Growing Assessment Capacity of Engineering Educators through ASSESS

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Dr. Shane Brown conducts research on cognition and conceptual change in engineering. He received his bachelor's and Ph.D. degrees from Oregon State University, both in Civil Engineering. His Ph.D. degree includes a minor in Science and Mathematics Education. His master's degree is in Environmental Engineering from the University of California, Davis. Dr. Brown is a licensed professional civil engineer and has six years of experience designing water and waste water treatment facilities in central California. He was the recipient of the NSF CAREER award in 2011. Dr. Brown's research interests are in conceptual change, epistemology, and social or situated cognition. Specifically, his research focuses on theoretical approaches to understanding why some engineering concepts are harder to learn than others, including the role of language and context in the learning process.

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Dr. Brian French is an associate professor in Educational Psychology and co-director of the Learning and Performance Research Center in the College of Education at Washington State University. He teaches courses in measurement, statistics, and advanced quantitative methods. His research is in the area of educational and psychological measurement with an emphasis on test score validity. Samples of topics of interest include measurement invariance, structural equation modeling, item response theory, factor analysis, and Monte Carlo studies. Dr. French earned a B.A. in Psychology and Spanish from Seattle University and M.S. and Ph.D. degrees in Educational Psychology from Purdue University.

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Abstract

The Appraisal System for Superior Engineering Education Evaluation-Instrument Sharing and Scholarship (ASSESS) is a web-based information repository and search engine for locating assessment and evaluation instruments relevant to engineering education. The ASSESS database is populated with instrument names and both technical and nontechnical characterizations of each instrument. It identifies outcomes for which an instrument is applicable, target audiences, administration conditions, and availability of evidence for score reliability and validity. Each instrument also is described by a summary written for assessment novices and marked by visual indicators for amount of supporting evidence available and user ratings. Information provided for each instrument enables people accessing the site to determine the appropriateness of individual instruments for an intended use.

The ASSESS site also offers tools to facilitate locating the desired instruments and to help users to understand assessment and network with assessment professionals. Searches using both keywords and specification of desired instrument characteristics enable the user to efficiently find the most relevant instruments. A glossary of assessment terms and an assessment wiki offer basic assessment knowledge to help those new to assessment. In addition, users may rate instruments in ASSESS, suggest instruments for inclusion in ASSESS, and suggest revisions to the ASSESS website. The ASSESS website will undergo user testing in 2013, after which the site will be launched fully. The combined features of ASSESS will build the engineering education assessment community and expand appropriate use of assessments in engineering education.

Background

As outcomes-based assessment and accreditation of programs and institutions raise the bar for assessment competencies of engineering educators, selection of assessment instruments to determine the impacts of educational or program innovations is an increasing priority. On a classroom scale, individual faculty need easy-to-use instruments to measure student learning under different instructional methods and classroom conditions. Moreover, writing competitive grant proposals requires assessment of envisioned project impacts to obtain initial funding and to argue for subsequent funding. A major obstacle to each of these assessment challenges is locating the correct instruments for the situation at hand and the outcomes to be measured. This paper describes the development of a web-based aid for locating desired instruments while also growing the assessment capacity of engineering educators using an online search tool: the Appraisal System for Superior Engineering Education Evaluation-Instrument Sharing and Scholarship (ASSESS).

ASSESS
The ASSESS project is a National Science Foundation (NSF) Transforming Undergraduate Education in STEM (TUES) Type 2 project (DUE 1065486) founded on a precursor NSF Course, Curriculum and Laboratory Improvement (CCLI) Type 1 project, Inventory of

Evaluation Tools for Engineering Education Projects. The Inventory project (a) established the need for a readily available repository of high quality evaluation tools to support evaluation of engineering education projects, (b) identified some of the tools and characteristics that may be valuable for an evaluation tools database, and (c) identified potential user groups who could benefit from an engineering education evaluation tools database. As part of the precursor project, a panel of national engineering education experts and evaluation professionals called for the development of a web tool designed to house the evaluation tools information database, now known as ASSESS.

The goal of ASSESS is to increase the evaluation capacity of engineering educators by offering a one-stop site in which users can locate instruments for assessing the impact of educational innovations and student learning in the classroom. Over the life of the project, development of the website and supporting database have undergone significant review and revision to establish a tool that will be meaningful to a variety of engineering education users. In particular, refinement in the second project year, 2012, focused on three areas: (a) instrument identification, entry and editing, (b) development of the ASSESS website to support entry of and access to instruments, and (c) conducting adoption research by surveying and interviewing prospective users of the ASSESS web tool. A consultant meeting in August, 2012, provided further clarification and future directions for identifying instruments and for developing the website. The next sections describe the aforementioned activities in more detail to give a broader picture of the ASSESS web tool as it currently exists. Public release of a beta version is expected in spring of 2013.

