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# Adoption of Technological Innovations: A Case Study of the ASSESS Website

SARAH BROOKS

SHANE BROWN

DENNY DAVIS

AND

JENNIFER LEBEAU
Washington State University
Pullman, Washington

## ABSTRACT

In engineering education, assessment instruments are often developed to evaluate programs and projects. Unfortunately, these innovations are not always adopted by intended audiences. Rogers' Diffusion of Innovations (DI) Theory provides a framework to analyze characteristics of an innovation that will affect adoption. The Appraisal System for Superior Engineering Education Evaluation-instrument Sharing and Scholarship (ASSESS) is a user-driven, web-based catalogue of assessment instrument information. The purpose of this study is to develop an understanding of ASSESS' adoptability as well as to characterize lessons learned and how to apply them to other technical innovations. Interviews with potential users were used to explore user perspectives of ASSESS. It was found that the innovation's *Use as an Alternative* and its *Functionality of Design* were the primary categories important for adoption. These categories relate to the *Relative Advantage*, *Complexity*, and *Compatibility* DI characteristics. Focusing on these categories and DI characteristics is recommended for developers of engineering education technological innovations.

**Key Words**: Assessment, Diffusion of Innovations, Adoption, Engineering Education

## INTRODUCTION

Educational innovations to improve and assess engineering education are often developed, but not commonly adopted by the intended users. An abundance of assessment instruments, such as

concept inventories and self-efficacy instruments, have been developed for engineering education. However, these instruments are not broadly adopted. Rogers, who developed the Diffusion of Innovations Theory (DI), notes that even innovations with obvious advantages are slow to be adopted in educational institutions (Rogers 2003).

Adoptability studies are usually performed after the development process and typically study how an innovation is adopted (Rogers 2003, pg. 219). One issue with studying adoptability by looking at the adopters is that at this point it is too late to make significant improvements or changes to the innovation to aid its adoption. Studying the characteristics of an innovation can be done before the innovation is released for adoption, allowing for improvements to be made. This study will investigate potential adopters' views of a web-based database developed to house information on engineering assessment instruments during the development process, allowing for insights into adoptability of technological innovations as they are developed and providing feedback to the developers for improved adoption. The paper has implications for engineering educators, researchers, and evaluators intending to adopt assessment instruments for improved classroom performance or for measuring progress toward goal attainment in evaluation of research innovations.

## LITERATURE REVIEW

When new innovations are created, developers may be interested in how they will diffuse to their intended audience. This raises the question of how to determine the adoptability of the innovation. This information is important when defining the success of the innovation (Procaccino et al. 2005). One common method for understanding the adoptability of an innovative technology, especially in an educational setting, is Rogers' DI Theory (Martins et al. 2004, Kebritchi 2010). Kebritchi (2010) notes that "*Rogers' theory has been widely used in a variety of settings, ranging from diffusion of rural technology among farmers to the adoption of innovations in educational settings. This theory is useful for instructional technologists to explain, predict and account for the factors that impede or facilitate the diffusion of their products*" (p. 258).

Rogers' theory follows the diffusion of an innovation, looking at characteristics of an innovation, the social system in which it is diffused, the type of innovation decision, the types of communication channels used, and any promotional efforts used by change agents (Rogers 2003, pg. 11). Most of these variables occur after an innovation is released for adoption. The DI characteristics of the innovation itself can be addressed during the development phase of the innovation. Because this research is focused on the development phase, this paper will use DI characteristics to examine adoptability.

DI Theory suggests that five characteristics relate to the adoptability of an innovation, as summarized in Table 1 below (Rogers 2003, pg. 15-16). DI Theory states that "*The characteristics of*

| 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. |

***Table 1. Diffusion of Innovations Characteristics***

*innovations, as perceived by individuals, help to explain their different rates of adoption*" (Rogers 2003, pg. 15). The "individuals" mentioned are potential adopters, not the developers of the innovation. Most adoption studies neglect the perspective of the developer all together. Developers often have little or no awareness of what potential users are looking for in an innovation (Vonk et al. 2007). Ravitz and Hoadley point out that "*One gap [in communication] is between technology users and technology developers, making it more difficult for developers to seek and obtain feedback from users*" (Ravitz and Hoadley 2005). This study is unique in that developers will be immediately aware of potential users' views of the adoptability of the innovation.

There is disagreement in DI literature about which of Rogers' characteristics are the most important for the adoption of technological innovations (Kebritchi 2010, Martins et al. 2004, Samarwickrema and Stacey 2007). Literature about adoption studies for technological innovations in education helped determine what DI characteristics would be important for this study. Studies that operationalized the five DI characteristics for use as interview questions were specifically explored and the resulting three studies are described below.

Kebritchi studied the adoption of a mathematical computer game (2010) targeted to middle school teachers to help their students learn Algebra. The DI characteristics that were the most important were *Relative Advantage*, *Compatibility*, *Complexity* and *Trialability*. *Relative Advantage* was the most important factor, because the game had to be more effective at teaching Algebra than other options available to the teachers. *Compatibility* was also highly important because teachers needed the game to fit well into their schedules and curricula. If the game could not be adjusted to their requirements, it would not be helpful. *Complexity* was important for teachers in respect to how the game challenged their students. They did not want a game that was too easy, but if it was too challenging it would not be useful. It also had to be simple enough for the teachers to help their students if they ran into difficulty. Finally, teachers wanted opportunities to test the game before they committed to adopting it. Without at least minimal *Trialability*, few teachers were willing to implement the game. *Observability* was not important because teachers wanted to base adoption on their own experiences.

In researching the adoption of Internet resources for teaching foreign language in schools, Martins et al. found that *Trialability* and *Observability* were the most significant DI characteristics (2004). Their study showed that participants who received more training on using the Internet for this purpose adopted the resource in their classroom. They found that when the applications were observable, diffusion was more likely to occur. The other three DI characteristics were not perceived as important as *Trialability* and *Observability*. During training teachers mentioned the advantages of using the innovation (*Relative Advantage*) and the ease of use (*Complexity*) were apparent. Thus, *Relative Advantage* and *Complexity* played a role in adoption, but were actually initially considered part of *Trialability* by the researchers.

Another adoption study was focused on web-based learning and teaching in higher education (Samarwickrema and Stacey 2007). *Relative Advantage* was discovered to be the most influential DI characteristic followed by *Compatibility*. The features of the web-based approaches, such as communication options, were often cited as reasons for adoption. Adopters previously did not use web-based learning, so the adoption of these methods was an alternative to classroom education. The study found that when the participants' social systems encouraged them to adopt, they were more likely to do so. Because the systems were compatible with their values and those of their social network, they were comfortable with adoption. *Trialability*, *Observability*, and *Complexity* did not affect adoption as much. This could be because most adopters were adopting based on the end goal (web-based learning) instead of based on the learning management system being recommended. If the instructor wanted to provide a web-based class (or was asked to do so by administration), then these three DI characteristics became less important for adoption to occur. The advantages of the system and whether they are compatible with the educational environment are important. Whether or not the adopter's colleagues had used the system, the system was simple, or a free trial was offered, were found to be less important for adoption.

