STEM Career Exploration Database (CED?)

Introduction / background

STEM professionals are well compensated and highly in demand. Yet, the STEM training pipeline appears to be leaky. Many students who start out in pursuit of STEM degrees end up switching majors, or dropping out of college. Even STEM graduates often do not continue along a STEM track in pursuit of a STEM-related career. [add REF - expected job vacancies in STEM]. The issue of persistence is most particularly pronounced among traditionally underrepresented stakeholder groups in STEM. One of the high-impact practices that can promote STEM retention, of a broad cross section of students, in a STEM path is participation in an undergraduate research experience (URE). In UREs, students conduct research with a faculty mentor in the field in which they are studying, either during the academic year, or during the summer. There is a large - and growing - body of research describing the benefits of URE to students. Yet, the mechanism explaining how UREs generate positive outcomes is not well understood. Our goal is to understand how specific aspects of UREs are related to positive student outcomes. To achieve this goal, we are characterizing URE structure using theoretical framing from the domain of work psychology, with specific emphasis on the implications of job characteristic theory and the work design model. According to the work design model ([Morgeson and Humphres, 2006](#)), work can be characterized along four dimensions: task characteristics, knowledge characteristics, social characteristics and work context. In our project, URE participants will report on their experience in terms of these four dimensions, and on the perceived benefits of having participated. Participants will receive feedback on their responses, and encouraged to interact with the web-based exploration database to: 1) reflect on their research experience, 2) compare it to the experiences of other URE participants, 3) and to a sample of STEM-related occupations with attributes coinciding with students' URE-anchored preferences drawn from professional occupational databases (O*NET).

The anticipated benefits of the project fall into three broad categories: benefits for individuals, benefits for society and benefits for our participants in our research group:

For individuals. Individuals pursuing a STEM-related degree will have the opportunity to explore a curated, comprehensive set of STEM-related occupations drawn from the Occupation Information Network (O*Net). O*Net is a free, online database that contains almost a thousand job definitions, designed to enhance students' and job seekers' understanding of the occupational landscape in the United States today. Systematic, curated exposure to the O*Net will help students currently pursuing STEM degrees to explore career options directly coinciding with their academic interests, to identify a subset of matching occupational tracks, and to find professional occupations they will find fulfilling based directly on their STEM-related preferences and interests.

For our research group. This research focuses on relationships between the structure of undergraduate research experiences (UREs) and a range of positive STEM-related outcomes. In this research we use a survey-based approach to collect data bearing both on students' research experience, as well as their preferences for various aspects of this research experience. We are developing a comprehensive STEM-occupational database to allow research participation to directly benefit from their participation by using their survey responses, and their preferences/likes/dislikes to explore a range of STEM-related career options. Importantly, because students will be able to access the interface being developed for this project again and again, they can engage in more refined occupational search as their research preferences and interests mature over time.

For society. Broad work-force involvement in STEM-related careers is recognized as a priority by a number of governmental agencies. The curated exposure to STEM-related occupations the process described in this proposal facilitates should systematically increase students' persistence in both STEM-related college degrees, and following graduation subsequent persistence toward and into STEM-related careers.

Methods (sources of data)

There will be four types of data **stored** in the database:
Job Characteristics, Job Title and descriptors from O*NET database and User Profiles.
1. "Job characteristics" are characteristics of a job generated by the user "Professional" based on their individual experiences (STEM Professionals take a survey describing their work experience in terms of the 4 dimensions of work structure, training and years of experience, and job title corresponding to title in O*NET).

        These records can be of 3 types based on the source of data:

                Survey
                Interview
                Survey and interview
        And have status "provisional" or "reviewed."

        The data can be added by the database administrator as a file upload or by users "STEM Professional." The Administrator also has the ability to review "provisional" records, and change their status to "reviewed."
        The survey data can be entered by the users "STEM Professionals" who complete the survey on the database website or upload a data file that was previously generated by completing the survey and saving results by the user. Every time the user uploads the survey results from a file or completes the survey, they are asked if they would like to add their data to the database. Contributing data is not required, but if the user agrees - their data is added to the database as a provisional record and they receive an expression of gratitude ("thank you" words on the webpage? fireworks or confetti?).
        Provisional self-reported record can be reviewed by the database administrator and provisional status changed to "reviewed." "Administrator" may also upload "job characteristics"

records as a file with record tagged "interview and survey" or "interview." In addition, special user "interviewer" may also upload these types of records under status "provisional."

