From Dissemination to Propagation: A New Paradigm for Education Developers

Introduction

“We know that developing a strong product and telling people about it does not lead to sustained adoption; we just do not know what else to do.” This quote from a developer of educational innovations illustrates one of the main challenges in improving adoption of evidence-based teaching practices.

Numerous researchers, working in many contexts and disciplines and supported by a wide variety of funding agencies, have built an extensive set of evidence-based practices and demonstrated their effectiveness. However, this knowledge is not being translated into practice by large numbers of STEM instructors (Committee on Undergraduate Physics Education Research and Implementation, 2013; Graham, 2012; Prince & Felder, 2006). While many papers have examined various reasons for the lack of broad adoption (e.g., Foertsch, Millar, Squire, & Gunter, 1997; Fox & Hackerman, 2003; Henderson & Dancy, 2007; Seymour, 2001), we argue many change agents who are working to promote systemic adoption of these teaching practices use approaches within what we call the dissemination paradigm. Further, we argue efforts within the dissemination paradigm have not led, and are unlikely to lead, to systemic adoption. We offer the propagation paradigm as an alternative paradigm with the potential to produce improved results.

We contend many education researchers and developers are currently working within what we call the dissemination paradigm. Education reformer Elaine Seymour describes the dissemination paradigm as the belief that “good ideas, supported by convincing evidence of efficacy, will spread ‘naturally’—that, on learning about the success of particular initiatives, others will become convinced enough to try them.” and then goes on to point out the deficiencies of this approach (Seymour, 2001, p. 92). A key assumption of this paradigm is that instructors will change their teaching practices once they become aware of a new teaching practice that is supported by a compelling body of evidence. That is, awareness and compelling evidence are necessary and sufficient conditions to support broad adoption. Along with Seymour, we argue that efforts made
within the confines of the dissemination paradigm will not lead to large-scale change of teaching practices across undergraduate STEM education.

Poor results from working within the dissemination paradigm are increasingly recognized by organizations that fund STEM educational development. In response they are emphasizing expectations for propagation of educational innovations rather than simply expecting projects to “disseminate their work”. For example, the current solicitation for the National Science Foundation Improving Undergraduate STEM Education (IUSE) program states “transferability and propagation are critical aspects for IUSE-supported efforts and should be addressed throughout a project's lifetime…..” The Alfred P. Sloan Foundation, in reference to STEM Higher Education, states “[s]uccessful proposals are expected to be…concerned with the dissemination and portability of results to other institutions.” These shifts suggest that funders of educational reform agree with our assertion that change efforts within the dissemination paradigm have not led, and are unlikely to lead, to systemic adoption of evidence-based instructional practices.

When the need for increased emphasis on propagation was initially recognized, there were limited and insufficient resources to support work within the propagation paradigm, such as development of propagation plans, as opposed to dissemination plans. We have worked for some time to better understand the extent to which evidence-based instructional strategies have been incorporated into undergraduate teaching practice, as well as identifying barriers to adoption. As part of our work we have analyzed typical dissemination practice, specifically 71 education development proposals funded by NSF in 2009. Through expert consultation we have also identified 44 well-propagated innovations in undergraduate STEM and have conducted in-depth case studies of three. We have also reviewed the relevant literature from a wide variety of disciplines. Based on this research, we have developed a set of resources (www.increasetheimpact.com) to address developer concerns about not knowing how to propagate educational innovations.

The work of the authors and many others ultimately leads to the conclusion that continuing efforts within the dissemination paradigm will not lead to widespread adoption of evidence-based instructional strategies (e.g., Borrego & Henderson, 2014; D’Avanzo, 2013; Graham, 2012; Henderson, Cole, Froyd, & Khatri, 2012; Khatri et al., 2016; Stanford et al., 2016). Therefore, a new paradigm is needed. Our work has led us to
articulate the propagation paradigm that may help achieve the goal of broad adoption of effective teaching and learning strategies for undergraduate STEM. The purpose of this article is to examine both paradigms.

**Overview**

Table 1 compares and contrasts the two paradigms across a set of dimensions. Note that the goal within both paradigms is broad adoption of the educational innovation.

