**2. Research Studies**

**Study 1 – South East Hub:** **Institutional Factors and SWD Persistence**

While student participation in the Bridge Model will be examined as part of the evaluation, this research will further examine key constructs in relation to SWD institutional commitment, persistence, and retention. This research study is focused on SWD persistence and is based on decades of research on student persistence (Reason, 2009) and research using social cognitive career theory (SCCT) to examine persistence among students with disabilities (Cardoso, et. al., 2013). The study will examine two primary research questions:

RQ1: What is the relationship between student background experiences and dispositions (e.g. student demographics, family background, motivation, academic efficacy) and persistence for students with disabilities (SWD)?

RQ2: After controlling for student characteristics and dispositions, what is the relationship between organizational context factors and student experiences on student institutional commitment, persistence, and academic retention?

**Sample.** The primary sample will be SWD from each TAPDINTO-STEM alliance site, representing varying institutional contexts (public/private, 2 year/4 year, HBCU/MSI/PWI) so that such critical contextual factors can be examined. In addition to this sample of SWD, samples of students without disabilities will be drawn from two other NSF-funded projects (LSAMP, S-STEM). This creates a valuable opportunity to determine the extent to which the factors related to student persistence and retention differ for students with and without disabilities.

**Instrumentation and Data Collection.** Student characteristics such as age, gender, race/ethnicity, disability, and family background (e.g., parents’ level of education) will be examined to determine their relationship with SWD persistence. In addition, other student experiences and dispositions will be examined. These include academic preparation and prior performance, academic efficacy, goal orientation, motivation, social connection, and overall commitment to persistence in STEM degree programs. Organizational factors such as size of program and institution, mission focus (research and/or teaching), admission selectivity, and sources of support (teaching or research assistantships, loans, and stipends) will also be examined. Finally, the peer environment will be examined. These variables include student perceptions of the campus climate and culture, their interactions with faculty, involvement in student groups or organizations and participation in curricular experiences such as orientations and seminars.

The researchers will draw from several survey scales they have used as part of a prior RDE project and current INCLUDES project (Dunn, et. al, 2018, in press). These surveys include measurement scales constructed to represent the constructs of interest in STEM careers, issues and challenges faced in college, self-advocacy knowledge and behaviors, academic efficacy, and intention to persist in their degree program, with all scale reliability estimates exceeding .70. An additional survey, focused on aspects of the mentoring process (interpersonal growth, level of support, communication, engagement, and overall satisfaction) will be used and has yielded supportive reliability estimates greater than .85. Finally, the researchers will use the College Persistence Questionnaire (Davidson, Beck, & Milligan, 2009; Davidson, Beck, & Grisaffe, 2015) The CPQ includes 10 constructs as indicators of college student persistence. Reliability estimates have been very supportive with an overall scale reliability of .858 and a median subscale reliability of .734.

**Data Analysis.** Multivariate procedures of structural equation modeling (SEM) and multivariate analysis of variance (MANOVA) will be used. Structural equation modeling (SEM) will be used to determine factors that influence student institutional commitment, persistence and retention for SWD. The model fit results will be evaluated using several criteria, including significance by using a chi-square test (p > .05), Comparative Fit Index (CFI) > .95 (Bentler, 1990; Byrne, 1999) and the Root Mean Square Error of Approximation (RMSEA) < .08 (Browne and Cudeck, 1993). Once a final model is determined, it will be applied to groups of students with and without disabilities to determine the comparability of fit across these groups. The context of an HBCU will also be critical as prior research has demonstrated that attending a HBCU has positive impact on African American students (Pascarella & Terenzini, 2005), so additional models will be examined over varying contexts (e.g., HBCU vs. MSI and PWI). In addition to SEM, a mixed MANOVA will be used to examine longitudinal changes for multiple groups (SWD and SWithoutD) on the multiple factors related to student persistence.

