A Tribute to "Unsung Teachers":
Teachers' Influences on Students Enrolling in STEM Programs with the Intent of Entering STEM Careers

An army of unsung teachers helped me along the way. That's what teachers do, you know…
--Student Participant in NSF Division of Undergraduate Education Noyce Grant Program (*teach*HOUSTON)

I can't remember their names and faces… But I do know teachers put me back on my feet whenever I floundered…
--Student Participant in NSF Division of Graduate Education Grant Program

Some provided meals and snacks when my hunger pangs were too intense for me to learn; others gave moral support and hope for the future.
--Student Participant in NSF Division of Undergraduate Education Grant Program

Seventeen undergraduate students are studying the STEM disciplines at [this research-intensive university] because of an Advanced Placement Calculus teacher at a high school near the ship channel… We still meet all the time… We are like family…
--Student Participant in NSF Division of Undergraduate Education Grant Program

When we traversed the field texts gathered from three U. S. National Science Foundation (NSF) grant initiatives providing scholarships to Science | Technology | Engineering | Mathematics (STEM) undergraduate and graduate students interested in entering discipline-related careers (one STEM teacher education grant [*teach*HOUSTON], one undergraduate cybertechnology grant, one graduate cybersecurity grant), several research themes from which knowledge could be disseminated locally, nationally and internationally rose to the fore. Among the topics were the value of scholarship programs to young people's potential careers and lives and the influence of parents, professors and teachers on students' entering STEM fields and STEM-related occupations. In this article, we focus on the influence of teachers on primary and secondary students who subsequently enrolled in university-based STEM programs with the intention of entering discipline-related professions. For readers' information, the article on the impact of parents (Craig,

Verma, Stokes, Evans & Abrol, 2018) has already been published and the papers on the effects of professors and the value of scholarship grants are currently under review.

From the outset, this work on the influence of teachers took a somewhat different path to the impact of parents and professors papers. Where the said articles were concerned, stories about named parents and professors bubbled to the surface in the individual and combined data pools. However, when teachers were mentioned, they were discussed in narrative fragments like the excerpts we used to introduce our research phenomenon and to open our paper. Put differently, the influence of teachers was communicated in small stories rather than in large narratives. Furthermore, the teachers in question were not identified by name nearly as often as were the professors and parents. The undergraduate and graduate students' primary and secondary educators tended to be remembered as 'unsung teachers…[doing] what teachers do'—to borrow the apt turn-of-phrase used by a *teach*HOUSTON student whose way-with-words was used to launch this article and part of its title.

We begin this work with our literature review, which is followed by our conceptual framework. After that, we outline our research methodology where we pay close attention to the role of small stories in narrative research. Next, we share three exemplars that instantiate the influence of teachers on undergraduate and graduate students' enrolling in the STEM disciplines and subsequently entering STEM-related careers. These elucidations breathe life into the small stories nested within metanarratives that were lived and re-lived, and told and re-told, by the two undergraduate students and one graduate student who constituted our sample of convenience for this research investigation. To conclude, we analyze and synthesize what can be learned about the short-term and long-term impact of teachers on students' tertiary education and career choices.

1. Literature Review

Our survey of the literature revolves around two strands of research: (1) the influence of teachers on student success, and (2) the use of narrative and narrative research in STEM education.

1.1 Influence of Teachers on Student Success

In the U.S., the Coleman Report (Coleman, Campbell, Hobson *et al.*, 1966), along with the Jencks Report (Jencks, Smith, Acland et al., 1972) and other contemporary American literature, has consistently upheld that teachers impact student success, especially where minority youth are concerned. The Coleman Report is known for being the most significant educational document of the 20th century as it set the American educational policy backdrop during the civil rights era and beyond. The survey research report asserted that

> the quality of teachers shows a stronger relationship [than school facilities and curricula] to pupil achievement [particularly for students of color]. Furthermore, it is progressively greater at higher grades, indicating a cumulative impact of the qualities of teachers…. on pupils' achievements. (Coleman *et al.*, 1966, cited in Goldhaber, 2016, online)

The finding that 'teacher quality is one of the few school characteristics that significantly affects student performance' is an influence that has continued to reverberate in the national and international literature, for example, in an OECD (2005) report having to do with Teachers matter, UNICEF's (2009) Child-Friendly Schools Program and UNESCO's (2011) teacher competencies framework.

Nationally, Linda Darling Hammond reviewed the policy documents from 50 American states to determine the relationship between teacher quality and student achievement. She concluded that 'the findings of both the qualitative and quantitative analyses suggest that policy investments in the quality of teachers may be related to improvements in student performance'

(Darling Hammond, 2000, p. 1). Furthermore, 'the effects of well-prepared teachers on student achievement [appear to] be stronger than the influences of student background factors, such as poverty, language background, and minority status' (p. 33). Additionally, quantitative value-added assessment studies of teacher effects in the classroom have also found that differential teacher effectiveness contributes to differences in student learning more than the effects of differences in class size and heterogeneity (Sanders & Rivers, 1996; Wright, Horn, & Sanders, 1997; Jordan, Mendro & Weerasinghe, 1997). Furthermore, students consecutively assigned ineffective teachers have significantly lower achievement and lower gains in achievement than those assigned to several highly effective teachers in sequence (Sanders & Rivers, 1996). Based on her own research and informed by the value-added findings, Darling Hammond (2000) concluded that teacher effects are 'additive and cumulative, and generally not compensatory' (p. 2). This is consistent with the results reported by the National Commission on Teaching and America's Future (1996) and with Goldhamer's (2016) more recent article in *EducationNEXT*, in addition to the policies and reports of the international agencies cited earlier.

