Intersections in Assessment

NOVEMBER 2022

NATIONAL CENTER FOR
SCIENCE & CIVIC ENGAGEMENT
NCSCE

Institute for
Learning Innovation

Abstract

This NSF IUSE funded project explored the potential of evaluation and learning assessment methods utilized in Free-choice (Informal) science learning (ISL) settings such as zoos, museums, and citizen science programs, to inform new approaches to Higher Education assessments. Approaches to assessment in Higher Education (HE) Science classrooms is currently being reconsidered as assessment experts and classroom instructors seek more meaningful and inclusive methods of understanding what learning is happening, and how to make learning more apparent to students and instructors alike.

Free-choice learning environments are very different from classroom settings. The non-captive audience is significantly more diverse in terms of age, previous knowledge and experience. Learning experiences may be only seconds long. Evaluation techniques in these settings have been developed to largely be activities or interviews and often just moments long. As well, the definition of learning in these informal settings values changes in attitude, interest and behaviour (affective changes) at the same level of importance as changes in knowledge or skill (cognitive changes).

Bringing seven recognized experts in HE assessment together with six experts in informal science learning evaluation and research for conversation and exchange resulted in the identification of key cultural differences between the two settings, new understandings of methods used in ISL assessment, and the development of ideas about how the body of knowledge of ISL assessment might inform improved HE assessment, with further study.

This report includes the comprehensive review of the conference proceedings, an annotated bibliography of the preparatory readings, final recommendations for future investigation and the conference evaluation report. Further dissemination through a shorter article and future conference sessions is planned. Key findings of this conference are:

Key Finding 1: *The cultures of HE and IE are different and these cultures shape what is assessed and how that is measured.*

Key Finding 2: *In informal education, assessment of any resulting change in individual learners is used as a measure of the impact and/or efficacy of the offering, whereas knowledge acquisition (content knowledge) remains a major focus of what is measured in higher ed.*

Key Finding 3: *There are far fewer repercussions for ISE team members when negative findings are identified from evaluation. Thus, a blend of assessment and program evaluation are more deeply embraced and utilized in ISL than in HE.*

Key Finding 4: *In ISL environments evaluation/assessment is the evidence that the museum is delivering on its mission.*

Despite our differences in culture and language, we discovered we have much in common. Our goals and aspirations for assessment are the same. These two siloed bodies of knowledge, if integrated, could help us measure what we wish to measure, align our assessments with our missions and goals, and help us demonstrate with data and evidence that we are delivering on our promise and our offerings.

Suggested Citation for this report:

Koke, J, and Smyth, D.S (2022). Intersections in Assessment: A Conference Report. Institute for Learning Innovation.

http://www.instituteforlearninginnovation.org/wp-content/uploads/2023/02/IUSE-Intersections-in-Assessment-Report.pdf

Co-Investigators,

Judith Koke and **Dr. Davida Smyth**

Table of Contents

Introduction

Higher Education is increasingly concerned about the use and effectiveness of assessment - whether methods are assessing what we think they are, or if we are, in fact, assessing the right things. Exams, particularly multiple-choice exams, while easier to administer for overburdened faculty with large class enrolments, are mostly designed to measure retention of knowledge rather than application, integration, and impact. Even when science fields have demonstrated effective new approaches in gateway courses such as introductory biology and chemistry (Carmichael et al., 2016; Drinkwater et al., 2017; *Evaluating the Evidence Base for Evidence-Based Instructional Practices in Chemistry Through Meta-Analysis – Center for Education Innovation and Learning in the Sciences*, n.d.; Lewis & Lewis, 2007), there remain several critical barriers to the widespread implementation and adoption of new assessment methods. Both instructors and students lack clarity and understanding of what is being learned (broadly defined), and how that learning is indeed influencing the student's ability to participate actively as contributing citizens.

In the world of Informal Science Learning (ISL) the broad diversity of audiences served at any one moment has required the development of unique assessment tools to describe the impact and outcomes of science programming and exhibitions. In response to the Government Performance and Results Act of 1993 (GPRA) and the ensuing emphasis on outcome-based evaluation, ISL evaluators and researchers heightened their focus on the development and validation of assessment tools that move beyond the acquisition of curriculum-driven knowledge and skills to include metrics that describe changes in science identity, science capital, interest and behaviors and perceptions of relevance to individual's lives and communities. In the twenty-five-plus years since GPRA, NSF-funded Advancing Informal STEM Learning (AISL) projects have supported and refined this work and shared it through the NSF-funded Center for the Advancement of Informal Science Education's site, as well as through the Visitor Studies Association, and their peer-reviewed journal *Visitor Studies*.
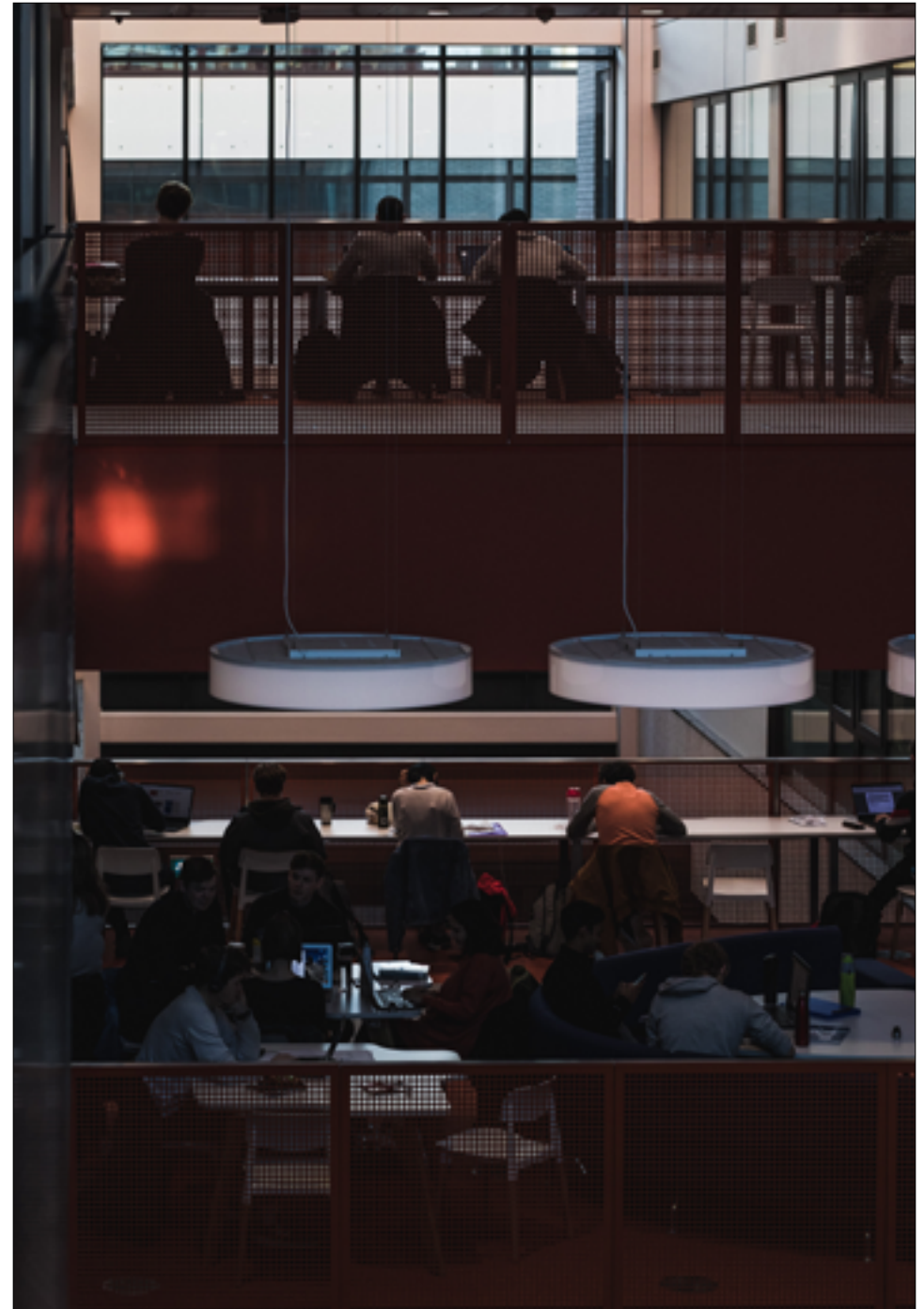
Why might assessment in HE institutions benefit from exploring ISL approaches?

The value, role, and purpose of student assessment in higher education continue to be a hotly debated topic among educators and educational leaders across the country (Carless, 2015; Gilles et al., 2011). Three key concerns regarding the efficacy of HE assessments are often referenced in the literature:

- *Are we assessing what we need to assess?* There is concern that the methods we are using to assess students are not entirely linked to student learning (Carless, 2009; Douglas et al., 2012; Trevelyan & Wilson, 2012; Webber, 2012). Most worryingly, several studies have raised the question as to whether or not there is gender bias in the way we format our assessments (Bolger & Kellaghan, 1990; DeMars, 1998; Simkin & Kuechler, 2005).

- *Faculty still lack education and training in assessment.* There is a pressing need to increase faculty commitment to the effect assessment can have on student learning and the role it can play in making effective changes in higher education (Postareff et al., 2012).

- *Faculty ambivalence regarding assessment.* Research has shown that educators do not always link assessment to the quality of their practice or to student learning (Postareff et al., 2012). Instead, they view assessment as a practice that signifies evaluation and the formation of grades (Sambell et al., 2012; Torrance, 2012). Faculty view assessment primarily as a punitive practice, tied to their promotion and hence, tenure and fear and mistrust, rather than seeing its value and purpose of providing actionable feedback to both students and faculty.

Together, these challenges contribute to a sense that assessment is a task or chore, rather than a useful tool that can support both students and their teacher in understanding how learning is occurring, better understanding the impact of teaching methods, and how to adjust classroom and study methods for improved performance.

In the past 30 years, ISL researchers have designed and validated effective assessment methods and instruments for environments where participants begin and end in different places, where there are **non-captive** populations unwilling to spend long amounts of time filling in forms and taking tests, and in which learning is understood quite broadly (by NSF's Division for Research on Learning) as a change in awareness, knowledge, behavior, interests, attitudes, and skill (*Framework for Evaluating Impacts of Informal Science Education Projects | InformalScience.Org*, n.d.). These methods focused on:

- The importance of front-end work to better understand the audience's "entrance narratives" and formative tools used during the development of experiences to ensure clarity and efficacy.

- The impact of participation in programs and experiences on participants' knowledge, interests, and awareness; often over extended time frames ranging from weeks to years post-experience.

- The subsequent or resulting use of ideas, science processes, and skills; and

- Subsequent changes in science confidence, science identity, and science participation.

As well as providing feedback about outcomes and impacts of carefully crafted learning opportunities, these studies offer ISL educators new information about how to shape future offerings, in an environment where participants are intrinsically motivated and may well choose not to participate.

Science Education Shifts

A changing world is redefining the skills that students require to work in and contribute to society (Levy & Murnane, 2005; Stewart, 2010; Wilmarth, 2010). In addition to core subject knowledge, the National Science Teaching Association has acknowledged the inherent and strong connection of many 21st-century skills with science education:

Science education reform focuses on fostering deep content knowledge through active intellectual engagement and emulating disciplinary practices and thinking, and 21st-century skills focus on developing broadly applicable capacities, habits of mind, and preparing knowledge workers for a new economy (Windschitl, 2009). Exemplary science education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy especially when instruction addresses the nature of science and promotes use of science practices. These skills not only contribute to the development of a well-prepared workforce of the future but also give individuals life skills that help them succeed. Through quality science education, we can support and advance relevant 21st-century skills, while enhancing science practice through infusion of these skills.

As we incorporate new pedagogy and curricula, effective assessment only increases in importance and complexity. ISL assessment techniques have already made the leap from measuring traditional content knowledge and skill acquisition to assessing the broader aspects of learning as detailed in discussions of 21st Century Science Learning (AACU (2007; Mishra & Kereluik (2011); NAE (2004); Partnership for 21st Century).

