guided by our theoretical framework, research questions, and findings from the survey. In order to

establish the trustworthiness of the study, we included thick description and triangulated multiple sources of data, member checked our interpretation of the data with individual interview participants, and engaged in the process of peer debriefing (Guba & Lincoln, 1982; Marshall & Rossman, 2006).

## Quantitative and Qualitative Findings

### High School Research Experiences

The results of the survey revealed that about 41 percent of IB alumni at the study institution felt prepared or very prepared for college courses involving research. Moreover, when asked how well their IB Extended Essay experience prepared them for undertaking a variety of tasks related to the research process, on a scale from one to ten, the mean response for the IB sample ranged between 7.78 to 9.22 (see Table 1).

**Table 1: IB alumni's perceptions that the Extended Essay experience prepared them for college-level work for a variety of facets of the research process**

	Mean	Std. Dev.
Identifying the research problem	8.19	2.18
Formulating a precise research question	8.24	2.16
Gathering and interpreting material from sources appropriate to the research question	8.53	2.16
Structuring a reasoned argument in response to the research question on the basis of the material gathered	8.54	2.13
Analyzing and synthesizing current knowledge regarding the research topic	8.34	2.16
Making and monitoring a research plan (design & time schedule)	7.78	2.40
Gathering and selecting information/data	8.33	2.24
Assessing the value and utility of data	8.29	2.27
Analyzing the data	8.39	2.35
Drawing conclusions	8.60	2.18
Creating a reference list	8.94	2.23
Citing other literature using a standard style (e.g., MLA, APA, Chicago)	9.22	2.26

To gain a more in-depth insight as to how the EE experience helped the former IB students feel more prepared for college, we queried this phenomenon in the student interviews and focus

groups.

When discussing their EE experiences, as well as their research experiences in college, all participants shared that the EE played a critical role in familiarizing them with the systematic process of research, providing them with a sense of research self-efficacy that they found valuable to university preparation. In particular, many participants felt that the EE taught them to effectively gather and evaluate sources for college-level research projects. Students also shared that the EE prepared them well for college-level writing.

**Gathering and evaluating sources.** In terms of gathering and evaluating sources, two students believed that they learned more about this skill set in college than they did from their respective EE experiences. Junior Kelly, for example, said that she had rushed through the process of gathering data for her EE, while senior Rachel shared that she had probably been overly reliant on web searches in high school. Yet Rachel acknowledged that the research she did for her EE project had likely served as a “jumping stone” for the development of more sophisticated research skills. Similarly, Min, a sophomore, shared that while she first learned to locate and interpret academic journal articles when she was working on her EE project, she felt that she had refined this skill while in college. Min said that, for the research papers assigned in her college science classes, she was required to review the extant literature on various topics. As she explained, she “had a general idea from high school about how to search for things,” but, she said, “I’m a lot better at researching things now because of all the science papers I’ve done [in college]. I guess once you get into college they assume you know that kind of stuff so it’s just really nice that I had that... I think it was just like practice, or you just know where to look.”

Other students felt more strongly about the skills they acquired through the EE. Sophomore Julie, for example, said, “we got pretty good exposure, knowing where to look for

sources and how to know which ones are valid, and just kind of gathering information that's pertinent to your topic." Similarly, Catherine, a sophomore, shared, "...it's so useful now because even in classes where we have to write research papers in a technical type field, you need to first know what you're writing about to then go and make intelligent conclusions or assumptions based off of what you found." Catherine went on to say that learning to engage in this type of analysis was, for her, the most valuable part about that entire [EE] research process.

**Writing skills.** All focus group and interview participants agreed that the IB curriculum, and the EE specifically, provided them with strong writing skills. These skills, they said, had prepared them well for college-level work. In particular, students shared that they arrived at college knowing how to: 1) manage their time when working on writing projects; 2) structure a research paper; and 3) write in a formal academic style. Students also said that their EE experience helped them feel less anxious about college-level writing.

With respect to time management, some students shared that this was a key writing skill they acquired from their EE experience. Min, for example, explained that her high school's IB program "gave us deadlines, like have your thesis done by this point," which later helped her set deadlines for herself when working on college-level writing assignments. Similarly, senior Emma said that the EE had provided her with "the ability to write at length about a subject and...structure my time a little bit to be able to do that." On the other hand, Julie, a first-year student, lamented the fact that she was not able to devote the same amount of time to college writing assignments as she did to her EE. As she explained, "I think the biggest difference [between high school and college] is that I probably don't have enough time or as much time to work on my papers here, so I know they're not as good sometimes." Nonetheless, Julie said that the writing involved in the EE had proven "really helpful."