The significance of the various DI characteristics on the adoptability of an innovation appears to be distinct for each innovation. Rogers himself stated that *Relative Advantage* is one of the strongest predictors of an innovation's rate of adoption, but not all literature is in agreement (Rogers 2003, pg. 233). Thus, developers are not able to select a DI characteristic for focus prior to initiating an adoptability study on their innovation.

## ASSESS

Advancing engineering education requires development and use of high quality educational evaluation instruments as well as a community of engineering educators prepared to properly implement these instruments. Many of the research questions addressed by engineering education development projects require both qualitative and quantitative methods of assessment to determine project impacts on performance, perceptions, and academic intentions of people being studied.

Project investigators often struggle to find an appropriate evaluation instrument, so they develop their own. This often results in use of less proven evaluation instruments or wasted effort as instruments are needlessly reinvented. Many investigators also lack the knowledge needed to select the best evaluation instruments, administer them as intended by the developer, and interpret evaluation results properly for the instrument and the conditions of its use. The final result is project evaluation that is inadequate for fully documenting the outcomes, guiding project implementation for maximum benefit, and determining real impacts of a given engineering education development project.

At a time when improvement of engineering education is crucial to the well-being of the nation, high quality evaluation instruments must be readily available and also empower project investigators to select and utilize them effectively. The National Science Foundation is also calling for evaluation capacity building (ECB) for personnel working on NSF projects (Katzenmeyer and Lawrenz 2006). A national workshop convened by the authors of this paper also produced recommendations calling for a well-developed clearinghouse for high-quality evaluation instruments to support engineering education (Davis et al. 2009). Thus, a national imperative exists to develop, make readily available, and properly use high quality evaluation instruments in engineering education projects to support vital advancement of engineering education.

Several online warehouses aim to address the need for more easily accessible assessment instruments. For example, Purdue's INSPIRE Assessment Center offers engineering education researchers, outreach developers, and P-12 teachers psychometric and descriptive information on approximately 60 research and classroom assessment instruments (see: https://engineering.purdue.edu/Inspire_center/assessment-center). The Assessing Women and Men in Engineering (AWE), developed by The Pennsylvania State University and the University of Missouri with supplemental funding from the Henry Luce Foundation, offers STEM assessment resources for K-16 educators, researchers, and evaluators (see: http://www.engr.psu.edu/awe/). Engineering Pathway offers a variety of K-12 and higher education teaching and learning resources (see: http://www.engineeringpathway.org). Other websites, such as the Online Evaluation Resource Library (OERL), http://oerl.sri.com/, and the Field-tested Learning Assessment Guide (FLAG), http://flaguide.org, offer strategies and tools for classroom assessment and project evaluation. The websites all address different user types and vary in levels of comprehensiveness; yet, offer some form of education on incorporating assessment or evaluation into research or classroom-based practices.

This study will examine the adoptability of the Appraisal System for Superior Engineering Education Evaluation-instrument Sharing and Scholarship (ASSESS), a user-driven, web-based database of evaluation instrument characteristics. While similar in nature to the aforementioned assessment resource websites, particularly INSPIRE, ASSESS houses more comprehensive psychometric and descriptive information for more than 100 instruments and is designed to meet the assessment and evaluation needs of engineering

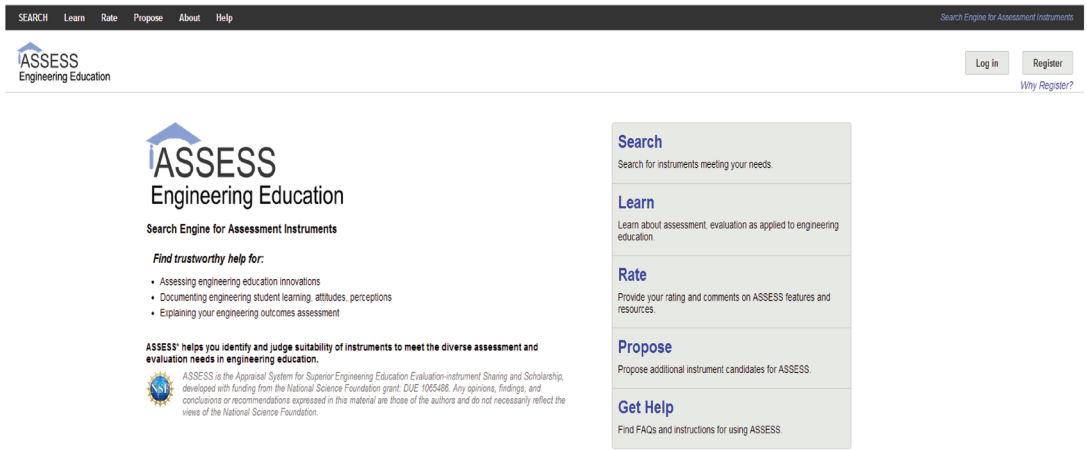



***Figure 1. Introduction to ASSESS.*** Link: https://www.youtube.com/watch?v=RmU4H0izrYA&index=6&list=PL84VcUp5xaBsRutUS-8KR2lwFxh8KfI9G

educators, researchers, and evaluators. For each assessment instrument, ASSESS provides descriptions, uses in engineering education, reliability and validity evidence, as well as both expert and user reviews that are unique to ASSESS. An introductory video describing ASSESS is available by clicking on Figure 1. The ASSESS website can be found at: http://assess.tidee.org/. Links to each of the previously mentioned assessment websites can be found by clicking on Resources under the Learn tab.

In considering the purpose and functionality of ASSESS and the literature related to the most important characteristics for adoption of comparable innovations, it appears that *Relative Advantage*, *Trialability*, and *Compatibility* will be the most important characteristics related to adoptability of ASSESS. This innovation is different from those presented in the literature review in that it is specifically intended for engineering education, as opposed to education in general. ASSESS allows for user input, a function the reviewed innovations did not have. Additionally, ASSESS serves as a database of information with search functions and additional opportunities for learning. However, all innovations included in the literature review are technological in nature and are used in education. One of the goals of this study is to compare the predicted and actual importance of DI Theory Characteristics.

The goals of the ASSESS project are to assist engineering educators in identifying assessment instruments suitable for use in specific education or research endeavors. The project also seeks to assist engineering educators in disseminating and refining assessment instruments that have been developed through research projects. ASSESS users are able to submit instruments for consideration for inclusion through the ASSESS interface.

ASSESS will potentially be used by teachers, program assessors and individuals writing grants and looking for information on assessment instruments. The development of ASSESS was chosen because it fills the need in engineering education for a source of information about assessment instruments and has a high probability of being adopted by large numbers of engineering educators. Finally, ASSESS takes the form of a database, which could be translated to areas in education that store other materials, such as curricular materials or assessment questions. Thus, the results of this study may be helpful to an audience much broader than those interested in the specific content area of ASSESS.