A National Research Council's consensus report (NRC, 2009) suggested that ISL measures should typically be organized into 6 strands (*Learning Science in Informal Environments: People, Places, and Pursuits | InformalScience.Org*, n.d.):

- **Interest:** Sparking & developing interest & excitement
- **Understanding:** Understanding science knowledge
- **Attitude:** Understanding science as part of everyday life and being motivated to participate
- **Engagement:** Actively participating in scientific reasoning and practice
- **Identity:** having personal connections with science and science enterprise
- **Science Capital** – the degree to which my life is science aware and rich.

Each strand is a proven influencer of effective science learning, and measures have been developed to identify the presence and change in each strand. Their utility for HE educators in understanding how well students are prepared for and connecting with learning goals, particularly among minority, underrepresented, and female students could prove invaluable.

The SENCER Context

Science Education for New Civic Engagements and Responsibilities (SENCER) was initiated in 2001 under the NSF's Course, Curriculum, and Laboratory Improvement national dissemination track. In brief, SENCER works to teach STEM through a focus on complex civic challenges that are relevant and of interest to students. SENCER's goals include increasing the interest of and engaging more students in science, helping students connect science learning to their other studies, and strengthening students' understanding of science and their capacity for responsible citizenship. The philosophy of SENCER is grounded in four main ideals:

1. SENCER connects science and civic engagement by teaching "through" complex, and unsolved public issues "to" basic science.
2. SENCER invites learners to put scientific knowledge and methods to immediate use on matters of relevance to them.
3. SENCER reveals both the power and the limits of science in addressing the great challenges of our time.
4. SENCER helps all learners connect civic issues of local concern to national and global "grand challenges."

SENCER has established formal projects designed to develop and implement SENCER courses with teams that have included thousands of educators, administrators, and students from more than 500 two- and four-year colleges and universities, non-governmental organizations, government agencies, educational associations, informal education venues, and community-based organizations. Committed faculty have moved beyond STEM content to include those from the humanities.

SENCER has been designated a Community of Transformation in its ability to scale science reform by the Pullias Center for Higher Education at the University of Southern California (Kezar & Gehrke, n.d.) and was specifically identified in AAAS's Levers for Change (Levers for Change, n.d.) report as an exemplar. As part of their effort to improve undergraduate education, the 2019 SENCER Summer Institute held a pre-symposium session on student assessment, a resulting insight from these cross-sector initiatives was that HE institutions may well find utility and solutions to their current assessment challenges by potentially adapting strategies and tools derived from informal learning research and evaluation.

In this context, the need for SENCER faculty to integrate alternative approaches to assessment is critical as instructors want to learn more about how this approach impacts students beyond content acquisition. The outstanding question then, was, which methods can be used to gather the data required for new understandings while minimizing the time and effort of data collection, grading, and interpretation?

The Project

This online conference convened a group of 13 Science Learning Assessment experts (seven from the Higher Education (HE) assessment field and six from the Informal Science Learning (ISL) assessment field) to explore how proven ISL assessment approaches may inform assessment methods in higher education. Its intended goals were:

1. Identify ISL assessment approaches and tools that seem well poised to benefit HE faculty and contribute to better HE assessment.
2. Develop a strategy to incorporate and test some aspects of key ISL assessment techniques to improve student assessment in higher education settings, in order to measure their actual impact, contribution, and efficacy.

SENCER
SCIENCE EDUCATION FOR NEW CIVIC ENGAGEMENTS AND RESPONSIBILITIES.ORG

How Participants were selected

This conference was a working meeting, planned and led by Co-PIs Judith Koke and Dr. Davida Smyth. Twelve participant experts were chosen by their diverse areas of assessment expertise, their publication history, and their experience with diverse organizations and engaging diverse audiences/students. In each case, the PIs held significant conversations with these individuals, who each expressed their strong interest and confidence in the value of this work. To review the backgrounds of each participant, please see Appendix A.

Higher Education Assessment Experts

1 Dr. Jay Labov: former Senior Advisor for Education and Communication for the National Academies of Sciences, Engineering, and Medicine

2 Dr. Eliza Reilly: Executive Director of the National Center for Science and Civic Engagement.

3 Dr. Yao Hill: Assessment Specialist for the University of Hawai'i at Manoa Assessment Office

4 Dr. Helen Chen: Research Scientist, Designing Education Lab, Stanford University

5 Dr. Kate McConnell: Vice President, Curricular and Pedagogical Innovation, American Association of Colleges and Universities.

6 Dr. Jeffrey Olimpo: Assistant Professor at The University of Texas at El Paso. Expert in Classroom Undergraduate Research Experiences (CUREs) and ethical conduct of research.

7 Dr. Monica Devanas: Director, Faculty Development and Assessment Programs, Rutgers University

Free Choice Learning Assessment Experts

1 Dr. John Falk: Founder and Principal Researcher, Institute for Learning Innovation and Emeritus Professor, Oregon State University.

2 Dr. Tina Philips - Assistant Director, The Cornell Lab of Ornithology. Expert in Citizen Science and Assessment

3 Dr. Joseph Heimlich - Sr. Director of Research, Professor and Director, COSI Center for Research and Evaluation; Professor Emeritus at Ohio State University.

4 Elizabeth Kollman - Director, Research and Evaluation, Boston Museum of Science.

5 Dr. Deborah Wasserman, Senior Researcher, COSI Center for Research and Evaluation, PI of ISEE project.

6 Dr. Martin Storksdieck, Professor and Director, The STEM Research Center, Oregon State University

Project Leadership and Supporting Personnel

Judith Koke, Co-PI, Deputy Director, Institute for Learning Innovation

Davida Smyth, Co-PI, Associate Professor of Microbiology, TAMUSA, Deputy Director National Center for Science and Civic Engagement

Dr. Eliza Reilly, Executive Director of the National Center for Science and Civic Engagement (NCSCE)

Destiny Guerra, Undergraduate student, Water Resources Science, and Technology Program

Casandra Maldonado, Undergraduate student, Water Resources Science, and Technology Program

Marcel Robitaille, Graduate Student, University of Toronto, Master of Museum Studies.

Organization of the Conference and Sessions

The Conference was originally planned to convene online in the fall of 2021. Due to Co-PI Dr. Smyth's relocation to a position in a different state, the program officer agreed to a change in schedule. The meeting was delayed and convened online in the spring of 2022. It was amended for a digital platform; the basic working conference design had been developed, and successfully implemented, on multiple occasions by the Institute for Learning Innovation. The key aspect of these meetings was that they are working meetings. Built into the design was the creation and dissemination of tangible products post-meeting. The goal was to build upon the knowledge and expertise of participants to foster creative contributions toward the Project Goals listed above. The high-caliber participants at the Conference, facilitated by the PIs, collectively determined how these important goals were addressed and answered.

All five 2-hour sessions were both recorded and captured in notes by a designated undergraduate note taker. Between sessions, students worked to stimulate exchange on the CUBES platform, but that occurred largely via email and is summarized in the discussion below.

By working in small and large groups to stimulate collaboration, meeting participants worked collectively, generating potential projects to improve the current state of HE Science Learning assessment. This report summarizes the conference discussion, including key issues the HE field faces in assessment, what key learnings from ISL were identified and discussed, and proposed ideas/strategies necessary to ensure support for new strategies to be tested in classrooms. A draft report was then shared with all participants for further review and input.

Conference Preparation

A QUBES site was developed as a shared platform to host recommended readings, participant biographies and pictures, and acted as a site for exchange and participation. Participants posted their photographs, their professional details, their interest, and their current projects as a form of introduction and community building. The project's students supported individuals new to QUBES.

All participants were asked to recommend background or working papers they believed would inform the meeting. The purpose of the advance reading was to share existing thinking on the issues, limitations, and challenges of assessment in formal education, as well as an introduction to the kind of work that is occurring in informal science environments. For a list of the selected readings please see Appendix B. The collection of selected readings was posted to the QUBES site, as well as circulated to all participants prior to the conference to ensure a shared understanding of both higher education assessment issues and the approach to informal, free choice learning. Participants also reviewed and committed to ILI's Meeting Code of Conduct.

SESSION ONE: May 2nd, 2022

After online introductions, the Co-PIs reviewed the background and goals of the project, reviewing the work plan and intended deliverables. A challenging discussion evolved about the need for the project, given the many significant efforts in the development of innovative assessment techniques that are occurring in multiple HE locations around the country. How would this project contribute? Dr. Kate McConnell of the AAC&U underscored that within Higher Education "what counts as good assessment is shifting" and that the challenges of diverse, noncaptive audiences have forced Informal, Free-choice learning organizations to develop methods of authentic assessment techniques, focused on higher levels of Bloom's taxonomy, in fast and simple ways.

Dr. Eliza Reilly, Executive Director of the National Center for Science and Civic Engagement (NCSCE) presented an overview of SENCER (an NCSCE program). It was important for the participants to understand the SENCER context as SENCER faculty will eventually provide the sample for any pilot project that emerged from this conference. Following the SENCER discussion, Dr. Joe Heimlich led a discussion of his article Environmental learning in everyday life: foundations of meaning and a context for change - one of the articles participants read prior to this first meeting. This article (see Appendix B) underscores that each student in a classroom comes to a classroom with unique values and expectations around what they should (or should not) pay attention to. A number of HE faculty found the article clarifying in terms of structures of learning (formal, informal, nonformal, and incidental[1]) which are defined by who chooses the content and who shapes the methodology. The discussion also highlighted that an important issue in higher education is that "we tend to assess what is easy to measure rather than what

we value." Dr. Labov voiced that there is an important conversation to be had in formal education about what is being assessed and why. One important consideration in this discussion was the difference in cultures of HE and informal environments and how those cultures shape what is assessed and how that is measured.

Key Finding 1: *The cultures of HE and IE are different and these cultures shape what is assessed and how that is measured*

In informal learning environments efficacy is dependent on a deep understanding of the intended audience's entrance narrative – their pre-existing knowledge, misconceptions, interest, and attitudes. The group identified a fundamental tension between HE and informal education – in that in informal education we are assessing the success of the program, not the learner. "We don't tell them they failed the exhibition – they tell us the exhibition failed to help them learn." The most frequent analog in HE is the end-of-semester Instructor Evaluation – which provides input into how the instructor performed the course – rather than an assessment of the course itself. One possibility of an outcome of this project is to shift the understanding of assessment from a result to a tool, finding ways to make student assessments more useful – not just at the end of the class, but throughout.

It is important to note here that SENCER has employed the student assessment of learning gains survey instrument (the SALG) as its major assessment tool for several years. While not used by all SENCER faculty, those that do use it have found it useful as a pre/post instrument that can inform the faculty member as to students' level of preparation, prior knowledge, and STEM disposition.

At the conclusion of this session, the Co-PIs was asked to clarify, for the next session, whether this discussion should focus on evaluation, assessment, or both, and it became apparent that a shared vocabulary would be important moving forward. In the week between sessions one and two, a lively online discussion was held regarding this clarification. While assessment in HE generally refers only to the effort of measuring changes in the student – usually related to knowledge acquisition, evaluation is conducted at the level of the program, and institution. For the purposes of this project then, it was determined that Assessment would be the act of measuring a change in the learner, while evaluation would refer to determining the efficacy, outcomes, and impact of the intervention (class, exhibition, program, etc.). It is important to note that in informal education, assessment of any resulting change in individual learners is used as a measure of the impact and/or efficacy of the offering and that knowledge acquisition is only a small part of what is measured. This clarification became the starting point for session two.

Key Finding 2: *In informal education, assessment of any resulting change in individual learners is used as a measure of the impact and/or efficacy of the offering, whereas* knowledge acquisition (content knowledge) remains a major focus of what is measured in higher ed.

