An Analytical Approach to Understanding Underrepresented Justice-Involved Youth Potential in STEM

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***Abstract*—This is a research, Work in Progress paper surrounding the topic of STEM education in juvenile justice facilities. While science, technology, engineering, and math (STEM) are the fastest growing fields today, students are not math and science ready to enter college. This leaves a gap between the number of STEM workforce jobs and the number of graduates to fill these positions. Meanwhile 30,000 students go unaccounted for each day. This is the number of youths that will enter a juvenile justice facility everyday. This is a vast amount of students who hold the potential to become a part of this growing STEM workforce that are overlooked and unsupported. Recent studies have demonstrated the need for educational reform within these facilities and detention centers. This project introduces foundational research on juvenile justice-involved youth's interest and knowledge in STEM subject matters and careers. This foundational reserach compares STEM education methods between traditional school settings and detention centers focusing on three specific areas of measure: formative assessment, qualitative skills, and personal development. Through surveys, this project will gauge the effectiveness of STEM education in juvenile detention centers, as well as provide an understanding of the potential this group of youth possess in the future STEM workforce. This is a work in progress; results of the surveys and work are still being processed.**

***Index Terms*—Youth, STEM, Education, Justice-Involved, Juvenile, Detention Center.**

I. Introduction

This paper presents a work-in-progress study on the workforce potential of justice-involved youth (JIY) in science, technology, engineering, and mathematic (STEM) fields with a focus on personal development, subject matter proficiency, and qualitative skillsets. With the increase in STEM education awareness from the exponential growth in technology, it is important to examine the upcoming potential of our youth. Currently in the United States, only 36% and 44% of students are science and math ready to begin a career in STEM and even less are on a proficient level, 21% and 26%, respectively [1]. This is causing a large gap between workforce needs and the number of STEM graduates, 230,246 to 30,835 in 2015, respectively [2].

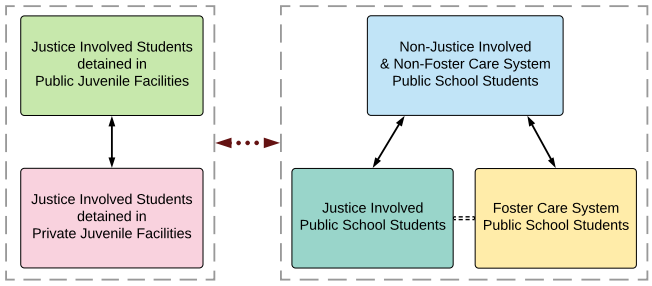

Fig. 1. Overview of Data Collection and Comparison

A JIY is an individual that has been entangled in the judicial system due to charges that have been brought up against him or her before the age of eighteen. Collateral consequences, stigma and disadvantages individuals face after becoming involved in the legal system, for JIY differ by jurisdiction and number in the thousands. One of these collateral consequences is educational disruption and with the long-term effect of permanently stunting the youth's career path [3]. This creates a large group of students who hold the potential to become an important role in the advancement of engineering and technology through STEM education, but are consistently overlooked in our society. Each day in the United States, approximately 60,000 youths are incarcerated in adult and juvenile facilites, and more than half of these students will enter a justice facility for approximately 3 to 12 months [4], [5]. The Obama administration, in 2014, released federal guidelines created to standardize and improve the quality of education provided in these juvenile justice facilities, but little to no assessment has been conducted to determine the outcome of these guidelines.

This research looks to compare the STEM potential and understanding between similarly-situated public school students and youth in juvenile justice detention centers and facilities,

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Figure 1. There is also a secondary goal of understanding the role foster care youth have in STEM fields as they typically have disruption in their education. Also, there are a significant amount of "crossover youth," which is when a JIY is from the foster care system [6]. The primary research questions include: (a) Do students in juvenile justice facilities have an interest in STEM and understand career opportunities in STEM fields? (b) Do students in juvenile justice facilities have the knowledge, initiative, and problem solving abilities (potential) to be successful in STEM careers? (c) How do these youths compare to their non-justice involved peers? and (d) Are youth being left behind partially because of detainment in juvenile justice facilities?