Two other meta-analyses of the international literature on teacher influences also point to the significant impact of teachers on student achievement and attainment and bear mentioning. One undertaken by John Hattie; the other was conducted by Debora Roorda and her research team members. Hattie (2008) focused his study on evidence supporting teachers making a difference on student achievement. He synthesized over 800 meta-analyses related to student achievement. Hattie determined that students themselves are responsible for 50% of the variance in their achievement test scores, that their homes, schools, principals and peers were each responsible for 5%-10% of their variance in scores, and that their teachers made up 30% of the variance in student test results (Hattie, 2003). According to Hattie (2003, 2008), the feedback, instructional quality,

styles and questioning strategies of teachers, among other considerations, contributed to their effects on students. Hattie also made fine-line distinctions between expert teachers and experienced teachers with expert teachers having the most effect. As for Roorda, Koomen, Split and Oort (2011), they more recently conducted a meta-analysis of 99 studies. Their overarching research question had to do with the influence of affective teacher-student relationships on students' school engagement and achievement. They found that engagement teacher effects were medium-to-large, while associations with student achievement were small-to-medium. Interestingly, Roorda *et al.* found stronger effects in the higher grades while negative effects were most profound in the lower grades.

Having established through mostly national and international quantitative research studies that teachers significantly impact students' experiences, engagement and achievement, we now focus attention on the second strand of this literature review: narrative research in STEM education.

2.2   Narrative research in STEM Education

Narrative inquiry has experienced a 'meteoric rise' (Lyons, 2010, p. 600) in nearly every disciplinary field, including computational mathematics. In fact, the influence of narrative has become so pervasive that Schwartz (2015) questioned whether it may be the 'secret sauce' of which STEM education has not fully taken advantage.

A comprehensive literature review about the use of narrative inquiry as a qualitative research method in the fields of teaching and teacher education has already been conducted. That review (Craig, 2011) pinpointed STEM-related narrative inquiries in biology (Chang & Rosiek, 2003), elementary mathematics (Ross, 2003, 2004) and secondary mathematics (Sack, 2008).

Since 2011, narrative research has been used in tertiary education by Mathematics and Mathematics Education faculty at a minority serving university (Sack, Quander, Redl & Leveille, 2016) and in a mathematics, chemistry and physics teacher education program (Craig, Evans, Bott, Stokes & Abrol, 2017). Further examples of narrative employed in the STEM disciplines can be found in the *Journal of Science Teacher Education* (i.e., Diez & Davies, 2009; Wagler, 2010) and the *Journal of Research for Science Teaching* (i.e., Kurth, Kidd, Gardner & Smith, 2002; Varelas, Kane & Wyle, 2012). Cumulatively, these articles show the symbiotic relationship that exists between the narrative inquiry research method where inquiring into narratives forms the *modus operandi*, and the subject matter of the STEM disciplines being both taught and learned through the scientific inquiry process. The 'secret sauce' to which Schwartz earlier referred might very well be the tight connections historically existing between and among STEM, narrative and inquiry. As an aside, it was no coincidence that Connelly and Clandinin (1986) published their inaugural narrative inquiry articles in the *Journal of Research for Science Teaching*. Connelly's subject area specialty was science (biology); his doctoral supervisor was Joseph Schwab (1960). Undoubtedly, Schwab's research on scientific inquiry contributed to Connelly and Clandinin's (1990) groundbreaking work on narrative inquiry. These science-inquiry associations will become even more evident as this article unfurls.

2. Conceptual Framework

Four key concepts underpinning narrative inquiry research frame this study: experience, story, identity and curriculum making. Each conceptualization will be discussed with respect to the influence of teachers on primary and secondary students who subsequently enrolled in university-based STEM programs in the hope of entering STEM-related professions.

2.1 Experience

Experience is "a changing stream…characterized by continuous interaction of human thought with [the] personal, social and material environment" (Clandinin & Rosiek, 2007, p. 39). At the intersection where this shifting stream of life begins, experience and education start as well. This is because life fuels both experience and education (Dewey, 1938). In this research study, students' experiences form an integral part of their lives from birth to high school to university and beyond. According to Dewey (1938), experience has both active and passive elements to it, with the active part being the students' attempts at 'trying' and the passive part being their simultaneous 'undergoing'. In other words, when students experience something, they act upon it while simultaneously having to live with its effects (Dewey, 1916, p. 163). Furthermore, current experiences build on past experiences to inform future experiences (Dewey, 1938). On this past-present-future continuum, experience cumulatively shapes how students live, how they learn, and ultimately, who they are. This point is important to keep in mind because what we focus on in this article are students' retrospective recollections of their teachers preparing them for the STEM disciplines as youngsters. The expansion of the students' streams of experience and their reflections on those experiences over time with multiple teachers also come into play.

2.2 Story

Experience is also intimately connected to narrative. In fact, experience can only be made visible through storytelling and represented in narrative form. Reflection is similarly implicated because storying and restorying involves probing changes and continuities through looking backward and forward, inside and out (Clandinin & Connelly, 2000). 'Following where [stories] lead' (Olson, 2000a) is how the contours of students' educational trajectories take shape.

According to Bruner (2002), 'stories start early and continue ceaselessly' (p. 1) throughout students' lives. Through the exchange of stories, 'a child's education is instantly, naturally, and authentically underway' (Pushor, 2013, p. 7). This means that youth grow up with certain narratives 'under their skin'. Some tales are 'weightless pleasures'; others are negatively imprinted on their psyches (Stone, 1988, p. 10). Narratives 'model not only a world, but minds seeking to give [the world] meaning' (Bruner, 2010, p. 27). Through the sharing of personal narratives, the world as embodied in the stories students live and tell becomes known.