## RESEARCH GOALS

Literature shows much disagreement on what DI characteristics are most important for the adoption of an innovation, a challenge for developers who would like to collect feedback on their innovation to improve adoptability. Adoptability studies need to be performed during the development process to allow developers to make adjustments to their innovations.

The purpose of this study is to demonstrate the perspectives of potential ASSESS users, gathered using the DI theory as a framework. The following research sub-goals will accomplish the overall research goal.

- Capture multiple perspectives of the innovation during the development phase to develop and refine ASSESS.
- Determine the relative importance of DI characteristics in technological educational innovations.

## METHODOLOGY

### Participant Selection

The participants were chosen based on their likelihood to adopt ASSESS, in a similar fashion to Guido Vonk in his study of planning support systems (Vonk, Geertman, & Schot, 2007). The first group, Participant Group (PG) One, is individuals who participated two years earlier in a workshop focusing on defining the need for and content of a database for engineering evaluation instruments. Everyone who participated in the workshop was invited to participate in this study. Of the 29 invited to participate,

nine agreed to be interviewed. PG One had already been exposed to the idea of ASSESS, but not the website itself. Since this group had chosen to attend the workshop and were engaged in engineering education and assessment, they were deemed likely potential adopters of ASSESS. PGs Two and Three were selected from the Educational Research and Methods (ERM) Division of ASEE. PG Two included nine individuals and PG Three included four individuals. ERM members consist of engineering educators and researchers who engage both in basic engineering education research and evaluation of their own and others' teaching practices. Both researchers and educators are the targeted audience for ASSESS. Many ERM members attend educational conferences where ASSESS has been and will again be presented. Their potential increased exposure to the ASSESS project from these conferences and the fact that they are interested in educational research made this group more likely to adopt the final innovation. Additional information about the ASEE ERM division can be found at: http://erm.asee.org/.

The three groups of participants were interviewed throughout the development process of ASSESS to form a complete perspective on adoptability. The interviews occurred after the initial prototyped site was completed, but before the website was in its completed stage. For PG One, ASSESS had basic functionalities and about 10 instruments with information. For PG two, ASSESS had the same amount of instruments with information, more search features, and outlines of additional pages (learn, rate, etc.). For PG three, some additional instrument information had been added, the additional pages had some information, and improvements had been made in the search features' functionality. Having the interviews staged at different times enabled the researchers to gather perspectives on changes made during the development process, allowing the development team to see what improved or what still needed to be worked on.

**Interview Protocol**

Interview questions were developed using the five DI characteristics as guidelines. Each of the DI characteristics had multiple questions associated with it, as shown in Table 3. In addition to these questions, general questions were used to determine the interviewee's background with assessment instruments. The interview questions were also developed, in part, based on previous studies that had operationalized the DI characteristics (Martins et al. 2004, White 2010, Kebritchi 2010, Samarawickrema 2007, Hill and Lee 2010, Liberatore and Breem 1997, Di Benedetto et al. 2003, Heri and Mosler 2008). However, Rogers discourages reusing other studies' questions as "*The specific ways in which the five attributes are expressed differs in each study, and so the measures of these attributes should be uniquely created afresh in each investigation*" (Rogers 2003, pg. 225). For each interview, the participants were also given the definitions of the five DI characteristics and were asked to describe their perspective of ASSESS demonstrating each of the DI characteristics. The wording of some of the interview questions was slightly modified after completing the initial group

of interviews to increase clarity and optimize data collection from participants' interviews. Table 2 provides a summary of the questions asked for the participant interviews and the DI characteristic they illustrate. Generally speaking, fewer questions were asked about *Trialability* and *Observability*. During the protocol development and the interviews participants had less to say about these characteristics, even when asked multiple probing questions. Therefore, the reduced number of questions does not represent a reduced opportunity to talk about these characteristics by the participants.

**Interview Methodology**

The goal of the interviews was to develop an understanding of the participants' views of ASSESS' adoptability using the DI framework. Interviews were semi-structured (Krathwohl 1998, pg. 287) with open-ended questions (Patton 2002, pg. 20-21). A semi-structured interview style was selected based on the complexity of responses from individuals. The ability to individualize the interviews to collect the participants' unique perspectives is critical when it is expected that aspects of each participant's perspective will be unique. The researchers did not want to assume that they could get all the information they needed from using a fixed set of questions, as would be the case in a closed-ended interview.

Participants were asked the questions presented in Table 2 and were encouraged to elaborate on their answers. Follow up questions (shown italicized in Table 2) were asked as necessary

| | |
|---|---|
| Background Questions | • What current methods do you use to access assessment instruments?<br>• What do you like/dislike about your current methods?<br>• What do you think of the ASSESS database? *What was your first impression of the database? Does it meet your expectations or not? How so?* |
| Relative Advantage | • What advantages or disadvantages does this database have over your existing methods for finding assessment tools?<br>• In what ways would this database positively or negatively affect your assessment capabilities?<br>• How would your assessment practices change if you were using this tool? Would you consider this change an improvement or a regression?<br>• How would your productivity change due to the use of this tool? |
| Compatibility | • How do you envision ASSESS fitting into your daily work activities?<br>• Why would you want to tell your colleagues about this? *What would you tell them?*<br>• In what ways could this be used in your department?<br>• In what ways could you envision your colleagues in your department using this tool? |
| Complexity | • When looking at the ASSESS database, what items, if any, do you not understand?<br>• How hard would it be for you to learn to use this tool?<br>• How long would it take you to become comfortable using ASSESS?<br>• How easily would you be able to get what you want out of it in an efficient manner? |
| Trialability | • What do you think the upsides/downsides to trying this tool are?<br>• What are you giving up/gaining from trying ASSESS? |
| Observability | • What other databases, similar in educational content to ASSESS, do you know of? *What do you know about them and where did you hear about them?*<br>• How would others know if you were using this tool? |

***Table 2. Participant Interview Questions***

for clarification. The interviews were conducted over the telephone and lasted between 10 and 20 minutes.

## ANALYSIS METHODS

The interviews were recorded, transcribed, and analyzed using Atlas TI (Scientific Software Development 1999). Although the three sets of interviews were conducted at different times during the development of ASSESS, there were not dramatic differences in participants' responses across the three groups. Therefore, the data from all three groups were analyzed together. Data analysis was done with increasing depth as described by Krathwohl (1998, pg. 308). The transcriptions were first read to obtain an understanding of the overall responses. An initial coding step was then completed, which is referred to as descriptive coding to "*see what is there*" (Krathwohl 1998, pg. 308). The data was coded for participant responses that mapped to one of the five DI characteristics. The next step of coding was to "*recode this same material at an interpretive level*" (Krathwohl 1998, pg. 308). The responses were then coded as they related to the DI characteristic – good or bad. The final step for analysis consisted of "*a still deeper level of analysis….code patterns of activities, themes, causal link*…," (Krathwohl 1998, pg. 308).

