Educators in Industry: An Exploratory Study to Determine how Teacher Externships Influence K-12 Classroom Practices

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Abstract

This exploratory study investigates the impacts of industry-based externships for K-12 teachers, and reports teachers' perspectives on how these experiences influenced K-12 classroom practices. The program of focus in this research study is the Educators in Industry: K-12 Externship Program. For four weeks in the summer, teacher-participants are placed at a company whose primary focus is engineering, continuous improvement, manufacturing, or other design or process-oriented activities. Participation in the program also involves completing an accompanying 2-credit university course in the summer, and a 1-credit follow-up course in the fall. In this qualitative research study, transcripts from individual interviews with teacher-participants were analyzed using a grounded theory approach. Results from this study provide empirical evidence that teachers who participated in an industry-based externship program demonstrated an increased understanding of the fundamental importance of skills for problem solving, collaboration, and communication in today's workplace environments, and expressed commitment to creating classroom opportunities for students to develop these skills through active learning in relationship to authentic, "real world" contexts.

Keywords: Teacher Externship; Industry Experience; Classroom Practice; Professional Development; 21st Century Skills; STEM Education; Qualitative Methods

In today's increasingly globalized and technological world, STEM (Science, Technology, Engineering, and Mathematics) education has important implications for America's economic competitiveness (President's Council of Advisors on Science and Technology, 2010). Research shows an increase in the demand for employees in STEM related fields (STEM Education Coalition, 2017; U.S. Department of Education, 2017). In response to the nation's need for a STEM-proficient workforce drawn from a STEM-capable citizenry, the *Next Generation Science Standards* [NGSS] (NGSS Lead States, 2013) and the *Common Cores State Standards* (National Governors Association Center for Best Practices [NGACBP], 2010) were anchored in a vision to produce college-and-career-ready high school graduates. College and career readiness extends beyond the mastery of rigorous and complex knowledge in foundational academic disciplines, and delves into the array of skills and dispositions necessary for success in post-secondary educational and employment environments (Achieve, 2017). For example, 21st century skills such as creativity and innovation, critical thinking and problem solving, communication, and collaboration are vital attributes of college and career readiness (Partnership for 21st Century Learning [P21], 2017a).

One of the critical challenges of STEM learning is making classroom content relevant (Ignite, 2017; Newman, Marks, & Gamoran, 1996; Stepien & Gallagher, 1993) while providing opportunities for students to demonstrate competencies of content standards by applying formal problem solving methods and 21st century skills (Ignite, 2017; NGACBP, 2010; NGSS Lead States, 2013; P21, 2017b). Teachers are continuously challenged with developing classroom activities that are engaging for students and involve an authentic component to real-world contexts (P21, 2017b). However, many teachers seem hesitant to include STEM learning concepts that develop 21st century skills in their classroom practices. This may be due in part to the fact that many teachers who obtained a teaching license through a traditional educational program do not have any training in the engineering design process (EDP) or other formal problem solving design methods (Bowen, 2013a, 2013b, 2014; National Academy of Engineering and National Research Council, 2009). Teacher externships have been shown to be a valuable professional development experience for giving teachers knowledge about STEM learning concepts (Barrett & Usselman, 2005, 2006; Basalari, de Seriere, Hawkins, & Miller, 2017; Bowen, 2013b, 2014, 2015, 2016; Dubner et al., 2002; Education Digest, 2009; Farrell, 1992; Silverstein, Dubner, Miller, Glied, & Loike, 2009). By showing 21st century skills and formal problem solving methods such as the EDP in action, corporate work experiences appear to impact a teacher's perception of the need to incorporate more classroom activities that integrate STEM learning concepts (Barrett & Usselman, 2005, 2006; Bowen, 2013b, 2014, 2015, 2016).

