What Makes Educational Innovation Stick? A Delphi Approach

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Abstract – To improve the widespread adoption of educational innovations, we must understand why some are adopted and routinely used, while others are not. This Delphi study included 45 Principal and Co-Principal Investigators who received Course, Curriculum and Laboratory Improvements (CCLI) or Transforming Undergraduate Education in STEM (TUES) grants from the National Science Foundation. Using the data collected, the research team identified and ranked 11 characteristics of educational innovations, 13 characteristics of faculty members, and 5 characteristics of administrators that relate to the successful adoption and routine use of educational innovations. The results of this study are used to develop the Characteristics of Dissemination Success (CODS) framework for STEM educational innovations. This framework provides useful guidance for educational innovators, faculty adopters, and school administrators seeking to develop, disseminate, and adopt educational innovations.

Keywords: Dissemination, Delphi Method, Education Innovations, STEM.

INTRODUCTION

In 2010, all United States federal agencies invested a total of $3.4 billion in Science, Technology, Engineering, and Mathematics (STEM) education [1]. The federal investments in STEM undergraduate education included efforts to: increase the number of students involved in STEM degree programs and careers; develop evidence-based STEM education models and practices; develop STEM skills or knowledge in students; and increase learner engagement, interest, and value in STEM areas [1]. During this same period, twelve private foundations committed $506 million through the "Investing in Innovation" fund to improve STEM education [2].

With all of the money being spent to improve undergraduate STEM education, it is disappointing that the pervasive classroom experience is still a faculty member lecturing for the majority of the class period [3]. With advances in technology, traditional teaching methods often fail to engage students' interests [4]. Numerous educational associations and government commissions including the American Society for Engineering Education [5, 6], National Academy of Sciences [7], and National Research Council [8] have suggested that scenario-, problem-, and case-based teaching and learning need to be incorporated into STEM classrooms. Faculty members who have used new instructional materials and strategies in their classrooms notice improved student engagement [9].

Despite efforts to encourage and promote better STEM education, the U.S. is not keeping up globally in STEM education outcomes. In 2008, the U.S. was ranked first in global competitiveness but 48th for the quality of math and

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science education out of 134 countries [10]. By 2013, the U.S. had dropped to fifth in global competitiveness and ranked 49th for the quality of math and science education [11]. One of the reasons that the U.S. has not moved forward in the international rankings may be due to the poor dissemination of evidence-based educational innovations [12, 13]. Dissemination is a complex process that has been defined several different ways. Although many think of dissemination as the simple broadcasting of information, Lomas [14] pointed out that dissemination "implies not only a more aggressive flow of information from the source, almost a launching, but it also implies targeting and tailoring the information for the intended audience" (p. 226). In this paper, we define dissemination as consisting of a process of first creating an awareness of an educational innovation, then influencing intention to adopt, the actual adoption, and finally the routine use of that innovation.

The primary reason why educational innovations do not successfully disseminate can be broken down into three categories: the innovation itself, faculty adopters, and the administration where the educational innovation is to be used [15-18]. Poorly designed educational innovations can be difficult for adopters to use which inhibits their dissemination [19]. Additionally, faculty members often resist changes in their classrooms due to their lack of knowledge about evidence-based teaching [13]. Research has shown that supportive and proactive leadership toward innovative teaching and learning results in a higher integration of classroom innovation at universities [3, 15, 18].

The goal of this article is to provide a cohesive answer to the following question: "What are the most important characteristics of educational innovations, faculty members, and administrators that influence the successful dissemination of educational innovations?" To answer this question, we solicited, via a three-round Delphi study, the opinions of 45 Principal and Co-Principal Investigators on Course, Curriculum and Laboratory Improvements (CCLI) or Transforming Undergraduate Education in STEM (TUES) grants with the National Science Foundation (NSF) in the areas of engineering and technology. The significance of this research is twofold. First, the data collected from the Delphi survey provide the foundation from which we developed the Characteristics of Dissemination Success (CODS) framework for STEM educational innovations. Second, the results of this study can serve as a guideline for successfully disseminating and adopting educational innovations into undergraduate STEM courses.