Instrument Identification, Entry, and Editing

In the first year of the project, a search strategy was defined to establish the procedure by which suitable evaluation instruments could be selected for inclusion in the ASSESS database.[1] The strategy incorporated three components: (1) search of peer-reviewed journal articles, such as the Journal of Engineering Education (JEE) and the International Journal of Engineering Education (IJEE), (2) use of branching techniques from reference sections of papers and reports, and (3) identification of innovative projects that may have developed and employed evaluation instruments, particularly by searching the NSF database as well as Frontiers in Education (FIE) and American Society for Engineering Education (ASEE) conference proceedings.

While comprehensive, the strategy in year one proved to be somewhat challenging for locating instruments. To address the issue, the project team decided to contact engineering faculty directly to identify instruments of value to the engineering education community. The team's experience with the ASEE Education and Research Methods (ERM) listserv suggested that people in the community were aware of instruments that should be included in ASSESS. The project investigator also suggested that the team utilize contacts established through the adoption research to determine whether interviewees could identify instruments or people who may be developing instruments. In addition, an email form was created to send to engineering faculty to gather information on instruments and instrument developers with whom they were familiar.

The challenges in identifying instruments also were discussed with the Consultant Team, and a portion of the Consultant Team meeting in August was spent as a work session in which

consultants identified candidate instruments, instrument developers, and contacts for establishing collaborations. The session produced approximately 10 instruments as well as a variety of constructs and contacts to consider for gathering additional information. Consultants also suggested accelerating population of the database by postponing detailed data entry until after the names of approximately 100 instruments were entered into ASSESS. A larger number of instrument names would then be searchable by the public upon release of the ASSESS beta version and having additional instruments could aid website development. To date, the ASSESS website houses the names of over 100 instruments and the process of entering detailed information for each is well underway.

Website Development
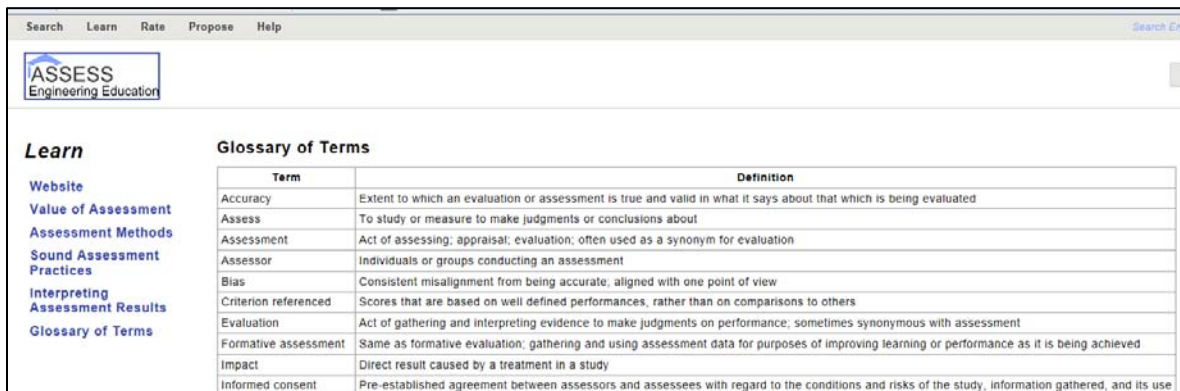
A primary focus of year two activities was continued refinement of the ASSESS website for instrument entry and editing. Throughout the course of the year, several steps took place to refine the database and web structure to create a user-friendly interface. At the beginning of the year, old instrument data were removed so the team could enter new data for instruments catalogued in the system. A pull-down menu was implemented for entering "strength of evidence," later defined as the "description of evidence," and currently named "Amount of Evidence," using three options: "none," "little," and "more." In addition, functional parts of the website were transitioned to the home page, links were made active, and glitches were resolved. Links across the top of the home page were aligned to provide the same functionality as the defined links for Searching, Learning, Discussing, Rating, Proposing, Getting Help, and Developing. Further, a landing page was developed for each link, as described and shown below:

1. **Search** – allows users to search for evaluation instrument information using filters and keywords. The search page below shows the structure for a search for instruments for which the term "attitudes" is included in the title or descriptions of the instrument.
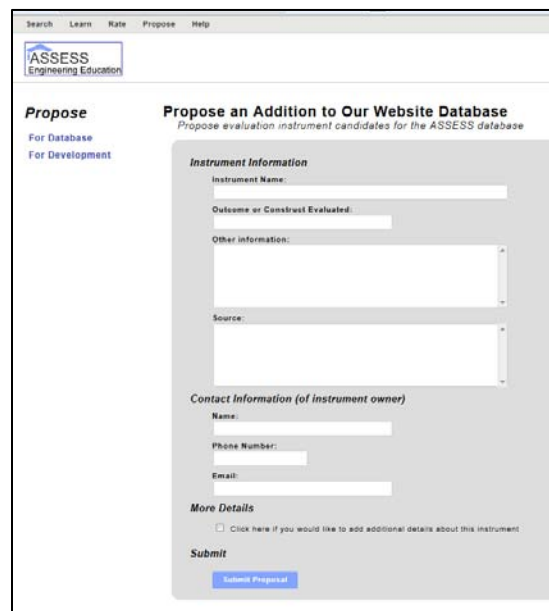
2. **Learn** – provides basic information to help novice users learn about assessment, instrument selection and use, and interpretation of assessment results. Shown below is the format of the glossary tab of the Learn page.

3. **Discuss** – includes structure for a wiki, a blog, and a forum. Content for the discuss page is currently under development and is not available to users at this time.

4. **Propose** – enables users to propose new instruments that should be considered for the ASSESS website or to propose instruments that need to be developed. Forms are available under the Propose page for making both types of proposals and for providing significant information about available instruments being recommended. The screenshot below shows the tab on the Propose page for users to propose an existing instrument for addition to the ASSESS website database.
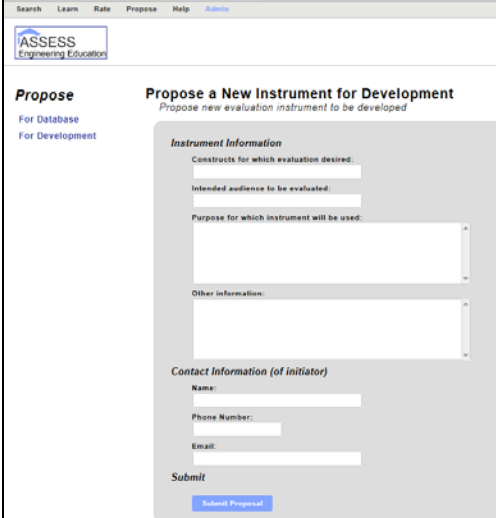

5. **Get Help** – provides users hints for addressing their problems with the website and includes frequently asked questions. This page is not yet developed.

6. **Development** – supports the ASSESS team in developing the website by providing data entry templates for new instruments and for editing data existing in the system. This section requires user login. The screenshot below shows the front page for proposing a new instrument for development.

Searching options, in particular, were made more robust and intuitive by adding Boolean features, such as "AND," "OR," "NOT," or others commonly found in library search engines. A button was also created to allow users to browse a list of all instruments included in ASSESS. Filtering for narrowing a search was restructured to include two initial categories: "Domains Assessed" and "ABET Engineering Criteria." Instruments are now categorized by six domains: (1) Knowledge, (2) Attitudes, (3) Behaviors, (4) Professional Skills, (5) Learning Environment, and (6) Institutional Data. Finally, several revisions were made to the ratings of instruments. For example, the strength or description of evidence ratings (none, little, more) for engineering use, reliability, and validity was displayed visually by different sized icons. In addition, user ratings were indicated by stars and a number of ratings considered for a star rating. Different formats for displaying the ratings (i.e., tabular and listing options) were implemented, and a table format was selected for its ease of use and visual representation of the information.

Additional revisions or developments to the website included:

a. Identification of ABET Criteria items by a short name rather than the entire definition of each criterion, with future enhancements including "mouse-over" definitions for each short name and inclusion of the 3a-3k numbering for each criterion.

b. Search results viewable in table format. Table formatting shows columns for name (full name of instrument), use in engineering (none, little, more and corresponding symbol), evidence for reliability (none, little, more and corresponding symbol), evidence for validity (none, little, more and corresponding symbol), and user rating (5 stars with the number of ratings in parentheses).

c. Enhanced user rating system. When an instrument is identified in a search, clicking the instrument name opens a window to display detailed information about the instrument. Selecting the Rate link then opens a box for the user to provide the instrument a star rating and user review comments.

d. Development of a status table to display the status of data entry for each instrument in the system (i.e., the amount of information in the database for each instrument compared to the total amount requested). When a user is logged into the website, the status table appears under the Development tab, Edit Instrument sub-heading.