Research Question

Enough preliminary and anecdotal evidence exists to suggest that teacher externships are a valuable program for teacher professional development. A limited number of studies have shown these types of teacher experiences have led to an increase in student achievement for their respective students in science (Silverstein et al., 2009) and increased use of research and design-based classroom activities for their students (Bowen, Kallmeyer, & Erickson, 2017). Early research also shows how externship programs improve a teacher's appreciation for the importance of exposing students to engineering and 21st century skills, and result in intentions to increase the frequency in which they incorporate these elements into general classroom practices (Barrett & Usselman, 2005, 2006; Bowen, 2013b, 2014, 2015, 2016; Kantrov, 2014). However, the overall breadth of empirical data for this type of research is extremely limited (Kantrov, 2014). This paper builds on previous studies and anecdotal research of other teacher externship programs (Barrett & Usselman, 2005, 2006; Bowen, 2013b, 2014, 2015, 2016; Dubner et al., 2002; Farrell, 1992; Silverstein et al., 2009) by focusing on the teacher-reported impacts of an industry-based teacher externship program. This research project is designed to answer the following research question: How do teachers describe influences of their externship experience on their classroom practices?

Teacher Externships

Importance

For many teachers, creating authentic connections in the classroom can be a challenge, since teachers that have earned a teaching license through traditional methods typically do not have any work experience outside of the classroom. Therefore, having knowledge about how industry is currently using different processes to solve technological problems may not be familiar to most teachers. However, teachers are continuously being challenged to increase student engagement in activities that help prepare them for the future workforce (Ignite, 2017; P21, 2017b). By giving teachers an opportunity to work in a corporate environment as part of an externship program, they can bring valuable knowledge back to the classroom (Barrett & Usselman, 2005, 2006; Bowen, 2013b, 2014, 2015, 2016; Farrell, 1992; Ignite, 2017; Silverstein et al., 2009). This may include new knowledge about the EDP, 21st century skills, team collaboration, global communi-

cation, problem-solving, critical-thinking, or many other types of skills needed to be successful in the workplace. Being able to increase student engagement through the use of these authentic skills will better equip them for the future workforce. Therefore, if teachers are to be challenged to train the future workforce, they need to have an understanding of how the current workforce operates.

Definition

The idea of teacher externships is not new and nationwide there are a number existing programs for teachers to gain industry and research experience as a professional development opportunity. They each have a different focus and offer teachers many different styles of opportunities. For the purpose of this project, the term to describe the type of program is a teacher externship and refers to *a summer work experience in an environment that engages the teacher in engineering or design-based activities in order to gain a practical understanding of how industry uses current tools, processes, and resources to solve technological challenges.*

Existing Models

Two popular externally funded programs for teachers to gain industry and research experience are the National Science Foundation's Scientific Work Experience Programs for Teachers (SWEPT) and Research Experiences for Teachers (RET). Both of these programs provide unique opportunities in different settings; the SWEPT programs typically place teachers in an industry environment while RET programs place teachers in an on-campus research facility. The goals for these programs are to increase the teacher's understanding of how content knowledge is being applied in an authentic real-world setting in order to increase students' engagement and achievement in the classroom through implementation of an authentic educational plan.

There are also many programs being implemented regionally that place teachers in a corporate work environment. Ignite (formerly the Industry Initiatives for Science and Math Education Program) is a well-established program located in California (2017). Initiated in 1985, this program places teachers into industry positions in STEM-related fields for 8-week summer work experiences. Once the experience is complete, the teachers are required to produce an Education Transfer Plan for integrating the knowledge gained through the work experience into the classroom (Barrett & Usselman, 2005; Ignite, 2017). Another program, Georgia Intern Fellowships for Teachers (GIFT), is sponsored by the Georgia Institute of Technology through its Center for Education Integrating Science, Mathematics, and Computing (CEISMC, 2017). Since 1991, this program has placed on average more than 75 teachers per year in university and industry settings to gain practical knowledge about current industry practices. Program evaluations on both the Ignite and GIFT programs reveal that after participating, classroom teachers are more likely to use "real-life" examples, incorporate hands-on activities, integrate other fields of knowledge within their course curriculum, and use scientific inquiry as a method of problem, investigation, and solution development (Barrett & Usselman, 2005, 2006; Ignite, 2017). It has also been shown that participating teachers have a higher retention rate than teachers who do not participate (Barrett & Usselman, 2005, 2006; Ignite, 2017). These are two examples of programs that aim to empower teachers with additional skills to increase authenticity of course material in the classroom.