BACKGROUND

Educational Innovations

Rogers [20] described innovations as ideas, practices, or objects that are perceived as new by an individual or group. In pedagogical research, Hazen et al. [21] define an educational innovation as any new instructional material, strategy, or pedagogical approach that differs from the current and previous materials or methods employed by an educator. In this article, we classify educational innovations as the development of new curricula, instructional materials, faculty expertise, and/or instructional strategies. *Curriculum development* deals with overarching changes planned or implemented for an educational program or curriculum, while *instructional materials* are specifically designed for use in a particular course or laboratory session. The *development of faculty expertise* refers to methods that can be used to help faculty members improve their teaching such as training workshops or mentoring. *Instructional strategies*, such as experiential learning or student centered learning, consist of both instructional design and pedagogy and include approaches that enhance the acquisition of knowledge [22].

Factors that Influence the Dissemination Process

There have been many attempts to synthesize the complicated change processes connected with dissemination into theories, models, and frameworks [23-25]. Dancy and Henderson [12] found that a gap exists between physics faculty members' decisions to try a new instructional strategy and the successful integration of that strategy into their classrooms. Henderson and Dancy [26] contend that current physics education research dissemination approaches, such as journal articles, conferences, and workshops, have been more successful in raising widespread awareness of new instructional practices than in helping faculty understand the underlying principles of these practices, or how to deploy them effectively. Borrego et al. [15] supported these findings when they found that 82% of department chairs were aware of seven specific educational innovations, yet only 47% had actually adopted any of the innovations at their institutions. These department chairs noted that financial resources, faculty time and attitudes, and student satisfaction and learning were all major considerations in the adoption decision.

Faculty resistance to change and environmental factors created by administrators result in many educational innovations not being adopted or routinely used [16]. Henderson and Dancy [17] discovered that some of the barriers that prevent the implementation of educational innovations include lack of instructor time, departmental norms, class size, and room layouts. The President's Council of Advisors on Science and Technology [13] found that administrators often lacked departmental rewards and expectations for good teaching since salaries and advancement are closely correlated with publication rate and not quality of teaching. In addition, faculty members often lack the time and incentives to find, read and evaluate of evidence-based teaching.

Because of all the barriers that can exist in the dissemination process, we sought to discover which factors lead to the successful dissemination of educational innovations. The goal of this paper is to develop a list of the most important factors that lead to the successful dissemination of STEM educational innovations.

THE DELPHI METHOD

The qualitative nature of the current study dictated the use of the Delphi method, a survey research technique developed by the Rand Corporation in the early 1950s. Delphi studies have been used to prioritize qualities, attributes, and best practices of expert panels and leaders [27]. The objective of the technique is to achieve consensus among experts regarding a specific topic [28]. In previous comparative analysis of group survey techniques, the Delphi technique achieved a greater level of accuracy than other group consensus techniques [29]. Therefore, the methodology seemed most appropriate for the current study.

Operationally, the application of the Delphi Method involves three phases: the selection of expert panelists, the collection of topic-relevant issues, and the ranking of reported issues [28, 30]. The term “expert” is subjective; therefore, a researcher must qualify, in some measurable terms, what constitutes an expert for the purposes of their study. Typically, researchers quantify experts based on factors such as years of professional experience, job or position tittle, level of education, and professional certifications. To collect topic-relevant issues, the initial round of the Delphi questionnaire is open-ended [30]. The purpose of the first questionnaire round is to aggregate information for subsequent ranking rounds of the study [27]. In the first round, the panel of experts contributes input that they feel is pertinent to the focus question of the study [31]. In the second round of the study, the panelists rank each of the issues from the first round [30]. From the data gathered in the second Delphi round, the study administrator scores the issues (typically using the weighted average method) and redistributes the results to the panelists [31]. In the third round, as well as any subsequent rounds of the study, the experts review the group rankings and rerank the issues given the aggregated responses of the group. The process of ranking and reranking continues until the panel achieves a consensus [30].