SESSION TWO: May 9th, 2022

After the clarification outlined above, the second session began with a review of participant observations over the intervening week. Thoughts included that the first week's conversation seems to repeatedly shift from a high-level overview of topics to a deeper dive into a method or theoretical specifics. While some participants hoped the group would decide at which level the conversation should be located, others hoped the conversation would continue to move between the two levels. As well, we were reminded that given the vocabulary clarification issues that arose in week one, the final report would need to carefully consider the level of sophistication (in the areas of assessment and evaluation) of the intended audience for the report, in order to communicate effectively. We then moved to some case studies of assessment and evaluation in informal learning environments to stimulate ideas for further discussion.

Deborah Wasserman – ISEE System (NSF 2039209)

The ISEE project developed a framework of outcomes progressions within NSF Advancing Informal STEM Learning (AISL) defined learning outcome categories which are:

Interest	STEM Capital
Attitude	Behavior
Knowledge	Science Capital
STEM Skills	Career Building
21st Century skills	

The project's white paper described levels of depth through an ordinal series of effects that can then be mapped to programming formats that range from short duration with simple content (e.g. a hallway cart demonstration can trigger situational interest) to extended duration with complex content (e.g. a youth internship can generate well-developed personal interest).

Experts in each of the outcome categories developed a series of six levels of progression with practitioners and informal learning researchers. While still in progress the ISEE project strongly delineates how informal learning practitioners and researchers think about learning generally, and areas they consider for measurement when performing evaluations and research. The conference participants found the framework extremely useful in considering a broader definition of learning that moves beyond knowledge and skill acquisition to dispositional changes and impacts.

[1] Formal Learning: Instructor determines content and method (school)
Non-formal Learning: Instructor determines method audience determines content by opting in (sign up for swimming lessons)
Informal learning: Learner determines content and method (museum)
Incidental Learning: (media, everyday life)

Elizabeth Kunz Kollmann – Chem Attitudes and Building with Biology

Next Elizabeth Kunz Kollmann discussed two projects recently completed at the Boston Museum of Science. The first, Chem Attitudes (NSF 1612482), explored how different activity formats and content will support the acquisition of different outcomes: interest, sense of relevance, or increased self-confidence, thus underscoring the importance of design choices in these areas. The findings from this project are summarized in a paper titled Design Strategies for Hands-On Activities to Increase Interest, Relevance and Science Capacity in Chemistry. A second project Building with Biology: Activities and Conversations about Synthetic Biology (NSF 1421179) reviewed a series of activities and forums designed for 200 scientists to use with the general public to engage them in conversations about the ethics and societal impacts of synthetic biology. The impact of this program and its associated research is summarized in a related evaluation report.

These projects were shared to initiate a discussion on the importance of understanding how instructors' choices of specific content areas and classroom activities will influence the nature of the learners' outcomes, and that understanding those choices and their influences can shift the learning that happens in classrooms. The review of the projects also reinforced an expanded definition of learning, beyond knowledge and skill acquisition to confidence, interest, and self-confidence.

Tina Phillips – Citizen Science

After a brief review of the field of Citizen Science, Dr. Philips illustrated the evolution of the intended outcomes of the field, which focused largely on data collection and research support, to the current understanding of community or participant learning that can develop as a result of participation in Citizen Science.
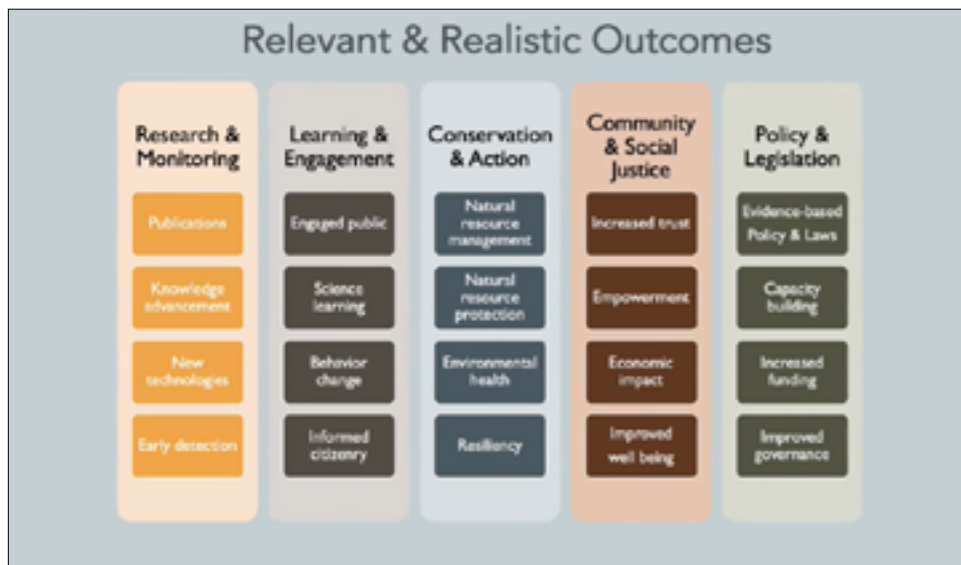
The field has worked to develop shared measures on various learning outcomes such as interest or motivation, and, today, the general understanding is that participation in Citizen Science can result in changes in the following constructs:

- Behaviour and Stewardship
- Efficacy
- Motivation
- Interest in Science and the Environment
- The knowledge of the Nature of Science
- Skills of Science Inquiry

Each of these constructs has been well developed, supported through research, and shared self-report measurement scales (with approximately 12 scales per construct) have been developed and con be accessed in this report. Dr. Phillips also shared an observational tool that relies not on self-report but on trained observer reports. The field has recently developed and tested embedded assessments (that do not rely on self-report) which have been shown to drive deeply reflexive practice on the part of the instructor. The scales are being used across the field and are beginning to build a shared vocabulary and database. The limitation of this last work is the significant time investment in its creation.

This review of Informal Learning can be continued on two websites that catalog these studies InformalScience.org and the Center for the Advancement of Informal Science Education.

SESSION THREE: May 16th, 2022

Session Three began with the HE Assessment experts sharing what they found interesting and potentially useful from the presentations from the previous week. Eight themes emerged:

1   There is a deep interest in ISL's strong focus on assessing learning beyond the cognitive (beyond knowledge and skill acquisition) which HE participants refer to as dispositional and affective changes. The fact that these psychosocial elements receive equal if not greater 'heft' or attention than the cognitive gain is recognized as an important difference from most HE assessment foci.

2   There was great interest in the sharing of tools used in ISL to gather these data – be they self-report or observational in nature. Significant discussion of the broad and natural nature of the intended outcomes, the questions, and, again, their emphasis on the affective domain began to consider their application to HE. This, combined with a sense of individualism – every learning starting in a different place and moving through a trajectory of learning seemed to suggest a method of inspiring HE to think more broadly about what they are choosing to measure and why. One HE participant voiced interest in developing an observational tool to better understand the experience students are having in the classroom or laboratory, particularly among the General Education population. Tools need to be both time efficient and interpretable to be useful and lead to meaningful change.

3   An interesting conversation arose about the difference in the organizational culture and attitudes towards assessment and evaluation between the two contexts. In HE, assessment is often considered burdensome and punitive – for both student and instructor. It is additional work for the instructor and is experienced as a form of academic interference. For ISLs assessment is better understood as necessary for institutional learning - are we doing what we intended to do? How well? What else happened? There are fewer repercussions for team members when negative findings are identified. Thus, a blend of assessment and program evaluation are more deeply embraced and utilized in ISL than in HE.

4   The cultural conversation broadened to a discussion of whether or not HE institutions are making an effort to measure what they value. Have HEs held the conversation about what they value? Is that aligned with the institutional mission? Does assessment speak to delivering on the mission? In ISL environments assessment is the evidence that the museum is delivering on its mission.

5   The conversation on value moved to the concept of measuring what students, rather than experts, value. Moving to a more participatory model, can we engage students, and possibly communities, in discussions of what we all – instructor, student, organization, community – get out of the program or course – and use that as the definition of what gets measured? This would require an alignment of what students and their instructors and institutions value.

6   The conversation moved to connect back to Dr. Heimlich's presentation on the first day about a holistic approach to thinking about learning and education – that students bring their whole selves to the learning experience, and that learning is less of a punctuated learning experience that happens in an instance, but rather one of many points that connect across the interstitial spaces of the learners' everyday life.

7   The participants discussed the heightened focus on Diversity, Inclusion, and Access initiatives in their organizations, with conversations now expanding beyond DEI to discussions of Civic Engagement and Social Justice. A better understanding of learning in areas of attitude, behavior change, and twenty-first-century skills supports these conversations.

8   Finally, the conversation landed on STEM education and General Education (Gen Ed), as an access point for initiating changes in HE assessment. HE participants underscored the tension that can arise when these conversations begin to encroach on resource allocation between Gen Ed and the science departments and become complicated by concern about FTEs and workloads – underscoring systemic challenges in HE. Again, the conversation should begin by defining what is valued, how the program delivers on its mission, and how to improve the program so students are learning what they need and want to learn.

Key Finding 3: *There are fewer repercussions for ISE team members when negative findings are identified. Thus, a blend of assessment and program evaluation are more deeply embraced and utilized in ISL than in HE.*

Key Finding 4: *In ISL environments evaluation/assessment is the evidence that the museum is delivering on its mission.*

SESSION FOUR: May 23rd, 2022

Prior to this session Co-PIs Koke and Smyth reviewed the discussion from previous weeks and outlined 4 emerging potential areas for further development. These challenges were shared with participants a week before the fourth session and participants were invited to choose an area they would like to work on.

Small Group A: The Learning Landscape

In considering the different cultures in HE and ISL, and the challenges and changes confronting HE organizations now and, in the future, would it be useful to develop integrated formal and free-choice learning outcomes. Can we argue for expanding the goals and rationale of science education well beyond knowledge to a wider range of outcomes, including values, dispositions, connections to other disciplines, and knowledge domains by looking across both fields and building a case for a new perspective?

Small Group B: Practical Methods of Collecting Data re: Dispositional Learning Goals and Understanding the learning experience.

Instruments and methods used in ISL were shared with the group in Week 2. Week 4 discussion illuminated interest in developing practical tools (both self-report and observational) that move beyond the assessment of cognitive gain to explore changes in attitude, interest, motivation, and confidence, as well as career inclinations and twenty-first-century skills.

Small Group C: Does the SENCER approach increase students' sense of relevance and civic responsibility more than most Gen Ed science classes?

Given the pandemic, climate change, and impatience with social inequity, the climate is ripe to prove that SENCER-type courses contribute to a) better citizens and/or b) communicating the relevance of science. Would there be value in developing a quasi-experimental approach to understanding the difference in long-term outcomes between SENCER and more traditional general education science classes?

Small Group D: Meeting the students where they are.
As learning becomes increasingly student-centered, how do instructors establish students 'entrance narrative:" the knowledge, misconceptions, interests, and attitudes related to the content to better situate the learning experience in the students' context.

The four small groups were asked to imagine a project in response to each challenge in response to the following questions:

- What could we do in this area?
- To what end? – Purpose (Offer 1 or 2 examples)
- What would you need to do it? (people, time money)
- What would the product(s) be?
- What would be the benefit of doing it?

The groups met online for two hours making notes in a shared google doc, and then continued to develop their thinking and approaches over the two-week interim before the next meeting, where they were asked to present their thoughts and recommendations to the larger group.

SESSION FIVE: June 6th, 2022

Small Group A: The Learning Landscape

The group discussed how integrating formal and free-choice learning outcomes had been central to the major reform projects in both formal and informal STEM for several decades. SENCER and SENCER-ISE had arisen in response to this. The idea of "liberalizing" STEM learning goals towards more civic relevance had been the focus of several big NSF, AAAS, and privately funded projects in the late 80's and early 90s and certainly front and center at AAC&U in the 90s. The group asked,

"Can we argue for expanding the goals and rationale of science education well beyond knowledge to a wider range of outcomes, including values, dispositions, connections to other disciplines and knowledge domains".