Educators in Industry

The program of focus in this research study is the Educators in Industry: K-12 Externship Program. Started in 2011, and located in the upper Midwest region, the Educators in Industry program provides in-service teachers an opportunity to experience how corporations are currently using the EDP and 21st century skills to solve technological challenges. The Educators in Industry program is a collaborative effort of different entities including university faculty, local economic development corporations, education cooperatives, and businesses. Businesses may participate in the program if they meet certain qualifications including, but not limited to, ability to provide an externship coordinator, available resources for engaging the teacher in authentic design, manufacturing, or problem-solving activities, and contributing a portion of the teacher's stipend. The primary aim of the program is for the teacher to gain an understanding about the kinds of knowledge, skills, and dispositions essential for successful employment in engineering-based work environments. The teacher can then return to the classroom or the school with the ability to make their course content or other learning experiences more relevant and engaging for the students. It also provides a more relevant basis for teachers to engage students in career awareness activities. This program, unlike many others, accepts teachers from all K-12 grade levels and from any discipline area. The program leadership team believes that teachers in any grade level and discipline will benefit from the experience. The program also accepts educators in other positions such as media specialists, career counselors, and administrators. Therefore, the term *educator* is sometimes used to describe program participants, in order to encompass any educational stakeholder with the capacity to engage students in valuable learning experiences or have influence over the design or implementation of these experiences. This is also the reason this term is used in the title of the program.

Teacher selection

To be eligible for the program, teachers must be actively teaching in a K-12 classroom, or be in a position that involves regular interaction directly with students, such as a media specialist or career counselor. The selection process begins with an application and a short telephone interview. The university faculty and a member of the local economic development corporation review the applications, and these same team members as well as human resources representatives from various industry participants conduct the interviews. Company participation in the interview process provides an authentic experience for the teachers similar to seeking industry employment. Although as many teachers are placed as possible, spaces are sometimes limited, and the application and behavior-based interview process confirms a teacher's commitment and fit for the program. Teachers are then selected based on the program leadership team's consensus on which applications offer the best potential for impact on classroom practices for the teacher and their students.

Summer work experience

For four weeks in the summer, teachers work for a company whose primary focus is engineering, engineering design, product development, continuous improvement, manufacturing, or other design or process-oriented activities. During this time, the teacher is exposed to all the different steps of the EDP and how these processes are used to solve technological challenges in a global environment. A unique aspect of this program is the type of exposure the teacher receives in regards to all the different processes of the corporation. The teacher does not perform the same task throughout the work experience. The teacher may be given an overall project to develop that requires short term deliverables to accomplish as they move through different departments within the corporation. With the assistance of an externship coordinator assigned by the company, the teacher's time is coordinated in order that they may be exposed to as many different steps of the EDP as possible during the work experience. This allows the teacher to observe many different projects that are in various stages of their development. This experience is not about matching the teacher's skill set with the company's needs. Rather, this experience is about exposing teachers to situations to which they may be unfamiliar in order to equip them with additional knowledge and tools to better prepare students with awareness and understanding of the engineering-based work environments, 21st century skills, and career opportunities in STEM fields. The focus is on process knowledge, not content knowledge. The teacher also participates in ancillary activities such as completing the new employee training, having access to appropriate email and server files, attending department and company-wide meetings, and participating in any other activity deemed necessary for a fully immersive experience.

