Altering the Vision of Who Can Succeed in Computing

Couragion

ORACLE Academy

Preface

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For at least two decades, the public education system in the United States has focused heavily on the development of what are now commonly called STEM skills – skills in science, technology, engineering and math. When education standards are created, when curriculum is developed, when academic research is carried out, and when the popular media talk about "the skills gap," the focus is consistently and repeatedly on skills. What skills do we need to help students develop? What skills does industry want students to have? How do we develop effective skills assessments? How do we scaffold skills pathways? And so on.

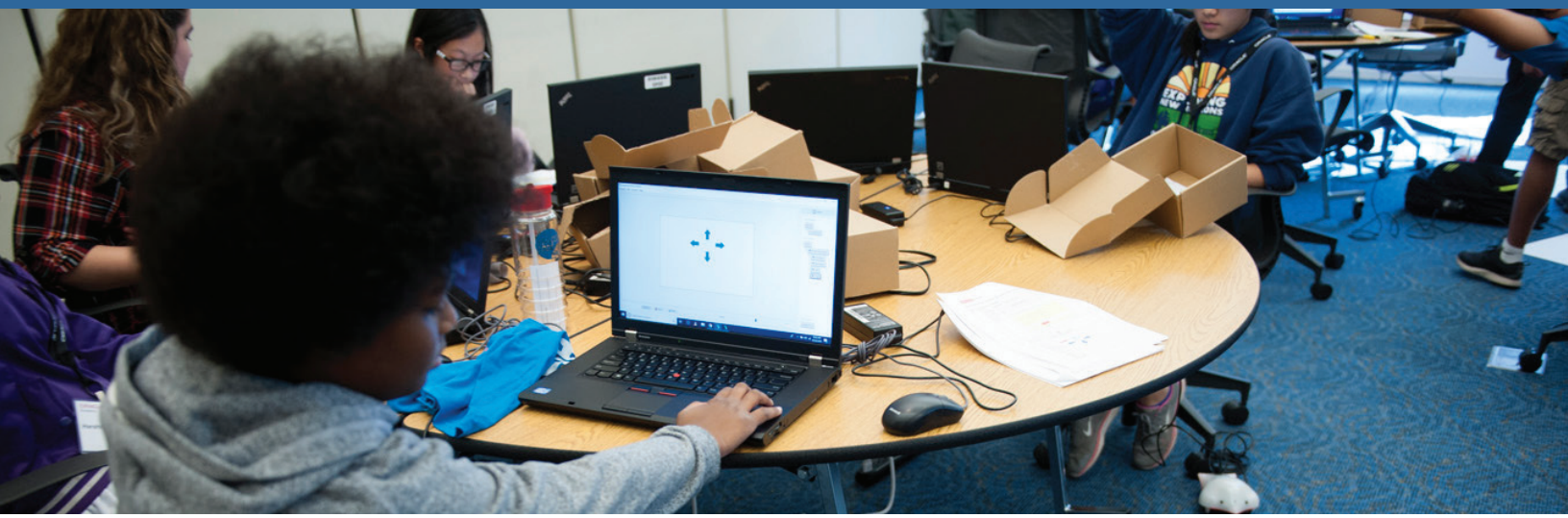
As educators and policy makers, this focus on skills has been effective for better articulating desired learning outcomes, developing consistent standards for student learning, and better measuring student achievement. It's clear that creating classroom tools that facilitate and focus on skills development – regardless of the pedagogical methods employed in teaching and learning – potentially achieves good ends for educators, policy makers, and students who engage with the content. Yet, even with heavy classroom emphasis and myriad interventions, many STEM disciplines, including and especially computer science (CS), still fail to engage many students. This is true especially for girls and women, some racial and ethnic minorities (notably Blacks, Hispanics, and Native Americans) and socio-economically disadvantaged students.

At Oracle Academy we wondered, how can it be that all the current arguments about why CS skills are important fail to resonate with certain populations? What parts of computer science are failing to engage or even pushing away students from underrepresented populations? As stakeholders in CS education, where are our interventions failing? What are we doing wrong?

These kinds of questions were the genesis of this project. From an Oracle Academy perspective, our initial research question was about the efficacy of interventions, which often are anecdotally effective and yet lack qualitative or quantitative research data to support either claims of effectiveness or generalization to broad populations. For example: does a "coding Barbie" or a pink computer really inspire more girls to engage with computer science? If projects in computer science classes focus on "making the world better" rather than on solving puzzles, does that make girls or underrepresented students like computer science more? Or, if an introductory computer science course de-emphasizes programming in favor of robotics or ethics, does that change the engagement or retention of different categories of students for the better?

Couragion has developed a unique platform for helping students develop computer science skills, one that facilitates visibility into how students learning computer science spend their time, and whether they are repeating or taking extra time on certain concepts and skills because they are struggling to learn them, or because they enjoy them and repeat them for pleasure. We anticipated this research would help us better understand student engagement with various computing concepts and skills in a quantitative way that could inform our curriculum design. Instead, it provided an unexpected insight: our collective failure as a society to engage groups that are currently underrepresented in computing may have less to do with how we teach computer science and much more to do with our focus on skills in conversations about CS with students.

Preface (cont.)



Imagine if someone asked you, "Do you want to study gross anatomy?" You might not know what gross anatomy is, and so decline. If they asked, "Do you want to study gross anatomy? You have to study a lot of chemistry, too," you might decide you don't enjoy chemistry and so now definitely don't want to study gross anatomy, no matter what gross anatomy is.

Now, imagine if someone asked you, "Do you want to become a doctor, work in a busy hospital, and help people?" You might say, "Yes, I love busy, interactive environments and I dream of helping people." If that person said, "Do you want to become a doctor, work in a busy hospital, and help people? You'll have to learn gross anatomy and chemistry to do that," you probably would still say yes, and even be open to giving anatomy and chemistry a go because they are the means to an end that is meaningful to you.

Given the data in this white paper, the conclusion seems obvious. Students, like the rest of us, don't think of their futures in terms of the skills they have to have or the skills they will need to learn. Students, like the rest of us, become interested in careers because of the people they will work with, the kinds of environments they will work in, and the kinds of opportunities they will have. In other words, like the rest of us, students think about their futures in terms of what they want to **do**, not in terms of what they need to **know**.

If we want to inspire students to study CS, we need to talk about CS as an enabler for what they want to do. A substantial part of our challenge with engagement in computing could be addressed just by talking about computer science differently. Instead of asking students, "Do you want to learn to code in Java or SQL?" the data indicate we should be asking, "Do you want to make it easier for people to use computers?" or "Do you want to help find a cure for cancer?", and then adding, "To do this, you'll have to study Java or SQL programming and math."

As the data in this paper reveal, in conversations with students, the contextualization of skills within a framework of daily activities and outputs within a career is crucial. If we only ask students to engage in the learning of specific computer science skills, we will fail to ignite the imaginations of many. If we focus instead on what students want to do and how that means they will spend their time at work, then the CS skills are relegated to being what they should be – the infrastructure that supports careers students feel passionately about.