This was an almost verbatim restatement of Dewey's 1909 speech at AAAS, as Dr. LaBov pointed out in his Liberal Art of Science essay. The group presented several resources including reports from the National Academics of Science Engineering and Maths.

The liberal art of science project asked: Do SENCER courses better prepare students to form an argument/communicate well and solve problems? The group suggested that a case study style design could be used to measure responses to social problems by investigating a sense of responsibility to contribute to their solution. How could this be tailored to develop understanding, and problem-solving ability? The group also posed several critical questions which included how to measure how individuals might tackle problems from multiple pathways, addressing problems culturally and coming from different educational systems. They also discussed the culture and rules that limit the system currently, and how silos are preventing students from making connections across different fields and finding interdisciplinary solutions. The group discussed how SENCER models, that place science in context, could be of value. Service-learning projects would

enable working with the community, to find out what the community needs are, and conduct research with the community and town council. The question remained of how to measure integration, other skills, and what we value in such a community-based approach. What constitutes truly interdisciplinary engagement?

The group discussed what success would look like in terms of civic engagement. And asked several questions such as "Should this be tied to a semester (systems problem)" and should the participants be working "Beyond data analysis, working with others, engaging with government officials". They also considered if "a learning objective given in the freshmen year and assessed in senior year to determine the impact on a community" and if we should do away with transcripts, reconsider pass/fail grades and identify a new way to measure. The audience for considering such work is ideally educators from Higher Ed and from among the SENCER community. A sample could be drawn from SENCER and non-SENCER classrooms.

Small Group B: Practical Methods of Collecting Data re: Dispositional Learning Goals and Understanding the learning experience.

"Our goal is to Inform instructors in the SENCER teaching field and provide assessment tools and strategies to assess students' learning broadly and reflect critically on their teaching".

This group suggested using the ISEE frameworks as the starting point and the ID 5-12 learning communities with 4 faculty from each different educational context. These learning communities would each have a mentor and work together to develop the first round of tools and strategies. They would then work to develop examples of measures including both embedded and discreet tools while using both HE and ISE tools and insights. This process would be repeated with the other cohorts. This would build the resource tools library and allow those from the first cohorts to be the mentors. Process guidelines would be constructed for identifying desired outcomes and adapting approaches/tools along with a "field guide" for SENCER instructors. The group outlined a rough structure for the field guide entitled "Practical and Transformational Assessment Method for SENCER Educators" which included chapters on constructing learning outcomes, practical and transformational methods to collect evidence for learning, developing criteria to evaluate student and professional progress, and success as well as reflecting on and refining teaching and student learning environment based on assessment results. The last chapter would help readers develop leadership and scholarship in SENCER using assessment strategies.
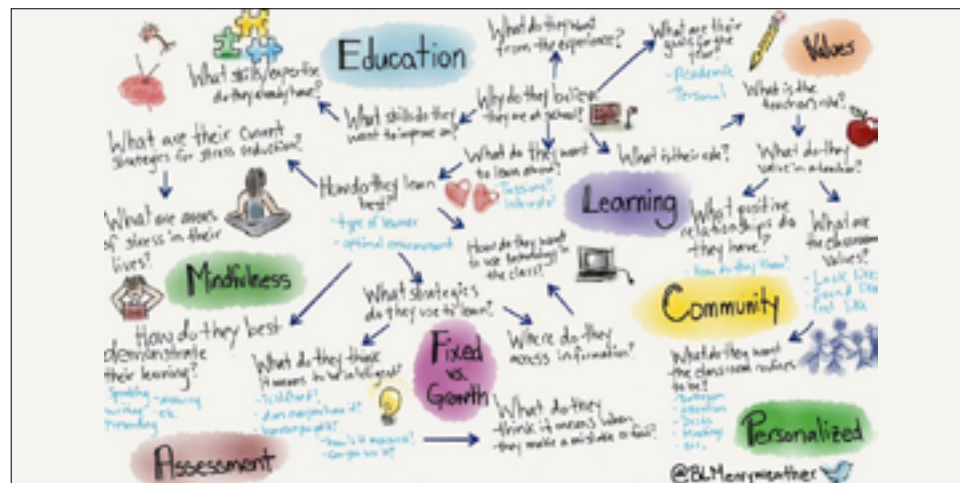
To accomplish these goals, the group would need to follow a "discipline-based education research" or DBER process as well as financial resources and time. Workshops and webinars would need to be offered and case studies and the field guide developed. The products would include a set of guidelines/process overview, examples of practical

strategies as well as examples of reporting methods across "mini" measures to mark progress (teaching and learning). Along with producing a collection of measures and strategies for building tools, the process would also result in a more comprehensive understanding of the efficacy of teaching using evaluation data. The benefits of this guide and mentoring framework would include the growth of teachers as professionals, the development of approaches and strategies in more progressive teaching, and the engagement of the students in co-constructing learning.

Small Group C: Does the SENCER approach increase students' sense of relevance and civic responsibility more than most Gen Ed science classes?

Is there value in developing a quasi-experimental approach to understanding the difference in long-term outcomes between SENCER and more traditional general education science classes?

The efficacy of a SENCER course could be assessed on a variety of scales – from pre- and post-personal meaning maps (PMM) to a large, quantitative research study. Meaning maps can be used for immediate feedback, or for deeper analysis. They can be used very qualitatively, or they can be quantified. The discussion about the use of PMMs seemed to emerge out of a desire to keep any investigation somewhat qualitative, and it was determined that a quasi-experimental approach with control groups, etc. could perhaps be useful, but would require very significant time and resources. The discussion again underscored the importance of techniques, not to gauge the learning but rather to support metacognition around the act of learning and teaching.

citations:
https://www.tandfonline.com/doi/abs/10.1080/03004279.2019.1574855?journalCode=rett20
https://www.jstor.org/stable/10.1353/roe.2016.0003

Small Group D: Meeting the students where they are through Front-End Evaluation.

As mentioned above, in ISL an evaluation technique named Front-end Evaluation is often used to establish the audience or learners' "entrance narrative" (the knowledge, misconceptions, interests, and attitudes related to the content to better situate the learning experience in the students' context). One discussant observed that "In HE we don't often ask people to talk about what they know and what they're interested in – an act that is very empowering." Group D considered the application of this approach to classroom learning.

The purpose of a project in this area would be to provide easy data collection tools to better understand students at the beginning of a course to help professors understand the students' backgrounds, interests, and areas of relevance and connection. Again, the purpose of this work would not be to contribute to student assessment, but rather to support the instructor in understanding how to build personal connections and relevance for students and supporting them to customize examples and activities to this particular group of students. As well, the approach makes explicit to students both their learning needs and achievements. Instrument items might include questions related to

- Demographics
- Reason for course enrollment
- What they already know/ hope to know
- Connections of class content to their everyday lives
- Attitudes to /feelings about the class at the outset
- Other questions from Yale Poorvu Center for Teaching and Learning

Methods developed would need to feel more like an activity than a test and data analysis would need to be rapid. Many different approaches are used in informal learning environments, all, by necessity, rapid and engaging, all based on individualized, asset-based approaches, rather than underscoring gaps and deficits. The project would begin with a pilot study to develop the method and instruments with volunteer SENCER instructors. After implementing the approach for four semesters, (each time with a larger cohort of instructors) the PIs could gather data on how the use of front-end evaluation changed the instructor's approach, the student's experience of the class, and qualitative data about the impact on learning, that could inform a later project assessing the impact on learning of doing this work. The group unscored the importance of methods being 'quick and easy' and that the process is bookended with reflections on whether expectations were met, and to make learning explicit and concrete. They also reinforced that there are many different ways to approach the same topics, and hence, if the instructor has identified what students find relevant, they can choose an approach that aligns with those interests. The benefits of doing this front-end evaluation are shown in the table below.

For the Professors	For the Students
Reveals information to help improve the course	Provides a course advance organizer to support learning
Based on an asset approach	Helps them reflect on the relevance of the course
Increases ability to be responsive and inclusive of students	Makes student learning explicit
Supports DEIA and mental health goals	Provide increased sense of responsibility
Could lead to an understanding of common concerns in a subject or course	

Project Report Review

A draft of this report was circulated among all participants in August of 2022. Given a month to review and consider the report, each participant was invited to share their response, edits and recommendations in either a written format or through a forty-minute interview. The results of these conversations influenced this revised draft and almost unanimously identified the important suggestion to create develop a shorter, focused article for broader consumption that would link back to this more detailed report, embedded on both ILI and SENCER's websites.

SENCER Summer Institute

A discussion session reviewing this project was held at the 2022 SENCER Summer Institute, at which a group of 25 new HE educators were introduced to the project, its key findings and possible topics for further research. The group discussed the key findings and the possible utility and importance of future work on the four key areas, and felt all would yield useful results, but prioritized developing an approach to the classroom use of Personal Meaning Maps to inform both the instructor and as a tool to visualize learning and pre-existing knowledge and interests for students.

Recommendations

Key Findings:

Our conference discussions and breakout sessions resulted in several key findings that have been highlighted above.

1. The cultures of HE and IE are different and these cultures shape what is assessed and how that is measured.

   a. Assessment in IE is perceived less as a burden but rather as an essential, natural, and valued part of developing offerings. ISL supports assessment as a tool for effective practice. In HE, the assessment process is often undervalued and is perceived as a burden.

   b. IE is supporting non-captive learners. Should HE adopt the idea that we must "captivate" our captive learners - this could increase our efficacy, and help us achieve our goals? The SENCER ideals certainly could help with captivating learners.

2. In informal education, assessment of any resulting change in individual learners is used as a measure of the impact and/or efficacy of the offering, whereas knowledge acquisition (content knowledge) remains a major focus of what is measured in higher ed.

   a. ISL thinks about learning more broadly than most HE institutions

   b. Our focus in HE remains on how well the student absorbed the content not on how the offering (course, assignment, activity) supported the content acquisition. This is despite mountains of evidence to suggest that we should not focus on the content but rather on values, skills, and dispositions.

3. There are fewer repercussions for team members when negative findings are identified. Thus, a blend of assessment and program evaluation are more deeply embraced and utilized in ISL than in HE.

   a. This is a critical difference. Assessment data can often be used against a faculty member in HE (their grade distributions, student evaluation surveys) and these measures can impact contracts, hiring, and tenure decisions. Contingent and part-time faculty in particular, can be vulnerable to deleterious actions that result from poor assessment results.

4. In ISL environments evaluation/assessment is the evidence that the museum is delivering on its mission and its values.

   a. This is another fundamental difference. Assessment is not tied directly to the mission and values in HE. This means that data on student performance, skill, attitudes, and dispositions towards STEM, particularly disaggregated data, are not often being used, strategically to improve the offerings. Data-driven approaches are still sparse in the higher ed landscape. We need to figure out what we value in HE and assess that.

   b. The Value rubrics from AACU provide a framework for just that and these have been adopted by SENCER faculty.

Despite our differences in culture and language, we have so much in common. Our goals and aspirations for assessment are the same, even if HE approaches could be improved. These two siloed bodies of knowledge, if integrated, could help us measure what we wish to measure, align our assessments with our missions and goals, and help us demonstrate with data and evidence that we are delivering on our promise and our offerings.

Next Steps

This conference built upon some preliminary projects including workshops at SSI and a faculty mentoring network in collaboration with QUBES on assessing SENCER. Three natural follow-on projects emerged that will be initiated.

1. The first would be to establish a working group at SENCER with the goal of assembling a manual as described by group B. This manual would outline best practices for assessment but also leverage the extensive back catalog of SENCER courses, assignments, and examples used by faculty and could be integrated into the manual. In addition, a specific focus would be placed on highlighting how the same or similar assessments can be used in both HE and IE contexts, how it would be used, and how it would inform the assessment effort.

2. The second project would be to assemble a group of SENCER faculty to conduct a study of personal meaning maps. These appear to be similar to concept maps that have been widely adopted by HE faculty. This pilot would however use the PMMs in the manner that has been used by IE practitioners. Both of these projects will be announced at this year's SSI 2022 and participants recruited therein. SENCER will work to submit follow-up proposals for NSF funding in 2023.