The responses were then categorized further with individual tags for the reasoning behind the categorization. For example, a participant's response that said they liked the database because they found it self-explanatory and easy to use would be coded as "Complexity – Good – Simple" because it demonstrated good (low) levels of *Complexity* because of how simple it is to use the interface. The dataset was then recoded according to descriptions of the site that are more in terms of the interviewees' language, both for interpretive value and to facilitate transferring findings to the developers. For example, responses were coded as "Additional Features" or "Suggested Changes" to help with the development process. The data were analyzed iteratively to connect the interviewees' descriptions with the DI characteristics. For example, the description of available information is related to DI characteristics *Relative Advantage*, *Compatibility*, and *Complexity*. Finally, for each category of overlap between interviewees' descriptions and DI characteristics the approximate frequency of this occurrence was determined and characterized as high, medium, or low and as either positive or negative. If less than 25% of participants mentioned the category a "low" ranking was assigned, between 25% and 75% received a "medium" ranking, and 75% received a "high" ranking. For example, "Negative High" indicates that most responses were negative and greater than about 75% of participants believed this category was important. Greater precision in these levels is not possible due to the inherent challenges and potential misrepresentation in assigning numerical data to interview responses, coupled with the limited value in doing so.

Data from PG Three did not reveal substantial new information beyond the previous interviews, known as data saturation. During analysis, 37 codes were used for PG Two, 36 of these were also used in PG Three. No new codes were added in analyzing PG 3. Krathwohl defines data saturation as the point "when new observations cease to add much to previous ones" (Krathwohl 1998, pg. 260). Therefore, no additional interviews were conducted after PG Three, because no new observations were being added.

## RESULTS AND DISCUSSION

The results are presented in terms of six categories that were identified in terms of interviewees' language: *Expectations of Instrument Inclusion, Available Information*, *Community Features*, *Use as an Alternative*, *Searchability,* and *Functionality of Design*. This allows for a more reader-friendly presentation because it is an organization and representation in the terms and the words of potential users, and it is expected that readers will more likely understand categories representing these potential users than the DI characteristics that most will not be familiar with. Also, this choice provides a more reader-friendly presentation of videos embedded into the article based on the six categories. These six categories, and the DI characteristics they relate to, are shown in Table 3 below, with a "Positive" or "Negative" sign indicating if overall responses were positive or negative. If no responses related to a DI characteristic for one of the six categories, this space was left empty in Table 3. The discussion will focus first on each category and then on how each DI characteristic related to that category. Videos are also included to provide an overview of the functionality of ASSESS and features that resulted from or were already aligned with feedback from interviewees.

| | Expectations of Instrument Inclusion | Available Information | Community Features | Use as an Alternative | Searchability | Functionality of Design |
|---|---|---|---|---|---|---|
| Relative Advantage | Negative High | Positive Med | Positive Med | Positive High | | Positive Med |
| Compatibility | Negative Low | Positive Med | Positive Low | Positive Med | Positive Med | Negative Low |
| Complexity | | Negative High | | | Positive Low | Positive Med |
| Trialability | | | | Positive High | Negative Low | Positive Low |
| Observability | | | Positive Low | Positive High | | Negative Med |

***Table 3. Ratings for DI Characteristics***

**Expectations of Instrument Inclusion**

The first category is "*Expectations of Instrument Inclusion*" and is related to expectations of interviewees to find information on specific instruments. This category includes aspects of the *Relative Advantage* and *Compatibility* DI characteristics, as shown in Table 3.

*Relative Advantage* - Participants expressed concern about the database being comprehensive: "*Downsides, like with all repositories, it's only as good as the effort to be inclusive of getting things into it*," "*there's also kind of a concern about would it be updated over time*," and "*The other thing is I tend to not only look at instruments that have only been done in engineering because I like looking at a wide variety of fields*." This concern is especially understandable considering the low number of instruments that had information available in the database at the time of the interviews.

While the *Relative Advantage* DI characteristic did receive a high negative rating for *Expectations of Instrument Inclusion*, not all of the responses were negative. Some participants looked beyond the current size of the database and considered the end result: "*I think the advantage is that it [ASSESS] is engineering focused and we are an engineering school so it filters out…things that I don't want*."

*Compatibility* - Participants were concerned that the database might not include information on the types of instruments they would be interested in: "*I think there would need to be more focus on concept inventories and things of that nature, you know, specific skill-based as opposed to attitude and things of that nature*," and "*I guess for me the really emphatic point here is I'd like to see more qualitative instruments such as open ended surveys and guided survey questions and how to conduct a focus group*."

In an effort to alleviate the concerns found in this category, the development team requested instrument suggestions from interview participants and has begun requesting them from conference attendees where the ASSESS website is being presented. The ASSESS website, once fully developed, will also have a feature that will allow users to suggest or submit instrument information to be included in the database. Thus, the database should evolve to be a highly inclusive set of instrument information providing for each user's individual needs.

**Available Information**

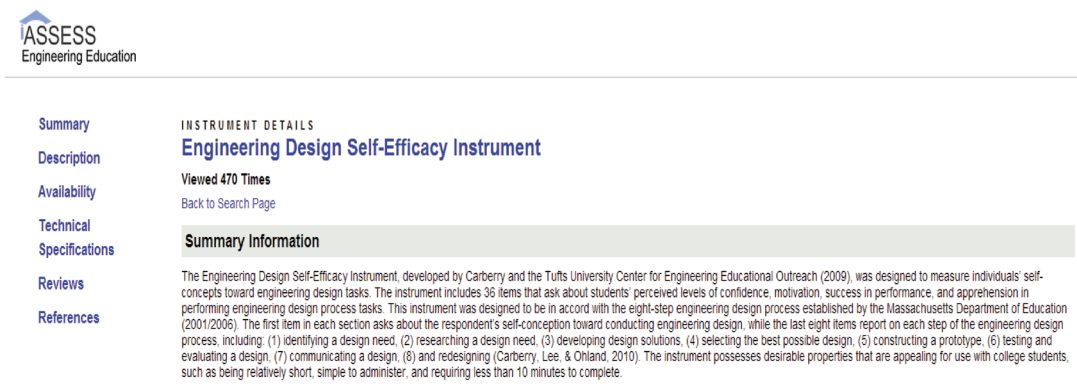
*Available Information* includes the participant perspectives of the information available on the ASSESS website. Examples of information are: specifications about instruments, information about how to use ASSESS, and information about assessment instruments in general. These responses relate to the *Relative advantage*, *Compatibility*, and *Complexity* DI characteristics. Table 4 shows that *Relative Advantage* and *Compatibility* received medium positive ratings and that *Complexity* received a high negative rating.