**Study 2 – Northeast Hub: Impact of student support services on academic, social, and employment outcomes for STEM college students with ASD**

**Purpose.** This study aligns with the Alliance goal of increasing STEM degree completion for students with ASD by examining students’ use and perceptions of support services provided by either the STEM department or disability services. College SWD who use a variety of support services are significantly more successful in completing college (Newman, Madaus, Lalor, & Javitz, 2019). Also, STEM students with ASD are more likely to enroll in two-year community college programs. According to the NLTS2 (Newman et al., 2011), 81% of students with ASD enroll in two-year community colleges. Students with ASD are more likely to persist in two-year programs and are twice as likely to transfer to 4-year colleges than their peers in non-STEM majors. One-third (33.1%) of young adults with ASD chose a STEM major whereas 22.8% of the general population chose a STEM major (Wei et al., 20012; Wei et al., 2013). This research study will examine the use and value of support services aimed at improving SWD academic and employment outcomes. Services focused on academic outcomes will include tutoring services provided by STEM departments and private tutors, disability support accommodations (extended time, distraction free environment for testing, notetakers, etc.) and assistive technology (speech-to-text; text-to-speech; electronic notetaker pens; etc.). Support related to social outcomes will include peer mentoring and mentoring by teacher/faculty member, social skills instruction and life coaching with a trained facilitator. Employment focused support services include career services (career fairs, stipends, job placement services, job coaching services etc.) and services provided by disability services/organizations (campus disability office, VR – job placement services, job coaching services). All support services will be examined in order to identify those most valued by SWD and the extent to which such services should be tailored to students with different types of disability. Finally, use of these services will be examined in relation to academic, social and employment outcomes.

**Research Questions:** Two main research questions will be addressed:

RQ1: What support services used by students with ASD that promote their academic success?

RQ2: Which academic, social and employment experiences are correlated with increased employment outcomes?

**Research Design.** A mixed-methods design is proposed, in which quantitative analyses addressing RQ1 and RQ2 are employed concurrently with qualitative analyses to triangulate the intensity and duration of support services used with students’ success. More specifically, correlational methods will be used to examine the use of support services, success in STEM degree programs and employment outcomes. In addition, the study will include secondary analysis of the *AccessSTEM/AccessComputing*/*DO-IT Longitudinal Transition Study (ALTS)*database (Study 6) to analyze the relationship of use of support services (duration and intensity) with academic and employment outcomes.

**Sample.** The sample will include five students with ASD from each of 26 partner institutions for a total of 130 students. We will also randomly select 10 students each year (30 students overall) for individual interviews (see Measures), which should provide subsamples representative of the overall sample in terms of student background characteristics and academic motivation.

**Measures.** Demographic variables will be collected on the application for STEM stipends provided by the project. An online student questionnaire that supplements the ALTS survey/interview and a structured interview protocol will be developed. Other student outcome variables, as well as student covariates, will be measured using an online questionnaire for each SWD, and for a subsample of 20 students three times over the five-year project, a structured individual interview. Institutional/program variables will be measured using an annual written questionnaire and a structured interview administered to faculty leads at each institution. The questionnaire will consist of selected-response and open-ended questions about the characteristics of their Alliance programs, including types and amounts of supports available to students with disabilities. The structured interview will be audio-recorded and transcribed.

**Quantitative and Qualitative Analysis**. Qualitative data will be obtained from student and faculty interviews and open-response questionnaire items. Project researchers will code transcribed interview responses and questionnaire responses to identify recurrent themes and calculate inter-rater reliability using Krippendorf’s alpha. Quantitative data will be analyzed through descriptive statistics, correlations, analysis of variances to examine differences between subsets of participants, and stepwise regression to identify academic services and experiences contributing the most to student success and employment.

**Study 3 – Mountain Hub: Bias, Discrimination, Stigma, and Intersectionality**

This study aligns with the Alliance goal of increasing STEM degree completion for students with disabilities by describing barriers and challenges to student success in STEM through an intersectionality lens. Intersectionality theory is inclusive of individual factors associated with holding membership in multiple and often intertwined social as well as the relational and systemic dynamics of power that can lead to bias, stigma, and discrimination (Atewologun, 2018; Cho, Crenshaw, & McCall, 2013; Severs, Celis, & Erzeel, 2016). Since originating in the 1990s (Crenshaw, 1990), an intersectionality lens has been applied broadly across disciplines, including higher education. However, disability has not widely been considered as an element of intersectionality in higher education (Nichols & Stahle, 2019).