In this paper, we employed the Delphi process to aggregate three separate consensuses regarding what the expert panel believed to be the most important characteristics of educational innovations, faculty, and administration that influence the dissemination of STEM educational innovations. The three Delphi techniques discussed herein were all conducted via e-mail correspondence and the online survey software Qualtrics. Initially, we identified a total of 307 potential expert participants, each were Principal Investigators (n=139) or Co-Principal Investigators (n=168) of CCLI or TUES grants with the NSF in the areas of engineering and computer science. An initial list of 307 potential subjects was assembled by analyzing past and current CCLI and TUES grants and searching the internet for Co-Principal Investigators e-mail addresses that were not listed on the NSF website. As part of the subject solicitation process for the current study, each of the 307 potential panelists received an email describing the current study and an invitation to participate in the study by responding to the following three questions:

- What characteristics of educational innovations influence successful dissemination?
- What characteristics of the faculty members influence the successful dissemination of educational innovations?
- What characteristics of the college or university administration influence the successful dissemination of educational innovations?

Participation By Round

In Round One, participants were given two weeks to respond to the open-ended research questions. The response rate was 14.66%, with 45 responses including 23 Principal Investigators and 22 Co-Principal Investigators (Table 1). In total, we had 18 non-deliverable emails and 15 individuals declined to participate. Members of this expert panel include one member from 25.81% of all CCLI and TUES grant projects that received this survey.

Table 1: The distribution of subjects and response rate over the three rounds of the Delphi study

	No. of Invited Participants	No. of Respondents Round 1	Initial Response Rate	No. of Respondents Round 2	Round 2 Response Rate	No. of Respondents Round 3	Round 3 Response Rate
Principal Investigator	139	23	16.75%	17	73.91%	17	100%
Co-Principal Investigator	168	22	13.10%	18	81.82%	17	94.44%
Total	307	45	14.66%	35	77.78%	34	97.14%

A significant number of unique comments were generated by this group of participants (Table 2). As is always the case with the Delphi technique, many of the comments generated by the members were redundant. To assess the redundancy in the feedback provided by the expert panelists, a three member committee was established consisting of one researcher with experience in the research domain and over 15 years of experience in educational innovation and dissemination, and funded through several NSF CCLI/TUES grants, one researcher that was an expert in the diffusion of innovations and the Delphi approach, and one researcher that was not an expert in the research domain, but was proficient in qualitative research methodologies. To maintain a high level of inter-rater reliability, each of the committee members individually reviewed all of the contributed comments and subsequently classified them into their own respective categories. On completing their individual classifications, the committee met to discuss each individual's classification of the comments and subsequently agreed on a single comment classification schema. The unique list of the classifications from the participant's comments is presented in Table 3.

Table 2: Unique comments generated in round one of the Delphi survey

	Total Number of Comments Generated	Number of Unique Constructs
Characteristics of the Innovation	174	11
Characteristics of Faculty	165	13
Characteristics of Administration	135	4
Total	593	34

N=24 PI/23 Co-PI

Table 3. Unique list of the classifications from the participant's comments

Variable	Contextual Definition
Characteristics of the educational innovation	
Adaptability	The degree to which the user can modify the pedagogical innovation as deemed necessary (i.e. ability to be tailored by adaptors, sufficiently flexible, etc.).
Communicability	The ease with which the results of using the pedagogical innovation can be easily described to others (i.e. ability to communicate the results, the ability to articulate the problem addressed by the innovation, etc.).