3. The PIs for this project are developing a manuscript that summarizes these findings for a broader audience for a spring 2023 submission.

Evaluation Report:
Intersections in Assessment National Conference

Dr. Elysa Corin

NOVEMBER 14, 2022

The goal of this evaluation was to collect feedback from participants of the Intersections in Assessment conference pertaining to:

1. the extent to which participants perceived specific elements of the conference experience to be helpful to their engaging in the work of the conference

2. participants' reflections about what they learned and how the conference impacted their thinking as experts in their respective fields

3. participants' suggestions for continuing this work into the next phase of the project

The evaluation was conducted by Dr. Elysa Corin, Senior Researcher with the Institute for Learning Innovation. To become familiar with the conference work and process Dr. Corin watched all recorded conference sessions and reviewed the group discussions and resources shared asynchronously on the conference message board space. Dr. Corin met with the conference organizers before the conference began and after the last session to co-identify goals for the evaluation and broad themes around which to collect participant feedback. A post-conference evaluation survey was drafted, reviewed by the conference organizers, and approved (see Appendix A). Data was collected from conference participants during September 2022 via the SurveyMonkey platform, the survey took participants 15 minutes on average to complete. All thirteen expert attendees completed the post-conference evaluation.

A. Feedback on Specific Conference Elements

Conference participants were asked to rate the extent to which they agreed or disagreed with six statements on a six-point Likert agreement scale. Possible answer choices were Strongly Agree, Agree, Slightly Agree, Slightly Disagree, Disagree, Strongly Disagree, N/a, and respondents could also choose to not provide any response. Data were collected from 13 conference attendees, seven experts in Higher Education Assessment and Evaluation and six experts in Informal Education Assessment and Evaluation.

A.1. Assigned Readings - Conference participants were sent articles to read ahead of some of the sessions during the early weeks of the conference. The purpose of the shared readings was to develop a degree of common understanding of important considerations for evaluation and assessment in Higher Education and Informal Education environments. Most participants agreed with the statement "Readings assigned prior to the meetings were helpful" to some extent, with two participants selecting N/a (one Higher Education expert and one Informal education expert). This may have indicated that some of the conference participants opted out of this meeting activity and did not engage with the suggested readings. One participant commented that additional readings providing information to the informal education experts about the range of assessment innovations already attempted or commonly used in Higher Education environments would have been helpful preparation for the conference.

A.2. Meeting Structure - The greatest range in ratings occurred on the two questions pertaining to participants' experience of the structure of the conference meetings. Responses ranged from *Strongly Agree to Disagree* to the prompt "There was sufficient structure provided in the meetings," and from *Strongly Agree to Slightly Disagree* to the prompt "There was sufficient space and opportunity for me to share my opinion or ask questions." Approximately a third of participants may have preferred additional structure for the meeting sessions: while eight individuals either strongly agreed or agreed that the amount of structure provided was sufficient, three participants slightly agreed, one slightly disagreed, and one disagreed. The structure of the meetings also may have affected the extent to which a few participants participated. When asked if there had been sufficient opportunity to share their opinion or ask questions, one participant selected *Slightly Agree* and one selected *Slightly Disagree*. The remaining 11 participants either strongly agreed or agreed with the statement, indicating the conference did provide ample opportunity for them to participate.
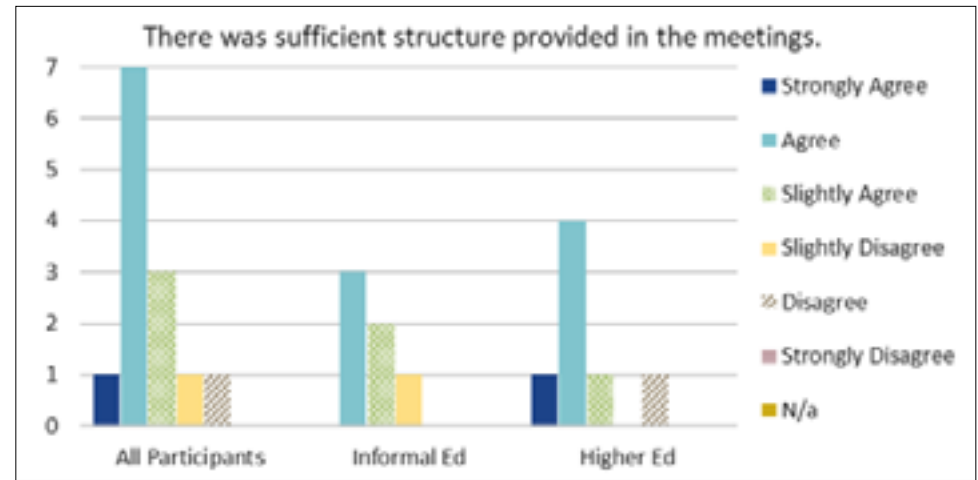
Approximately a third of participants may have preferred additional structure for the meeting sessions.

There was sufficient space and opportunity for me to share my opinion or ask questions.
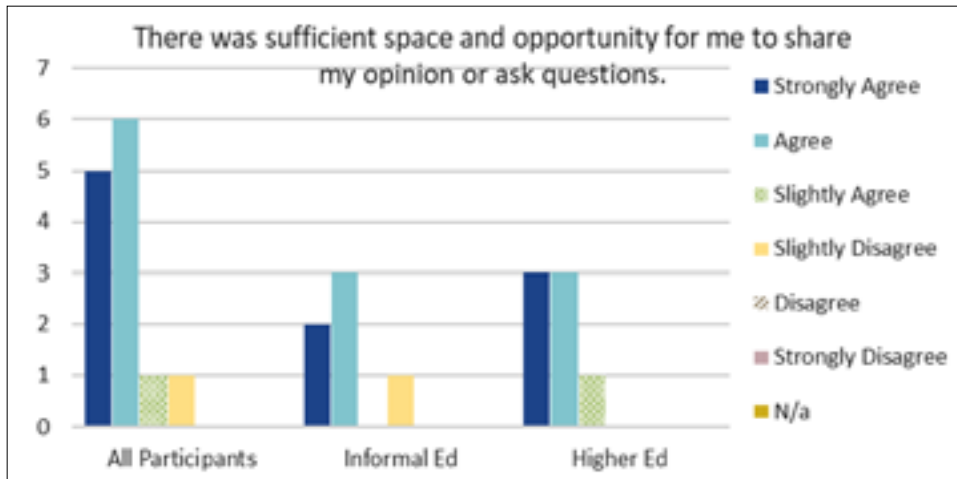
When asked to elaborate on their ratings a participant shared **"I think it was a great structure, allowed for interaction that was meaningful within the challenges of a virtual set up, and overall addressed the agenda items presented well."** Several participants also noted that the small group breakout sessions and the presentations by conference attendees were particularly engaging, enjoyable, and valuable to their experience. Participants also commented on the differences between their experience of the early and latter sessions of the conference, with more time set aside during the early sessions for conversation to build common understanding between the two communities of experts.

» I was surprised at how much meeting time it took to break through 'silos' [between informal learning experts and higher education experts]

» I would say that I enjoyed the conference more in the later part where there were expert presentations and small group discussions. The process and purpose for the first two meetings were not clear thus people seem to be talking in circles.

A.3. Effectiveness of the Moderators - Participants all agreed to some extent with the statements "The moderators (Judy, Davida) successfully managed the conversation" and "The moderators (Judy, Davida) successfully summarized and distilled the ideas presented." Several participants elaborated on their ranking by expressing appreciation of the efforts the moderators put into the conference, including **"I think Judy and Davida did a fabulous job negotiating the space as a learning environment for all of us."** One participant noted the moderators were successful despite the challenges posed by the online format and shared, **"The online format restricted real interaction and full exchange that can better be managed in person. Given the restrictions, the moderators did amazing work."**

A.4. Overall Impression of Success - All participants agreed with the statement "The conference was successful" to some extent. Three participants characterized their agreement as *Strongly Agree* (two Higher Education experts, one Informal Education expert), seven selected *Agree* (three Higher Education experts, four Informal Education expert), and three selected *Slightly Agree* (two Higher Education experts, one Informal Education expert).
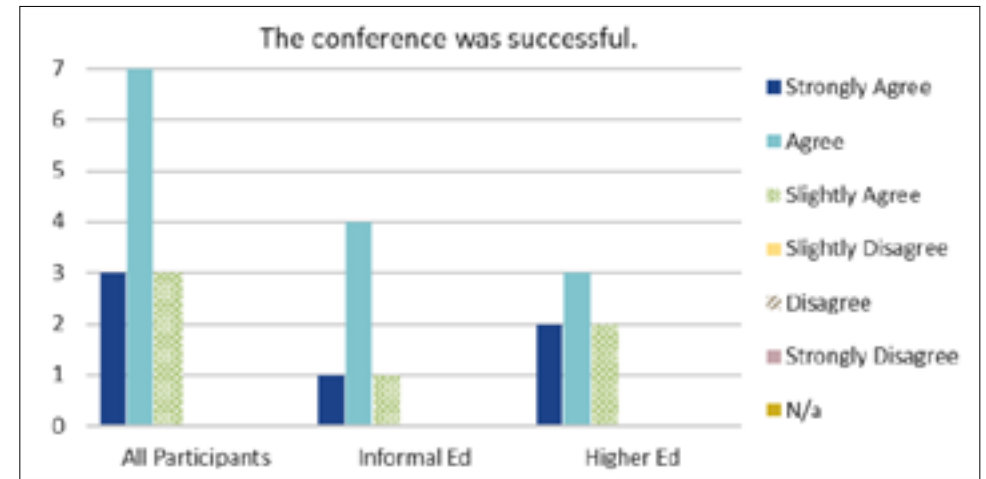
All participants agreed to some extent with the statement "The conference was successful."

B. Conference Takeaways: Impact on Participants' Thinking

Conference participants were asked several open-ended questions asking them to reflect on ideas from the conference that remain unresolved, what they may have learned from the conference experience, and ideas from the conference that would impact their work, if applicable.

B.1. Reflections on the Experience - When asked if they were coming away from the conference with a new perspective or understanding, overall participants expressed gratitude for the opportunity to get to know and learn from colleagues from the other professional culture. Participants described their greater understanding and appreciation of each other's work and challenges in several ways.

Reflections from Higher Education experts:

» I really appreciated hearing the perspectives of the Informal Science experts, especially around how evidence of impact is documented.

» I am happy to learn from the informal education evaluators about the work done to understand the dimensions and development of STEM skills and dispositions.

» I came to realize how much higher education representatives can learn about new ways to assess learning and program effectiveness from assessment experts in the informal education sector.

» I better understand and appreciate the challenges of those in free-choice educational environments, i.e., how do you know the kindergarten class that just came through your environmental center "learned" from your exhibits.

Reflections from Informal Education experts:

» I was unaware how much SENCER [instructors] (in representing higher ed) struggle with advocating for student outcomes that differ from grades, course completion and course assessments that go beyond student feedback.

» I learned a lot about the SENCER initiative, which I knew very little about, but was happy to learn of the focus on civic engagement. ...I really wasn't aware of the assessment issues that plague most institutions. In particular, I learned about many of the systemic issues in higher education that make change very challenging.

» I learned about the pressure on university faculty to have good assessments and focus on learning outcomes.

» As an informal evaluator/researcher... my perspective on course evaluations shifted dramatically. I have much greater sympathy on the trap good evaluation can be for the professor.

When reflecting on the conference experience, some participants also expressed their surprise in the amount of work it took to bridge the differences between the two education contexts, including differences in assumptions, terminology, and assessment culture. Still others expressed their appreciation for the commonalities they discovered between the approaches and methodologies used by both groups.

» I was surprised at the difficulty in getting people to think together and not just present their special knowledge (and to move outside their expertise). It happened eventually but took longer than I anticipated!

» It was lovely to connect with colleagues from the informal learning space. I think one of the things that was most edifying was realizing that, from a methodological perspective, there was greater overlap/synergy than difference, at least on the part of those of us who indeed focus on social science research and/or assessment methodologies.