**Research question.** This study aims to answer one overarching research question: “Using an intersectionality lens, what are the disconnections and gaps between (a) the experiences of post-secondary STEM students with disabilities related to bias, discrimination, and stigma, (b) information and messaging available to IHE faculty and staff pertaining to inclusion and recognizing intersectionality, and (c) IHE faculty and staff perceptions that perpetuate bias, discrimination, and stigma?

**Method.** A sequential transformative mixed methods approach (Creswell & Creswell, 2017) will be used beginning with a qualitative phase followed by a quantitative phase. Across phases, intersectionality dimensions will include disability, gender, race, ethnicity, social class, sexuality, religious affiliation, family status, age, and place-based identity sorted by zip code.

***Qualitative phase.*** The qualitative phase will involve two data collection approaches. A PhotoVoice approach (Nykiforuk, Vallianatos, & Nieuwendyk, 2011) will be used for gathering student with disabilities perspectives of situations in which they feel bias, stigma, discrimination, or other feelings indicative of imbalance of power. Across Alliance hubs, 20 undergraduate and 20 graduate STEM students with disabilities will participate in the PhotoVoice element of this study. The other qualitative data will be extracted through a document review of information made available to IHE personnel pertaining to diversity, inclusion, and recognizing intersectionality. The qualitative data will be analyzed to inform the development of a survey to be administered in the quantitative phase.

***Quantitative phase.*** During the quantitative phase, two surveys will be distributed with a goal of 200 responses for each survey. One survey will be distributed to students with disabilities in STEM undergraduate and graduate education at hub institutions, including students who are who are not involved in any Alliance activities. The second survey will be administered to IHE staff at hub institutions. The purpose of the quantitative phase is to (a) gather perspectives more widely than what is feasible through qualitative methods, (b) test parameters of intersectionality that correlate with systemic and relational variables, and (c) produce results more generalizable across institutions to inform program improvements.

***Analysis.*** As a sequential approach, analysis of qualitative data will inform the quantitative phase. At the end of quantitative phase, all data, including revisiting the qualitative data will be analyzed in response to the research question. Using descriptive statistics, correlations, and analysis of variances, the quantitative data will be analyzed to address the research question. The findings will then be affirmed or challenged by the qualitative data. The mixing of this data will increase the depth of the response to the research question as well as inform future research on survey methods using an intersectionality lens in post-secondary contexts. A research team, including the Alliance leadership team and led by the Mountain hub PI, will convene prior, during, and after each phase of the research to design research protocols and interpret findings.

**Study 4 – Midwest Hub: Student Success Programs Through the Lens of Completion by Design’s Loss/Momentum Framework**

**Purpose.** This study aligns with the Alliance goal of increasing STEM degree completion for SWD by better understanding the mechanics of success for students with disabilities. The study will use The Loss/Momentum Framework (Completion by Design, 2018; Gill & Harrison, 2019; Howell et al, 2019; Jenkins et al, 2018; Martinez & Munsch, 2019) to examine how the student success supports each institution implements either aids or does not aid reaching each critical juncture for students with disabilities: access, entry, progress, completion, and transition. While Completion by Design’s Loss/Momentum Framework initially focused on community college systems, it is now used to support educators in designing each step of students’ pathways to completion by examining loss points and momentum strategies. Knowledge gleaned from the study will be available for TAPDINTO-STEM Alliance partners for mid-course adjustments and ultimately to discover how well-known interventions like mentoring, applied in combination with other success programs, lead to innovations that improve degree completions for SWD STEM majors.

**Research questions.** Two main research questions will be addressed:

RQ1: Does the student success model each institution implements increase the access, entry, progress and completion of students with disabilities to its programs? If so, how?

RQ2: Does the student success model each institution implements aid the transition of students with disabilities from college to occupation and/or career? If so, how?

**Research Design.** A concurrent triangulation mixed-methods design is proposed, in which quantitative analyses addressing RQ1 and RQ2 are employed concurrently with qualitative analyses to triangulate the phenomena of interest (i.e., the impacts of the loss/momentum model) (Cresswell, 2013). More specifically, correlational methods will be used to examine which SWD success model components will be associated with changes from the beginning of the program to the end in the postsecondary access, entry, progress, completion, and transition. In addition, the moderation effects of several student and institutional variables on the associations between SWD success program factors changes in student outcomes over time will be tested.