The teachers work full time Monday through Thursday, and each Friday is dedicated to a half day meeting with the other teacher-participants and the research team. These Friday meetings provide valuable collabora-

	Participants (pseudonyms)								
Item	Todd	Hannah	Brandon	Emma	Julia	Evan	Jon	Erika	Allison
Gender	Male	Female	Male	Female	Female	Male	Male	Female	Female
Grade Level	5	6-8	9-12	4	7	3	7-12	7-8	6-12
Subject[1]		Comp.	Math		Math		Eng.	AVID	Math

Comp. = Computers; AVID = Advancement Via Individual Determination; Eng. = Engineering
1. Elementary grade teachers do not teach a specific content area.

Table 1. Teacher Demographics.

tions where the teachers not only reflect and share about their own experiences, but learn from the experiences of the other teachers as well. Since each company has unique processes, it is extremely beneficial for the teachers to be able to share the different experiences of the week. During this time, the discussion focuses on how this new knowledge could be translated into the classroom to increase student engagement, relevance of classroom activities, improved classroom management, and developing effective project-based learning activities. The teachers receive a stipend at the conclusion of the work experience, half of which is covered by the company, and the other half of which is covered by the local Economic Development Corporation.

Coursework

One of the requirements for participating in the Educators in Industry program is registering for university coursework. One member of the research team acts as the instructor of record for the course. The teachers are required to take a 2-credit course in the summer and a 1-credit course in the fall. These continuing education credits can be used for merit pay increase or license renewal based on their district's policies. The ultimate goal of the program is to influence classroom practices. Therefore, coursework is integrated into the program to provide accountability for documenting the summer experience, such as weekly reflections, as well as implementing a related lesson during the fall semester immediately after participating in the program. This lesson plan is designed around the new knowledge gained throughout the work experience and has been proven to be a valuable component of an externship experience (Bowen, 2015, 2016; Bowen & Finch, 2014; Ignite, 2017). Once the lesson is implemented, the teachers reflect, redesign, and submit a "classroom-ready" version to the instructor of record.

Methodology

This qualitative inquiry study sought to determine how teachers describe influences of their externship on their classroom practices. A grounded theory methodology was chosen due to the interpretive nature of the research question and the focus on exploring the teachers' own perspectives. Grounded theory has been described as "a general methodology for developing theory that is grounded in data systematically gathered and analyzed" (Strauss & Corbin, 1994, p. 273). In this type of qualitative research, theory is regarded as "plausible relationships proposed among concepts and sets of concepts" (Strauss & Corbin, 1994, p. 277). The researchers sought to develop an in-depth understanding of the teacher-participants' experiences, in order to develop an "explanation 'grounded' in the data from the participants" (Creswell, 2005, p. 53). The following sections describe the research participants, the data collection process, and how the data were analyzed.

Research participants

The participants in this study were from the population of educators that participated in the Educators in Industry program during the summer and fall of 2016. Eleven educators participated during 2016, nine of which were classroom teachers who agreed to be participants in the research project. There were five females and four males from a variety of grade levels and subject areas. A summary of the teacher demographics is shown in Table 1.

Data collection

Data collection consisted of individual telephone interviews with each participant. Interviews occurred at the end of their first semester after participating in the externship program. Each interview was conducted by the same member of the research team to maintain continuity of the process. The interviews were semi-structured, lasted approximately 40 minutes and were audio recorded to ensure accuracy. Interviews were semi-structured to allow a formal but flexible approach to gathering data. To collect information about various aspects of the teachers' experiences with the externship program, the researcher used guiding questions to facilitate the discussion. However, if the participant mentioned something of particular interest to the study, the researcher would probe that area to deepen the level of understanding. Each interview was transcribed for data analysis.