B.2. Ideas that will Continue to Impact - Participants were asked to share their biggest takeaway from the conference that would be impacting their own work moving forward. Several Higher Education experts made note of tools or ideas from the conference that they would be integrating into their own work or sharing with faculty they work with. One participant shared they planned to add attitudinal measures of *interest* and *engagement* to their assessments, while another noted,

» [Attending the conference] has made me more thoughtful about the types of assessments I conduct both in the classroom as well as the education research studies I perform.

Several Informal Education experts appreciated learning more about the SENCER philosophy. One participant envisioned bringing this approach to community science contexts while another shared,

» I have begun to think more about SENCER-type experiences as important to youth programs and how we are researching them.

Experts from both Higher Education and Informal Education referenced their conversations with colleagues about the nature of evaluation and assessment as their most important takeaway from the conference.

» I think this reinforced for me some of the key differences between program evaluation, which happens routinely in ISL vs. assessment which happens more routinely in formal schooling including higher ed.

» It just caused me to think more about the differences in assessment for museums and universities, and that it could be a positive thing for formal education to think more about how they can include ISE goals in their own environment.

Experts from both Higher Education and Informal Education referenced their conversations with colleagues about the nature of evaluation and assessment as their most important takeaway from the conference.

B.3. Remaining Questions to be Resolved - Conference participants were asked to share if there were any ideas of hurdles they felt were inadequately addressed or resolve by the group. Several participants wondered how both communities would continue to learn together, work together, and find additional opportunities to for exchange and exploration. A third of conference participants commented that there was still much work to be done to tackle systemic issues in Higher Education pertaining to assessment. One participant shared,

> » I don't think we made much headway in terms of a plan or process for better understanding and tackling the systemic issues in higher ed that prevent more robust assessments beyond knowledge gains. Maybe that was not the goal for this [conference], but my small group spent a lot of time talking about this but with no clear resolution or path forward.

Similarly, another participant felt an important unanswered question was how to get Universities and Administrators to value assessing outcomes beyond learning content, such as interest, motivation, and attitude change. Several other participants commented that work exploring how to craft systems for assessing broad outcomes of student learning beyond an individual course was still needed. This work would necessarily involve convincing Higher Education colleagues to value thinking long-term about student learning and assessment, and beyond the scope of their specific course and curricular goals. Another participant shared that while two levels of thinking emerged during the conference, **"...one that focused on the mechanics of assessment, and the other that attempted to see effective assessment approaches as part of a larger set of issues with the higher education system,"** but it wasn't yet clear to them how these two important topics would be connected.

C. Ideas for the Next Project Phase

Conference participants were asked to share their ideas for the next project phase, including additional perspectives that should be included in future work, and other considerations and suggestions for this project moving forward.

C.1. Perspectives to Include in Future Convenings - Participants suggested many important perspectives to include in future convenings, including K-12 assessment experts due to the progress they have made on assessment in their context, as well as several different stakeholders from higher education environments. Suggestions were made to include members of the administration, such as chairs, deans, and directors, to bring their perspectives pertaining to assessments. Specifically including people with decision-making power pertaining to how institutions of higher education judge course success and student outcomes was deemed very important to any future work. Several conference participants found the participation of two undergraduate students in the conference to be helpful to their thinking and provided important "reality checks." They encouraged

further participation from students, perhaps from a greater number of students with a broader diversity of background and experience.

Multiple conference participants recommended including more people who have experience working in both Informal and Higher Education spaces, in particular people who **"...are committed to, have a stake in, and are experienced in meshing and navigating the two cultures might help."** A specific suggestion was made to include colleagues from Agriculture Education due to their experience engaging in extension/informal education and evaluation and working in a Higher Education environment. **"Some of the best evaluators I know come from the College of Agriculture at land grant institutions."** Colleagues from the student affairs assessment field were also recommended due to their focus on learning beyond the classroom. Two participants also mentioned including Higher Education instructors from the ranks of those who do most of the teaching: adjunct faculty and lecturers. The point was made that **"No matter how great our assessment strategies are, if they are not feasible and meaningful to the instructors, they won't be adopted or implemented."** One participant also voiced an interest in wanting to hear from faculty who are successfully navigating this tricky assessment environment and already engaging with multiple approaches to course evaluation.

C.2. Additional Recommendations - Multiple participants expressed a desire for more time and opportunity to work together. Several people acknowledged the high level of expertise among the conference attendees and their appreciation for the opportunity to learn about each other's work and collaborate on a common problem. Additional suggestions to improve collaboration in subsequent rounds included establishing group working agreements and expectations for dialogue, acknowledging the differences between professional cultures and that all participants will need to commit to learning about each other's cultures, and being paired with someone from the other professional culture to exchange ideas and reflect as conversation following each session.

Some participants expressed their interest in exploring additional ideas that were surfaced during the conference conversations. Though not a focus of this conference, it was noted that there was much Informal Educators could learn from Higher Education experts and several participants of this conference would welcome the opportunity to do so. One participant mentioned a specific area of collaboration,

> » ISE are doing great in assessing a multitude of outcomes but are weak in testing knowledge and skill gain - in part because "testing" is inappropriate, and those outcomes are rightfully seen as inappropriate in many ISE settings. Nonetheless, they are sometimes asked for and ISE people are weak on cognition and skill. We did not chew through how that could be addressed, how assessing changes in knowledge at some deeper level, or skills could be done within free-choice environments in some embedded ways that do not feel like explicit tests.

Another participant suggested more generally that the group look for opportunities for **"...two-way sharing and two-way opportunities to inform and improve practice"** between the participating Informal Education and Higher Education experts.
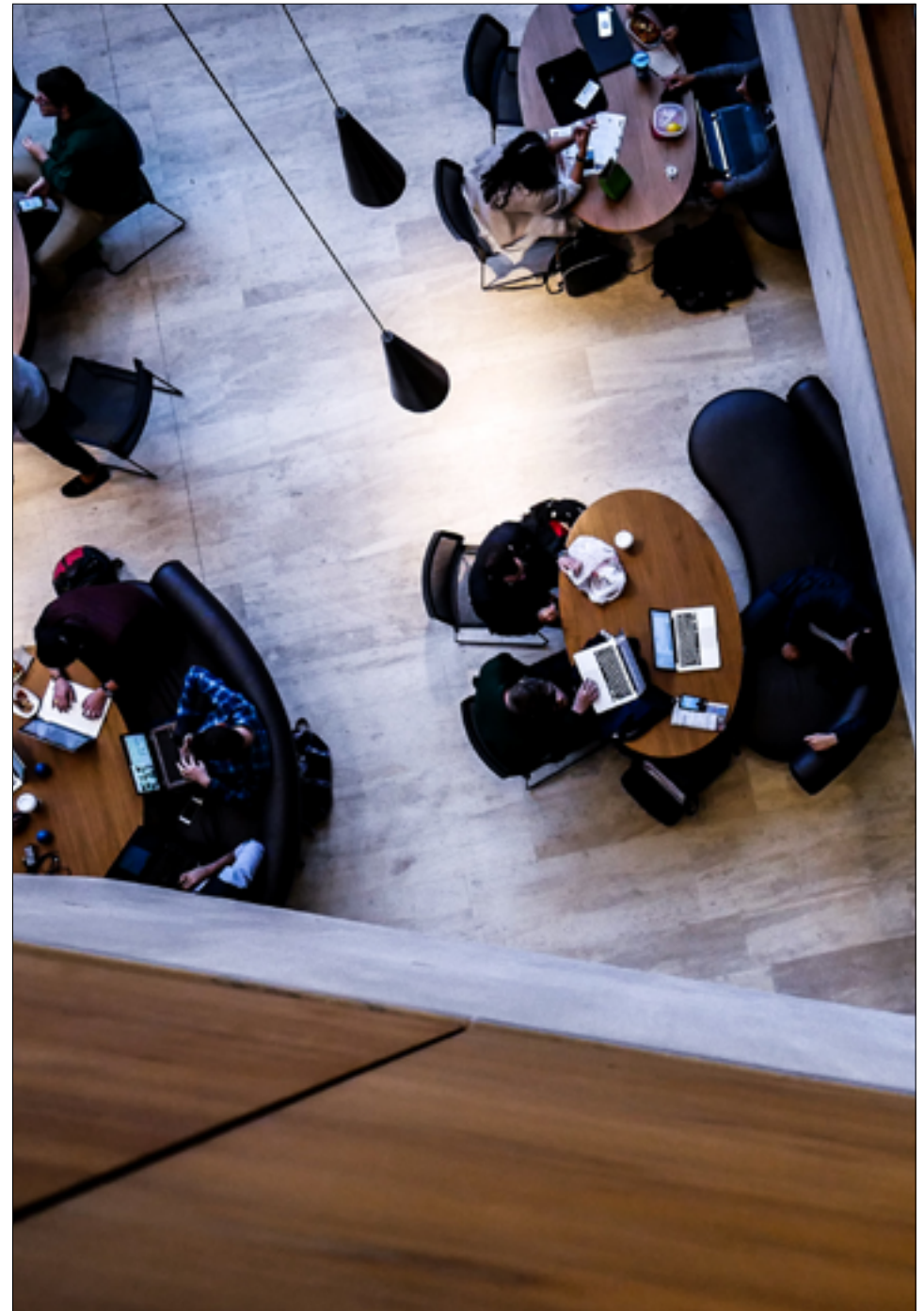
Post-Conference Evaluation Survey

My Takeaways from the Intersections in Assessment Conference:

If you learned something new during the conference or came away from this experience with a new perspective, please briefly describe below. *[Short Answer]*

What is your biggest takeaway from this conference that will impact your own work? If this does not apply to you, please write "n/a." *[Short Answer]*

Thinking back to the conference discussions, what are you still stuck on? Are there any ideas or hurdles you feel were not adequately addressed or resolved by the group? *[Short Answer]*

Feedback on Specific Conference Elements:

To what extent do you agree or disagree with the following statements about the conference:
[Answer Choices: Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree]

Readings assigned prior to the meetings were helpful.

- There was sufficient structure provided in the meetings.
- There was sufficient space and opportunity for me to share my opinion or ask questions.
- The moderators (Judy, Davida) successfully managed the conversation.
- The moderators (Judy, Davida) successfully summarized and distilled the ideas presented.
- The conference was successful.

If you would like to elaborate on your ratings above or share any thoughts about other conference elements, please do so here. What worked well, and what could be improved? *[Short Answer]*

Ideas for the Next Project Phase:

Thinking ahead to the next phase of this project, how might the conference organizers better prepare future participants to be successful? How can they support individuals from different professional cultures successfully engage with one another, negotiate space, and exchange ideas to bring new and innovative approaches to assessment in Higher Education learning environments? *[Short Answer]*

Thinking ahead to the next phase of this project, whose voices were missing from the conversation? Who else should be involved in this work, who would you like to hear from? *[Short Answer]*

If you have any additional feedback to share, please do so here. *[Short Answer]*

Evaluation References

American Association of Colleges and Universities. (2007). College learning for the new global century. Retrieved from http://www.aacu.org/leap/documents/GlobalCentury_final.pdf

Bolger, N., & Kellaghan, T. (1990). Method of Measurement and Gender Differences in Scholastic Achievement. Journal of Educational Measurement, 27(2), 165–174. https://doi.org/10.1111/j.1745-3984.1990.tb00740.x

Carless, D. (2009). Trust, distrust and their impact on assessment reform. Assessment & Evaluation in Higher Education, 34(1), 79–89. https://doi.org/10.1080/02602930801895786

Carless, D. (2015). Excellence in university assessment: Learning from award-winning practice (1st ed.). Routledge.