Indeed, another way in which Julie and others found the EE helpful was its emphasis on structure. As Julie explained, learning to format findings and present them in a logical fashion was a writing skill that she had used in college. Similarly, Shilpa, a senior, said that her EE experience taught her the importance of developing a thesis, and structuring papers in a way that supported the thesis. As she explained, “Honestly I think one of the things that I got most out of...was being able to write a good thesis statement for any essay. I think that’s probably one of the best things I got out of [the IB program].” Min also shared that she felt “confident about making a thesis” as a result of her EE work. Her EE advisor, she said, had emphasized the role of the thesis in the overall structure of her EE. As Min explained, “I would be like, ‘what order do I put it in?’ She made it very simple. She was like, ‘use a tripartite thesis where you have three things that you focus on,’ so I would do that.” Min said that this training had not only informed her college writing, but also her research, since she used theses as a framework for evaluating potential sources for papers and projects.

Participants said that their EE experiences informed not only the structure of their college writing, but also their writing style. In particular, students said that the EE had provided them with practice writing in the formal academic style required by college work. As Min explained, “you can’t use contractions and you can’t use ‘I’ and we were like, ‘that’s so annoying,’ but I understand why you would do that now.” She also said that she learned to write in the active, rather than the passive, voice. Similarly, Julie noted that she had learned through the EE how to appropriately cite sources and document those sources in a bibliography. In addition, she learned how to write an abstract. As she explained, “I had never written [an] abstract before, so that was new. It was kind of hard at first, but I’m glad I learned how to do it.”

Beyond the specific writing skills that students discussed, several also shared that

successfully completing the EE reduced their anxiety levels related to college-level writing. First year student Bradley, for example, said of the transition from high school to college,

I definitely think it helped me kind of learn to put together a paper on that size...I think from there entering into [college] it was a good starting point to kind of build on doing into the papers I've done here. I definitely think it did make me comfortable coming into a situation like that, personally, and just being like 'oh okay I can do this.' It's not something that I need to really freak out about because it's just a paper -- I've done that before."

Others shared that simply knowing they had written a long paper before college significantly bolstered their confidence about their writing skills. Prior experience also helped participants move beyond feelings of intimidation when faced with their first large writing assignments in college. As Michelle, a senior, explained,

[The EE] was definitely the longest paper I wrote in high school, so I think that in my first year here...I ended up in a class that was exclusively English majors dealing with history and things like that, and it was really overwhelming, but I just stuck with it because I didn't want to withdraw because I didn't know that that was something that's okay to do...But I think that knowing that I had written a long paper made writing those long papers easier.

Mei, also a senior, said that she had a similar experience with her first lab report in a college chemistry class. "I remember they made it sound really, really scary," she said. However, when her instructor started listing the criteria against which lab reports would be evaluated, she realized that the criteria resembled those used for the EE and other IB writing assignments. "So," she continued, "it was just really similar and wasn't as scary."

### **Undergraduate Research Participation**

According to the survey results, the vast majority of IB alumni at the institution participated in undergraduate research of some kind: 65.0 percent conducted research for a class assignment; 12.1 percent completed a cumulative project such as a thesis; 12.8 percent performed research or assessment for a job or internship; 8.7 percent worked on a professor's project, and 8.2 percent pursued an independent research project. Regarding their experiences with these research projects, we again turn to the qualitative analysis.

While most participants seemed to have developed an interest in conducting research while working on their EE projects, we found that this interest was only sustained for some IB alumni as they moved through college. Our findings suggest that creativity and autonomy were key factors in research interest. Specifically, license to choose a topic – in particular, one with real-world applications -- seemed to have an effect on students' continued interest in conducting research.

Several participants were enthusiastic about the level of freedom they had in choosing a topic for their respective EE projects. As Sarah, a junior, explained,

So I thought that was interesting, getting to choose – am I going to write a English paper, am I going to write a history paper, am I not going to write a math paper -- kind of getting to make that decision, choose the topic that you were most interested in at the time and then having to formulate that research question as opposed to being handed, like, “this is kind of the topic, come up with the thesis”...that exploration process was pretty unique.