At Oracle Academy, we believe all students should have the knowledge and skills to achieve their dreams; in the 21st century, this necessarily includes computer science. We have been, and continue to be, troubled by the lack of diversity in computing and frustrated by the apparent failure of interventions to change the faces and profiles of computer scientists in any significant way. In that context, we find the research in this paper to be encouraging and invite educators, influencers and stakeholders to reconsider how we understand and address the engagement of underrepresented populations in computing. Perhaps part of the solution we are seeking isn't in changing how we teach computer science. Instead, it is in changing how we frame and contextualize computer science with students.

Introduction

With an estimated 11.5 million workers in 2017, computing jobs are a major factor in the U.S. economy both in the tech sector and in tech occupations across other industries[i]. Efforts to broaden participation in computing have been in process for decades with a focus on innumerable interventions, mentoring and networking initiatives. Yet our technology workforce continues to suffer from a lack of diversity[ii], and the demand for computing jobs continues to significantly exceed the pipeline.

Educators are uniquely positioned to promote an equality of opportunity for students. Unconscious bias, particularly amongst educators, fosters a stereotypically narrow view of who can succeed in computing. Reversing bias can affect a student's educational choices and could increase the number of individuals, especially those traditionally underrepresented, who pursue computer science and engineering fields[iii].

The research posits that it is a lack of awareness or poor perception of computing careers that contributes to the lack of diversity in tech. A lack of knowledge or negative images of computing careers is correlated with a lack of interest[iv]. Students and career influencers are not aware of the breadth of career opportunities in computing. Many of those who are aware have a poor perception of such careers or who can succeed in them. Without a clearer understanding of the composition of a typical technology team, many students will continue to opt out of tech pathways.

Historically technology teams were inside tech sector companies like Apple, Microsoft, and Oracle. Now these teams are part of nearly every industry as organizations rely on technological innovation to operate and differentiate. These technology teams have the skills to develop and manage computer hardware, software, networks, and systems. There are Business and Systems Analysts who detail and design the user experience and product requirements, Project Managers who oversee the deadlines and deliverables, Architects and Programmers who specify and develop the products, Testers who perform quality assurance, Systems Administrators and Security Engineers who protect and optimize the technology environment, and Product Managers who own the strategy and commercialization efforts. Current student and educator awareness of the actual careers available in tech and computing is predominantly focused on programmers, although the core roles described above have been required for the past three decades and will continue to be prevalent.

There is a national imperative to increase the access and quality of computing education to fulfill current and future job demand. We must integrally incorporate career exploration to broaden participation in computing education, boost both the number and diversity of the individuals pursuing tech occupations, and thereby close the gap between job openings and skilled talent. This report will investigate student exposure to high-demand careers as a framework for occupational identity research. Occupational identity presents "a composite sense of who one is and wishes to become" and discusses what inspires individuals and how they select occupations[v]. This research seeks to determine if exposure to a breadth of tech careers and access to more engaging career exploration leads to redefining who can succeed in computing.

The report sections proceed as follows:

- Research Method
- Findings
- Discussion & Insights
- Recommendations for Educators & Advocates

Research Method

Participants

Students engaged with Couragion's online pathway exploration platform to improve their awareness of potential careers. The curriculum and interventions were embedded into school classrooms employing nonprobability convenience sampling. The integration into existing classes resulted in meaningful participation by female students and students of color. For this research, Couragion evaluated 3,612 students aged 10 – 16 at the completion of the 2017/2018 school year – of which 49% were female and 65% were students of color. There were no other inclusion or exclusion characteristics. The results are statistically relevant for the target population with a confidence level of 95% and a +/- 2% margin of error.

Materials, Design & Procedures

Couragion's online pathway exploration platform was accessed by students from a web browser on school computers, laptops and tablets. Students were introduced to a set of technology careers that focused on roles developing and managing computer hardware, software, networks, and systems. The platform was the result of occupational identity R&D funded by the National Science Foundation since January 2016.

As part of the student onboarding process, Couragion gathered a set of occupation-agnostic preferences during which students were provided concise directions and tips that defined terminology. After those required questions were completed, students were presented with a career selection screen where they could review career titles and overviews. For each career selected, students completed a series of self-reflection exercises as they were exposed to career videos and the occupational attributes of each career. For every career explored, Couragion gathered a set of occupation-specific preferences which when combined with the occupation-agnostic preferences above fed the 'Best Fit' algorithm. 'Best Fit' notifications indicated that the career explored matched student's personal preferences and encouraged students to continue the exploration and potential pursuit of such careers. The converse of a 'Best Fit' was called a 'Lower Fit' which helped students to understand that not all careers aligned to their interest, values, and desired work characteristics. Students received an unlimited number of 'Best Fit' careers as they iteratively discovered them.

At the completion of each career explored, students provided occupation-specific feedback in an open text field that was used to perform machine learning sentiment analysis. While this sentiment is not factored in the 'Best Fit' calculation, it provides an additional reference point of students' perceptions of tech jobs.

Measures

To discover the student's occupational identity, the research explored 'Best Fit' Careers and Student Sentiment through a lens of 6 Technology Occupation Pathways. Each of the following constructs within the research are operationally defined and discussed below.

Research Method (cont.)

'Best Fit' Career Construct

The 'Best Fit' career construct compared student preferences with attributes of each occupation. The occupational attributes were determined through a combination of both primary research from industry expert interviews and externally sourced secondary research. A sample attribute would be "Type of People I Want to Work With" which is sourced from the RIASEC Holland Model in the "Interests" section of O*Net Online[vi]. These occupational attributes are also used in the Technology Occupation Pathways section of the paper to provide the Education, Training and Critical Skills of each Pathway.

For each career explored, Couragion requires 25 occupation-specific student preferences and 20 occupation-agnostic student preferences to feed the 'Best Fit' algorithm. For occupation-specific preferences, word scores are assigned to a numerical scale whereby higher scores indicate a more positive association with the preference. Sample occupation-specific preferences would be "Testing robots in a lab environment" or "Creating apps that are easy to use". Sample items are scored on a 3-point scale with the ordinal response categories of "Positive", "Neutral", and "Negative".

For occupation-agnostic preferences, 45% of the questions used multiple-answer, unordered lists. A sample would be "How much work travel (greater than 1 hour away) is acceptable to you?" with the potential responses of "None", "4 Times Per Year", "Weekly", "1 Time Per Month", "2 Times Per Month". The remaining questions used single-answer, ordinal response categories. A sample would be "I need a career that enables me to be creative.", with a potential response selected from a sliding scale of "Strongly Disagree" to "Strongly Agree" – whereby scores were assigned to a numerical scale with higher scores indicating a more positive association with the preference.

The 'Best Fit' metric was presented on a 100-point scale showing the percentage of career completions that result in a 'Best Fit'. This data was stratified by race and gender.

Couragion conducted classroom pilot tests through several rounds of primary research via user acceptance and usability testing where students completed pre-surveys and post-surveys with improvement suggestions. Additionally, Couragion provided a built in "Feedback" feature designed to encourage ongoing inputs from students.