Carmichael, M. C., St. Clair, C., Edwards, A. M., Barrett, P., McFerrin, H., Davenport, I., Awad, M., Kundu, A., & Ireland, S. K. (2016). Increasing URM Undergraduate Student Success through Assessment-Driven Interventions: A Multiyear Study Using Freshman-Level General Biology as a Model System. CBE—Life Sciences Education, 15(3), ar38. https://doi.org/10.1187/cbe.16-01- 0078

DeMars, C. E. (1998). Gender Differences in Mathematics and Science on a High School Proficiency Exam: The Role of Response Format. Applied Measurement in Education, 11(3), 279–299. https://doi.org/10.1207/s15324818ame1103_4

Douglas, M., Wilson, J., & Ennis, S. (2012). Multiple-choice question tests: A convenient, flexible and effective learning tool? A case study. Innovations in Education and Teaching International, 49(2), 111–121. https://doi.org/10.1080/14703297.2012.677596

Drinkwater, M. J., Matthews, K. E., & Seiler, J. (2017). How Is Science Being Taught? Measuring Evidence-Based Teaching Practices across Undergraduate Science Departments. CBE—Life Sciences Education, 16(1), ar18. https://doi.org/10.1187/cbe.15-12-0261

Evaluating the Evidence Base for Evidence-Based Instructional Practices in Chemistry Through Meta-Analysis – Center for Education Innovation and Learning in the Sciences. (n.d.). Retrieved February 22, 2020, from https://ceils.ucla.edu/2020/02/07/evaluating-the-evidence-base-forevidence-based-instructional-practices-in-chemistry-through-meta-analysis/

Framework for Evaluating Impacts of Informal Science Education Projects | InformalScience.org. (n.d.). Retrieved March 15, 2020, from https://www.informalscience.org/framework-evaluating-impacts-informal-science-educationprojects

Gilles, J.-L., Detroz, P., & Blais, J.-G. (2011). An international online survey of the practices and perceptions of higher education professors with respect to the assessment of learning in the classroom. Assessment & Evaluation in Higher Education, 36(6), 719–733. https://doi.org/10.1080/02602938.2010.484880

Levy, F., & Murnane, R. (2005). The New Division of Labor. https://press.princeton.edu/books/paperback/9780691124025/the-new-division-of-labor

Lewis, S. E., & Lewis, J. E. (2007). Predicting at-risk students in general chemistry: Comparing formal thought to a general achievement measure. Chemistry Education Research and Practice, 8(1), 32–51. https://doi.org/10.1039/B6RP90018F

Mishra, P., & Kereluik, K. (2011). What 21st century learning? A review and a synthesis. In M. Koehler & P. Mishra (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2011 (pp. 3301–3312). Chesapeake, VA: AACE

National Research Council of the National Academies of Science, (2009). Learning Science in Informal Environments: People, Places and Pursuits. Washington, DC: National Academies Press Retrieved July 20: https://www.nap.edu/catalog/12190/learning-science-in-informalenvironments-people-places-and-pursuits

Partnership for 21st Century Skills. (2007). Framework for 21st century learning. Retrieved from http://www.p21.org/documents/P21_Framework_Definitions.pdf

Postareff, L., Virtanen, V., Katajavuori, N., & Lindblom-Ylänne, S. (2012). Academics' conceptions of assessment and their assessment practices. Studies in Educational Evaluation, 38(3), 84–92. https://doi.org/10.1016/j.stueduc.2012.06.003

Sambell, K., McDowell, L., Montgomery, C., McDowell, L., & Montgomery, C. (2012). Assessment for Learning in Higher Education. Routledge. https://doi.org/10.4324/9780203818268

Simkin, M. G., & Kuechler, W. L. (2005). Multiple☉Choice Tests and Student Understanding: What Is the Connection? https://doi.org/10.1111/j.1540-4609.2005.00053.x

Stewart, V. (2010). A Classroom as Wide as the World. http://www.ascd.org/publications/books/109008/chapters/A-Classroom-as-Wide-as-theWorld.aspx

Torrance, H. (2012). Formative assessment at the crossroads: Conformative, deformative and transformative assessment. Oxford Review of Education, 38(3), 323–342. https://doi.org/10.1080/03054985.2012.689693

Trevelyan, R., & Wilson, A. (2012). Using patchwork texts in assessment: Clarifying and categorising choices in their use. Assessment & Evaluation in Higher Education, 37(4), 487–498. https://doi.org/10.1080/02602938.2010.547928

Webber, K. L. (2012). The Use of Learner-Centered Assessment in US Colleges and Universities. Research in Higher Education, 53(2), 201–228. JSTOR.

Wilmarth, S. (2010). Five Socio-Technology Trends That Change Everything in Learning and Teaching. 4 http://www.ascd.org/publications/books/109008/chapters/Five_SocioTechnology_Trends_That_Change_Everything_in_Learning_and_Teaching.aspx

Windschitl, M. (2009). Cultivating 21st century skills in science learners: How systems of teacher preparation and professional development will have to evolve.

National Academies of Science Workshop on 21st Century Skills, Washington, DC, USA. Vandell, D., Reisner, E., and Pierce, K. (2007). What are the Benefits of High-Quality Afterschool Programs: Longitudinal Findings from the Study of Promising Afterschool Programs. University of California, Irvine. Retrieved July 12, 2020 from: https://files.eric.ed.gov/fulltext/ED499113.pdf

Appendix A:

Participant Bios

Project Co-PI's

Davida Smyth, Ph.D.

Assistant Professor of Microbiology at Texas A&M University in San Antonio. Smyth is a Senior Science Education for New Civic Engagements and Responsibilities (SENCER) Leadership Fellow, a Partnership for Undergraduate Life Sciences Education (PULSE) Fellow and Ambassador, and the Deputy Director of the National Center for Science and Civic Engagement. She is also the co-PI of the NSF-funded Research Experiences in Microbiomes Research Coordination Network and Collaborative Research: Metapopulation Modeling to Develop Strategies to Reduce COVID-19 Transmission in Public Spaces projects.

Judith Koke

Ms. Koke is Director of Professional Development at the Institute for Learning Innovation. With a career spent in both research and museum leadership, she has over 50 publications related to understanding museum learning. Currently the PI of the NSF funded research project Building Capacity for Inclusive STEM Learning Opportunities for People with Autism Spectrum Disorder (NSF # 2005901), Koke has been the Co-I or lead researcher on several NSF informal learning research and evaluation projects.

Assessment in Higher Education Experts

Helen L. Chen, Ph.D.

Director of ePortfolio Initiatives in the Office of the Registrar at Stanford University, and a co-founder and co-facilitator of the Electronic Portfolio of Action and Communication (EPAC), a community of practice focused on pedagogical and technological issues related to ePortfolios. Chen is a Senior Researcher in the Designing Education Lab in the Center for Design Research within the Department of Mechanical Engineering at Stanford University. She serves as a board member for the Association for Authentic, Experiential and Evidence-Based Learning and collaborates with the Association of American Colleges and Universities on a variety of general education and assessment-related initiatives.

Monica Devanas, Ph.D.

Director, Faculty Development and Assessment Programs, at the Center for Teaching Advancement and Assessment Research at Rutgers University. Dr. Devanas brings expertise in STEM education, persistence of women in STEM, general education reform in STEM. With a PhD in microbiology, she has been a leader in the SENCER community since the initiative's beginnings.

Yao Zhang Hill Ph.D.

Dr. Hill is an Assessment Specialist for the University of Hawaii Manoa Assessment Office, which collaborates with faculty, staff, students, and administrators to establish meaningful, manageable, and sustainable assessment for its programs. Dr. Hill has presented and published widely, offering numerous engaging workshops on various assessment topics. She is involved in the evaluation aspects of the model projects the NFLRC is constructing and serves as guest lecturer in the NFLRC intensive summer institutes.

Jay Labov, Ph.D.

Prior to becoming a STEM education consultant at TERC, Dr. Labov served as a member of the staff of the National Academies of Sciences, Engineering, and Medicine for 23 years, serving as Senior Advisor for Education and Communication since 2008. He directed or contributed to more than 30 National Academies reports focusing on undergraduate education, teacher education, advanced study for high school students, K-8 education, and international education.

Kate Drezek McConnell Ph.D.

Vice President, curricular and Pedagogical Innovation – AAC&U and Executive Director of VALUE. An educational psychologist by training, Dr. McConnell has written extensively on the reliability and validity of the VALUE approach to assessment. Her other research and campus consultations focus on using course-embedded assessment to improve teaching and learning while also addressing accountability and accreditation requirements; course-embedded assessment; aligning pedagogy with assessment efforts; faculty development; and leveraging the learning sciences in teaching, assessment, and evaluation.

Jeffrey Olimpo, Ph.D.

Provost Faculty Fellow in Curriculum Effectiveness and Improvement at University of Texas at El Paso. Using both quantitative and qualitative approaches, Dr. Olimpo's research focuses specifically on a) identifying predictors of student success and persistence in biology, particularly among underrepresented groups; b) the impact of course-based undergraduate research experiences (CUREs) on student learning and affect; and c) the professional development of UTAs.

Informal Science Learning Assessment Experts

John. H. Falk, Ph.D.

Executive Director of the Institute for Learning Innovation; Sea Grant Emeritus Professor of Free-Choice Learning at Oregon State University. Dr. Falk is internationally recognized as a leading expert on free-choice learning. Dr. Falk has authored over 250 articles and chapters in the areas of learning, ecology and education, two-dozen books, and helped to create several nationally important out-of-school educational curricula. Falk earned a joint doctorate in Ecology and Science Education from the University of California, Berkeley.

Joseph E. Heimlich, Ph.D.

Sr. Director of Research, COSI Center for Research and Evaluation; Professor Emeritus. The Ohio State University in Extension, the School of Environment & Natural Resources and the Environmental Science Graduate Program. Dr. Heimlich has worked in environmental learning in informal settings, for over 40 years. He is a past president of NAAEE and Visitor Studies Association. Area(s) of specific expertise he brings to this project are evaluation in non-school settings; research in learning structures and learning in non-school settings; environmental learning.

Elizabeth Kunz Kollman

The Director of Research and Evaluation at the Museum of Science, in Boston. Ms. Kollman has been co-PI for several NSF-funded projects including Dimensions of Public Engagement with Science, Complex Adaptive Systems as a Model for Network Evaluations, Public Engagement with Science and the ChemAttitudes projects. In her years at the Museum of Science, she has conducted over 50 evaluations of public engagement and served as program chair for the American Association of Museum's Committee on Audience Research and Evaluation

Tina Phillips, Ph.D.

Assistant Director, Center for engagement in Science and Nature, Cornell Lab of Ornithology, Cornell University. Dr. Phillips conducts social science research and evaluation across numerous citizen science projects both within and outside the Cornell Lab. Her research interests center on understanding and documenting the educational, social, and conservation impacts of citizen science globally.

Martin Storksdieck, Ph.D.

Professor and Director, The STEM Research Center, Oregon State University. The STEM Research Center conducts applied research on STEM education and science engagement at the intersection of research, policy and practice, with a strong focus on equity and social justice. Dr. Storksdieck has more than 25 years of experience with educational research and evaluation in STEM-related fields and in environmental and sustainability

education. Prior to joining OSU, Martin directed the Board on Science Education and the Roundtable on Climate Change Education at the U.S. National Academy of Sciences. Currently, he serves on the Science Advisory Boards for the National Oceanic and Atmospheric Administration (NOAA) and the Leibniz Institute for Science and Mathematics Education in Kiel (Germany). He is an elected fellow of the American Association for the Advancement of Science.

Deborah Wasserman, Ph.D.

As a Senior Researcher, COSI Center for Research and Evaluation, Dr. Wasserman designs and conducts human service program research and evaluation while applying her extensive knowledge in how systems-thinking perspectives affect this type of research. She has a particular interest in the self-determination of program participants and providers (consumers and employees) and the consequent vitality of the entire system. She is the Principal Investigator in a number of NSF grants that define, categorize and measure science learning and its impact on youth development and career aspiration and choice. Areas of expertise she brings to this project are Self-Determination theory-based program evaluation of STEM & STEAM informal learning, youth development, and social service programming.