This freedom, students said, inspired a level of excitement about engaging in research which some of them had not sustained into their college years. Several students said that while they



enjoyed the challenge of their EE experiences, and had developed an interest in conducting research as a result of their EE experiences, the constraints of college assignments made college-level research less appealing to them. Shilpa, for example, shared, “[Research] hasn’t particularly been an interest of mine. I guess if I’m doing it for a paper, if I like the topic, I’ll enjoy it.” In contrast, several students – most of whom were involved in intensive undergraduate research projects -- continued to feel excitement about conducting research.

Senior Michelle, for example, said that the college research project of which she was most proud was a research paper she wrote for an upper-level Biology seminar. For the paper, she said, “we had total freedom to pick whatever we wanted to talk about, and had to come up with the narrow question. So it was a lot like the EE, now that I’m thinking about it...I wrote about melanoma because it’s such a prevalent cancer and it’s something that we’ve got a lot of new work on.” Several students had engaged in research within the context of team projects that were funded through institutional undergraduate research grant programs, as well as through individual academic departments such as Biomedical Engineering and Nursing. For example, Melissa, a senior Nursing student, said that she traveled to Ghana to volunteer with a team of other Nursing students, and developed a research project based on her experience there.

It was awesome. I went and we helped out at an orphanage for children who had lost one or both parents to HIV (or AIDS). It was just something that I was like, you know, I don’t want to just have this information and do nothing about it at this point...So I wrote about implementing a policy to empower women who are HIV positive in this one small village. It was just kind of all about figuring out why the rates are so high and what’s going on in this one little village.

Her time in Ghana, Melissa said, was deeply meaningful for her; she characterized her research experience as not only positive, but also “powerful.”

### **Educational and Career Goals**

The results of the survey suggest that students’ research experiences do play a role with their future educational and career goals. On questions for which responses ranged from 1=strongly disagree to 5=strongly agree, former IB students at the study institution strongly agreed (mean=4.4; std. dev.=0.9) that having good research skills would be important for their future career or profession, and they also agreed (mean=4.2; std. dev.=0.9) that they anticipated using research skills in their future profession.

In the qualitative portion of the study, when discussing their future plans, many participants planned to attend graduate school, and among these students some aspired to careers in which their primary activity would be conducting research (e.g., academia, science). These students directly attributed their career interests to their research experiences in high school and college. Other students also traced their research interest to their earlier research involvement, and said that they would likely utilize their research skills in graduate school, as well as in aspects of their future occupations (e.g., law, medicine). Even among those who either were not sure about their future plans, or who planned to enter the workforce directly after college, students anticipated using their research skills in some way. Sophomore David, for example, said of his future work in the corporate world, “I expect that all of the work I do forever will be research in some sense.” These findings therefore suggest that for many students, the effects of the EE were sustained not only as students continued through university studies, but also potentially beyond students’ college years.

### **Discussion**

**Limitations**

There are three key limitations for this research study. First, the study was conducted at a single institution with a unique student sample: the participants in this study participated in a demanding high school curricula and enrolled in a highly competitive university. Additionally, students' average parental income indicates that respondents came from more privileged backgrounds. Second, the data was derived from self-report data, which studies suggest is not the best mechanism for understanding students' actual research abilities (Gilmore & Feldon, 2010). Finally, focus group and interview participants self-selected into the qualitative data collection and therefore their personal research experiences and reflections may not be representative of the entire sample of IB students in the quantitative analysis.

**Summary and Discussion**

This mixed-method study examined students' perceptions of their intensive high school research experiences vis-à-vis the IB Extended Essay project, and the ways in which these experiences shaped students' research self-efficacy, interest, and undergraduate research participation. In addition, this study explored the nature of students' undergraduate research participation, as well as the impact of students' cumulative research experiences on their educational and career goals. Our findings suggest that students' pre-college research experiences, specifically their engagement with the IB Extended Essay, enhanced their research self-efficacy, which for some students led to an enduring interest in and confidence with conducting research during college. Additionally, through their pre-college and undergraduate research experiences, students developed skills that are in alignment with those expected by college and university accrediting bodies (e.g., ABET, 2012; State Council of Higher Education for Virginia, 2007), such as written communication and critical evaluation of information

sources. Students also anticipated that they would use research skills in their future professions.

In terms of high school research experiences, focus group and survey data suggest that – in keeping with the SCCT model (Lent, Brown & Hackett, 1996) -- the Extended Essay and projects like it may play an important role in preparing students for college-level work and fostering interest in research. Specifically, our findings show that students' past performances with high school research served as success experiences that affected their self-efficacy with respect to engaging in research-related tasks in college. Indeed, consistent with prior research (Unrau & Beck, 2004), the experience that students gained through the IB research curriculum not only provided them with confidence in their ability to take on later research tasks, but also provided a foundation upon which they built more advanced skill sets in areas such as writing and critical evaluation.