Student Sentiment Construct

Sentiment analysis is the contextual mining of text, also known as opinion mining, within the discipline of Natural Language Processing (NLP). Couragion captured student's verbatim comments iteratively as they self-reflected at the completion of each career. This occupation-specific feedback was captured in an open-ended question where students are asked to share "My thoughts/comments about this (career) quest". Couragion used a hybrid system that combines both rule-based and automatic machine learning approaches to extract attributes about the statement's polarity, the students who express their opinions, and a topic model.

For the sentiment analysis, the system identified and categorized each statement's polarity as positive, neutral or negative. The data is presented on a 100-point scale showing the percentage of "Positive Comments", "Neutral Comments", and "Negative Comments". Using sentiment topic modeling, emergent themes were identified as word clusters. Additionally, student comments provided the verbatim feedback along with the gender and race of the student.

Technology Occupation Pathway Construct

With a focus on improving the awareness and perception of a breadth of tech careers, the following Technology Occupation Pathways were used as a lens for organizing and presenting the research: 1) Data, 2) Design, 3) Product, 4) IT Support, 5) Programming, and 6) Robotics. The Technology Occupation Pathways were selected based on above average Forecasted Job Growth and/or above average Current Job Demand. The only exception was Robotics which was selected for inclusion and comparison due to its dominant focus in K-12 education.

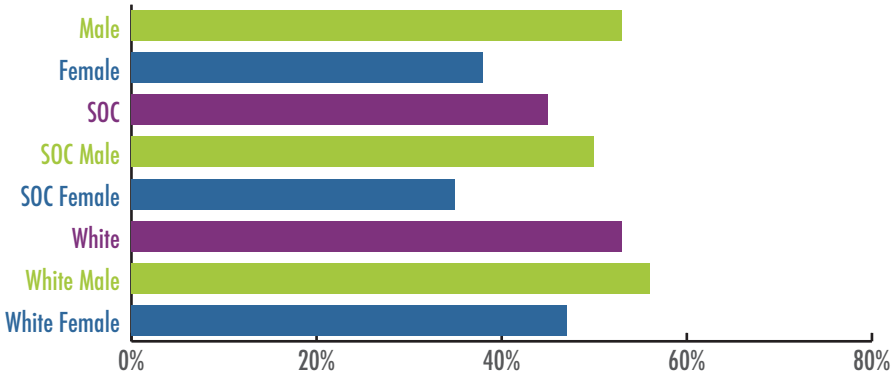
For each of the 6 Technology Occupation Domains, data on the Forecasted Job Growth and Current Job Openings were detailed to align workforce and labor demands with educational areas of focus. Forecasted Job Growth is a standard measure from the Bureau of Labor Statistics Employment Projections (EP) program[vii] which develops information about the labor market for 10 years in the future. The Current Job Demand was derived from online job postings collected in August of 2018[viii].

Findings

'Best Fit' Rate

When a student receives a 'Best Fit' it is an indication that the career is aligned to the student's interest, values, and desired work characteristics. The 'Best Fit' metric is presented on a 100-point scale showing the percentage of career completions that result in a 'Best Fit'. Below is the Average 'Best Fit' Rate for the Technology Occupations explored. Couragion's research showed a 47% 'Best Fit' rate for all students. Female students of color had the lowest 'Best Fit' rate at 35% while white males had the highest 'Best Fit' rate at 56%.

Average 'Best Fit' Rate for Technology Careers



This data was segmented by each of the 6 Technology Occupation Pathways and is presented in that section below.

Occupation-Agnostic Preferences

Occupation-Agnostic preferences serve as one indicator to consider when determining what is meaningful in determining occupational identity. To decode 'Best Fit' careers, occupation-agnostic preferences were used to elucidate what contributes to a career becoming a 'Best Fit' or a 'Lower Fit'.

The top reasons why students received 'Best Fits' for tech careers, regardless of race or gender, are as follows:

- Students want a high level of 'creativity' in the occupation.
- Students want to attain a 'four year degree' when selecting amongst a set of choices.
- Students want the ability to 'learn new things' in the occupation.
- Students want the opportunity to work as 'part of a team'.

The top reasons why tech careers are not 'Best Fits' for students also don't vary by race or gender. These disconnects for tech careers are as follows:

- Students want more 'work related travel' than is required for these occupations.
- Students want to work in smaller 'team sizes' of 2-3 people.
- Students want a greater 'work purpose' than is offered by these roles.
- Students want more 'work related risk' than is needed by these occupations.

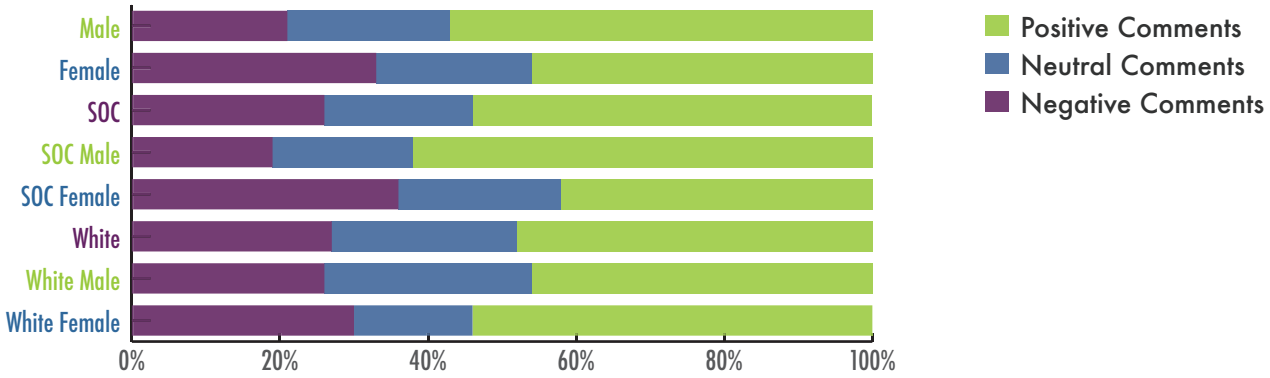
While it is interesting to note that the top occupational-agnostic reasons for receiving or not receiving a 'Best Fit' career do not vary when segmenting by gender and race, this is not the case when drilling into the occupation-specific preferences forthcoming in the 6 Technology Occupation Pathways. The occupation-specific preferences show varying degrees of alignment and misalignment between occupational attributes and student preferences and prove to be instrumental in highlighting the differing perspectives from a race and gender perspective. That data will be covered below in the Technology Occupation Pathways discussion.

Findings (cont.)

Student Sentiment

The system identified and categorized whether the attitude towards a given tech career is positive, neutral or negative. Couragion's research showed that students express positive sentiment about tech careers 53% of the time, neutral sentiment 22% of the time, and negative sentiment 25% of the time. Non-positive sentiment was indicated most frequently by female students of color with 36% of their comments reflecting a negative sentiment. Positive sentiment was indicated most frequently by males of color with 62% of their comments reflecting a positive sentiment.

Student Sentiment Trends



Using sentiment topic modeling, the following emergent themes were identified across all tech careers a) hating or fearing math, b) loving math, c) desiring a greater purpose to solve problems or help people, and d) wanting a fun office environment. A drill down on the Student Sentiment Construct will also be included in the Technology Occupation Pathways section for each of the Pathways.