2.3 Identity

In narrative research, the term, 'stories to live by' (Connelly & Clandinin, 1999) connotes identity. The concept of 'stories to live by' relates to how 'our identities [are] composed and improvised as we go about living our lives embodying knowledge and engaging our contexts' (Connelly & Clandinin, 1999, p. 4). 'Stories to live by' are both personal—reflecting students' school and life histories, and social—reflecting their milieus—including the formal and informal learning milieus, in which students have interacted. In other words, students' 'stories to live by'— their identity-related narratives—are shaped by their knowledge forged in multiple contexts. Concurrently, students' 'stories to live by' are affected by the different landscapes in which they have lived and the kinds of feedback they have received from others. including teachers (Clandinin & Connelly, 1995). The feedback they experience 'give[s] messages and instructions; …offer[s] blueprints and ideals; [and]… issue[s] warnings and prohibitions' (Stone 1988, p. 5), which, in turn, influences their identities. In this way, students' identities are

> …an evolving nexus where all the [streams of experience] that constitute life converge in
>
> the … self: genetic makeup, the nature of the man and woman who gave life, the culture

in which [students are] raised, people who have sustained [students] and people who have done [them] harm, the good and ill [they] have done to others and to [themselves], the experience of love and suffering – and much, much more. In the midst of this complex field, identity is a moving intersection of the inner and outer forces that make [youths] who [they are]… (Palmer, 1998, p. 13).

Within this complex constellation (Craig, 2007) of shaping forces, individual teachers play an important, though transitory, role. For one or more academic years, they spend more time with students daily than their parents do. As Schwab (1983) put it, students 'are better known by no one [else] but the teacher', because the teacher is the only one who actively 'tries to teach them'; he/she is the only one 'who lives with them for the better part of the day and the better part of the year' (p. 245). Because of the intensity of the teaching-learning relationship, teachers are positioned to shape what students come to know, what they do and who they are. Individual youths, however, retain the power to dramatically change their 'stories to live by' and alter the course of their unfolding lives (King, 2003) at any juncture of time.

2.4 Curriculum Making

Every curriculum making situation requires a teacher, a learner, subject matter and milieu working in synch with one another and contributing in equal ways (Schwab, 1973) (See Figure 1). These four irrefutable curriculum commonplaces are essential for curriculum making to take place.

Insert Figure 1 here: Commonplaces of Curriculum

2.4.1 Teacher

For Schwab, teachers—the first commonplace to be described—are 'agents of education, not [of] its subject matter' (1954/1978, p. 128). Schwab made this distinction in the passage below:

[The teacher] wants something more for his students than the capacity to give back to him a report of what he himself has said. He wants them to possess a knowledge or a skill in the same way that he possesses it, as a part of his best-loved self…He wants to communicate some of the fire he feels, some of the Eros he possesses, for a valued object. His controlled and conscious purpose is to liberate, not captivate the student (Schwab, 1954/1978, p. 124-125).

In other words, Schwab saw teachers as opening up worlds and possibilities for careers for students rather than chaining them to the subject matter knowledge they (the teachers) teach.

2.4.2 Learner

The second curriculum commonplace is the learner. Learners enter the teaching-learning situation with 'different personal histories which confer on [them] widely varying wants and capacities for satisfaction' (Schwab, 1959/1978). Schwab further emphasized that 'what [learners] are, what [learners] know, how [learners] have been bent, and what [learners] remember, determine what [learners] experience…' (Schwab, 1961/197 8, p. 272) in the curriculum making act.

2.4.3 Subject Matter

Where the third commonplace, subject matter, is concerned, Schwab wrote that the disciplines have no fixed catalogue of structure (Schwab, 1961/1978). To him, *nobody* knows the structure of the disciplines (p. 243; italics in original) because there are no 'natural joints' of discipline that occur in nature (Schwab, 1980, p. 365). Because Schwab rebelled against the certainty—'the rhetoric of conclusions'—that stable inquirers attribute to science (including education understood as a scientific enterprise), he believed that 'facts' in textbooks and other documents should be presented as 'tentative formulations—not facts, but *interpretations* of facts'

(p. 242; italics in original). Thus, subject matter in lessons and textbooks, to his way of thinking, would be filled with "examples of the uncertainties, the differences of interpretation, and the issues of principle which characterize the disciplines."

2.4.4 Milieu

Schwab's linking of subject matter with inquiry also sheds light on his understanding of the fourth curriculum commonplace, milieu. For Schwab, 'knowledge of a context of discourses [Note: multiple discourses; not one discourse] gives us…a fuller knowledge of the scope and meaning of the conclusions…'. This led Schwab to declare that 'To the question, how big a context? There is no clear answer. There is yet more to know or more to know about…' (Schwab, 1956/1978, p. 153). Here the impulse to inquire coupled with the indeterminable nature of context distinguishes Schwab's rendering of milieu. Also, the phrases, to know and to know about, imply that, for Schwab, there would be infinitely more to do and think about doing. This disciplined approach to knowing and doing eventually led to Schwab's outright declaration that 'the problems of education arise from exceedingly complex actions, reactions, and transactions… these doings constitute a skein of myriad threads which know no boundaries…' (Schwab, 1971/1978, p. 329).