**Sample.** The primary sample will include SWDs and project personnel from each TAPDINTO-STEM alliance site, representing varying institutional contexts. We will also randomly select 20 students each year (60 students overall) for individual interviews (see Measures), which should provide subsamples representative of the overall sample in terms of student background characteristics and academic motivation.

**Measures.** Most student outcome variables will be measured with data available from the institutions, such as admission to a program, credit hours and semesters completed, graduation, and time and semesters to graduation (IPEDS data and data pertaining to SWD STEM majors). Other student outcome variables, as well as student covariates, will be measured using an online questionnaire for each SWD, and for a subsample of 20 students three times over the five-year project, a structured individual interview. Institutional/program variables will be measured using an annual written questionnaire and a structured interview administered to project leads at each institution. The questionnaire will consist of selected-response and open-ended questions about the characteristics of their Alliance programs, including types and amounts of supports available to students with disabilities. The structured interview will be audio-recorded and transcribed.

**Quantitative and Qualitative Analysis**. The research questions involve three levels of nested measurement—student at Level 1, institution at Level 2, and at Level 3 the relationships among several variables at each level, including cross-level interactions (e.g., types of institutional support for students with disabilities and number of semesters to graduation). In addition, several outcome variables will be categorical in nature (e.g., admission to degree program, number of semesters to graduation). Therefore, statistical analysis will be conducted with hierarchical generalized linear modeling (HGLM), which can model categorical data with multilevel structures (Snijders & Boster, 2012). A research team will code open-ended questions and transcribed interview responses and will identify recurrent themes. The team will assess inter-rater reliability using Krippendorf’s alpha (Hayes & Krippendorf, 2007). Selected-response option items that can be aggregated into composite scales will be assessed for internal consistency reliability using Cronbach’s alpha, and for dimensionality using exploratory factor analysis.

**Study 5 – Islands Hub – Research in Disabilities in a Multicultural Setting**

**Purpose:** This study focuses on students with disabilities (SWD) and the unique issues of culturally and linguistically diverse (CLD) SWD (i.e., Native Hawaiian, Pacific Island, and Asian American students) as there is a continued issue of access for these subset of students (King, 2009; National Academies of Sciences, Engineering, and Medicine, 2016). The study will be conducted in stages. In Year 1, we will investigate factors (e.g., historical, social, cultural, disability, and other personal factors) that facilitate or impede students’ attitude toward and access to postsecondary education and STEM, identity development in STEM, and persistence towards and graduation with a STEM degree to understand the students’ needs, conditions, and circumstances. Then, in considering those factors and different educational stages students are in, we will identify effective strategies to develop a tailored bridge and mentoring activities (e.g., e-mentoring, internship, course guidance, research support, student-family activities) appropriate to individual students’ needs, conditions, and circumstances. Subsequently, from Year 2, we will provide a personalized menu of mentoring activities tailored to specific SWD to support their retention and graduation.

**Research Questions (RQs): RQ 1 (Year 1):** What factors (e.g., historical, social, cultural, disability, and other personal, historical factors influence (facilitate or impede) the development of students’ attitude toward and access to postsecondary education and STEM, identity development in STEM, and persistence towards and graduation with a STEM degree? **RQ 2 (Year 1):**  Considering identification of those influencing variables and educational stages students are in, what bridging and mentoring strategies impact positively upon their access, retention, and graduation in STEM fields? **RQ3 (Years 2-5):** Based on the results of RQ1 and 2, to what extent, and how do the personalized menu of bridge and mentoring activities influence the students’ access, retention, and graduation?

**Sample:** In Year 1, 300 SWDs will be surveyed. Year 2-5, 16 students, totaling 64 students will receive a stipend and intervention.