Compatibility	The consistency of the pedagogical innovation with current pedagogy (i.e. ability to integrate with existing program, match of innovations goal with the goal of the faculty and students, etc.).
Ease of Use	The degree to which a pedagogical innovation is perceived as relatively easy to use and understand (i.e. conceptually simple so that it can be easily understood by adaptors, relatively simple and user friendly, etc.).
Ease to Implement	The degree to which a pedagogical innovation is perceived as relatively easy to implement and adopt (i.e. ease of adoption, not too disruptive to implement, etc.).
Measurability	The degree to which the impact of the pedagogical innovation can be assessed in particular the ability to clearly attribute the effects to the innovation (i.e. innovation must have solid evaluation data, statistical significance of results, etc.).
Practicality of the Concept	The degree to which the innovation is based on a clear definition of basic terms and clear methodology applicable for the specific situation (i.e. a clear link between the innovation and a prevalent problem, innovation is rooted in a documented need, etc.).
Quality of Initial Information	The degree to which the initial information regarding the pedagogical innovation is relevant, timely, complete, and appropriate in terms of amount so as to add value (i.e. completeness of he "package" of how to use the innovation, innovation description including scenarios in which it can be applied, etc.).
Relative Advantage	The degree to which the pedagogical innovation is perceived as being better than its predecessor (i.e. saving time and money, clearly an improvement, etc.).
Relevance to Job	The ability of the pedagogical innovation to enhance the educator's or student's performance (i.e. innovations seems useful to my work, professional relevancy, etc.).
Theoretical Coherence	The degree to which pedagogical innovations are based on a theoretical understanding of pedagogy or learning (i.e. the innovation is based on theory, highly based on a strong literature review, etc.).
Characteristics of the faculty members	
Attitude to Innovation	The opinion that a person holds toward the pedagogical innovation.
Awareness of Innovation	The degree of awareness from the faculty toward the pedagogical innovation (i.e. awareness of innovations through reading, conference attendance, word-of mouth, etc.).
Care about Student Learning Outcomes	The degree to which faculty focuses on the learning process and not the results (i.e. focused on learning rather than being focused on grades, faculty's personal desire to improve their students' learning and success, etc.).
Cultural Acceptance of Innovation	The degree to which the cultural differences of the students and faculty influence the acceptance of the pedagogical innovation.
Innovativeness	A faculty member's willingness to try out a pedagogical innovation (i.e. being willing to take the risk to try something new, creativity to come up with new ideas, tolerance for early failure, etc.).
Motivation to be Innovative	The wants, needs and set of circumstances that drive a person to be innovative (i.e. funding, facilitating new experiences, saving time, social gains and tenure/promotion process, etc.).
Professional Social System	A set of interrelated units that are engaged in joint problem solving to accomplish common professional goals (i.e. networking, professional associations, etc.).
Receptivity to Change	The degree of receptivity from the faculty toward the pedagogical innovation (i.e. flexible, openness to change, willingness to try new things, etc.).
Self-Efficacy	The belief that one has the capability to perform the pedagogical innovation (i.e. confidence in using the innovation, etc.).
Supportive Faculty Community	The degree to which the faculty community supports and encourages continuous teaching improvements regardless of measureable or successful outcomes.
Tenure Status	Whether the individual that is adopting the pedagogical innovation is a tenured or non-tenured faculty member.
User Support	The degree of support from the educators and the students toward the pedagogical innovation (i.e. workshops, webinars, websites, etc.).
Value Teaching in Addition to Research	The degree to which the faculty balances the priorities of teaching and research (i.e. recognition that teaching is of real value, strong commitment to teaching, etc.).
Characteristics of the Administration	
Facilitating Conditions	The degree of availability of resources necessary to facilitate dissemination of pedagogical innovations (i.e. travel funds for conferences and presentations, infrastructure to support the use of the innovation, etc.).

Management Support	The degree of support provided by institutional authorities (i.e. government, university administration, college deans, department chairs, etc.). Examples include support flexible program changes, release time from courses, and demonstrate real, tangible record of valuing the teaching mission, etc.).
Promote and Reward Innovation	The degree to which the administration rewards and encourages innovation in the classroom (i.e. are innovations in teaching rewarded in the promotion and tenure process, reward educational research, etc.).
Receptivity to Change	The degree of receptivity from the administration toward the pedagogical innovation (i.e. flexible, openness to change, willingness to try new things, etc.).