3. Research Methodology

3.1 Introduction to Narrative Inquiry

In narrative inquiry research, narrative serves as both the method of investigation and the phenomenon of inquiry (Connelly & Clandinin, 1986; Connelly & Clandinin, 1990). Reduced to its essence, narrative is 'the portal through which a person enters the world' (Connelly & Clandinin, 2005, p. 477). Simply stated, story is the 'portal to experience' (Xu & Connelly, 2010, p. 352). Because of this, narrative inquirers intentionally avoid strategies, rules and techniques

(Clandinin & Connelly, 2000) from other places because 'life is not made up of separate pieces' (Bateson, 1994, p. 108). Teaching and learning are personal and emotional as well as cognitive and rational (Hollingsworth, Dybdayl & Minarik, 1993). Narrative inquiry is a relational form of research with three commonplaces: temporality, sociality and place/situation (Dewey, 1938). Clandinin and Connelly's use of the term, commonplace, directly connects the method's roots to Schwab's (1969) 'practical, a language for curriculum' and his commonplaces of curriculum, whereas temporality, sociality and place/situation locate the origins of the narrative inquiry research method in Dewey's (1938) philosophy of experience. Hence, for a narrative inquiry to reflect its field-based lineage (Xu & Connelly, 2010), all three commonplaces must be present and interacting simultaneously.

5.2 Sources of Evidence

Three forms of evidence constitute the storied data pool for this article. The first two are regularly scheduled interviews and focus group sessions with the graduate and undergraduate students and their professors, which occurred for all three funded grant projects. The third piece of evidence is reflective writing in journals or via email communications as some students graduated and entered the workforce in other parts of the country.

5.3 Tools of Analysis

Three analytical tools—broadening, burrowing and storying and restorying (Connelly & Clandinin, 1990)—are used to report the storied evidence in this research study. A fourth tool—fictionalization—was added to the three initial tools to further protect the privacy of students' personal narratives and to allow complex, contested narratives to be told and re-told while they continue to be lived and re-lived.

5.3.1 Broadening

Through broadening, we historically trace our work to the Coleman Report, the first American policy document which asserted that teacher quality affects student outcomes, particularly where students of color are concerned. We similarly use broadening to show the tight bond that has been forged between scientific inquiry (Schwab) and narrative inquiry (Connelly and Clandinin) as well as the strong link between Dewey's theory of experience and Connelly and Clandinin's narrative inquiry research method.

5.3.2 Burrowing

By engaging in burrowing, our second research tool, we dig deeply into particular aspects of the stories of three undergraduate and graduate students in our sample of convenience. We particularly unpack—burrow into—the influence of teachers on the educational trajectories of undergraduate and graduate students studying the STEM disciplines with the intent of entering STEM-related careers. Through burrowing, we illuminate teachers' impact on primary and secondary students and how that influence continues to unfurl in the students' tertiary education environment and beyond.

5.3.3 Storying and Restorying

The third analytical tool, storying and restorying, allows us to animate instances of prior curriculum making and how those past situations connect to the three students' current participation in the scholarship grant programs and engage in possible/current STEM careers. Storying and restorying becomes evident when narrative inquirers skillfully interweave texts from various other data sources (multiple interviews, focus group participation, email/cell phone communication).

5.3.4 Fictionalisation

Fictionalisation (Clandinin et al, 2009; Caine et al, 2016) is the fourth interpretive device we use in this narrative inquiry. We use fictionalisation to shift situations in ways that mask students' identities, so they are not as recognizable to others, especially professors and classmates immediately around them. Our intent is to respect students' privacy as much as possible while telling experientially rich stories of their lives. This means we purposely leave out details that are non-essential to our articles' storylines. Through shifting some recognizable narrative material, we are able to tell stories previously not shared because of their sensitive natures.

5.4 Serial Interpretation

In addition to the four analytical devices we have sketched, this narrative inquiry also engages in overarching, cross-case analysis called 'serial interpretation' (Schwab, 1954/1978). Serial interpretation increases explanatory power and gives the findings of multiple studies added heft. It serves as a vehicle to discuss 'encompassing idea[s]' that transcend multiple research investigations. Serial interpretation involves 'talking across' (Stone, 1988, p. 2) or 'see[ing] across' (Clandinin, 2013, p. 131) several research projects, rather than reporting a single case or a single grant's results. It recently has been used by Craig (2018) to unpack metaphors of knowing, doing and being in teaching and teacher education arising from multiple research studies and by Craig, You, Zou *et al.* to analyze the nature of embodied knowledge in cross-case, funded projects. These latter two articles form vital pieces of the foundation on which this research study is built.

5.5 'Small Stories' and Meganarratives

Following in the footsteps of Olson and Craig (2009) and Ciuffetelli Parker and Craig (2017), this research also spotlights 'atypical, non-canonical "small stories"' (Georgakopoulou, 2004) of curriculum making that took place between teachers and students. In this paper, formal and informal curriculum making between three current undergraduate and graduate students and

their former elementary and secondary teachers is featured. These personalized, contextualized small stories are presented in juxtaposition to STEM education's meganarratives. Meganarratives or 'grand stories', as Cohen and Garet (1975) called them, cohere around 'large and loose set[s] of ideas about how [STEM education] works, why it goes wrong and how it can be set right' (p. 21). Grand stories are very influential because educational decision making tends to be informed by policy rather than by local educational conditions or other shaping forces (Cremin, 1990, p. 72). Also, meganarratives typically overshadow small stories lived by K-12 students and their teachers in local settings. This article attempts to counterbalance 'seeing [STEM] education small'—that is, at a distance through a systems lens (Greene, 1995)—as in longitudinal, multi-million- dollar NSF grants and 'seeing [STEM] education big' through up-close, personal lenses of experiences that contributed to individual students' university and career trajectories. The act of 'seeing [phenomena] big' in Greene's terms allows small stories of individuals to surface. At the same time, the ability to see both small and big helps researchers 'to learn to move back and forth, to comprehend the domains of policy and long-term planning while also attending to particular [students], situation-specific undertakings, the unmeasurable, and the unique' (p. 11).