As a result of the aforementioned revisions, the ASSESS website is more easily managed by administrators and will be more easily used by engineering educators.

Adoption Research

As previously mentioned, a primary aspect of year two activities was adoption research aimed at understanding user needs through interviews with potential users. Interviews were conducted with participants of the 2009 workshop on the precursor project, Inventory of Evaluation Tools, as well as with individuals from the ASEE ERM division membership. A total of 23 individuals were interviewed from the two groups between April 2012 and August 2012.

Roger's theory of diffusion of innovations was used to design the interview questions.[2] Diffusion of innovations theory suggests that five characteristics relate to the adoptability of an innovation. These characteristics, as summarized below in Table 1, were operationalized into a set of interview questions and used to conduct open-ended phone interviews. Follow up questions were used as necessary to obtain more detailed responses. The goal of the interviews was to develop an understanding of the participants' views of the ASSESS database as they related to adoptability.

Table 1. *Diffusion of Innovations Characteristics*

Characteristic	Definition
Relative Advantage	The degree to which an innovation is better than an existing method/practice/idea.
Compatibility	The degree to which an innovation matches the needs, experiences and views of the adopter.
Complexity	The degree to which an innovation is perceived as difficult to use or understand.
Trialability	The degree to which the innovation may be experimented with before committing to adoption.
Observability	The degree to which the results of an innovation are visible to others.

Interview responses were analyzed using an iterative coding process. Responses were linked to the appropriate characteristic, given a positive or negative label, and then given an additional label concerning the specific area of the response. For example, if a participant responded that they liked the database because they found it easy to use, their response would be coded as

"Complexity – Good- Simple" because it demonstrated good (low) levels of complexity in relation to the simplicity of the database.

Little variance in responses occurred over the interview time line. The later interviews were more positive and less critical of the ASSESS system, possibly due to the system's more developed and refined state or to the lower expectations held by the participants who had not been previously exposed to the ASSESS project. Complexity and trialability received the most positive responses in the interview process. Potential users expressed that they felt the database was intuitive to navigate and use. Most users also mentioned that the database has a high level of trialability in its current stage, because participants are able to experiment without registering or paying a fee. Observability received few positive responses, but some mentioned that this was mostly due to the current stage of the database. Observability is expected to increase as ASSESS is given more exposure in conferences and journals. Finally, relative advantage and compatibility received mixed responses as the expectations of potential users varied greatly, ultimately affecting participants' opinions in these two areas.

As an important step toward making the ASSESS website functional for multiple users, the adoption research team is conducting a usability study to learn the functions that users hope to see on the ASSESS website and to determine the ease with which users can navigate the website and accomplish specific tasks as intended. The former data were gathered in October and November, while the latter were gathered in November or December. In short, results from 29 educational researchers and ABET evaluators showed that most users want the ability to search by keywords and to sort by instrument characteristics. Additional findings from the study will guide development of ASSESS as data are gathered and analyzed.

Conclusion

To date, the general structure of the database supporting ASSESS is developed and functional. Additional revisions will be made upon entry of more instruments in the database when functionality can be tested using a larger number of instruments. Similarly, the web interface is mostly developed and is currently undergoing revisions to enhance usability and professional appearance of the website. At the time of this paper, names of over 100 engineering education evaluation instruments are housed in ASSESS, with many of them having detailed information to guide users in identifying instruments that match their interests and assessment needs. In addition, the adoption research team is preparing the testing protocol for user performance on the website, pilot testing the protocol, and planning a user feedback survey to be used after the site is functional and well-populated.

ASSESS is a one-stop website in which a variety of engineering educators and evaluators of engineering education projects can easily access desired evaluation instrument information. As demands for assessment and accountability increase, ASSESS offers one solution for overcoming challenges in locating assessment instruments to appropriately measure educational outcomes, such as student beliefs, attitudes, professional skills, or other attributes. Additionally, the ASSESS tool can be used by engineering educators to learn more about assessment and to network with others in the field. By housing information for a variety of instruments and by expanding appropriate use of instruments in engineering education, ASSESS is a sustainable

resource for building evaluation capacity within the engineering education assessment community. As the project team prepares to implement a beta version of the ASSESS website for public use in spring of 2013, suggestions for instruments or other contributions to the website and database are welcomed. If you have helpful suggestions for ASSESS, please contact the authors.

Acknowledgement

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