To begin round 2, the specific unique results were reported, via an online survey, to the panel's respondents with instructions to review the characteristics identified in round 1 and rank them in order from most important (1) to least important (11, 13, or 4, respectively). Each of the participants was given two weeks to individually evaluate the characteristics that influence the successful dissemination of educational innovations and rank the associated items. The response rate for round two of the Delphi method was 73.91% (17/23) for Principal Investigators, 81.82% (18/22) for Co-Principal Investigators, and 77.78% (35/45) overall. The ranking for the overall group was computed using the weighted average method and the results are presented in Table 4.

Table 4: Weighted average ranking of the characteristics following round two and three.

Rank	Characteristics of the Innovation	Characteristics of the Faculty Members	Characteristics of the Administrators
1	Relative Advantage	Receptivity to Change	Promote and Reward Innovation
2	Ease to Implement	Care about Student Learning Outcomes	Receptivity to Change
3	Ease of Use	Attitude to Innovation	Management Support
4	Practicality of the Concept	Innovativeness	Facilitating Conditions
5	Relevance to Job	Motivation to be Innovative	
6	Adaptability	Value Teaching in Addition to Research	
7	Compatibility	Self-Efficacy	
8	Quality of Initial Information	Awareness of Innovation	
9	Communicability	Supportive Faculty Community	
10	Measurability	User Support	
11	Theoretical Coherence	Professional Social System	
12		Tenure Status	
13		Cultural Acceptance of Innovation	

For round three, the participants from round two were invited to participate in an online survey and given the groups rankings from round two. Each of the participants was asked to review the group's weighted average ranking of the characteristics and again rank the characteristics in light of the group rankings. The response rate for round three of the Delphi method was 100% (17/17) for Principal Investigators, 94.44% (17/18) for Co-Principal Investigators, and 97.14% (34/35) overall. The ranking of this group was computed using the weighted average method. Following the completion of the third round of the study, an inspection of the results revealed that none of the rankings of the items changed between the second and third round results. Therefore, a concordance assessment was made.

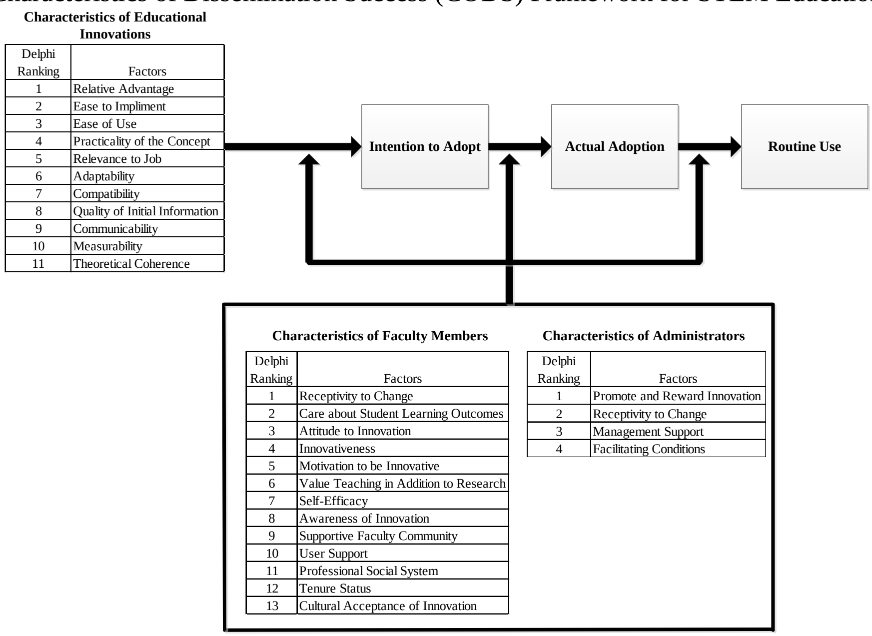
The computation of Kendall's Coefficient of Concordance (*W*) revealed that a consensus exists among the participants with respect to the to the round-three rankings of the importance of the items. Kendell's *W* is a measure designed to determine the degree of agreement among individual sets of ranked scores [32]. A significant *W* indicates that the participants applied essentially the same standard in judging the importance of the issues and they are in consensus. For the third-round rankings of the Delphi survey, the *W*s ($W_{(\text{Educational innovations})} = .900$, $p < .001$, $W_{(\text{Faculty})} = .929$, $p < .001$, and $W_{(\text{Administration})} = .788$, $p < .001$) were all statistically significant.