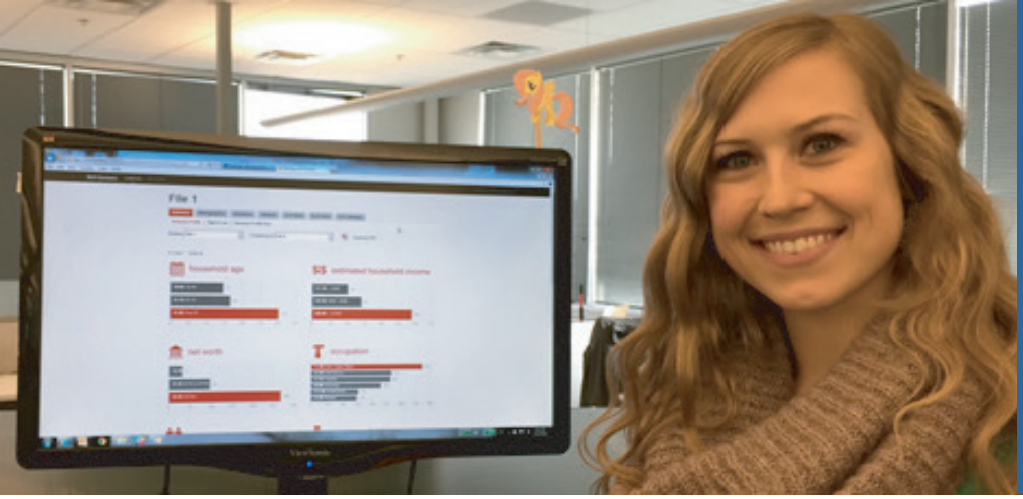
Technology Occupation Pathways

The research focused on the following Technology Occupation Pathways: 1) Data, 2) Design, 3) Product, 4) IT Support, 5) Programming, and 6) Robotics. With a combined 753,000 Current Job Openings for Data, Design, Product, and IT Support, the demand is nearly 5X than that of Programming and Robotics[viii].

The Forecasted Job Growth data show how employment in these fields is projected to grow over a 10-year period. Product, IT Support and Robotics all project average growth between 5% to 9%. Data, Design, and Programming project much faster than average growth. While the Bureau of Labor and Statistics determines 'much faster than average' as 15% or higher – these are growing at hyper accelerated rates of 24% to 30%.

Occupational Pathway	Representative Job Titles	Current Job Openings	Forecasted Job Growth
Data	Data Analyst, Business Intelligence Manager	227K	27%
Design	UX Technologist, Graphic Designer	194K	30%
Product	Product Manager, Project Manager	170K	9%
IT Support	Systems Administrator, Help Desk Manager	162K	6%
Programming	Software Developer, Quality Assurance Engineer	140K	24%
Robotics	Robotics Engineer, Electromechanical Technician	18K	5%

In the Findings to follow a specific job title was selected to illustrate each Pathway. The Findings for each Technology Occupation Pathway highlight the Occupation Overview, Student Data Summary, Market Outlook, Observations, Student 'Best Fits' Chart, Verbatim Student Comments, and Student Sentiments Chart.



Findings (cont.): Data Occupation Pathway

Occupation Overview

Data Analysts collect, cleanse, manipulate, analyze, and visualize information. The typical education and training for this career are Math or Computer Science Degrees and Data Science Bootcamps. The critical skills required are Statistics, Data Manipulation, Data Visualization, Problem Solving, and Critical Thinking.

Student Data Summary

A particularly high number of females and students of color receive a 'Best Fit' match for this career, whereby less than half of white males do. 70% of students share positive sentiments about this career in their verbatim feedback. However, female students express exceptionally positive sentiment regarding this career at a rate of 1.6X as frequently as males. The top reasons why students receive a 'Best Fit' for the Data Analyst are the security of many job openings, that others perceive the career as challenging, the desire to work with facts and details, the ability to collaborate with other internal departments, a flexible schedule, and the ability to work in an office with many perks. White males did not receive as many 'Best Fits' as they dislike changing processes, explaining things to external clients, and collaborating with other departments and clients. The top sentiment themes are liking the strong math and data components of the career and the required teamwork. The white male sentiment was that the job was boring and 'not for them'.

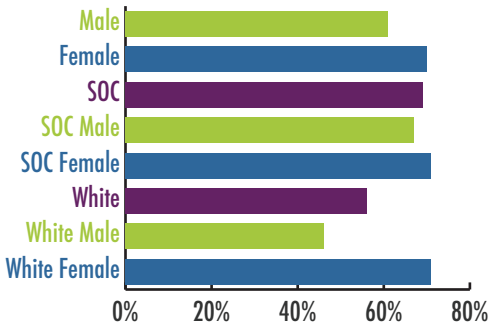
Market Outlook

Data Analysts are in exceptionally high demand and there is a huge number of current job openings. A Gallup poll, conducted for the Business-Higher Education Forum, revealed that by 2021 69% of employers will give preference to candidates who possess data analysis skills, while only 23% of college and university leaders say their graduates will have those skills. Notably, the demand for data analytics skills is growing in all industries with the largest number of openings in information technology, financial services, and professional, scientific, and technical services[ix].

Observations

Integrating data science and data analytics units like Statistics, Data Manipulation, and Data Visualization into multidisciplinary classrooms can help to build the foundational, employability skills required for the data-driven jobs of the future across a multitude of business Pathways. Furthermore, because this career results in higher numbers of 'Best Fits' for females and students of color, data analysis curriculum may better engage underrepresented populations in CS and technology classes and pathways.

Student 'Best Fit' Career Match



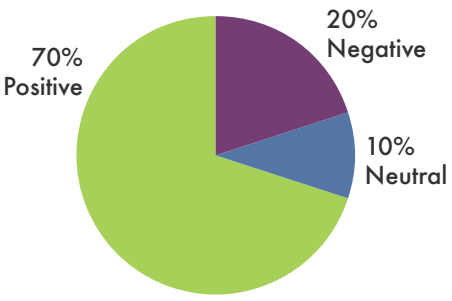
Student Comments

"I love all the organization and data and details of this job. One thing I don't particularly like is the amount of difficult looking math that this would require. I also enjoy learning code. I currently know a bit of c# code but learning new versions of a computer language would be fun."
- White Female

"I don't really like this career. It looks hard and you need know math to know what to do. I don't know that much math but I would try it."
- Male of Color

"It sounds interesting and it sounds like it would be challenging."
- Female of Color

Student Sentiments



Findings (cont.): Design Occupation Pathway

Occupation Overview

User Experience (UX) Technologists bridge the gap between design and engineering by creating application prototypes and user interfaces. The typical education and training for this career are Human-Computer Interaction or Graphic Design Degrees and UX Bootcamps. The critical skills required are Design, User-Centered Research, Active Listening, and Critical Thinking.

Student Data Summary

This career is more likely than not to be a 'Best Fit' for any student, regardless of race or gender - with 64% of all students receiving a 'Best Fit'. 55% of students share positive sentiments about this career in their verbatim feedback. The top reasons why students receive a 'Best Fit' for the User Experience Technologist are the desire to work on many different projects, the high number of job openings in the field, the desire to help others, being motivated to create applications that are easy to use, the ability to collaborate with customers, that the career is perceived as prestigious by others, and the ability to work flexibly and in a fun office environment. The top sentiment themes were stating that the job was a good fit and that students liked the design and creativity aspects of the job.