5.6 Description of Undergraduate and Graduate Students

Although many undergraduate and graduate students participating in the three scholarship grant programs stressed the influence of their teachers had on their schooling, we decided to work with a convenience sample of three individuals with compelling stories to tell: Joyce Harding, Omid Kassem and Lee Michaels (LM). The two males, Omid and LM, were students of color and the first-in-their-families to attend university. As for Joyce, she is a rare white physics preservice candidate and also the first-in-her-family to enter higher education. Joyce, Omid and LM each

represent one of the three grant programs. Joyce Harding is a white female from Texas who was a participant in *teach*HOUSTON, the STEM teacher education grant; Omid Kassem is an Iranian American male who was part of the undergraduate cybertechnology program; and LM (Lee Mitchell) is an African American male who participated in the graduate cybersecurity program.

3.   Small Stories of Experience

6.1 Joyce Harding

Joyce Harding faced many challenges with her family during her K-12 years of schooling. She explained in her own words,

> I faced dark times growing up with my family… [I experienced] issues with [family members]. We were very poor and moved around a lot … and that definitely created a strain in my relationship with my parents. And it made it hard for me to want to do well in school…

She added: 'My family was a religious one and I can remember, even as a kid, my Dad saying things like "Your Mother does not know anything because she comes from Eve"….and even as a young child, I thought there was something wrong with that argument…' In Joyce's opinion, what her parents taught her was 'not right'. Furthermore, they attempted 'to suppress [her] propensity for critical thinking…'. Consequently, when she began school, she encountered '...materials that would contradict things that [she] had learned at home'.

Yet, the tough times Joyce experienced in her youth were often offset by 'really great teachers who just gave me words of encouragement and advice that really stuck with me as I grew up'. She continued: 'I did have a few who did not really teach, but then I would always compare them to the many strong teachers I had who really taught and pushed us and asked deep probing questions… I soon recognized that was what good teachers did….'. Still, Joyce admitted to having

one or two teachers who were 'awful to [her]' because '[her family's] electricity had been turned off [again] and [she] could not complete [her] assignments'. At the same time, Joyce recognized that 'the majority of [her] teachers were really understanding and would say: "You know what? You are a good student" or "What's going on in your life?" or "I am not going to let this one grade affect you" or "You can turn [the work] in when you get a chance".' They were 's-o-o-o understanding', Joyce observed, 'and that meant the world to me'. Hence, 'over my childhood and then into my early teens, I learned how to handle knowledge from my teachers and that I could do my own thinking for myself'.

Joyce eventually learned that logical fallacy was what her father was using when he traced her Mother's origins to Eve in a subtractive rather than an additive way. 'I knew there was something awry with his argument. But I did not realize [as a young child] that it was ad hominin debate… that it was logical fallacy… That is what someone says when they do not have an argument'.

The teachers who particularly helped Joyce seek out evidence to support viewpoints were her high school English teachers. According to her,

> One [male teacher particularly] caused me to question a lot of things. He made us read more advanced pieces such as *The Waste Land* by T. S. Eliot. Understanding that poem was very difficult. But I really, really liked the challenge… I like being intellectually stimulated and forced to ask hard questions… I like to think of things in different ways.

Hence, Joyce graduated from high school knowing that she was able 'to ask better questions in class to get a better understanding of topics…'. Further to this, she had learned from her primary and secondary years of schooling how to 'access literature to help solve complex problems'.

Later, when Joyce enrolled in undergraduate STEM classes and teacher education classes at university using her scholarship award, she encountered situations with a professor as well as with male students that echoed her experiences with her father in her home environment. She explained:

> One of my professors said that he expects males to do better in class because males have evolved to hunt and track the motions of animals and so they have better mental manipulation of objects and more abstract concepts… And females—because we have evolved to have babies—we are not so good at that…

From Joyce's perspective, 'this was crazy [to say] in a gender-mixed classroom of over 100 students'. Also, the professor did not select many females to answer questions in class. Joyce made the following sense of what was going on: 'So, as a woman…in a lab, the professor ignores me because I am a girl…So, I started to do what the boys do. I started to call out answers'.

Moreover, Joyce felt the professor's seeming gender bias helped to normalize sexist behaviors that may/may not have already existed among some male students in the laboratory. Here is how she explained one situation that transpired with her male peers and her:

> I was in a lab and the only female at a table and I was trying to assert that we can't solve two unknowns with only one equation…We needed to have a second equation. That is just basic algebra… I met serious opposition from the three males at the table who were sure I was wrong… I felt like [my solution] was dismissed…

At the same time, Joyce, in her words, '…looked around to see that were more males than females in the class---And then I remembered my test scores… They were higher than all of the guys around me, yet I was being ignored by the professor and the male students???' Immediately, Joyce exited the science lab and transferred from the male professor's lab to a similar STEM class

taught by a diverse, female professor where no such issues existed. Joyce ended her small story by saying: 'This is how the critical thinking skills that my teachers taught me in K-12 have continued to inform my education and actions and hopefully my future interactions'.

6.2 Omid Kassem

Omid Kassem immigrated to the United States with his birth parents and his brother when he was a teenager. The family came from Iran to join his aunt who already resided in North America. Omid became an American citizen 'as quickly as possible' after that. The move, he said, afforded 'many opportunities' for his family. The fact that he could attend university tuition-free as the first member of his family was a 'huge achievement'. His father and mother—a grocery store clerk and a hair stylist in the Persian community—would never have been able to afford his tuition. Neither would they have been able to point him in the direction of higher education.

'It was not easy,' said Omid, as he reflected backward on his high school education in the U.S. This was mostly because he was a newcomer and 'did not know how to speak English'. In Iran, English is not taught as a school subject until high school.   He explained: 'High school was very hard for me…I had no knowledge of English grammar. I absolutely could not speak any English at all…'. The following discussion about Omid's high school experience then ensued:

Cheryl Craig: … so you only attended high school in the U.S. for two years? Did you have English as a Second Language (ESL) classes in high school?