       2. URE characteristics - compiled from individual student survey responses contributing data regarding the structure of their UREs, discipline and institutional context.

       3. O*Net job titles and occupational descriptions drawn from O*NET, labeled as STEM and non-STEM. When retrieving job titles, the user has the option to look only at STEM jobs or non-STEM jobs or both.

       4. User accounts for people interested in exploring careers and saving their history, as well as sharing their history with researchers. User account may contain

       1) one or more individual experience profiles (a job, an undergraduate research experience) that includes results from survey for one or more jobs or undergraduate research experiences (users may label each set of results with a label of their choice, for example "Cal Poly 2021-22 URE," Amgen summer URE, "Galapagos URE," "lab tech for Amgen," Postdoc, etc.),

       2) for each descriptor from the survey, the user may indicate and store preference rating and importance rating. The preference rating is on a 5-point scale for liking and disliking specific attribute e.g.1 = strongly dislike, 5 = strongly like), the importance rating is on three point scale (very important, somewhat important, not important).

       3). User accounts may also contain job title lists from searches of O*NET occupations based on specified criteria.

       4) user notes

Additional data that will be used, but not stored:
- URE description based on survey (uploaded into active session from a file)
- Individual preference and importance ratings for users who wish to use the database without creating an account.

Functionality

Users:

Student who completed a URE:

1. Participants will complete an online survey (outside of the website - due to IRB concerns related to research with human subjects). The survey will capture the nature of participants' experience in the URE or internship. Participants' responses will be "saved" and their individual results will be emailed to them and they will be asked to grant permission for their responses to be added to the public database to create a student-normed archive. (addition to the database will require QC…admin, ?)
2. Students' survey responses will be compared the the WDQ-aggregated URE profile of other research participants, providing students insight into the consistency between their own experiences and those of other URE participants. The reported benefits and outcomes associated with their URE experience also will be compared to the aggregate

benefits and outcomes associated with URE profiles associated with the same STEM discipline, work setting (e.g., lab, field, computer, field-education)
Students will gain insight into the consistency of their URE experience with contemporaries involved in similar research activities. Students will also gain insight into the perceived benefits of contemporaries involved in similar activities, and the consistency of their own perceived benefits with those experienced by their contemporaries. This insight addresses three important questions that individuals: making the time, energy, and effort investment to participate in a URE are likely to have:

> a) Was my URE experience typical or atypical relative to the normative experiences of similarly aged, similarly experienced cohort members participating in comparable UREs ?
>
> b) What kinds of outcomes and benefits do other student participants in UREs tend to have?
>
> c) Were the outcomes and benefits that I experienced as a result of my participation in a URE similar to or distinct from the outcomes and benefits reported by others, and what were those similarities and differences?

3. Students will be able to compare their own WDQ-URE profile to the WDQ-URE profile of STEM professionals in their anchored discipline. This will allow them to address two important questions associated with STEM persistence.

> a)How typical of the STEM-anchored occupational classification I'm potentially interested in pursuing was this URE experience?
>
> b) What STEM-anchored occupational titles matched or coincided with my preferences following this research experience?

4. Students will be able to compare their own WDQ-URE profile to anchored occupational titles from O*NET, and through determination of this matched correspondence identify what occupations in O*NET have similar characteristics to what I experienced? Students will also be able to identify what occupations in O*NET have similar characteristics to the attributes of the URE that I most preferred.

5. Participation in this research will also facilitate curated evaluation and reflection: Following participation, research participants will be in position to consider several important questions. a) Which dimensions or aspects of their URE experience did they either most like or most dislike. In light of these preferences, what kinds of future work experiences are most likely to allow participants to be involved in similar kinds of activities?
b) Which aspects of their URE participation are likely to be most directly related to their future job satisfaction?

6. Participation will also allow students to create what can be characterized as an "ideal profile". This would be accomplished by modifying their current profile to incorporate students preferences, and identifying occupational matches for some aspects of the URE and weighting these aspects more heavily, while essentially mitigating others by weighting these aspects less heavily. Importantly, again, because participants can go through the process iteratively they can update their preferences following subsequent URE experiences to identify more occupational categories that align with their maturing and evolving preferences and experiences.