High school research experiences also shaped students' interest in conducting research. However, this interest seemed to wane for some students over the course of their college years. While 65 percent of participating IB alumni reported conducting research for a class project, a smaller percentage (20.3 percent) had engaged in undergraduate research over which they had complete control (e.g., a thesis or independent research project, as opposed to work for a job or a professor's research project). Analyses of focus group data suggest that this issue of control was a critical contextual influence proximal to student choice behaviors regarding undergraduate research participation. Students whose interest in conducting research continued throughout college were those who engaged in undergraduate research opportunities that allowed them to replicate the creativity and autonomy they experienced with their Extended Essay projects.

A second contextual influence on students' choice behaviors was utility. Participating in undergraduate research projects with real-world applications was meaningful for students,

providing them with self-satisfaction and positive outcomes -- characterized by Lent et al. (1996) as performance attainments. Such projects enabled students to see how they might apply the research skills they had acquired over the course of high school and college in professional contexts, and contributed to sustained interest in conducting research. This connection between academic research skills and their use in settings outside the classroom is an important consideration, as prior research shows that making this connection motivates students to further develop their research skills in college (Murtonen, Olkinuora, Tynjälä & Lehtinen, 2008).

Finally, students' outcome expectations with respect to research, as well as their educational and career choices, illustrate the interplay among factors in the SCCT model. Among survey respondents, IB alumni anticipated using research skills in their future careers and believed that research skills would be important for their future work. In addition, many study participants planned to attend graduate school, often in research intensive fields. These students directly attributed their career interests to their cumulative research experiences.

### **Implications for Policy, Practice and Research**

These findings suggest several implications for policy and practice, most importantly that for optimal levels of research self-efficacy to flourish in college, research skill-building should begin during the high school years and extend into students' postsecondary education experiences. Moreover, undergraduate research experiences offered by institutions should be varied, with increasing creativity and autonomy integrated into the experiences. As the tenets of SCCT suggest, students in this study observed that their research competence improved with each new research project they undertook: some noted increased proficiency in locating and interpreting academic journal articles, others noted a greater ability to manage their time, and others mentioned increased confidence in writing in a formal academic style. Thus, if institutions

offer their students many opportunities to conduct research, their students' self-efficacy will continually improve with practice. However, institutions should not just offer the same type of research experience over and over to students; instead, the results of this study suggest that they might structure research experiences to become increasingly more autonomous and applied to "real-world" contexts as students' undergraduate careers unfold. For example, a few students in our study gained the most confidence and felt the most proud of their research accomplishments when: a) they were allowed to choose their own topics, and b) the topics could be something related to their personal or career interests. And, note that these types of research experiences typically take place in students' senior year, or near the end of their undergraduate experience, and thus serve as a capstone learning opportunity.

Furthermore, providing undergraduate students with multiple opportunities to conduct research and the prospect to engage in research with practical, real-world applications may enhance students' commitment to pursuing research beyond their college years. The vast majority of students in the study, no matter their disciplinary or career interests, perceived that good research skills would be important for their future careers or professions. In addition, some students in the qualitative interviews traced their interest in conducting research back to their earlier research involvements, including their Extended Essay project in high school. Thus, providing students early and varied research opportunities may have long lasting influences on their professional and career plans.

The findings from this exploratory study are preliminary, and require additional research. Most importantly, future empirical inquiries should address any differences in research experiences by type of project as well as broaden the scope by studying different types of students. For example, do other research projects that students may undertake in high school,

other than the IB Extended Essay, facilitate similar or different influences on students? In addition, does it matter what type of research project a student undertakes in order to have an impact on his/her cumulative sense of self-efficacy (i.e., are there differences in influences on self-efficacy among undergraduate research undertaken as part of a class versus as a senior thesis versus working with a professor's research)? Further, are there differences in research related outcomes for students pursuing research in different disciplines? While this study included students conducting research in a variety of academic majors, the focus of this inquiry did not include categorizing research experiences by discipline. Regarding the types of *students* who choose to conduct research, do increases in research-related self-efficacy only pertain to high-achieving students, such as former IB students, or are these types of experiences beneficial for a wide range of college students, and perhaps even at-risk students?