**Methods:** A mixed methods study approach (Creswell & Creswell, 2017) will be used to address the research questions. For RQ1, a student survey will be developed building upon the ALTS questionnaire and administered to SWDs enrolled in the University of Hawaiʻi system campuses. A multivariate analysis will be used to analyze the quantitative data, and a content analysis will be conducted to analyze the qualitative data. The results will be used to develop a focus group questionnaire for RQ2. For RQ2, a stakeholder/expert (dual enrollment counselors, University Student Services (advising, counselors, bridge program, disability services office, facilities/dorms, STEM instructors, SWDs, families of SWDs, faculty with disabilities) interview/focus group will be conducted, and a content analysis will be conducted. The results will be utilized to develop a personalized menu of tailored mentoring activities. For RQ3, a student survey and focus group as well as a transcript analysis will be conducted with the student participants, including students receiving the project stipends, to triangulate the data sources to determine the effectiveness of the personalized mentoring. Using the results, we will develop a STEM success profiler for CLD SWD at different educational stages.

**Intellectual Merits & Broader Impact:** The STEM success profiler will be useful for the stakeholders and experts, listed in RQ2, to assess and guide culturally and linguistically diverse SWDs to access and persist in and graduate from a STEM degree program. In addition, the survey results of various factors will help researchers and practitioners understand the diverse needs and conditions of the sub-groups of students. Further, this will ultimately increase diversity and enhance the infrastructure in postsecondary STEM and in the STEM workforce.

**Study 6 – West Coast Hub: Longitudinal Transition Study of NSF-funded Students with Disabilities**

A longitudinal research database regarding characteristics, activities, and academic and career progress of individuals with disabilities was created with earlier NSF funding (*AccessSTEM1* RDE award #HRD-0227995). Participants in the *AccessSTEM/AccessComputing*/*DO-IT Longitudinal Transition Study (ALTS)2* are interviewed at multiple points in time to document the progress of respondents through critical junctures toward postsecondary degrees and careers. Recruited through their participation in activities, respondents are interviewed in person, by email, and/or by phone. Their records are added to an online database. The ALTS database is analyzed by an external evaluator.

Since this is a longitudinal database, project staff strive to re-interview TAPDINTO-STEM participants every other year. Additionally, records are updated between interviews with information gathered through other participant contacts. Areas of collected outcome and impact data include transition steps; enrollment and success in high school and college; academic progress; persistence and success in securing undergraduate and graduate degrees, and employment; accommodations and supports used; and participation in work-based learning, mentoring, and other activities. The study is designed in such a way that respondent content can be updated and data can be analyzed at any time. The “on track” status of students is determined as they progress through critical junctures that lead to degrees and careers in science, technology, engineering, and mathematics (STEM), recognizing that at any point some respondents in the study are still enrolled in secondary school or are recent high school graduates.

This hub will use the framework of the ALTS study to examine the educational and career achievements of Research in Disabilities Education (RDE) Alliances and SEAPD-STEM DDLP graduates. In determining educational and employment achievement, this study will determine the perceived value of the interventions (e.g., Bridge Model, e-mentoring, internships). All student participants in the Alliance will be invited to participate in the ALTS study. Specific research questions related to Alliance interventions include:

RQ1: Which interventions are regarded as most valuable?

RQ2: Are patterns evident linking student demographics or interests with the intervention(s) used and their perceived value, or with student pathways?

RQ3: Is there evidence of how interventions might be improved or expanded to be more beneficial or more broadly beneficial?

The progress of ALTS respondents is compared with national3-6 data for example participants in the National Longitudinal Transition Study-27 (NLTS2) (SRI International, 2001-2011). Although ALTS participants were not randomly selected and the two groups are not identical in characteristics, both groups are composed of college-bound youth with a wide range of disabilities and interests.

This study will report findings on the extent to which participant characteristics and participation in peer mentoring and the Bridge Model influenced the number of Students with disabilities persistence in STEM degree programs. Findings from this research will also be submitted for presentation at national and international conferences and leading research journals in the field. Results from this research will also be disaggregated and disseminated by gender, ethnicity, disability, and foreign-born, as long as the sample size for each subgroup permits anonymity to be maintained. Such disaggregated findings will have implications for the recruitment and preparation of future students with disabilities in STEM degree programs. Furthermore, all de-identified TAPDINTO-STEM student data will be accessible to alliance partners and a national longitudinal database from the TAPDINTO-STEM project will be established.