Professional in a STEM job:

1. Complete the survey (WDQ-URE, specific context, [ideally job code - but how?], save individual results, and grant (or not) permission to add their data to the database to facilitate generation of a normative baseline .

   (If the future: if measures of job satisfaction/benefits are easily obtained - add them - to allow for reflection and comparison?)

   Add qualifier: self-reported or from interview

   Go onto 3-6 above

High school student or freshmen: considering internships or research experience or just future career: steps 5 and 6?

Software should:

1. Generate aggregate profile for all jobs with specific title or all research experiences based on the STEM discipline, identify attributes with low and high variability among individual entries from the same category.
2. Compare individual experiences to aggregate URE experiences.
3. Compare individual experience or job characteristics to "professionals" experiences
4. Compare individual experience or job characteristics profile to job descriptions in O*NET and return most similar on all attributes, or on "important" attributes. When matching based on preference rating and importance, maximize match for "liked" and important attributes, and minimize match for disliked and important attribute. Ignore matching based on the attributes that are not important.
5. Provide graphic visualization of aggregate profiles from #1 above.
6. Provide graphic visualization of similarities and differences upon comparisons 2, 3, 4
7. Provide links to O*NET job titles (so users can get more info).

Data

1. Student experience: Individual profile of the experience in URE based on survey completed by individuals

   The survey has four sections:
   > I. Characteristics of undergraduate research experience (URE)
   > II. Work-Design Questionnaire (WDQ) for URE
   > III. Outcomes of URE participation

2. STEM Professional background info and WDQ profile
   > Background info includes: discipline, years of experience (? year BS, MS, PhD was earned and current year?), job title from O*NET, type of organization (industry - start up, small company, large company, academia: carnegie classification? Government agency?

3. Job titles with a set of descriptors from O*NET database
(Occupational Information Network job analysis database:
https://www.dol.gov/agencies/eta/onet)

Mapping between O*NET descriptors and WDQ is here (Dan's spreadsheet)

Use Case
1. A user "STEM Professional" on either a PC or a mobile device opens an email and clicks on a URL.
2. The URL houses a "survey". The user works his/her way through the survey questions – as outlined in discussion and content documentation.
3. Embedded within the content of the survey are a set of "items" reflective of the structure of a URE experience/Internship experience, etc. – as outlined in the course discussion from 4/5/2022.
4. The responses that the user provides to these "items" take two forms.
    a. A report of the experience that the user had in the URE
    b. A "wish list" of most preferred/most important attributes of the URE
5. Reported Experience
    a. Based on attributes of the experienced URE, the user is provided with a list of STEM occupations that correspond with these attributes. This list gives users insight into the ways in which his/her experience correspond with a range of different STEM occupations. These occupations will populate a report reflective of the user's experience.
    b. Based on the "wish list" of most preferred/most important attributes of the URE, the user is provided with a list of STEM occupations that correspond with these attributes. This list gives users insight into the kinds of STEM occupations he/she might pursue, given lived experience and preferences for various aspects of this lived experience. These occupations will populate a report reflective of the user's preferences.
6. The user will be able to use a "slider" tool for these URE attributes to change his/her preferences. A consequence of changing his/her preferences will be an updated list of STEM occupations, which will populate the report reflective of the user's preferences.
7. The user will be able to download and save a digital list of occupations derived from his/her preferences
8. The user will be able to download sand save a digital list of preference settings.
9. The user will be able to save his/her "profile", and come back to the interface at a later date, with his/her previous preferences saved in the interface.

10. Best case - the list of STEM occupations will be "grouped" based on required educational attainment necessary for the occupation - this information is available in O*Net - i.e., College Degree, Master's Degree, Doctorate

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Table: field /description details

[need to add]

WDQ:
Job Characteristics Profile based on WDQ: numeric score [None, 1-5?] for each of the categories below, average score based on 3-6 survey items

Task Characteristics
Autonomy
 Work Scheduling Autonomy
 Decision-Making Autonomy
 Work-Methods Autonomy
Task Variety
Task Significance
Task Identity
Feedback from Job

Knowledge Characteristics
Job Complexity
Information Processing
Problem Solving
Skill Variety
Specialization

Social Characteristics
Social Support
Interdependence
 Initiated Interdependence (others depend on you)
 Received Interdependence (your work depends on others)
Interaction outside the Organization
Feedback from others

Work Context
Ergonomics
Physical Demands
Work Conditions
Equipment Use