Table 1: Characteristics of the dissemination and propagation paradigms

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<tr>
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<th>Dissemination Paradigm</th>
<th>Propagation Paradigm</th>
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<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Broad adoption of the educational innovation</td>
<td>Broad adoption of the educational innovation</td>
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<tr>
<td><strong>Focus of the paradigm</strong></td>
<td>Evidence. Telling potential adopters about the innovation and its efficacy.</td>
<td>Fit. Interacting with potential adopters throughout the development and dissemination process.</td>
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<td><strong>What innovation characteristics should be prioritized by the developer?</strong></td>
<td>Innovations should be optimized for outcomes. It is important for the developer to collect strong data regarding efficacy, preferably using an experimental design.</td>
<td>Innovations should be optimized for usability. It is important for the developer to work with potential users in multiple settings to develop a product with wide applicability.</td>
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<td><strong>What is the purpose of developer interactions with potential adopters?</strong></td>
<td>Raise Awareness. Focus on getting the word out about the innovation and evidence of its efficacy.</td>
<td>Support Adoption. Focus on learning through engaging with potential adopters to promote productive implementation, including customization.</td>
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<td><strong>How does the instructional system influence adoption?</strong></td>
<td>Instructional systems are largely a source of barriers to adoption, increasing the need for more convincing evidence. Insufficient thought is given to effects of customization, which is viewed as</td>
<td>Instructional systems provide both affordances and barriers and are key to successful adoption. Customization is necessary to adapt to the local instructional system and, when done</td>
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Four key terms in Table 1 may need some explanation: efficacy, fit, affordances, and barriers. We use the Diffusion of Innovations framework (Rogers, 2003) to help define these terms. According to this framework, the attributes of an innovation that promote adoption are: (1) relative advantage, perceived benefits compared to existing practice; (2) compatibility, perceived consistency with individual needs and values as well as consistency with practice in the local instructional system; (3) complexity, perceived difficulty to understand and apply; (4) trialability, perceived ease of giving it a try; and (5) observability to those people within the social system. For most educational innovations, relative advantage is communicated in terms of evidence supporting the efficacy of an educational innovation in achieving the intended outcomes – usually improvements in student learning. The second term, fit, can be viewed as a composite of compatibility, complexity, and trialability. Another way to think of fit is as the degree to which an educational innovation is compatible with the instructional system and/or the pedagogical beliefs of potential adopters. Mediating factors in addition to these characteristics include affordances and barriers that are part of the instructional system. Affordances are aspects of the instructional system that support or can be used to support changes to teaching practice, while barriers prevent or deter change.
Figure 1 (above) shows relationships among fit, efficacy, and adoption, based on the diffusion of innovations framework.

**Illustrative Scenarios**

Two scenarios describe and contrast the two paradigms, in addition to illustrating the elements in the table.

**Dissemination Paradigm Scenario**: A change agent (educational developer) identifies a local instructional problem and has an idea to fix it. The change agent, perhaps with a few collaborators in their department, writes and receives a grant based on this idea and then works hard to develop the innovation for specific needs within their instructional context. The developers use the new instructional innovation for a few semesters in their classes and collect evidence of improved student performance. After development and implementation efforts are nearly complete, they carefully compile and document curricular resources related to the new instructional innovation and then start to share this information with potential adopters. They create a web site for the materials, give presentations at professional conferences, and write journal articles. In many cases they also give partial-day workshops at professional conferences. Their dissemination strategies focus on raising awareness, telling potential adopters about the innovation,
offering compelling evidence within their instructional context, and convincing potential adopters their innovation will work.