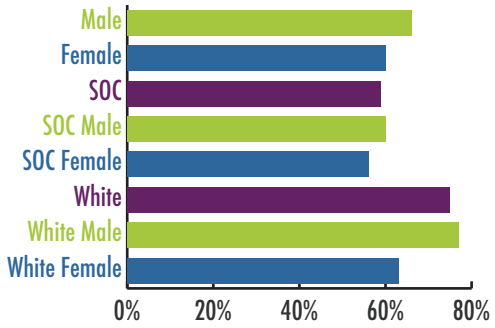
Market Outlook

The UX Occupation Pathway is in high demand today and is also growing rapidly. As recently reported by TechCrunch, the ratio of UX to developers is up 2.5 times over the last five years[x]. A search on Indeed.com results in over 194K current job openings and this career is projected to grow at a rate of 30%[viii].

Observations

An improved awareness of careers such as UX is required if we are to meet labor demands and prepare our students for these jobs. Practical computing knowledge that includes other occupational and essential skills like UX are a critical part of being qualified for the jobs of the future across a growing number of sectors, fields and professions. And because UX is more likely than not to be a 'Best Fit' for any student, regardless of race or gender, exposing students to the UX field and leveraging design as an entry point for computing can broaden participation in computing classes across the nation. Educators are advised to incorporate lessons on User Centric Research, Human-Computing Interactions, and Design Thinking into their CS and technology courses.

Student 'Best Fit' Career Match

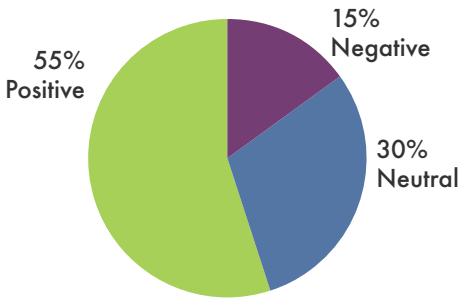


Student Comments

"I love the necessity for creativity and the fact that I would be designing something that will make people's lives easier. I think that the work environment is exactly what I want, and the crazy amounts of growth in the industry makes it seem like if I had the qualifications it would be easy for me to get a job."
- White Male

"I really enjoyed this quest. I felt my guide knew a lot about his field and was very passionate about it."
- Female of Color

Student Sentiments



Findings (cont.): Product Occupation Pathway

Occupation Overview

Software Product Managers lead and oversee the strategy, user requirements, and commercialization of software development initiatives. The typical education and training for this career are Business or Technology Management Degrees and ScrumMaster Certifications. The critical skills required are Software Product Design, User-Centered Research, and Organizing, Planning, & Prioritizing.

Student Data Summary

Half of all students receive a 'Best Fit' for this career as a good match. 49% of students share positive sentiments about this career in their verbatim feedback which is consistent with the average rate of 'Best Fits'. The top reasons why all students receive a 'Best Fit' for the Product Manager is their desire for seeing their product vision come to life, the desire for a non-coding centric technology job, the ability to have a flexible schedule, and to work as part of a team. The top reasons why all students did not receive a 'Best Fit' were the lack of desire to write software requirements like user stories, the need to continually keep up with new and emerging IT technologies, a lack of familiarity with the Agile Software Development methodology, and not wanting to manage the priorities of Software Developers and Quality Assurance Engineers. The positive sentiment themes were a desire for leadership, a flexible schedule, and ability to work with a team; while negative themes focused on not wanting to be in front of a computer all day.

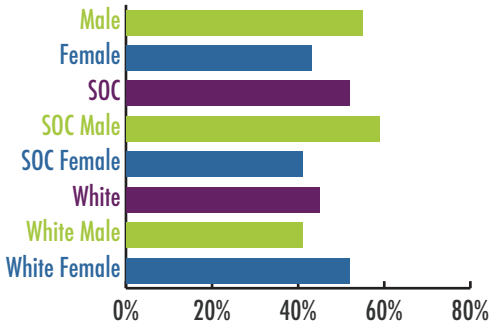
Market Outlook

There are currently 170K job openings for Product Managers and that is anticipated to grow at a rate of 9%[viii]. Recent salary trends would indicate that the supply of skilled Product Managers does not meet the demand. In 2017, Hired found that Product Manager salaries increased by 6% making Product Managers the highest paid position in tech - higher than even Software Developers[xi].

Observations

Market data and student 'Best Fit' rates highlight the importance of including Product Management concepts in tech and CS classes. Unfortunately, Couragion research (published in 2017) indicated that K12 entities are not addressing this workforce demand - with less than 15% of schools teaching technology competencies such as user experience (UX) or product management concepts[xii]. It is recommended that educators incorporate lessons that build students' skills in areas such as Agile Software Development Methodology, Software Product Design, User Centered Research, and Project Management.

Student 'Best Fit' Career Match



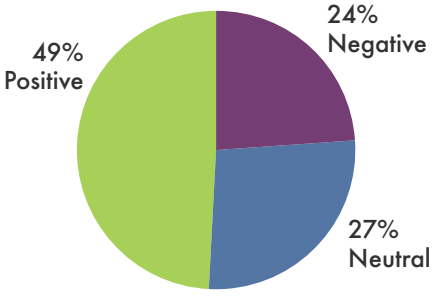
Student Comments

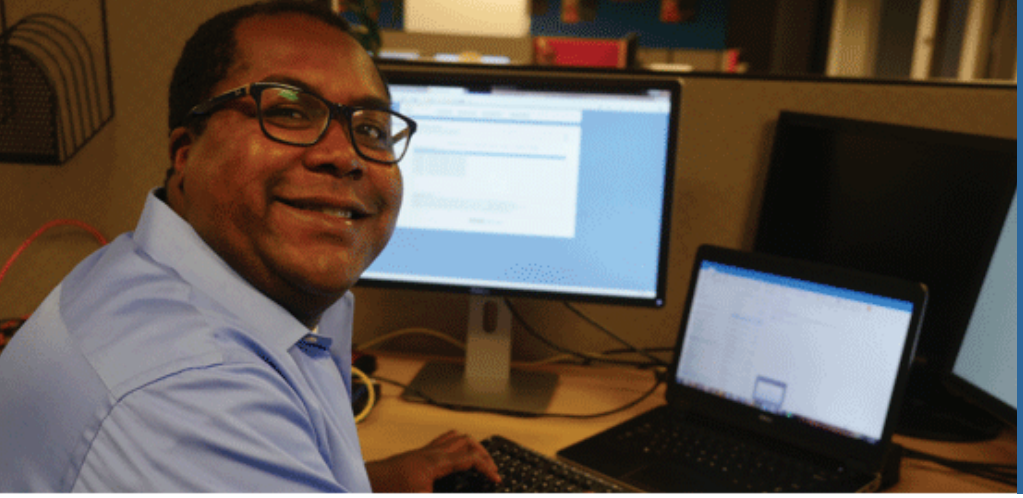
"This is very interesting because I love to work with others and I've always wanted to show off my creativity."
- Male of Color

"Love how a product manager has so much in their power that helps them help the team and create things that could be useful to both the public and anyone working there."
- Male of Color

"I like the idea of managing people and having the responsibility of managing work. I am very organized, but I am not tech savvy."
- White Female

Student Sentiments





Findings (cont.): IT Support Occupation Pathway

Occupation Overview

Systems Administrators are part of internal IT departments who deal with day to day operations and oversee the support, security, and maintenance functions of IT systems. The typical education and training for this career are Information Technology Degrees and Industry Certifications. The critical skills required are Computer Networks, Internet Protocols, Troubleshooting, and a Service Orientation.