Finally, it will be important to study the long-term effects of research experiences over the high school and undergraduate span of students' educations. For example, are levels of increased research related self-efficacy maintained throughout students' time in graduate school or in their professions? And, to what extent do early research experiences affect later experiences? Finally, do students actually perform research in their future careers, and does it play as important a role as they envisioned when they were in college? Answers to these types of questions will need to be addressed with a longitudinal study that spans not only students' high school and undergraduate educations, but their subsequent life experiences as well.

### **Conclusion**

Undergraduate research is seen by many higher education institutions as the key to a host of beneficial student learning outcomes, so much so that participating in research while in college is now considered a high-impact practice by the Association of American Colleges &

Universities. The results of this exploratory mixed-methods study show that the pathway to conducting research while in college may be first paved at the high school level, and that such early experiences clearly present an opportunity for increased practice with and confidence building for overall research competence. Moreover, although the results of this study are preliminary and limited to one particular four-year university, given the outcry for higher order cognitive skills among tomorrow's workforce that are assumed to be cultivated by research expertise (such as critical analysis, written communication, data-driven literacy, and creative problem-solving), the head start that early research experiences can give to its participants may ultimately help contribute to a more advanced and effective economy and society.



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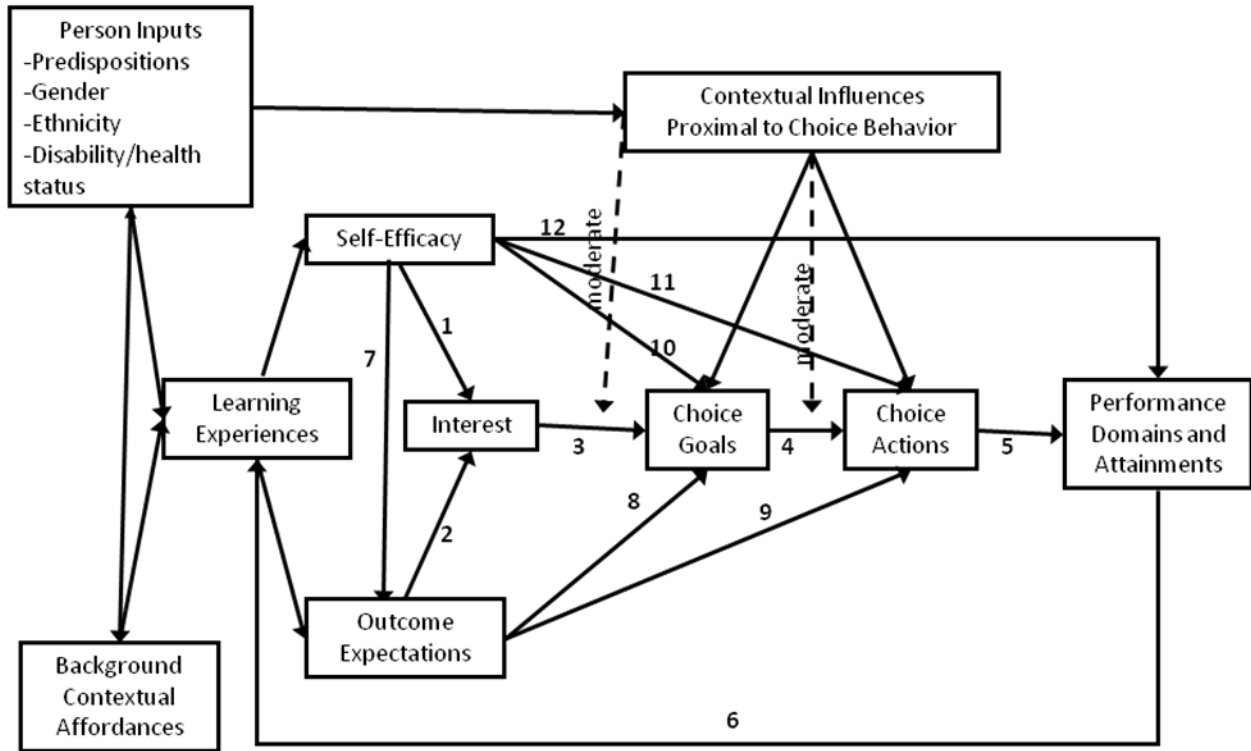


Figure 1. Person, contextual, and experiential factors affecting career-related choice behavior

Source: Lent, Brown, & Hackett (1996, p. 387)