Data analysis

Our research team used a grounded theory approach to systematically code the interview transcripts using NVivo 11 software. The purpose of coding is to "fracture" (Maxwell, 2005, p. 96) data in order to break it apart and rearrange it so as to compare and contrast emergent patterns. During the first phase of coding, initial or "open" codes were developed and refined through iterative review of the interview transcripts. In the second phase of coding, "axial" codes emerged from analysis of relationships between open codes, resulting in a second set of codes more abstract than the first. The five themes reported below emerged from analysis of relationships among these axial codes.

Findings

Grounded theory analysis produced five emergent themes that elucidated teachers' perspectives on how their externship experience influenced their classroom practice. The themes were: (a) value of problem-solving, (b) importance of collaboration, (c) importance of communication, (d) using "real world" connections, and (e) casting students as employees. Each of these themes is discussed below.

Value of Problem-Solving

One theme that emerged through analysis of the transcripts was the teachers' increased awareness about the value of problem-solving in both industry and classroom environments. Many teachers explained specific examples about shifts in their teaching practices driven by a new understanding about the importance of developing problem-solving skills. For example, Julia, a middle school math teacher, said:

> After spending time out in the in the field [at my externship], I see how important it is to be able to communicate and create a solution for something. I want a more student-led classroom where they're discovering things through activities, through more problem-solving than anything. So instead of me saying, 'Okay, this is how you do this,' I want them to try to use their resources to figure out how to do it.

Another teacher, Todd, completed his externship at a heavy equipment manufacturing facility that used a

Kaizen approach to continuous improvement. Kaizen, a Japanese word meaning "continuous improvement," involves improving the entire organization through continuous and small incremental changes, and the practices are embraced by top management all the way down to the workers (Imai, 1986). Todd decided to implement a modified Kaizen approach for an egg car engineering design challenge with his elementary students, requiring them to identify and solve design problems in order to incrementally improve their egg car performance. Furthermore, Allison, a 7th grade math teacher, explained how she previously would stand at the board and lecture students about adjacent, complementary, and supplementary angles, but after her externship she devised ways for students to discover relationships between these types of angles on their own. When reflecting about this shift in her day-to-day teaching, she commented, "This doesn't sound like a huge thing, but it is."

Importance of Collaboration

Several teachers expressed a deepening understanding about the important and extensive role of collaboration at their externship sites. The teachers indicated they came to more fully realize that collaboration skills were truly necessary for success in workplace environments, and consequently expressed increased commitment to having their students collaborate during classroom activities. Brandon commented:

> The biggest thing that I saw [at my externship] was just how much collaboration there really was. Like the road construction department was leading a job but they still relied on the water group to figure out how they were going to do a certain part of the project. They had individual groups, but on one given project, there would be like three or four groups working on that same project. And then when you got to a certain point, you had to make sure that everyone else on the project was at a common point before you could really continue on.

Later in his interview, when asked to talk about some ways that the externship experience had impacted things he was doing in the classroom, this teacher said, "It just helped me try and implement more of that collaboration, getting students to work together and collaborate more." Another teacher, Evan, said:

> Whatever you do in industry you're really part of a team. You need to be a team player and be willing to work with others and offer what you can to improve things because that's what they're looking for.

One way that Evan focused on student collaboration in response to his externship was by having his 3rd grade students reflect on their collaboration for team projects by completing a self-assessment survey that included items such as "I help my team solve problems and conflicts," and "I offer to help others do their work if needed."

Importance of Communication

Similarly, most teachers pointed out how communication repeatedly emerged as a pivotal competency at their externship site, and explained how this motivated them to increase opportunities for their own students to practice communication skills in the classroom. For example, Hannah stated:

> One of the things I asked every person I met at [Name of Company] was which one of the twenty first century skills was the most important and 99% of them said it was communication. They said they can train anybody to do anything, but it's having them able to communicate that's so vital in today's industry. So one of the big things that I'm doing in my middle school classes is they're going to communicate more. They're going to have more discussion to be able to communicate their thoughts.