Student Data Summary

Only 42% of all students receive a 'Best Fit' for this career as a good match – which is the second lowest of all Occupation Pathways investigated. Notably an extremely low number of white female students selected this career and none of them received a 'Best Fit'. 60% of students share positive sentiments about this career in their verbatim feedback which is uncharacteristically high in comparison to the 'Best Fit' percentages. The top reasons why students receive a 'Best Fit' for the Systems Administrator is the desire to help other people, wanting to be a team player, the desire to constantly learn new things, and the casual and fun working environment. The top reasons why students did not receive a 'Best Fit' are working long hours with an inflexible schedule, earning and renewing IT certifications, supporting remote workers via phone and email, fixing computer issues, and working in a cubicle. The top sentiment trends were the desire to help other people and to troubleshoot problems.

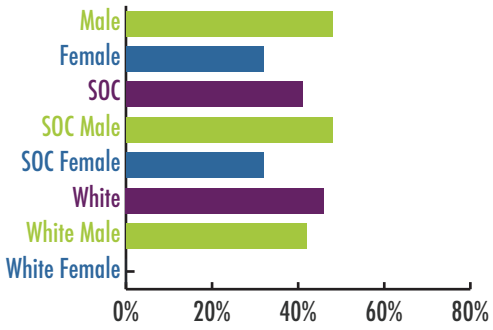
Market Outlook

At 6%, job growth is more modest than other Occupation Pathways explored. However, there is a very high current demand for IT Support functions, with a current search on Indeed.com yielding 162K openings[viii].

Observations

While student 'Best Fit' rates are lower compared to other Occupation Pathways, the current demand for IT Support skills is high enough to warrant inclusion of IT Support topics in K12 education settings. Educators should cover concepts such as Hardware, Software, Networking, and Troubleshooting in their tech and CS classes. Such topics should be covered through the lens of 'helping others' which is a stronger in IT Support than other Technology Occupation Pathways and which aligns to students' strong desire for greater work purpose. Couragion's analysis showed that 80% of students rated high work purpose as important and rates were highest among females and students of color. By blending IT Support topics with examples of how such skills incorporate greater purpose, educators can help students to see how technology jobs can address their passion for helping others.

Student 'Best Fit' Career Match



Student Comments

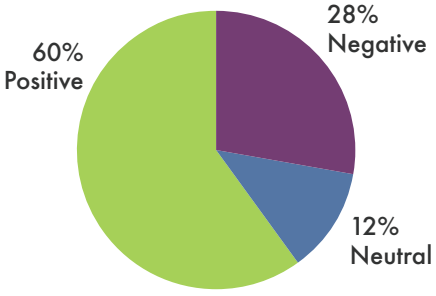
"I like troubleshooting and helping people – so this could be a great fit for me! "
- Female of Color

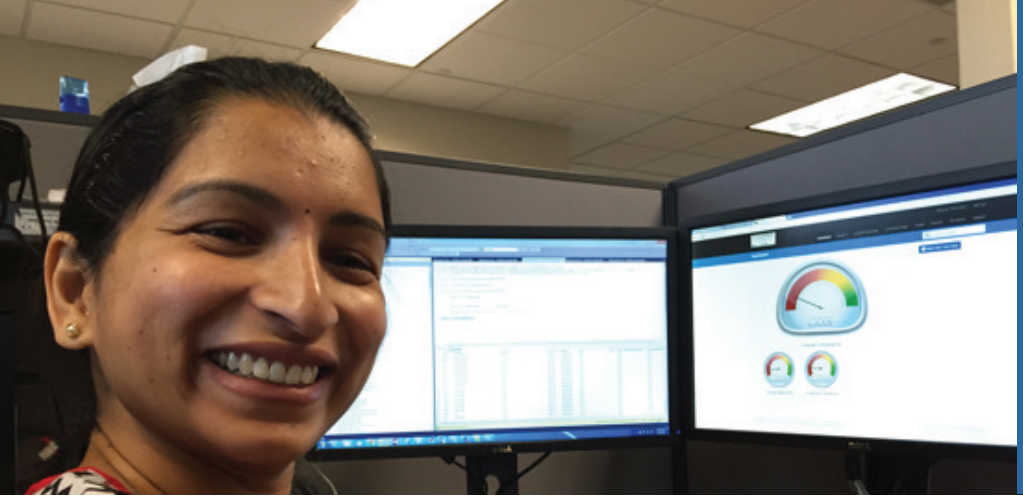
"I feel like he loves what he is doing but I just can't see myself doing something of that nature because I don't like working for anybody. I want to be my own boss."
- Male of Color

"The IT field is interesting to me and I would enjoy working there."
- Male of Color

"It would be fun to help others."
- White Male

Student Sentiments





Findings (cont.): Programming Occupation Pathway

Occupation Overview

Software Developers build and implement software programs as specified by product management using creative problem solving techniques. The typical education and training for this career are Computer Science Degrees or Coding Bootcamps. The critical skills required are Algorithms, Programming, Problem Solving, and Teamwork.

Student Data Summary

Only 33% of all students receive a 'Best Fit' for this career – which is the lowest of all Occupation Pathways investigated. However, males are 2X as likely as females to receive a 'Best Fit'; and white males are 3X as likely as female students of color to receive 'Best Fits'. 37% of students share positive sentiments about this career in their verbatim feedback which is in line with the overall average of 'Best Fit' careers. While females and females of color overall were open to learning how to code, the top reasons why they received so few 'Best Fits' are an aversion to a potential career progression path in becoming a Software Architect and an aversion to learning new specific underlying technologies such as databases, developer platforms, and services-oriented communication frameworks. Students, regardless of race or gender, receive fewer 'Best Fits' for this career with the primary reasons being that the job requires working in a cubicle, working on building internal business applications (not games) and interacting with the quality assurance team. The top sentiment themes were largely negative in that students don't want to fix software bugs or work on a computer all day.

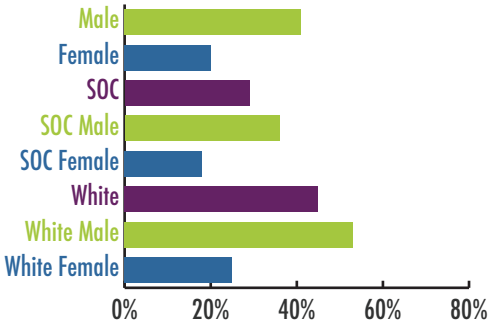
Market Outlook

Job growth and current demand are very high for Programmers with 140K job openings and a projected growth rate of 24%[viii]. A Burning Glass and Oracle Academy report entitled "Rebooting Jobs: How Computer Science Skills Spread in the Job Market[xiii]" highlights the computing skills required to adequately prepare our future workforce. Programming skills are in the top position and account for 38% of the CS skills required.