*Relative Advantage* - Participants overall were pleased with the amount of information available: "*Despite the fact that I need it or don't need it you have more details on the instrument. You have summary, description, you have the reference…where it was published, reliability and validity, you will have those links*." Additionally, participants thought that they would be able to learn from the information on ASSESS. These two areas increased the overall *Relative Advantage* for potential users.

*Compatibility* – Participants' views of the available information were generally positive. Again, the amount of information available was the most significant topic of responses: "*And if I dive into one in particular it's nice, you get the description, you get all the specifications of the material. You can link things, I can probably download things*." One concern for this DI characteristic was that novice users might still be confused and that there needed to be more information to guide these users: "*In my experience, a lot of faculty members really don't even understand what assessment is. I mean they have so little knowledge where their glossary isn't going to be sufficient for them, at least that's been my experience. Now, maybe people going into this website already know something about assessments, but I wouldn't count on it.*"

*Complexity* – The main area of concern was that the information available on ASSESS was too confusing. Symbols and terminology used throughout the website were misunderstood and questioned by participants: "*Utility standards of program evaluation; I don't even know what that means*." Another issue was that the amount of information provided was overwhelming for some participants, "*It might just be 'We're putting all this information out there for you to use,' but I'm just wondering if it could be filtered down first so I can click and go into more details, try to find in the areas that I'm more interested in, whatever it may be in those particular areas*."

In order to minimize confusion, the development team reviewed the terminology used on the website. Some symbols and terms were altered and a glossary was added to assist with the remaining terminology. Additionally, a "learn" tab was added to the website. This tab includes information about the website, about assessment instruments, methods, practices and results, and the glossary of terms. While some participants had mentioned that the amount of information was troubling, the additional information will be sorted into smaller chunks. Therefore, the information would presumably not be overwhelming. Another feature that has been added to minimize confusion is a question mark icon available above potentially confusing sections of text. If this icon is hovered over using a mouse, a pop-up window opens with additional explanatory information. These changes should make the information on the ASSESS website more applicable for all users. A video detailing information available on ASSESS can be accessed by clicking Figure 2. The video highlights the areas that participants noted as positive as well as the areas of improvement.




- Each instrument includes tabs of information. The summary tab gives the user an overview of the instrument including recommendations for use and how it has been used in engineering education.
- General information about assessment instruments and terminology is also available.

***Figure 2. Available Information in ASSESS.*** Link: https://www.youtube.com/watch?v=J0upB71Avh4&index=7&list=PL84VcUp5xaBsRutUS-8KR2lwFxh8KfI9G

**Community Features**

This category is focused on the interactive aspects of the website, including user ratings of assessment instruments and users' ability to submit information about assessment instruments. *Relative Advantage* has a medium positive rating while *Compatibility* and *Observability* are low positive ratings, as shown in Table 3.

*Relative Advantage* - Including interactive possibilities on ASSESS increases the *Relative Advantage* over alternative ways of researching assessment instruments. Participants felt that these features would be beneficial: "*It becomes a very useful way for me to follow what others are doing*" and "*Once it gets more reviews and commentary from the community, I think you're gaining collective knowledge, gaining access to collective knowledge*."

*Compatibility* - Participants provided positive comments about the *Community Features*, because it gave them some control over the database. It was evident that participants wanted to have the ability to give input on the database: "*The ability to have input on things by either offering reviews or submitting instruments yourself is good, that way it can grow, but grow in a way where there's some control with reviews, maybe some control in quality*."

*Observability* - The *Community Features* also provide participants with greater confidence in using ASSESS. As one user stated, "*If I see a bunch of user comments then that tells me right away people are using this website*." Participants expressed greater likelihood to use ASSESS if they knew other people were successfully using this resource. The *Community Features* demonstrate the number of users on ASSESS to potential users.

Originally the development team was uncertain as to whether to include user or expert reviews of assessment instruments on ASSESS. The feedback in the *Community Features* category convinced the developers that user reviews are a valuable feature to include in ASSESS. At this point, the ASSESS database includes only the functionality for user reviews, but expert reviews functionality may be added as well. Figure 3 provides access to a video about the *Community Features* in ASSESS. The video shows how users can rate instruments, the website itself, as well as proposing instruments for inclusion.