An additional estimate of group consensus, the percentage of respondents whose issue rank matched the group rank provided further support that each group was in agreement. Based on the Kendell's *W* and the rank percentage, it was clear that consensus was achieved and no additional Delphi rounds were necessary.

TOWARD THE CHARACTERISTICS OF DISSEMINATION SUCCESS (CODS) FRAMEWORK FOR STEM EDUCATIONAL INNOVATIONS MODEL

From the initial comments of the Principal Investigators and Co-Principal Investigators in round one of the Delphi study and the final conclusions, this study produces three sets of characteristics that are important in the successful dissemination of educational innovations. We will now develop a research model to show how the characteristics of educational innovations, faculty members, and administrators relate to successful dissemination. Based on the results of this study, we develop the CODS framework for STEM educational innovations (see Figure 1). This model is an extension of the Framework of Educational Innovation Dissemination (FEID) [24]. The CODS framework for STEM educational innovations is based on the theories of reasoned action [33], and planned behavior [34].

Figure 1. The Characteristics of Dissemination Success (CODS) Framework for STEM Educational Innovations



The Stages of STEM Educational Innovation Dissemination

Our expert panel of Principal Investigators and Co-Principal Investigators identified 11 characteristics of educational innovations that lead to successful dissemination. Five of the characteristics identified in this Delphi study discuss the inherent attributes of the innovation (i.e.., relative advantage, ease of use, compatibility, communicability, and measurability) that have been studied in diffusion of innovation literature[20]. The applicability of the educational innovations to the faculty members intending to use the innovation was identified with four characteristics of the innovation (i.e., practicality of the concept, relevance to job, quality of initial information, and theoretical coherence). Finally, two characteristics of the innovation identified deal directly with the implementation of the innovation into the classroom (i.e., ease to implement and adaptability) that are often studied in education, information systems, and marketing literature [35].

Taylor and Todd [36] decomposed the theory of planned behavior and found that characteristics of innovations (e.g., relative advantage, complexity, and compatibility) are antecedents to ones intention to adopt, whereas intention to adopt is then an antecedent to actual adoption. Moreover, post-adoption implementation activities directed toward embedding an adopted innovation help to ensure that the innovation becomes routine [37]. This is evident in Henderson and Dancy [26] were the majority of faculty members in physics make minor or significant modifications to research-based instructional strategies before they were routinized. Consistent with well-established and empirically tested theories like the theory of reasoned action [33], and the theory of planned behavior [34], we believe these relationships will remain significant in the domain of STEM educational innovations. Our proposed framework is based upon the constructs (characteristics of the educational innovation, intention to adopt, actual adoption, and routine use).

Factors Affecting STEM Educational Innovation Dissemination

In the CODS framework, a variety of factors affect the dissemination process. Our inclusion of these factors comes from research regarding the diffusion of innovations, technology acceptance, and education literature that have shown a wide variety of factors that have affected the dissemination of different types of educational innovations. While characteristics of the innovation have been found to be direct antecedents to the intent to adopt, literature has suggested that the dissemination of innovations may be moderated by the users, environment, and culture in which the innovation is to be used [20, 24]. In higher education, the adoption decision is often a group or organizational decision that allows a delicate blend of academic freedom to choose educational innovations and different stakeholders, such as faculty members, administration, book sellers, and external grant giving agencies have a role in this process. The results of this study suggest that in order to successfully disseminate educational innovations, one must to consider the characteristics of the faculty members and administration.

Thirteen characteristics of faculty members were identified that lead to the successful dissemination of educational innovations. Most of the characteristics broke down into three common themes: faculty member's personal attributes (i.e., receptivity to change, innovativeness, self-efficacy, and tenure status), faculty member's network (i.e., supportive community, professional social system, and cultural acceptance of innovation), and thoughts regarding teaching (i.e., care about student learning outcomes and value teaching in addition to research). Unlike the FEID, the result of this Delphi study led us to consider that a faculty member's awareness of educational innovations may moderate the relationships between the stages of the CODS framework rather than just be an antecedent to intention to adopt an innovation.