Observations

Regardless of 'Best Fit' trends, the market demand shows the importance of teaching students to code. However, because underrepresented students in particular have less 'Best Fits' and more negative sentiments, educators must look for ways to expand students' views of tech and computer science jobs. Integrating complementary lessons into coding classes, such as Product Management, Data Analysis, and UX, is one way to help students understand that while coding is a critical skill to have, 'sitting at a desk all day and coding' is not the only job in technology. Such knowledge may help to keep underrepresented students better engaged in CS.

Student 'Best Fit' Career Match



Student Comments

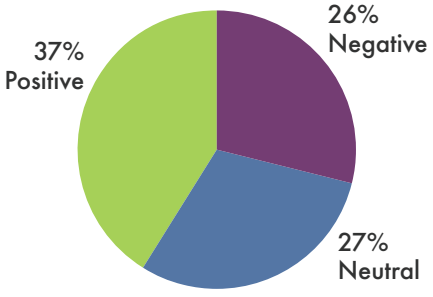
"Well this is fun, but I don't want to sit at a computer all day and work only on one thing."
- Female of Color

"I think that this would be a good job for me because I have good critical thinking skills that I think could be used to create good programs."
- White Male

"This is a very boring job. I would not enjoy doing this."
- White Female

"I hate looking for bugs."
- Male of Color

Student Sentiments



Findings (cont.): Robotics Occupation Pathway

Occupation Overview

Robotics Engineers research, design, develop, and test electrical, electronic, mechanical, or integrated systems/equipment. Typical education and training for this career are Mechanical/Electrical Engineering, Math Degrees, and/or Engineering Licensure. The critical skills required are Systems Thinking, Programming, Persistence, and Problem Solving.

Student Data Summary

Males often select robotics engineers as one of their top careers, whereas only 1/3 of females do. Males receive a 'Best Fit' 1.7X as frequently as females. Female students are 3X as likely to express negative sentiment. Males comprise 73% of the sentiment dataset, thus the high positive sentiment rates overall are not representative of female students. The top reasons why male students receive a 'Best Fit' match for the Robotics Engineer are the desires to push the bounds of current knowledge, to work with cutting edge technology, and to test in a lab with other researchers. Females on the other hand are not interested in working with robotics technologies in general and were less keen to work for common robotics employers such as large corporations and academia. The sentiment themes were polarized – with males stating that 'robots are cool' versus females stating that 'robotics is not for me'. An additional theme that emerged from the male perspective was the desire to work hands-on via making or building.

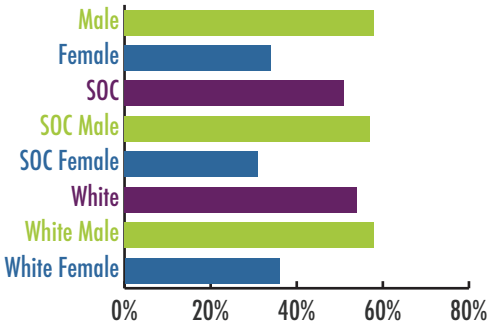
Market Outlook

The Burning Glass and Oracle Academy report entitled "Rebooting Jobs: How Computer Science Skills Spread in the Job Market[xiii]" highlights the high-value, high-demand computing skills required to adequately prepare our future workforce. As mentioned previously, programming skills are in the top position but robotics skills are only needed 1% of the time. In addition to current job and skills demand being low, job growth is slower than most other Technology Occupation Pathways - projected to be 5%[viii].

Observations

In prior research, Couragion asked educators which CS concepts were offered at their schools. Of the schools surveyed, 100% offered coding, 55% offered robotics, and less than 15% of schools taught other technology competencies such as user experience (UX) or product management concepts[xii]. With the polarizing response that the Robotics career receives from students and with Robotics' lower number of available jobs and slower job growth, educators should not over rotate on using robotics to teach coding and technology as it may alienate and discourage underrepresented populations, especially female students.

Student 'Best Fit' Career Match



Student Comments

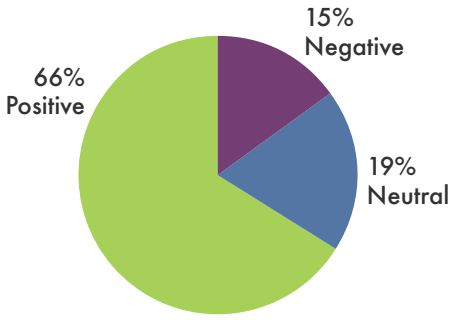
"When I saw this quest I instantly got hooked and I thought it was cool, so I would like to have a job like this."
- Male of Color

"I love working with robots, computer programming, and helping our world advance. I think it would be fun because it is mostly hands-on learning."
- White Male

"Being able to push the limits of what we know and how to improve them in an industry like this is awesome."
- White Male

"Not my cup of tea."
- Female of Color

Student Sentiments



Discussion & Insights

The intention of the occupational identity research focused on the exploration of a breadth of technology careers. With Couragion, students were exposed to career pathways while capturing occupational preferences that fueled the occupational identity research. The result is an 'insider view' from the student's perspective about their perception of tech careers and which indicators influence their own quest for occupational identity.

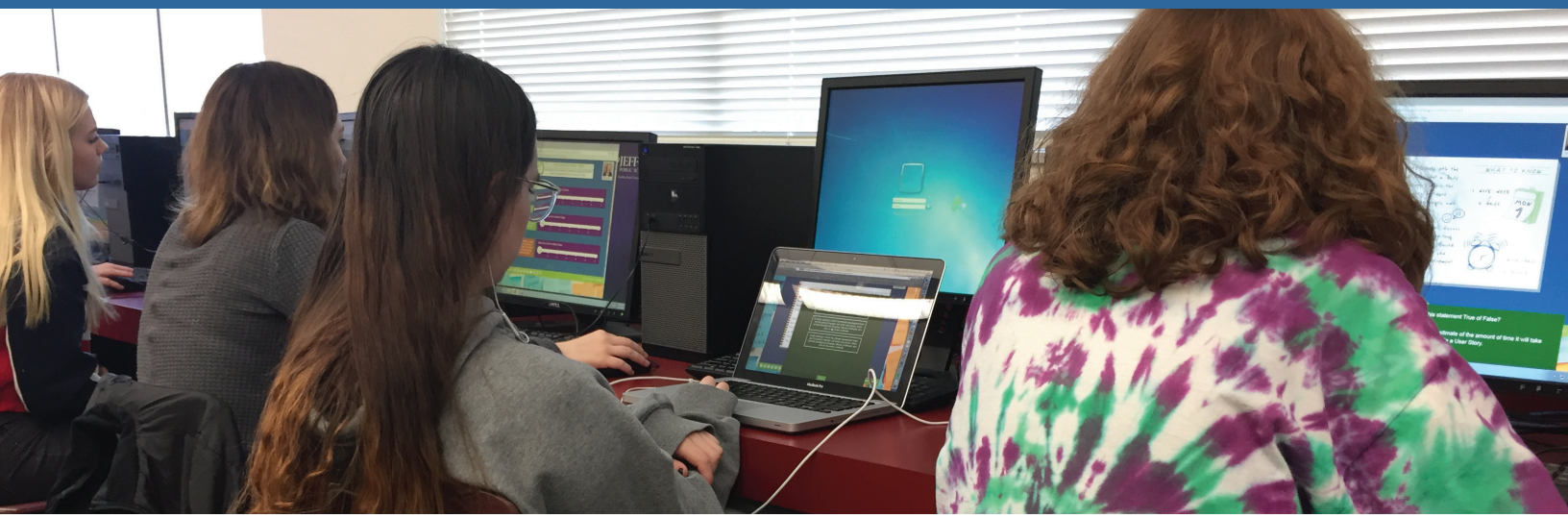
With mounting computer science education legislation and policy, there is an imperative to increase the access and quality of computing education. Accordingly, educators have moved forward with decisions about which concepts to teach and what curriculum to use. When Couragion surveyed educators about which computer science concepts were offered at their schools, 100% offered coding, 55% offered robotics, and less than 15% of schools taught user experience (UX) or product management concepts[xii]. Today, the clear majority of computing curriculum focuses on coding skills and robotics experiences. While school districts have rushed to embrace computer science, very few schools have incorporated other technology-oriented concepts required to fulfill current and future job demand. These existing methods for educating students on computing concepts have failed to motivate underrepresented populations.