II. Background

A. The STEM Workforce and Candidates

STEM careers are plentiful in today's economy with a wide variety of choices from aerospace engineer to zoologist. The National Science Foundation, one of the largest funding organizations of STEM defines these areas of study as Chemistry, Computer & Information Science & Engineering, Engineering, Geo & Life Sciences, Materials Research, Mathematics, Physics and Astronomy, Psychology, Social Sciences [7]. It is important to keep in mind that non-STEM career paths require the study of STEM subjects, such as business. Therefore, there are STEM jobs in areas outside of STEM fields, such as in the field of sports where there are statistical analysts. Therefore, STEM education, outside a traditonal STEM career path, is important not just for the sucess of joining the STEM workforce, but the entire societal workforce. Even with close to 8.6 million STEM field related jobs as of May 2015, there will be one million new jobs in the STEM fields by 2020 [8]. Currently, students that enter into a STEM career path for either an associate's or bachelor's degree, comprise 20% and 28% of the population entering into post-secondary schooling, respectively. Of this population of STEM majors, 48% of bachelor's and 69% associate's left their major for a non-STEM major or withdrew from college entirely, half and half, within a five-year period; a majority due to lack of proficiency and/or interest in the subject matter [9]. The result of this is a shortage of STEM graduates to fill the STEM job market needs.

Due to this workforce deficiency, a movement started that created STEM scholarships to encourage students to pursue STEM careers. However, these scholarships only reach a select group of students; with minorities making up less than 5% of students persuing a degree in STEM, the diversity of STEM candidates is an issue [10]. From 2015 to 2016, the number of caucasions that attained a STEM degree increased by 15%, while minorities' attainment decreased 15% [2]. Diversity is necessary in the progression of STEM problem-solving methodologies because the varying perspectives, backgrounds, and experiences allow individuals to take a unique approach to a situation and innovate through creativity. It is essential that minorities are given equal opportunities and resources to enter into STEM careers [11]. As of 2015, the percentage of minority students in juvenile detention facilities for Pensylvannia and New Jersey was 69-83% and 83-97%, respecitively [12].

In a paper by Nicholls *et al.* in 2010, a "good STEM candidate" is described through foundational research on factors that are significantly correlated with positive outcomes for a person in a STEM career. The top factors included: "math and science proficency, family composition, native language, type of school, student expectations, and demography." The authors state, that through these data points, one can easily identify good STEM candidates [13]. With many of these factors being related to uncontrollable life situations is it perhaps that the support for youth not in these ideal circumstances is lacking and unidentified. Simple encouragement and exposure to STEM can peak the student's expectations and lead to a greater number of STEM candidates.

B. Education in Juvenile Justice Facilities

There are over 125,000 students in 3,500 public and private juvenile-correctional facilities. This creates a disparity between activities from facility to facility, especially in education. For the privately run facilites, only 40% have educational data collection, while 60% do not share data, if any is even collected. The data collected by public and private facilities rarely overlaps in variables and no data is collected surrounding the topic of future career or subject interest and proficiency. Only 17 states (34%) evaluate the performance of schools, education providers, and educators within their juvenile justice facilities [5]. Education is often a black box in justice facilities, which lead to the observational research of Tannis *et al.*, that concluded educational standards in facilities for day-to-day teaching and learning is frequently a manila folder. This folder is simply a packet of work that is handed to the student at the beginning of the day and is expected to turn it in by the end [14]. This is far from the educational standard that occurs in a normal school setting.

The tendency for a justice-involved individual to reoffend is called recidivism. This rate can decrease due to various factors; one of which is for youth to have supervision and instruction in the area of career pathways and job-readiness supports to ensure that they are prepared to join and succeed in the workforce [15]. This is supported by programs like the Second Chance Act, which lowered recidivism rates for adults in certain states by 18% over the course of 3 years. These programs foster success by ensuring students enter the community with a proper education and access to the workforce [16]. With the goal of the juvenile justice system being rehabilitation, it is essential that youth reenter society equipped to be contributing members with life-sustaining occupations.

Students in facilities are less likely to have access to math and science courses compared to students in a traditional K-12 setting [17]. Currently, the high school dropout rate for JIY is 66%. Only 1% of the youth that are placed in these facilities each day end up graduating from post-secondary education [18]. These unimpressive success rates have not been attributed to a particular cause, but does have significant room for