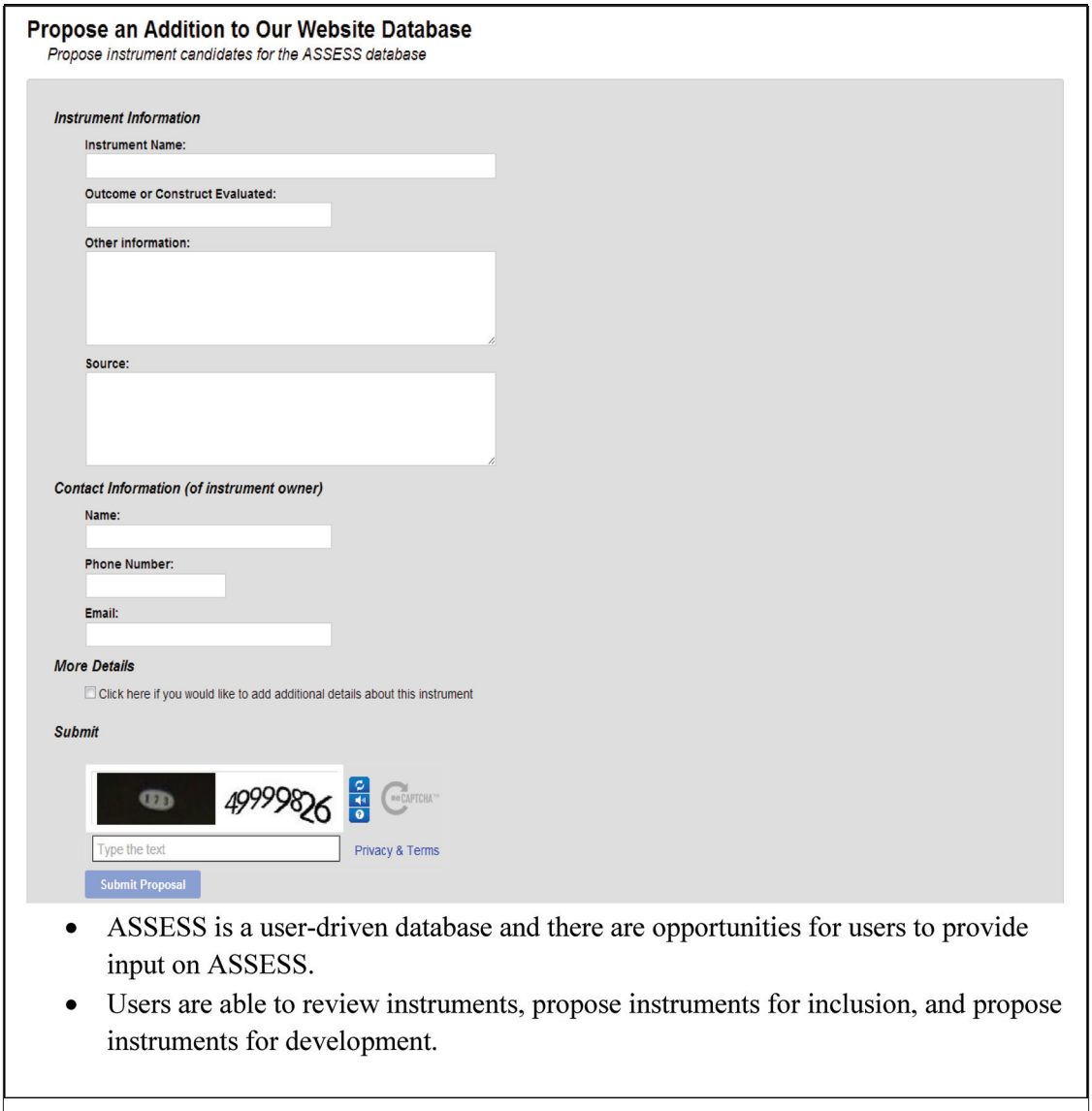



***Figure 3. Community Features in ASSESS.*** Link: https://www.youtube.com/watch?v=vVpmvVmibz8&index=8&list=PL84VcUp5xaBsRutUS-8KR2lwFxh8KfI9G

**Use as an Alternative**

This area was of particular interest, as the developers' priority was to ensure that the database would be a superior alternative to other methods for locating information about engineering education assessment instruments.

Because of its significance, many interview questions were targeted to specifically address this area. Questions such as "What current methods do you use to access assessment instruments?" and "What advantages or disadvantages does this database have over your existing methods for finding assessment tools?" were used to develop an understanding of participants' perspectives. Responses related to this category were found related to all DI characteristics except for *Complexity*, as shown in Table 3.

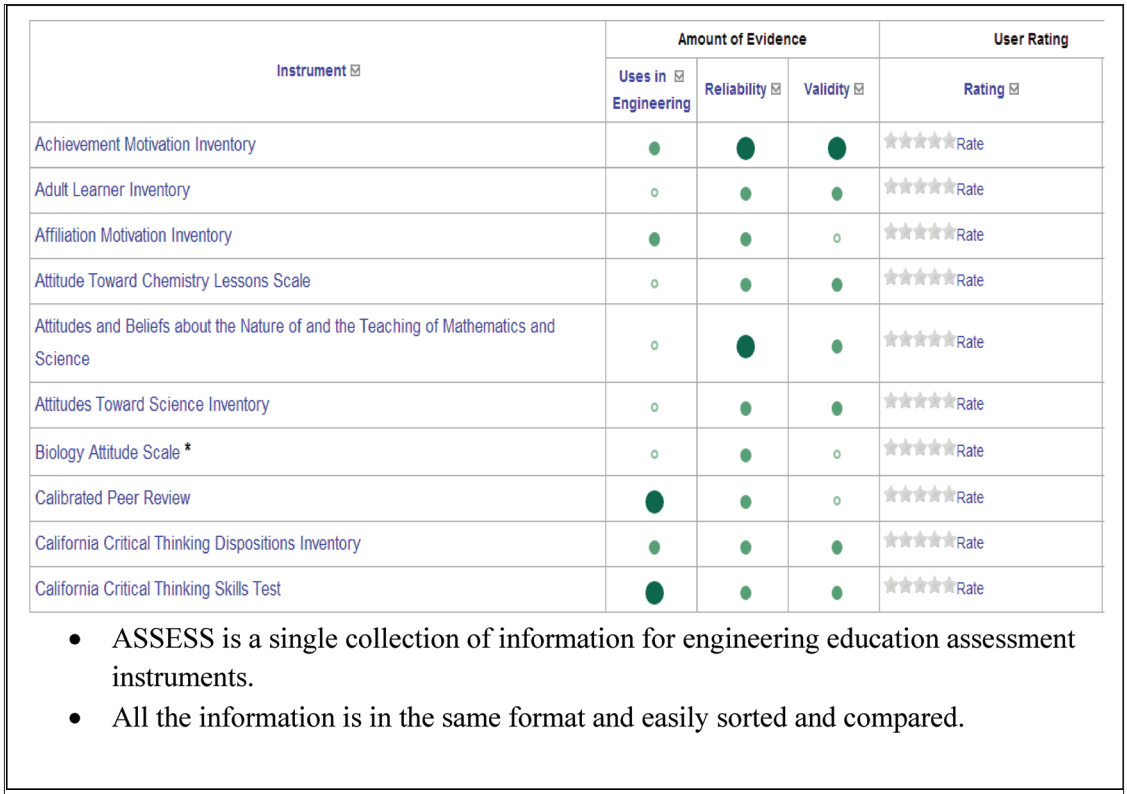
*Relative Advantage* – The most significant advantage over other methods was that ASSESS is a centralized location for information about assessment instruments. Many participants were frustrated with looking for information in a multitude of places and were looking for one inclusive resource: "*Its relative advantage if it is completed as I think it's envisioned is it would be a single spot to collect data from a lot of different sources* [in this case data about other assessment instruments]*, and it would reside in one spot*."

*Compatibility* – Participants felt that ASSESS would meet their expectations for finding information about assessment instruments. It was also evident that participants felt that ASSESS would be the first resource of its type: "*I'm intrigued with this concept in general because I think that this is something that we really need to have in the community*." Participants also agreed that ASSESS would assist them in identifying what assessment instrument they should use, "*If you're looking for tools you shouldn't have to create them yourself like I do right now*."

*Trialability* – Users reported that this DI characteristic was high, because it is a feasible alternative and requires no commitment to use. Participants were pleased that to use ASSESS there is no required login information and that it was free. The *Trialability* of ASSESS as compared to alternatives is excellent: "*I mean as long as it's free there's no commitment. So, it makes it incredibly easy to commit to use it*," and "*I certainly get the sense that with ASSESS I can find the things I need and look at it without having to commit to it*."

*Observability* – Participants recognized how easy it is to refer others to ASSESS. Multiple participants mentioned that other methods of looking up information are not conducive for referring other people to, especially in the case of novices. However, in ASSESS, participants felt that the set up and collectiveness of the information made it easy to refer others to, including novices and students. For some participants, they were most excited about this potential advantage, "*And so, I definitely can see referring people to this website*."