Similarly, Erika explained:

> When I think about getting students ready for the real world, I want them to be able to communicate effectively. Being able to have that face-to-face conversation, being able to get up in front of a group of people and share information effectively, that was huge [at my externship]. I went to a lot of meetings and I saw different ways of communication at [Name of Company], and as a teacher, I realize that I need to spend more time in my classroom doing that with kids. I've been having them share more. I'm having them get up in front of the class, that type of thing. I think it's a really important skill. A lot of the people at [Name of Company] said that they wished they would have done that more in school.

Using "Real World" Connections

A fourth theme identified through analysis was the teachers' increased use of real world connections to help students see applications of course content in authentic employment contexts. This theme was particularly common among the secondary teachers. For example, a high school teacher who was placed at a civil engineering firm later designed a math assignment about slope that was set from the perspective of a road construction crew laying storm sewer pipe beneath roadways. In conjunction with this assignment, a guest speaker from the engineering firm gave a class presentation about being a surveyor. To help students recognize "real world" uses for course content, other teachers related stories to students about experiences at their externships, such as the following example from Allison:

> I teach geometry. We're doing two column proofs right now, and the kids hate two column proofs. One of the programmers [at the externship site] said to me one day, "Do you teach two column proofs? That is so important. That is the same logic as writing code. This step has to flow into that step. You tell them [the students] they need to be good at that thinking, reasoning it out like that."

Casting Students as Employees

The last theme that emerged from this exploratory study was the development of assignments or projects that involved casting students as employees. This approach was particularly prevalent among the elementary teachers, all three of whom implemented projects that involved "hiring" their students to undertake design challenges. One elementary teacher, Emma, explained how her externship experience inspired her to transform a 4th grade research project, formerly involving students reading about severe weather then creating a poster, into an inquiry project about designing storm-resistant buildings. She said:

> This year, I worked to develop the unit as an inquiry based project and presented it as a consulting bid. I "hired" the students to be on my research team and wrote their project notes as a memorandum that included a task list, space for "field notes," and the resources needed to complete the tasks. They were immediately engaged when I told them they were now employed and were attending their first business meeting.

Discussion

The results from this exploratory study show that the teachers indicated their externship experience influenced their classroom practice primarily in two ways. First, it compelled them to want to create increased opportunities for their students to develop skills necessary for success in industry-related workplace environments. Through their externship, the teachers came to comprehend the extent to which skills for problem solving, collaboration, and communication were indispensable in corporate work environments. The teachers developed a greater awareness and appreciation for the importance of seeking 21st century learning outcomes in their classroom. This is supported by the previous studies that report how teachers intended to change their classroom practices after being exposed to industry practices (Bowen, 2013b, 2014; Kantrov, 2014). Second, teachers recognized the value of drawing upon their externship experience to motivate students by fostering "real world" authenticity in their classrooms. The secondary teachers in the study wanted their students to recognize and appreciate the value of learning subject area content and developing 21st century skills needed in "real world" employment environments. This builds on research that suggests teachers exposed to industry practices seek out opportunities for professional development in project-based learning and implementing authentic learning activities in the classroom (Bowen, 2015, 2016; Bowen, Kallmeyer, & Erickson, 2017). The elementary teachers in the study aimed to motivate students by framing projects and assignments as employ-

ment tasks for which they were "hired."

Future Research

Results from this study provide empirical evidence that teachers who participated in an industry-based externship program demonstrated an increased understanding of the fundamental importance of skills for problem solving, collaboration, and communication in today's workplace environments, and expressed commitment to creating classroom opportunities for students to develop these skills through active learning in relationship to authentic, "real world" contexts. Our next steps in research will seek to further deepen our understanding teachers' perspectives on how externship experiences influence their ideas about relationships between classroom learning and student readiness for success in workplace environments. Further, additional research is needed to directly examine teachers' actual classroom practices in order to more fully understand the impacts of participation in an industry-based externship program. The researchers will continue to expand this line of research in order to further strengthen the emergent research base on the impacts of teacher externships.

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