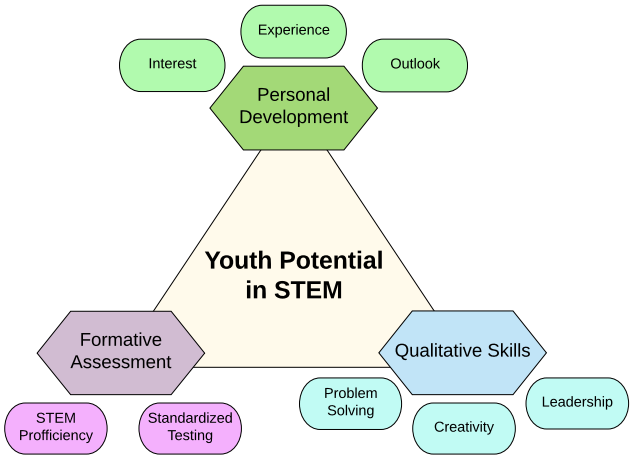

Fig. 2. Measures of Potential in STEM for Youth

improvement. Along with gathering information about STEM education in juvenile justice facilities, this project looks to increase students knowledge about STEM career opportunities and unearth the untapped potential of these youth.

III. Understanding STEM Potential in Justice-Involved Youth

Outside from identifying who a "good STEM candidate" is in traditional settings and uncontrollable life circumstances, this study focuses on the potential a youth has in STEM based on a student's qualitative skills, subject matter proficiency, and personal development, Figure 2. Moreover, the authors are looking to determine if the 30,000 youths that are placed into detention centers and facilities each day nationally hold the potential to become a part of the STEM workforce and, therefore, should be provided a sufficient support system to do so.

A. Qualitative Skills

The ability to join the workforce does not strictly depend on school-based content knowledge. There are variables of qualitative skills, or soft skills, that are important [19]. For the focus of STEM potential, the authors have broken these skills down into three categories: problem solving, creativity, and leadership [20], [21], [22]. Problem solving and creativity are part of innovation that directly drives engineering, which incorporates science, math, and technology [23]. Leadership includes working skills such as communication, work ethic, teamwork, and time mangement; skills that are not necessarily gained from a traditional school setting [21].

Creativity is linked to ideation, which is the core to innovation, and positive feedback can spur higher creativity [24], [25]. Most JIY students hardly ever recieve feedback or instruction to foster these outcomes. Instruction in facilities, as stated, is subpar; therefore, spatial skills that are obtained from STEM content, such as mathematics, can be lost. This interferes with the student's ability to understand, reason, and remember relations between concepts and objets [26]. Creativity measurement has developed overtime. The Torrance Tests of Creative Thinking, published first in 1966, has been critqued but also validated since its first appearnce to still be a good reference for creative ability [27], [28]. Creativity has been determined by many as a muscle, something that can have growth overtime with exercise and prompts. These exercises have been developed to gain perspective of creativity given a particular situations, such as with the book, "The Art of Innovation: Lessons in Creativity from IDEO," America's leading design firm [29].

B. Formative Assessment

While, proficiency in STEM subjects is not the only factor to a "good STEM candidate," it is important for entering the workforce. This is simply due to the ability to apply knowledge to a partcular situation in an efficient way while also understanding a situation due to content knowledge. Therefore, it is important to recognize formative assessment as a means for determining a youth's potential in STEM. For this study, formative assessment is broken down into the two categories of STEM proficiency and standardized testing. STEM proficiency is the evaluation, or academic grade, the student recieves in STEM subject matters. STEM proficiency in grade assessment and standardized testing have both been positively correlated to STEM degree outcomes [13].

C. Personal Development

When an individual persues a career, personal factors, like interest, are considered. As a high percentage of individuals are unhappy in their profession, this becomes an important factor in career selection, along with monetary income [30]. With that, STEM careers are in the top percentile of incomes, which is a drive for students to pursue these paths if they are provided the information. This study refers to this category as Personal Development, encompassing factors such as interest, experience, and outlook. As discussed prior in this paper, perspective is an important factor in the innovation and creativity that drives STEM; experiences provide an invidual with a different perspective than their peers and provides them with unique insight to solving or understanding a problem. Outlook or expectations is a key factor in identifying a "good STEM candidate." This relies heavily on internal confidence in oneself, as well as the opportunities surrounding an individual. Especially in the female population, it has been proven that role models can impact and influence STEM degree outcomes [31]. These positive experiences and opportunities hold the potential to spur interest in STEM. This also holds true in the opposite direction for negative experiences or viewpoints, such as gender sterotypes in STEM [32]. The exposure to the latter, the negative, is more likely in juvenile justice facilities.