The overwhelmingly positive responses in the *Use as an Alternative* category were very promising for the overall adoptability of ASSESS. If the ASSESS website is useful compared to existing



| Instrument | Amount of Evidence | | | User Rating |
|---|---|---|---|---|
| | Uses in Engineering | Reliability | Validity | Rating |
| Achievement Motivation Inventory | ● | ● | ● | Rate |
| Adult Learner Inventory | ○ | ● | ● | Rate |
| Affiliation Motivation Inventory | ● | ● | ○ | Rate |
| Attitude Toward Chemistry Lessons Scale | ○ | ● | ● | Rate |
| Attitudes and Beliefs about the Nature of and the Teaching of Mathematics and Science | ○ | ● | ● | Rate |
| Attitudes Toward Science Inventory | ○ | ● | ● | Rate |
| Biology Attitude Scale * | ○ | ● | ○ | Rate |
| Calibrated Peer Review | ● | ● | ○ | Rate |
| California Critical Thinking Dispositions Inventory | ● | ● | ● | Rate |
| California Critical Thinking Skills Test | ● | ● | ● | Rate |



***Figure 4. Use of ASSESS as an Alternative.*** Link: https://www.youtube.com/watch?v=PlwIWhCacq0&index=9&list=PL84VcUp5xaBsRutUS-8KR2IwFxh8KfI9G

alternatives for potential users, adoption should increase. All four DI characteristics that received responses for this category demonstrated that participants did find ASSESS useful as an alternative means of finding assessment instrument information. Because they were all positive, the development team made no changes based on this category of responses. A video highlighting the uses of ASSESS as an alternative is available by clicking on Figure 4. The main features identified by potential users as beneficial over alternatives is the focus of the video.

**Searchability**

*Searchability* is related to how easily and efficiently participants were able to use the search features in the database. These features include the key word search and the search categories available for narrowing a search.

The ability to search the database is a necessary feature for potential users to effectively use the database. Participant responses on searchability are related to the *Compatibility*, *Complexity*, and

*Trialability* DI characteristics. *Compatibility* received a medium positive rating, *Complexity* a low positive rating, and *Trialability* a low negative rating, as shown in Table 3.

*Compatibility* – Participants found the database to be compatible for this category. They mentioned that most users should have experience using online search features and that ASSESS was similar to what they were used to. Being able to narrow their search using the side bar of options was also compatible with their experiences and expectations, "*I thought the search terms were fabulous*." The one concern for *Compatibility* in the *Searchability* category was with the engineering fields in the search limiting options. Some participants did not find their specific type of engineering in this field and thus were concerned that they would not be able to find information that would be helpful to them.

*Complexity* – For the most part participants believed that the search features were not complex to use: "*It seemed pretty straightforward as far as searching on the different fields*." A few participants had issues modifying the search fields after their initial modification. While a system was in use to modify the search, some participants did not understand how to use it. An additional source of confusion for some participants was the amount of narrowing terms available. Users can narrow their search by format, administration options, and technical aspects. Some participants mentioned that there were too many choices and that it was hard to know what they should use to narrow their search.

Trialability – While this DI characteristic did receive a negative rating, *Trialability* did not have many responses addressing *Searchability*. The only concern was over how the *Searchability* would change with the addition of instruments. Some participants felt that *Searchability* could change, specifically that it would decline, once the amount of instruments was larger.

In order to improve ASSESS' *Searchability*, the developers made a few adjustments to the search page and functions. To minimize confusion, the narrowing options are now accessed by clicking "Advanced Search." Once this is clicked, three headings are shown that expand to show more options. The fields are also grouped by type, making it easier to find the correct field to narrow a search. An additional method of modifying search terms was added to address issues found by some participants: a "Show All" button was added to the search page. This button allows users to browse the available information without performing a search, aiding those users who do not want to limit instruments they see. These improvements should assist in increasing *Searchability* for potential users. An explanatory video of the searchability features in ASSESS is available by clicking on Figure 5. The changes made based on participant feedback are presented in the video.

**Functionality of Design**

*Functionality of Design* includes perceptions of the functionality of the website. The focus is on how well ASSESS works as a database and as a website. Perceptions of the information and the usefulness of the database are not included.

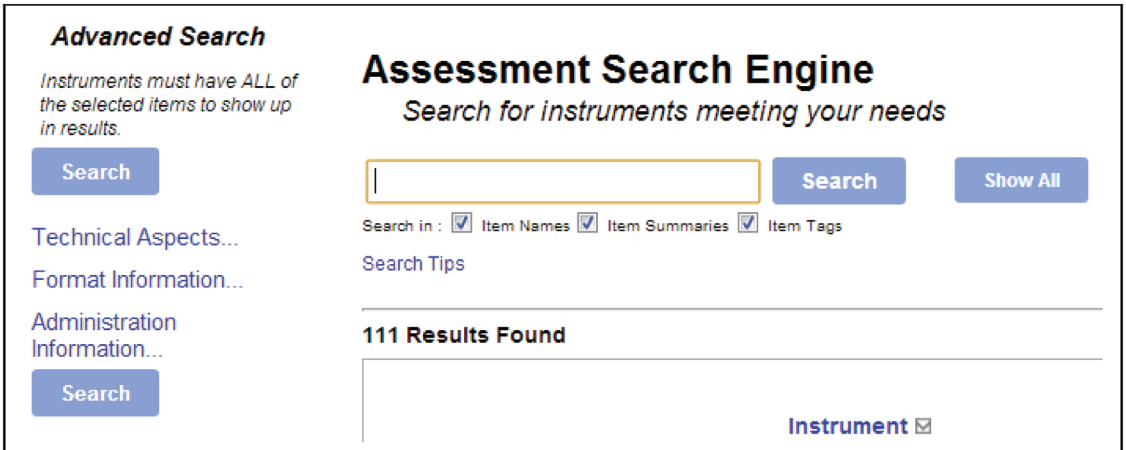



***Figure 5. Searchability in ASSESS.*** Link: https://www.youtube.com/watch?v=-rBJjgv7i7s&index=10&list=PL84VcUp5xaBsRutUS-8KR2lwFxh8KfI9G

The *Functionality of Design* received varied responses from participants, but responses relating to this category were found in all five DI characteristics. Table 3 shows that *Relative Advantage* and *Complexity* received medium positive ratings, *Compatibility* received a low negative rating, *Trialability* a low positive rating, and *Observability* a medium negative rating.

*Relative Advantage*, *Complexity*, and *Trialability* – The responses for these DI characteristics were all similar in nature. Participants felt that the website and database followed conventions with which they were familiar: "*It is very simple to use and I think it would be easy to go back to and somebody wouldn't walk away going, 'Okay, I'm never doing that again'.*" For the *Relative Advantage* DI characteristic participants felt that the website was especially effective compared to alternative methods: "*Then a definite upside is being able to find some of the best practices, the best tools with very little effort.*"

Observability – Participants were concerned that people might not be able to find the website: "*I don't know how else people would find it other than I got an email from you.*" The main source of dissatisfaction for the *Compatibility* DI characteristic was that it was unclear how to get to the assessment instruments. While ASSESS's purpose is only to house information about the instruments and not the instruments themselves, some participants were expecting to see at least part of the instrument on the website. Because the instruments will not be available directly on the website, this means that users will have to use the available information to find the instrument. For some participants this was frustrating, while others had expected this.