**Propagation Paradigm Scenario:** A change agent (educational developer) identifies a local instructional problem and has an idea to fix it. The change agent talks with other instructors from their discipline at a professional conference and finds that they also experience the same problem and think that the idea, within modifications, could also work in their institutions. The change agent incorporates these suggestions and insights into a grant proposal, asking some of these colleagues to serve in advisory roles or as beta testers. Alternately, the change agent coordinates a collective effort to write and receive a multi-institutional collaborative grant based on this idea. Once the grant is received the developers refine the instructional innovation a bit through use in their own classes and quickly develop a set of core ideas. Before refining their ideas, they talk to a dozen or so instructors from a variety of institutions who are teaching the same target class. Through these conversations the change agents are able to identify ways to make their ideas fit in a variety of contexts. They then continue development of the instructional innovation at their institutions. Once an early version of the instructional innovation is ready, the change agents again solicit the help of other instructors in testing the innovation. The goal of these tests are to document efficacy as well as to identify productive modifications and implementation difficulties. The developers carefully compile and document curricular resources related to the new instructional innovation. These resources include recommended variations in use and expected difficulties that will need to be overcome. They create a web site for materials and also give presentations, workshops, and write journal articles. Their most important source of potential users, though, is through word of mouth. The multiple developers and the instructors involved in the first round of testing are now able to go out and spread the word about the instructional innovation as well as to support additional adopters of the innovation. If the innovation ultimately becomes widely popular there may even be a community of adopters associated with it. Their propagation strategies focus on fit - interacting with potential adopters working in different instructional contexts throughout the development and dissemination process.
**Key Assertion**: Change agents, working within the dissemination paradigm, tell and try to convince adopters that an innovation is effective in achieving the desired outcomes. Change agents, working within the propagation paradigm, engage with adopters to understand their instructional systems and interactively develop a strong product adaptable to these contexts.

**Dissemination Paradigm**

As illustrated in the scenario, the underlying assumption of the dissemination paradigm is that a potential adopter who becomes aware of an innovation that solves an instructional problem and sees that it “works” (that is, there is sufficient evidence for efficacy of the innovation) will decide to try the innovation. Awareness and compelling evidence are necessary and sufficient conditions to support broad adoption. Once a “strong” product is developed, if the product is not used, one or both of the following assumptions are used to explain the lack of adoption: (1) potential users do not yet know about the product, or (2) potential users are not convinced by the existing evidence. Thus, efforts by change agents working within this paradigm, if broad adoption has yet not occurred, should focus on (a) doing a better job of getting the word out and/or (b) developing increasingly strong studies to demonstrate effectiveness.

If the innovation is not adopted and someone decides that the reason is lack of awareness, then more presentations should be made, more journal papers should be published, and the website should be improved. If the innovation is not adopted and the developer decides that the reason is insufficient compelling evidence, then more resources will be invested in more rigorous comparisons (e.g., greater numbers of students in treatment and comparison groups, random assignment to treatment and comparison groups, more efforts to reduce effects of confounding factors, etc.).

Alternatively, lack of adoption may be characterized as resistance. Instructors are labeled as “resistant” to change when they cite features of the instructional system that serve as barriers to change (e.g., lack of time for teaching, reward system that does not value
teaching). It is thought that this resistance can be overcome by stronger evidence of efficacy.

Within the dissemination paradigm, individual instructors are assumed make adoption decisions independently of other instructors and their departmental and institutional contexts; therefore, developers focus on convincing instructors that their current (traditional) teaching practices should be exchanged for an evidence-supported innovation that improves student learning. The expectation is that potential adopters will want to use “proven” materials that will improve student learning. In the dissemination paradigm, the instructional system plays at most a minor role.

However, significant research has found that many potential adopters hold beliefs and values about teaching and learning that more are aligned with the evidence-supported innovation than their current teaching practices but often these views have not resulted in changed practice (Henderson & Dancy, 2004; Yerushalmi, Henderson, Heller, Heller, & Kuo, 2007). Instead, potential adopters make their teaching decisions within the context of a larger system that is not addressed effectively in the dissemination paradigm. In interviews instructors often refer to elements of the system as barriers. For example, they will say that their institution does not reward time spent focused on teaching, or that the large class sizes prevent them from being able to implement interactive teaching strategies, or that they are required to cover so much material that only lecture methods could suffice. Within the dissemination paradigm these potential adopters are labeled as resistant to change.

Significant work within the dissemination paradigm has been done and strong bodies of evidence support the efficacy of many types of innovative instructional strategies. The work to develop these instructional strategies and demonstrate their effectiveness has been invaluable; however, only limited numbers of instructors have adopted these instructional strategies. Continued work within the dissemination paradigm will not lead to broad adoption.
**Propagation Paradigm**

In contrast to the dissemination paradigm, the essence of the propagation paradigm is that a potential adopter will adopt an instructional innovation that solves an instructional problem or improves some aspect of student learning or course delivery and fits well within their local instructional system. Since fit, alignment with both individual instructor needs, preferences, and beliefs, as well as the larger instructional system, critically influences adoption, developers should focus their efforts on understanding the instructional systems of potential adopters, identifying characteristics of the innovation that address concerns, working with potential adopters to design appropriate instructional innovations, and supporting adopters in adapting these innovations to their instructional system.