IV. Preliminary Data & Results

Working alongside the Pennsylvania Academic/Career and Technical Training (PACTT) alliance and Juvenile Law Center (JLC), researchers are employing a paper survey method that

queries youth knowledge of STEM fields, interest in STEM fields, future goals, creativity, and problem solving ability. The packet also includes a demographic questionnaire asking students to volunteer information regarding their socioeconomic status, race, ethnicity, family dynamics, age, sex, gender identity, and educational attainment. These surveys, delivered in-person or mailed to participating facilities, are completed by the student on their own before being returned to the researchers. Data analyses will incorporate youth responses to these survey questions, as well as available deidentified standardized test scores. This is a work-in-progress as surveys are being distributed to various facilities and data is being collected to analyze.

To begin work on this study, the authors have been communicating with juvenile justice facilities and the local community public schools in the Pennsylvania area. While choosing the surveys and course of action for this study, a focus group was piloted to determine further necessary information and to investivagate the outcomes of JIY STEM potential.

A. Methodology and Participants

There are two specific cohorts that were surveyed for STEM interest, STEM proficiency, and workforce ability for a total of 11 participants. Students also completed an accompanying demograpics survey. From this group of participants, 91% have or will have the entirety of a K-12 education by June 2018. Sixty percent of the participates identified as female with an overall average age of 18.5 years. In congruence with the national and local averages of minorities in juvenile-justice facilities, 91% of these participants identified as a racial minority. The survey was delivered to each youth by a staff member of JLC at a Youth Advocacy Program meeting. Students were informed that their participation was completely voluntary and their data would remain deidentified. The students provided informed consent and assent. The authors were not present for the collection of data. The validated survey from Unfried *et al.*, Students Attitude Toward STEM [33], was utilized as well as a demographic questionaire that was specifically created for this study.

B. Preliminary Results

The preliminary data gathered yielded important results. Interest was coded on a scale from 1 to 5, with 1 being not interested at all and 5 being very interested in the career. The results indicate that, overall, the youth hold a neutral interest in STEM career paths at 3.0. This could be due to the lack of exposure of STEM courses in their K-12 education and life circumstances. With regards to higher education, all students identified the desire to complete a bachelors degree; 40% presented a STEM major as one of their top three choices for their degree and 40% chose a STEM subject as their favorite school subject. When asked about factors that would help them have a career in STEM, it was noted that awareness, support, and exposure to people and experiences would be of extreme importance. This was further confirmed with the fact that none of the students knew a scientist and only 33% and 22% knew an engineer or mathematician, respectively.

For formative assessment, students self-reported their proficiency, performing best in English and language arts subject matter, 60% proficient, followed by science, 20% proficient, and then mathematics, 0% proficient. Suffering greatly in mathematics this is below the norm of American education. This is a general challenge for educators and a barrier in STEM education and interest. Students are highly confident in their qualitative skill set of accomplishing goals, developing plans, and communicating effectively. This did not match their belief of being successful in a STEM career, especially one that utilizes mathematics. Many students reported mathematics as a factor that hurts them in being sucessful in a STEM career. This is in congruence with a mathematics career choice holding the lowest interest for the students at 1.65.

V. Discussion and Future Work

The result of this work demonstrates a need for an innovative and collaborative practice to help prepare students in STEM through a better understanding of engineering and how it is applied in the world. Through the development of curriculum and standards geared toward understanding youth potential in STEM fields, a more comprehensive assessment of the future STEM workforce can be assembled. Future data collected from students regarding their personal development, subject proficiency, and qualitative skills can help to evaluate the ways in which youth can fill the rising employment opportunities in STEM careers. Due to the creativity and innovation encompassed in most STEM fields, it is essential to be inclusive and unearth the unique knowledge and experiences of all students, especially those who are commonly overlooked by traditional education systems. A takeaway from the preliminary focus group is the need of a STEM interest survey that is geared towards a JIY audience rather than the traditional K-12 setting.

The inadequate educational opportunities provided to students detained in juvenile justice facilities often lead these youth to fall behind academically and narrow their future career choices. The preliminary results show that JIY students demonstrate confidence in their abilities to learn and express possible interest in a STEM career, while simultaneously not understanding what jobs in these fields may entail. Students lack general knowledge of STEM fields because they are likely not given the opportunity or exposure to these particular career opportunities. One JIY student even shared, “I feel like if I have people who were into STEM that I might have taken interest.” Introducing and educating on more diverse academic topics inside juvenile justice facilities could lead to more productive workforce reentry, especially in areas, like STEM, where the job supply is greater than the worker demand. Most importantly, this work hopes to provide *all* students with the question, “Could I have a career in STEM?”

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