Because some participants felt that the website was not going to be easy to find, the development team has worked on a publicity plan for ASSESS. In these efforts to spread the word about ASSESS, an emphasis on the purpose of the website will be made. Emphasizing that instruments will not be included in the website should ensure that potential users can develop correct expectations of ASSESS.

**Diffusion of Innovations Characteristics**

Table 3 shows that the *Relative Advantage* and *Complexity* were the only DI characteristics to receive high negative ratings in any category. Also noticeable is that *Compatibility* was the only DI characteristic that had responses in all six categories. Therefore, these three DI characteristics were considered the most important to focus on during development. *Trialability* and *Observability* overall did not have very many responses. While they each received one category with a high rating, this rating was achieved from an overall lower number of responses than the other three DI characteristics received. Very few responses dealt with the *Trialability* and *Observability* DI characteristics. Thus, *Observability* and *Trialability* were not deemed important.

## LESSONS LEARNED ON ADOPTION CHARACTERISTICS

In a review of literature dealing with the adoption of technological innovations for use in education, predictions were that the DI characteristics most important for ASSESS were *Relative Advantage*, *Trialability*, and *Compatibility* (Kebritchi 2010, Martins et al. 2004, Samarwickrema and Stacey 2007). Most innovations, especially technical innovations, have *Relative Advantage* as a significant factor affecting their adoption. "*Diffusion scholars have found relative advantage to be one of the strongest predictors of an innovation's rate of adoption*" (Rogers 2003, pg. 233). *Trialability* was also predicted to be a significant DI characteristic. Technological innovations often involve unfamiliar features or functions, and individuals tend to need a testing phase with the innovation before they are willing to fully adopt. Lastly, *Compatibility* was identified as likely to be an important DI characteristic. The researchers believed that in order for an individual to adopt ASSESS, it would need to meet their expectations and work with their previous experiences. Also, if ASSESS did not fit the values or requirements of the individual's institution, they would be less likely to adopt.

As expected, *Relative Advantage* and *Compatibility* were both found to be important DI characteristics for ASSESS. ASSESS has consistent information for assessment instruments, is searchable, and allows for user input. These features contribute to the *Relative Advantage* of ASSESS over alternatives. At the same time, these features are *Compatible* with users' expectations, needs, and

experiences: "*It's very tailored to engineering education which is a fairly relatively speaking a new field, an emerging field. So that's fantastic*."

*Observability* was not expected to be important for the adoption of ASSESS. This prediction was correct. This DI characteristic did not receive very many responses. Many participants did not give it much importance: "*And then the Observability I'd say is still kind of unclear since it's still in the development process*," and "*Just because it's so new that it hasn't had the opportunity to be visible. I'm not sure you'll know the visibility also until it gets launched*."

While *Trialability* was expected to be important, there were not very many responses that dealt with this DI characteristic. ASSESS is currently free and does not require registration to search for instrument information. As such, *Trialability* is fairly high: "*I mean that seems like it's a high degree of trialability because it doesn't seem like too much effort to go in there and find something that might be useful and learn a little bit about it and figure out whether it's going to be what you need or not*." There may not have been very many responses about *Trialability*, because it is obviously high for ASSESS.

*Complexity* was determined to be an important DI characteristic, but had not been expected to be important. Many participants were concerned that novice users of assessment instruments would be confused by the information in ASSESS: "*I'm thinking about my friends who, they're interested in incorporating engineering education kinds of things into their regular grants or what they're trying to do in their classrooms or things like that but wouldn't be able to distinguish between … a more appropriate or a less appropriate instrument for what they want*." The ASSESS developers reviewed and adjusted terminology and formatting to decrease *Complexity*.

The researchers believe that these results can be applied to other adoptability studies looking at technical innovations in engineering education. While ASSESS is specifically designed to house information for assessment instruments, the function of this innovation could be changed and still have the same general implications in regards to DI characteristics and adoptability. Innovations meant to share curricula or exam questions between engineering educators would be expected to have similar results. Innovations that allow for user input are web-based, and serve as collections of information would be ideal applications for these results, regardless of the type of information involved.

## CONCLUSION

The six categories identified during the analysis can be applied to the development of other online innovations as well. In looking at the responses in each category, *Use as an Alternative* and *Functionality of Design* seemed to have received the most attention from participants. In other research efforts, developers could consider focusing their efforts with potential adopters towards these two

categories. High ratings in *Use as an Alternative* are necessary for adoption, if the innovation cannot be satisfactorily used instead of other methods, it will most likely not be adopted. Similarly, high ratings in *Functionality of Design* are also important. If an innovation does not function acceptably for potential adopters, they are not likely to adopt.

*Relative Advantage*, *Complexity*, and *Compatibility* were chosen as the most important DI characteristics. If ASSESS offers no advantages, whether economic, social, efficiency, or other, then individuals have no reason to adopt it or other technological innovations. *Compatibility* and *Complexity* relate to *Functionality of Design*. The innovation cannot be difficult for adopters to use and it must be based on what is already familiar. Innovations are less likely to be adopted when they are too confusing or against the experiences of the user.

The ASSESS development team is refining the website appearance and functionality to address issues of search effectiveness, information accuracy, and ease of use. The team continues to enter information for instruments already catalogued and to catalogue additional instruments as they are identified. ASSESS can now be found at: http://assess.tidee.org.

## ACKNOWLEDGEMENTS

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## AUTHORS

**Sarah Brooks** is a former graduate student at Washington State University in the Department of Civil and Environmental Engineering. She earned her B.S. in Civil Engineering from Oregon Institute of Technology in 2011. Sarah completed her M.S. in Civil Engineering at WSU in May of 2013, with a focus on Environmental Engineering.

**Shane Brown** is an associate professor at Oregon State University in the School of Civil and Construction Engineering. He earned his B.S. and Ph.D. from Oregon State University and his M.S. from the University of California at Davis. Dr. Brown's research focuses on learning and understanding, with a focus on how and why individuals adopt particular educational innovations.

**Denny Davis** is emeritus professor in the Voiland School of Chemical Engineering and Bioengineering at Washington State University. He received his B.S. in Agricultural Engineering at WSU and his M.S. and Ph.D. at Cornell University. His research focuses on development of resources for teaching, learning, and assessment of engineering design and professional skills. He is a Fellow of the American Society for Engineering Education.

**Jennifer LeBeau** is a research associate in the College of Education Learning and Performance Research Center and a clinical assistant professor in the Department of Educational Leadership, Sport Science, and Educational/Counseling Psychology at Washington State University (WSU). She earned a B.S. degree in Biology from the University of Idaho and M.A. and Ph.D. degrees in Higher Education Administration with an emphasis in Educational Psychology from WSU. She serves as an external evaluator for several projects and programs related to STEM education and student success.