The research presents evidence that the software developer jobs for which we are preparing our students with existing computer science education practices are least aligned to student's preferences. Only a third of students received a 'Best Fit' for a Software Developer, very few students shared positive sentiments about this career, and males were 2X as likely as females to have received a 'Best Fit'. While it was not surprising to see the gender gap – it was unexpected to see the Software Developer career at the bottom of the average 'Best Fit' stack across the Technology Occupation Pathways explored, regardless of gender or race.

The research also suggests that exposing female students to robotics does not encourage them to pursue computer science pathways and may alienate and discourage their pursuits. As males received a 'Best Fit' for the Robotics pathway much more frequently than females and female students were much more likely to express negative sentiment about the career. Coupled with Robotics' low number of available jobs and slower job growth, educators should reconsider using robotics to teach coding and technology in the classroom.

It is critical to improve the awareness and perception of a breadth of careers in computing to meet the demands of our workforce and the desires of our students. We need to elevate high demand and high growth computing fields such as user experience (UX) and data science - that when understood, appeal to and attract underrepresented populations. Females and students of color received unanticipated higher than average 'Best Fit' matches for these career pathways and could be a tipping point for redefining who can succeed in tech. The more students know about a diverse set of computing fields, the more likely they are to build a positive perception of computing jobs and find tech careers that meet their desired interests and work characteristics. Educators can leverage these findings to improve their teaching and learning with respect to what inspires individuals and how they select occupations.

Discussion & Insights (cont.)



Career exploration that incorporates real work context of how tech jobs help people, animals, and/or society can better serve to attract underrepresented populations to computing pathways. Students gravitate toward solving problems that are meaningful to them and need to understand how technology can be used to achieve a greater purpose. Regardless of gender or race, this desire for greater work purpose emerged as a key topical theme from the sentiment analysis and as a top reason why some tech careers are not 'Best Fits' for students. Notably, a high career purpose match was strongly associated with the IT Support and Design Pathways in the 'desire to help others' and 'make the lives of others easier'. All technology careers have the capacity to provide greater work purpose through either the direct work or via the employers' philanthropic activities. Educators can inspire these passions by helping students to understand how technology jobs offer greater purpose and by embedding purpose-driven concepts into ongoing classroom experiences. These continued encouragement supports are critical to cultivating persistence in the computing career pipeline.

There is a complete spectrum of careers in technology that are not identified or understood by educators or career influencers. Even those charged with postsecondary readiness and student transitions don't understand the career opportunities available to our students. Career competence should be part of every educator's job. To expand perspectives and broaden participation in technology and computing, we must integrally incorporate career pathway exploration and readiness into our education system. Career exploration and readiness focused on helping individuals select rewarding and suitable degrees, training, and careers will increase the likelihood that individuals thrive in those careers. If educators understood the diverse opportunities in technology, they could serve as better coaches, mentors and advocates for students.

While it is common to hear from the media and prior research about the diversity challenges in tech, those stories typically center around the archetype of the Computer Programmer or Software Developer as the only job available in tech. This viewpoint combined with the persistence of unconscious bias fosters a narrow view of who can succeed in computing. The research posits that it is a lack of awareness or poor perception of computing careers that contributes to the lack of diversity in tech. This research shows that exposure to a breadth of technology careers and access to more engaging career exploration leads to an improved awareness and perception of computing careers. The findings establish that computing careers are for everyone. We must appropriately communicate the opportunities and cultivate curiosity in computing pathways that are mission critical to the innovation, economic viability, and competitiveness of the U.S.

Practical recommendations for educators and advocates follow.

Recommendations for Educators & Advocates

1. Integrate computing education career knowledge and skill building beyond programming into teaching and learning practices.
2. Broaden interest in computing by highlighting unfamiliar technology careers pathways.
3. Ensure that students are exposed to careers in tech through career exploration and work-based learning experiences.
4. Discontinue practices poorly aligned with industry demand and workforce needs.
5. Integrate design and user experience (UX) to engage ALL students in computing education.
6. Assimilate data science and data analytics lessons into multidisciplinary classrooms.
7. Cultivate student's career passions and purpose by helping to translate them into near term experiences like project-based learning topics, service learning opportunities, capstone subjects or internships/apprenticeships focus areas.

Couragion

About Couragion

Couragion provides STEM career literacy and workforce development solutions for educators, students, and advocates. With a nationwide call for improving the accessibility and quality of STEM education, Couragion strongly believes that career context should be integrally woven into STEM education to improve classroom relevance, better inform student choice, and increase retention in real-world career pathways. Couragion works with educators to take their STEM curriculum to the next level and to support work-based learning initiatives. Couragion's machine learning and workforce analytics generate insights about the perception of careers to understand how to cultivate a STEM talent pipeline. Couragion provides professional learning experiences for educators so that they can be better advocates for students. Couragion is a social enterprise whose R&D is generously supported by the National Science Foundation and AT&T Aspire.

ORACLE® Academy

About Oracle Academy

As Oracle's flagship philanthropic educational program, Oracle Academy advances computing education globally to drive knowledge, innovation, skills development, and diversity in technology fields. In FY 2018, Oracle Academy worked with more than 15,000 educational institutions across 128 countries, supporting 6.3 million students worldwide. Oracle Academy offers educational institutions and educators free curriculum, resources, training, cloud-hosted technology and software, support, and certification resources. The program works with public and private partners to provide the tools educators need to engage, inspire and prepare students to become innovators and leaders of the future. Through Oracle Academy, students receive hands-on experience with the latest technologies, helping make them college and career ready in the era of big data, artificial intelligence, machine learning, cloud computing, Internet of Things, and beyond.

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