For administrators, four characteristics were identified that led to the successful dissemination of educational innovations. In this Delphi study, the most important characteristic identified at the department chair or dean level involves promoting and rewarding innovation in the classroom which is consistent with Martins and Kellermanns [38]. The President's Council of Advisors on Science and Technology [13] identified the lack of facilitation and rewards for good teaching as one of the top barriers and challenges to producing more STEM graduates. The American Society for Engineering Education [6] suggests that hiring, tenure and promotion guidelines, policies and practices need to be reviewed to ensure that educational innovations and pedagogical preparations beyond teaching excellence need to be recognized, rewarded, and transparent. Unfortunately, the majority of faculty committees, department chairs and deans feel that management support and degree of facilitating conditions lag in support of educational innovations [5]. In order for educational innovation to successfully disseminate, administrators will need to invest in changing the policies and practices that will update the infrastructure and make resources more readily available.

Past literature has shown that environmental and adopter characteristics affect intention to adopt and most likely also affect actual adoption and routine use [20, 24]. For example, faculty members may intend to adopt an innovation, but due to the lack of rewards, facilitating conditions, or fear of poor student evaluation may prevent the actual adoption of the innovations. In addition, an adopted innovation may not become routinely adopted for the same reasons. Therefore, we believe that the characteristics of faculty members and administrators will moderate the relationships between the stages of the CODS framework.

LIMITATIONS AND FUTURE RESEARCH

The current study utilizes a qualitative research methodology as a means to elicit a rich contextual perspective on the dissemination of educational innovations in STEM. We believe this type of research approach is critical for the development of an exploratory analysis that may lead to the development of new research directions in the existing body of knowledge regarding dissemination and a deeper level of understanding regarding a complex unstructured process that is not well suited for empirical analysis. However, we do understand that there are several limitations in the current study that should be addressed. First, our sample consisted of a relatively homogenous group of participants and may not reflect concerns that would have been expressed by faculty members in other fields.

Second, the themes for aggregation of the indicators within each of the dimensions were inductively derived by the investigators. While this is necessary to support the eventual development of the CODS framework, this process suggests clarity of meaning and content balance clearly supported by the findings. Another limitation is presented by our exclusive use of grant recipients. We understand that the dissemination process is very complex and involves members from many different areas in academic organizations. Thus, our data may present a perspective that is inherently limited in point-of view. In addition, while our sample was sufficiently large, we did experience some subject attrition through the rounds of data collection. This attrition may have also limited the scope and perspective of the data and subsequent conclusions.

Future research that operationalizes our proposed CODS framework, in part or in its entirety, will serve to allay the aforementioned limitations and enhance our understanding of the dissemination process in academic institutions. By operationalizing the CODS framework, future research may be able to create a score card, index, or decision support tool that may be used in an educational setting. Similarly, our study is focused generically on educational innovations. Although our results can be of use to scholars and practitioners, future research may wish to examine specific types or categories of educational innovations in order to provide more particular guidance. Using our results as a starting point, additional research may be able to offer a more refined version of our CODS framework for specific categories of educational innovations.

CONCLUSION

The Delphi study performed in this study contributes to the development of a conceptual framework describing the factors that influence the successful dissemination of STEM educational innovations. A particular strength of this study is the rankings of the characteristics required to successfully disseminate educational innovations. This paper incorporates multiple theories and perspectives to identify the most important characteristics of educational innovations, faculty members, and administrators. The ranking of the characteristics and framework developed provide useful guidance for educational innovators, faculty adopters, school administrators, and grant program managers seeking to disseminate and adopt new engineering educational innovations. We recommend that empirical studies be conducted to determine the extent to which the identified characteristics of educational innovations, faculty members, and administrators significantly influence the dissemination process. The conceptual framework proposed in this paper does, however, require further testing to validate its use in the future.

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