Omid Kassem: Yes, but I was only in ESL for one semester because I needed to take two English courses [to fulfill my graduation requirements] …

Cheryl Craig: So that must have been tough?

Omid Kassem: Yes, it was very tough….

Cheryl Craig: You must have been a good student?

Omid Kassem: I graduated high school with a 3.9/4.0 Grade Point Average (GPA)…And, although I have been called talented in sports and some academic subjects, I think the term, *hard worker*, is a much better 'label' for me.

Omid then proceeded to explain that he could only take two Advanced Placement (AP) classes because he did not have the Pre-AP prerequisites to enter other classes like Computer Science. The two AP classes he chose to enroll in were AP-Mathematics and AP-Science.

Omid Kassem, as readers probably have presupposed, was very strong in Mathematics and Science, scoring among the top 10%-15% in his home country before entering the U.S. schooling system. However, he believes that he could never have achieved what he did without the support of his high school English as a Second Language (ESL) teacher who, fortuitously for him, spoke Arabic. It seems that she not only provided language support and ways to navigate his academic program in his high school, but also helped him to be strong in a context entirely new to him and sometimes stacked against him as a newcomer to the school and/or the country. Not only did she stay after school to work one-on-one with Omid, she encouraged him to meet regularly with other students who were fluent in both English and Farsi to complete their homework assignments together. According to Omid,

my ESL teacher was always supportive of me and encouraged me. She recognized my potential and kept in close touch with my other teachers through email…They told her how impressed they were with my progress in their classes, given how little language I knew.

However, his ESL teacher was not the only one who deserves special mention, according to Omid Kassem. Omid's success was also leveraged by his high school Science teacher who also played a leading role. That individual alerted him to the fact that the local, research intensive university had a Department of Computer Science that had scholarship grants available for talented students who were financially in need. Not only did that teacher encourage Omid to consider

Computer Science, she mentioned the leader of the program's name and that professor would subsequently 'take [him] under his wing'. Since then, that professor has 'provided me with an inside look at what computer science is' and 'what it might be in my future'. Omid further elaborated:

> …My professor is so much more than a scholarship sponsor to me. He is my mentor and I go to him whenever I have questions about my courses, my projects and graduate school…He has taught me many things. He has cultivated my interest in research and pursuing a graduate degree. He's been such an influence that my project received the top prize in the summer of 2016.

In Omid Kassem's words, this is how teachers at his high school prepared him for university to work alongside the professor described above. This is how his teachers personally, socially and academically helped him to enter the field of Computer Science, a field that will enable him to obtain a high-salary, STEM position, which will lift his family's socio-economic status while he concurrently serves as a role-model for his brother.

6.3 Leon Mitchell (LM)

Leon Mitchell, who goes by LM, initially lived in a historical African American community where his parents had also been born and raised. In fact, his parents were part of a groundbreaking period in history: they were among the first African Americans bussed from their segregated black community to become racially integrated on white high school campuses. His mother graduated from the integrated high school setting; his father did not receive his high school diploma. His Mom immediately found secure employment cleaning offices in a high rise building downtown, a job she continues to this day; his Dad worked as a laborer on various projects—sometimes employed, sometimes not. According to LM, his family is 'a textbook case of the

working poor'. Still, the poverty his sister and he experienced 'was similar to [their] classmates'. Despite many low-income families living in their historical black neighborhood, 'everyone in the small community lived in a circle of love'.

In his early years of schooling, this feeling of comfort 'while not necessarily having enough food' extended to the school. In his beginning years, '[LM's] kindergarten teacher and the school librarian were known for supplying small snacks to needy kids'. LM continued: 'Another go-to person was the choir director—which may have had something to do with the size of the school chorus!!!' He added that he always brought his younger sister to choir practice with him to make certain she made it to school on time, but also to guard against her being hungry. This was because their Mom left for work in the city center in the early hours of the morning and their father often did not come home.

In LM's late elementary years, however, his family arrangement changed. His father's substance abuse problem had escalated to a point where his mother felt it 'endangered the family'. LM explained: 'My Mom, my sister and I left in the middle of the night. From that point onward, my family—as I knew it—was never the same'. His father visited LM and his sister intermittently but did not contribute regularly to the costs of their upbringing. In the meantime, his mother began to work overtime so she could provide for '[her children's] needs as best she could'.

When his parents' marriage dissolved, LM and his sister not only lost daily contact with their Dad, they also lost the 'security net' of their community—as LM referred to it. Furthermore, completing his final elementary years in school with mostly white classmates was 'a culture shock' for him. Still, his sister and he continued to find teachers of all races who supplied them with food. One East Indian teacher, for instance, stood out in LM's telling. As he put it, 'in whatever

school I was in, there was someone who noticed that we were not always well-fed—and stepped up to the plate and made sure we were'.

By middle school, LM's mother decided her family would return to a different part of the historical community where they previously had lived. This allowed her children to maintain contact with her former husband, extended family members and friends. As he began middle school, LM said, in his words:

> I questioned what had happened to my family unit, the role of my Mother (who was not entirely innocent) and how my Dad had not seemed to shoulder his responsibilities… I was growing quickly and dealing with increased hunger…Also, it was "not cool" to have your little sister hanging around… I was becoming very angry and there were plenty of other angry kids with whom I could have gotten in trouble.