Student Representatives

Destiny Guerra

Currently a full-time research student studying Water Resources at Texas A&M-San Antonio. Currently, she works in the Smyth Lab isolating and identifying microbes in environmental samples and wastewater. Ms. Guerra was a QUBES site facilitator, a notetaker and participant observer on this project.

Cassandra Maldonaldo

A full-time undergraduate student studying water resources at Texas A&M-San Antonio. Ms. Maldonaldo was a QUBES site facilitator and participant observer on this project.

Marcel Robitaille

Graduate Student, University of Toronto, School of Information. An emerging museum professional who is keenly interested in history, media, interactable technologies and visitor research, Mr. Robitaille joined this project as the Summer 2022 ILI intern. Mr. Robitaille was a notetaker and participant in this project.

Appendix B:

Annotated Bibliography of Preparatory Readings

Museum of Science: The Relationship Between Design and Outcomes In Informal STEM Education Experiences

Kollmann, Elizabeth Kunz. Museum of Science: The Relationship Between Design and Outcomes in Informal STEM Education Experiences. Qubeshub.org. Accessed on July 16, 2022. https://qubeshub.org/app/site/collections/32001/2022_SENCER_ISE_HE_assessment_pre4sentation.pdf

- Informal science practices informed by a public understanding of science increases the public's collective understanding of scientific content and practices.
- The ChemAttitudes project aimed at increasing the public's interest in chemistry, understanding and increasing the perception of chemistry's relevance, and feelings of self-efficacy.

Understanding Behavior to Understand Behavior Change: A Literature Review

Heimlich, Joe E., Nicole M. Ardoin. Understanding Behavior Change: A Literature Review. In Environmental Education Research 14, number 3 (2008): 215-237.

- Behaviour represents a complex intermingling of affective and cognitive processes. To understand its components, it is important to explore the interplay between them.
- Three pathways to changing attitudes: directly experiencing the object, persuasive communication, and induced behavior change.
- Behaviours are contextually based and represent a compilation of skills; they are not directly teachable. Learning must take into account the mental and physical habit-forming principles.
- Beliefs directly influence skills. They are not fixed but created by social contextualization.

Design Strategies for Hands-On Activities to Increase Interest, Relevance, and Self-Efficacy in Chemistry

Anderson, Allision and Elizabeth Kunz Kollman, Marta Beyer, Owen Weitzman, Marjorie Bequette, Gretchen Haupt, Hever Velazquez. Design Strategies for Hands-On Activities to Increase Interest, Relevance, and Self-Efficacy in Chemistry. In Journal of Chemical Education 98, number 6 (2021): 1841-1851.

- People engage with and explore science throughout many informal learning activities and opportunities daily. However, the most critical are museums, after-school programs, libraries, television, and media.

- A motivating factor in informal learning is self-efficacy – improving their self-confidence increases their ability to understand.
- Self-Efficacy and interest increased after participating in the hands-on activities.
- Content and format related design choices were important in increasing their feelings of interest in chemistry.
- Incorporating hands-on activities is essential in creating feelings of self-efficacy within participants.

Fostering Conversation about Synthetic Biology Between Publics and Scientists: A Comparison of Approaches and Outcomes

Todd, Kate and Gretchen Haupt, Kilzabeth Kunz Kollmann, Sara Pfeiffle. Fostering Conversation about Synthetic Biology Between Publics and Scientists: A Comparison of Approaches and Outcomes. In Journal of Microbiology and Biology Education 19, number 1 (2018): 1-8.

- In recent years, a growing divide between the public and scientists has been noted. This increases distrust of the public toward science.
- Public Engagement with Science initiatives create a two-way communication between these two groups – fostering trust.
- PES lowers polarized views of established science; it creates valuable information in understanding future behavior.
- For free-choice family experience, the findings show that those public events with hands-on activities are seen as valuable learning opportunities.

A Framework for Articulating and Measuring Individual Learning Outcomes from Participation in Citizen Science

Phillips, Tina and Norman Porticella, Mark Constas and Rick Bonney. A Framework for Articulating and Measuring Individual Learning Outcomes from Participation in Citizen Science. In Citizen Science: Theory and Practice 3, number 2 (2018): 1-19.

- Three goals of citizen science practitioners: increase scientific literacy and public understanding, citizens actively contribute to the development of the database, and help build an understanding of the methods and results of scientific research.
- Proposal of the new framework and primary learning outcomes: Interest, self-efficacy, motivation, content, price and nature of scientific knowledge, skills of scientific inquiry and behavior and stewardship.

- Interest is noted as an important precursor to deeper engagement in democratic decision-making processes regarding science and technology.
- Students who participated in projects showed a greater gain in self-efficacy than the control group.
- The hands-on nature of many environmentally based citizen science projects makes them particularly suited to influence the development and/or reinforcement of certain science-inquiry skills.

Environmental Learning in Everyday Like: Foundations of Meaning and a Context for Change

Ardoin, Nicole M., Joe E. Heimlich. Environmental Learning in Everyday Like: Foundations of Meaning and a Context for Change. In Environmental Education Research 27, number 12 (2021): 1681-1699.

- We primarily learn about environmental systems and our roles within them through daily life activities that include direct observations, discussions, and decisions.
- Learning and environmental learning occurs across a variety of physical and cultural settings – it is a lifelong process.
- Memorable moments occur during physical or emotional intensive endeavors – this immersive memory events create openings for learning.
- Environmental learning often focusses on formal contexts, this emphasis overlooking the expanse of other settings where environmental learning occurs daily. A broad approach does not preclude, but rather draws together learning that may occur in a range of contexts.
- Social role theory along with life-course theory emphasizes that humans of all ages are complex socially oriented animals who operate within a social environment.
- In the learning landscape frame, every day and incidental experiences provide the glue. The interstitial spaces where meaning is made become the most critical sites for everyday learning.

ISEE Strategic Outcomes Framework for Measuring Informal Education Outcomes and Institutional Impact: Revisions and Additions in Response to Expert Explorations April 2021

National Museum of Natural History. ISEE Strategic Outcomes Framework for Measuring Informal Education Outcomes and Institutional Impact: Revisions and Additions in Response to Expert Explorations April 2021. Accessed on July 16, 2022. https://qubeshub.org/app/site/collections/31486/Strategic_Outcomes_Framework_Conference_White_Paper_2022.01.17.pdf

- Participants noted that programs with intended outcomes aimed at affecting the greater good, such as community building or healing, would have difficulty locating those outcomes in the STEM learning framework.
- Throughout the conference participants struggled with reconciling the framework with how it can be supportive of, responsive, and conducive to issues of diversity, equity, access, and inclusion at both personal and systemic levels.
- Another way of making the framework more culturally responsive is to find ways of building into its structure co-production of program outcomes to include participant's voice.
- Participants were informed to portray education outcomes as a series of fabric knots. In this way. Knots tied from various outcome strands helped participants consider the framework as offering structures for purposefully considering how various outcome intentions work together to reflect or intentionally create multidimensional programming.

Assessment During a Crisis: Responding to a Global Pandemic

Jankowski, N. A. (2020, August). Assessment during a crisis: Responding to a global pandemic. Urbana, IL: University of Illinois and Indiana University, National Institute for Learning Outcomes Assessment.

- This report describes how assessment changed during the pandemic and provides a very thoughtful list of Dos and Don'ts for how to move forward.
- Made a strong case for focusing on equity and ensuring that student voice, flexibility, and understanding remain at the core of assessment strategies. What is reasonable and what is doable?

A Critical Review of Research on Student Self-Assessment

Andrade, H. L. (2019). A critical review of research on Student Self-Assessment. Frontiers in Education, 4. https://doi.org/10.3389/feduc.2019.00087

- Investigated 76 empirical studies and made a case for a greater focus on the cognitive and affective mechanisms of formative self-assessment.
- Provides a useful taxonomy and summaries of the papers in the supplement which also categorized them.

Classroom Assessment as Co-Regulated Learning: A Systematic Review

Andrade, H. L., Brookhart, S. M., & Yu, E. C. Y. (2021). Classroom assessment as co-regulated learning: A systematic review. Frontiers in Education, 6. https://doi.org/10.3389/feduc.2021.751168

- Focused on studies that enable students and teachers to use assessment to scaffold co-regulation and classifies as Classroom Assessment as Reciprocal, Interactive Co-regulation.
- Figure 3 provides a framework for students, teachers, and peers.

Does Assessment Make Colleges Better? Who Knows?

Gilbert, E. (2022, June 14). Does assessment make colleges better? who knows? The Chronicle of Higher Education. Retrieved July 30, 2022, from https://www.chronicle.com/article/does-assessment-make-colleges-better-who-knows/

- The article asks the important question as to whether or not anyone has looked at whether or not the assessment has actually made the American colleges, or students, better. They ask if anyone tried to compare institutions with different approaches to assessment.
- They suggest that if we could demonstrate that good assessment has made an impact on the institution such as "changes in a college's reputation, ranking, or employment prospects for its students" - this could help change faculty perceptions of the value of assessment.

<u>Additional Resources</u>

Does Assessment Make Colleges Better? Let Me Count the Ways

Kevin. (2015, August 19). Does assessment make colleges better? let me count the ways. World leading higher education information and services. Retrieved July 30, 2022, from https://world.edu/does-assessment-make-colleges-better-let-me-count-the-ways/

A Simple Model for Learning Improvement: Weigh Pig, Feed Pig, Weigh Pig

Fulcher, K. H., Good, M. R., Coleman, C. M., & Smith, K. L. (2014, November 30). A simple model for learning improvement: Weigh pig, feed pig, weigh pig. occasional paper #23. National Institute for Learning Outcomes Assessment. Retrieved July 30, 2022, from https://eric.ed.gov/?id=ED555526

Authentic assessment. Center for Innovative Teaching and Learning. (n.d.). Retrieved July 30, 2022, from https://citl.indiana.edu/teaching-resources/assessing-student-learning/authentic-assessment/index.html

Perceived supports and evidence-based teaching in college STEM

Bathgate, M. E., Aragón, O. R., Cavanagh, A. J., Waterhouse, J. K., Frederick, J., & Graham, M. J. (2019, April 9). Perceived supports and evidence-based teaching in college stem - International Journal of STEM Education. SpringerOpen. Retrieved July 30, 2022, from https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-019-0166-3

Developing Assessments for the Next Generation Science Standards

Contributor(s): National Research Council; Division of Behavioral and Social Sciences and Education; Board on Testing and Assessment; Board on Science Education; Committee on Developing Assessments of Science Proficiency in K-12; James W. Pellegrino. (2013, December 17). Developing assessments for the next generation science standards.

The National Academies Press. Retrieved July 30, 2022, from https://nap.nationalacademies.org/catalog/18409/developing-assessments-for-the-next-generation-science-standards

McConnell, K., Rhodes, T., Horan, E., and Zimmerman, B. (2022, April 5). We have a rubric for that: The value approach to assessment. AAC&U. Retrieved July 30, 2022, from https://www.aacu.org/publication/we-have-a-rubric-for-that-the-value-approach-to-assessment

On Solid Ground: Value Report 2017

McConnell, K., Rhodes, T. (2017) On solid ground: Value report 2017. AAC&U. Retrieved July 30, 2022, from https://www.aacu.org/publication/on-solid-ground-value-report-2017

Nationalacademies.org. (n.d.). Retrieved July 31, 2022, from https://www.nationalacademies.org/event/05-23-2022/roundtable-on-systemic-change-in-undergraduate-stem-education-spring-hybrid-meeting

National Academy of Engineering; National Academies of Sciences. (2022, January 18). Imagining the future of Undergraduate Stem Education: Proceedings of a virtual symposium. Proceedings of a Virtual Symposium |The National Academies Press. Retrieved July 31, 2022, from https://nap.nationalacademies.org/catalog/26314/imagining-the-future-of-undergraduate-stem-education-proceedings

Quantitative literacy through community-based group projects. NCSCE.net. (2017, December 15). Retrieved July 31, 2022, from http://ncsce.net/quantitative-literacy-through-community-based-group-projects/

RETURN TO TABLE OF CONTENTS