Trying not to assume a plotline like his father's while not fully succumbing to his Mother's matriarchal grip, LM continued to find emotional release in music and, by happenstance—a friend's referral—he discovered that participating in the track club helped him to develop laser-sharp focus. But it was not only running that assisted him in growing academically and physically. It was his African American high school track coach who became a 'role model' to LM. What his coach did was regularly share breakfast one morning per week with his peers and him and engage them in conversations about sports, education and life. One such discussion was particularly memorable:

> My track coach outright confronted me about my anger. He said that anger is an important stage in growing up for African American boys. He told me that I needed to channel my rage appropriately and to not let it destroy me… He said I must use it to make me stronger rather than weakening myself and risking becoming part of what is currently termed the

school-to-prison pipeline… He held my shoulders, looked me directly in the eye and said

that he thought I was smart and …capable of attending university in the future.

LM said the team then went out for a run. On that run—and on many more runs that followed, LM

imagined how his future would unfold differently if he attended college and how that might affect

not only his life trajectory, but the life trajectories of his sister, his mother—and even his father.

Two years later, LM finished middle school. At the graduation ceremony, he recalled his

track coach shaking his hand, reminding him how he could be college-bound, and telling him that

he had some contacts if LM ever decided to enroll in university. LM thanked him and pledged to

keep in touch.

LM entered high school with thoughts of higher education floating in his head. In his

classes, he continued to develop the mathematics, science, and fine arts focus offered by the

magnet schools in his historically black community since his elementary years. As a high school

freshman, he waved at his track coach a few times when he visited his old middle school to

accompany his sister to appointments.

By the time LM was a junior, he knew he had the test scores, the participation in school

and community activities and the will to attend college. Still, he did not feel comfortable filling

out college applications only with his high school counsellor. He desired input from his track

coach who had planted the seed of a university education in his middle school mind. Also, he

vaguely remembered his coach saying he had some possible university pathways in mind for LM.

When LM returned to his former middle school to speak with his teacher-coach-mentor,

this is what happened in LM's words:

He [my track coach] did not seem fazed at all to see me… He quietly sat me down and

said: "I knew you had it in you." He asked whether I was still interested in entering the

sciences. I said yes—and that I was pretty certain I wanted to pursue an undergraduate degree in Computer Science. He inquired about the university campuses my high school counselor had suggested. He nodded quietly and then questioned: "Have you considered any historical black universities (HBUs)?" He said he knew a few—one in particular—that excelled in computer science education…

After this fruitful meeting with his track coach, LM returned to his high school counsellor with three more colleges to add to his list. He then shared with the counsellor that one of those three universities had become his first choice were a scholarship to become available for him. After a very long wait, LM received positive feedback from three campuses, one being his first choice. He immediately sprinted from his home to his old middle school campus to share the good news with his track coach friend.

LM does not 'know if the coach advocated for [him] behind the scenes…' What he does know is that he ended up with an esteemed African American professor as his undergraduate supervisor in Computer Science. That professor carefully guided him to the completion of his Bachelor of Science degree[1]. Furthermore, that individual knew that the Department of Computer Science at the comprehensive university near his historical African American community was one of the top fifty in the nation and that it had been awarded a prestigious NSF cybersecurity grant that would make graduate scholarships available to deserving students in need, providing they were American citizens. LM finished his small story by asserting that 'an invisible web of teachers' supported him, eventually delivering him into the hands of professors who have done— and continue to do—the same.

4. Serial Interpretation

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[1] The influence of professors is another paper in the series.

Having featured three cases from the three awarded scholarship grants, we now present five overarching themes that cut across the representative cases. The five encompassing themes are: 1) same programs, different narrative histories; 2) in loco parentis, 3) learning in small moments; 4) counter stories; and 5) the importance of the liberal arts in STEM education.

7.1 Same Programs, Different Narrative Histories

When professors teach undergraduate classes sometimes numbering 100 students or more, they tend to view students as a group, all being similar, all enrolled in similar classes and programs. However, our paper series shows the different ways that students' experiences have been shaped— or bent, as Schwab phrased it—by parents, teachers and professors. Furthermore, even among these three possible effects, there are different ways that influence plays out on students. In this work, the longitudinal effect of undergraduate and graduate students' primary and secondary teachers is foregrounded. All three students, for one reason or another (high poverty, historically underserved minority, immigrant, ESL, etc.), would have been classified as likely failures in the state accountability system because it evaluates students' test results in relation to their peers' academic performances. At one point or another, each would have been 'a bubble kid'—a student at high risk of dropping out. However, various teachers intervened in ways that greatly increased both the well-beings and academic successes of Joyce, Omid and LM. Think for a moment what could have happened without the contributions of their elementary and secondary teachers, for example, their home room teachers, the ESL teacher, the choir director, the track coach, the high school English teachers, their STEM teachers and so forth. As Joyce succinctly put it, what her teachers did 'meant the world' to her. Quite possibly Omid and LM would have said the same, if asked. Without their teachers' actions, their narratives—and, hence, their lives—would not have changed in the forward-moving ways they describe in this article.

7.2 In Loco Parentis

What teachers of all races did, of course, was to take the *in loco parentis* roles they played very seriously. *In loco parentis* means that teachers are charged with acting in students' best interests like Joyce's, Omid's and LM's parents would have done were they able and present in the featured situations. In this article, we see teachers acting as proxies for parents by providing students with food, listening to their stories, engaging them in hard conversations, offering advice when needed and providing words of comfort, support and direction. The teachers also openly advocated for Joyce, Omid and LM. The teachers' actions clearly aided the students' best-loved selves (Craig, 2013; Schwab, 1954/1978). We would argue that these teachers were not personally enacting 'teacher as savior' roles (Brown, 2013; Trop, 1996, in Ladson-Billings, 1998) through 'rescuing' students from themselves, their families and their communities (Baker, 1996, in Ladson-Billings, 1998). Rather, what these teachers did—beyond being responsible professionals—was what 'the best and wisest parent[s]' would do on behalf of their own children (Dewey, 1899/1980, p. 5). At the same time, the American educational system—through denying sufficient resources to the schools and special assistance to at risk learners—leaves teachers in impossible positions, according to António Nóvoa (2013) who explained that 'Problems…will not be solved only within [schools]. Prophecies of salvation through [schools] enclose teachers in unreasonable ambitions, blaming them for the failure of school reform' (p. 35).

7.3 Counter Stories

The teachers—frequently acting as parental proxies for Joyce, Omid and LM—planted seeds for different 'stories for them to live by', but the students themselves had to accept the plotlines of these counter narratives as part of their identities. For Joyce, her counter story had to do with learning to think and reason for herself despite the 'truths' she had learned in her family.

For Omid, a first-generation-to-college youth, it meant learning ESL, Mathematics and Science at a highly accelerated rate. This enabled him to take full advantage of the opportunities that the American educational system offered. For LM, it involved seeing himself as university bound even when that story did not exist in his family or in his historically black community. In all three students' cases, their teachers introduced them to powerful counter narratives to live by, which the students embraced through breathing self-sustaining life into them and making them their own. As Lindemann Nelson (2001) explained: 'counterstories...are told in dialogue with others…they are …told together with other tellers, fragment by fragment, each person contributing to plot and character and…thought' (p. 38). This counter storying process is especially evident in the point-counterpoint conversations that took place between LM and his track coach.

7.4 Learning in Small Moments

Small stories unfurling over time between many teachers and the three students helped the youths to excel in the STEM disciplines in their undergraduate and graduate education and fueled their hopes for future STEM-related careers. These stories, which sustained Joyce, Omid and LM and prepared them for higher education, were not grand stories or meganarratives (Olson & Craig, 2009) of STEM education. Rather, they were small stories—petite plotlines—that emerged in rather mundane situations in everyday elementary and secondary school life. In fact, for the students, it was all about 'learning in small moments' (Meier, 1997). These 'bite-sized' narratives, as Meier called small stories, laid the foundation for the stunning progress the students made. For Joyce who was enrolled in *teach*HOUSTON, it was a constellation of K-12 teachers who helped her become an independent thinker, always weighing evidence before arriving at decisions. For Omid, it was enrolling in Science as a high school option and having a dedicated teacher who knew that the local university had a scholarship program in Computer Science for which he would qualify.

Finally, for LM, it was eating breakfast weekly with his middle school track coach and other teammates and discussing sports, education and life, which subsequently opened the doors to his majoring in a STEM discipline.

7.5 Importance of the Liberal Arts in STEM Education

The teachers who supported Joyce, Omid, and LM on their journeys to undergraduate and graduate education in the sciences were not only STEM educators, but also liberal arts (including performing arts) teachers. Martha Nussbaum (2010) asserts that the lessons that the humanities teach about emotions, human differences and community are critical to the maintenance of democracy at a time when it is fiercely under attack by neo-liberals calling for the marketization and privatization of public education (i.e., Cochran-Smith, 2003). Nussbaum maintains that those who teach the humanities teach students about human emotions and human frailties in ways that those who teach the STEM disciplines are not able. In the featured narratives, we can specifically connect Joyce's English teacher and Omid's ESL and Science teachers with LM's track coach and choir director since 'physical education—can be identified as one of the forms of liberal education, comparable with music and the non-verbal arts as a source of one of the kinds of meaning that enriches man's [sic] comprehension of reality as he knows it' (Metheny & Ellfeldt, 1961, pp. 282-290). In fact, LM's small story uncannily resembles that of philosopher Michael Oakshott (1989) who credited his gymnastic teacher with introducing him to 'patience, accuracy, economy, elegance and style' (p. 62).

Closing Statements

What this article on the influence of teachers on primary and secondary students who enroll in university-based STEM programs in the hope of entering discipline-related professions shows is that the public sadly takes too narrow of a view of teachers, their roles in a democratic society,

their input into students' experiences, engagement and understandings and their impact on students' attitudes, achievement and attainment. In the local school system, the value of a teacher is currently reduced to one academic year of influence via value-added modeling approaches and is considered through the lens of one content area in the middle school and high school years. This exploratory research study abundantly shows the influence of teachers acting as agents of education in its entirety, not simply as agents in one disciplinary field.

It is therefore essential that teacher education programs prepare prospective teachers for their comprehensive roles, which necessarily includes *in loco parentis* responsibilities. Furthermore, the concerns of the unknown teachers featured in this article were not merely for the academic development of Joyce, Omid and LM, but also for their physical, emotional and social well-being—in short, their teachers actively assisted these students in developing a strong sense of their best-loved selves. Their teachers' understanding of their roles as pedagogues involved the development of Joyce, Omid and LM as whole persons, a perspective that necessarily needs to be stressed in teacher education programs despite it being an unmeasurable quality. Additionally, the public tends to look at what is calculable, observable and marketable about students from an outside perspective but fails to see 'the skein of myriad threads that know no boundaries' and how these threads intersect in highly productive, life-giving ways in students' inner beings. This fine-grained research demonstrates how qualitative studies can be productively accumulated across grant programs. It vividly shows how the concerted efforts of 'an army of unsung teachers' has had a lasting impact on the disciplines the particular students choose to study, the careers to which they will devote themselves, and the lives they wish to live. Lastly, Joyce's, Omid's and LM's narratives of experience offer insights into what might constitute an ideal STEM teacher education curriculum, a curriculum that would be a far cry from the neo-liberal version currently being

touted.   Finally, the university students' stories—alone and together—form models that are instructive to their siblings and other STEM students who will follow in their footsteps as well as to teachers (Heilbrun, 2008) who will feel heartened and affirmed to hear of their lasting human impact, especially when societal forces are currently demonizing public education and minimizing or nullifying teachers' contributions.

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