Implementing an educational innovation likely requires that some aspects of the instructional system be changed. These aspects can be envisioned in terms of four structural levels: individual, departmental, institutional, and extra-institutional (Henderson, Finkelstein, & Beach, 2010; Stanford et al., 2016). Within the propagation paradigm, developers understand what will need to change, what elements of the system will aid adoption (affordances), and what elements of the system will hinder adoption (barriers). Then, they apply this knowledge in the development of the innovation; determining what factors should be considered in the evaluation of the innovation, e.g., gathering evidence on content coverage, and determining supports for implementation. In general, the greater the change in the instructional system required by adoption, the more difficult it will be to make the change. Propagation strategies need to adjust depending on the degree of change required.

Unlike the dissemination paradigm, developers working within the propagation paradigm expect individual instructors will almost always modify an instructional innovation for better fit with the local instructional system. Thus, change agents work with potential users from the very beginning in order to develop a product that emphasizes compatibility with instructional systems of individual users as well as effectiveness in addressing intended learning goals. Evidence is still important, but it is embedded in the
context of fit. Further, at least one-third of instructors who try an educational innovation stop using it (Henderson, Dancy, & Niewiadomska-Bugaj, 2012). We call this adopt and drop. Therefore, providing users support following initial adoption will be just as important as engagement to promote initial adoption.

Peer Instruction is well propagated and has wide appeal because its developer, Eric Mazur, understood instructional systems in physics. Mazur, a physics professor at Harvard, knew that his lectures were not achieving the outcomes he wanted. First, he thought about teaching students in smaller groups – quickly nixed. While small-group instruction would likely have been effective and he might have been able to pull that off with Harvard’s resources, he wanted to have an impact on college physics teaching as a whole. Any systemic change would need to be cheap and not require significant extra time on the part of instructors or TAs. Peer Instruction was successful in part because Mazur understood the instructional systems in physics, and what was likely to be adopted widely.

Lack of adoption is viewed as a result of an innovation not matching sufficiently with the local environment or insufficient support being provided to sustain adoptions. Barriers to adoption are seen as legitimate reasons for concern, instead of undesirable sources of resistance. Therefore, developers explicitly identify (a) who makes adoption decisions, (b) characteristics of these potential adopters, and (c) affordances and barriers arising from the instructional environments in which adopters reside. Instead of being unaware of barriers, ignoring barriers, or promoting adoption despite barriers, developers modify their innovations or offer workarounds. They identify potential incompatibilities early in the development process and modify or redesign innovations to reduce incompatibilities when possible. When not possible, developers construct strategies that acknowledge and address barriers. In addition, developers are aware of and take advantage of affordances.

Within the propagation paradigm, developers focus on both product development and potential adopter development (Blank & Dorf, 2012; York & Danes, 2014).i.e., understanding factors that positively and negatively influence adoption and addressing these factors, understanding the multiplicity of instructional contexts and making the innovation easily adaptable, and providing opportunities for potential adopters to participate in the development process. Developing archetypes of specific adopters and
the instructional systems in which they work allows change agents to better identify specific individuals representing these archetypes who can provide feedback. Early in the development process, engaging potential adopters provides insight into what drives the decision to adopt, what the major barriers to adoption are, and how changes in the innovation can minimize those barriers without sacrificing the innovation’s effectiveness. Engaging several different types of individuals from different contexts can inform a developer about how features of an innovation fit in different contexts with different people. After an innovation is mostly developed, continuing this interaction through initial implementation by additional adopters (beta testers) provides a developer with information about the issues instructors have when implementation is less controlled and what actions and structures will support adoption both in initial implementation and throughout sustained adoption. Keeping the communication channels open also provides insight into additional support that may be needed as an adopter becomes more familiar and comfortable with an innovation, and how to empower adopters to share their experience and enthusiasm in a way that increases interest in the innovation. Identifying and interacting with potential adopters to better understand the affordances and barriers of the instructional system that need to be addressed to encourage and support implementation is as important as developing a strong product.

**Potential Adopter Development**

Engagement with potential adopters throughout the development process stands in stark contrast to strategies used in the dissemination paradigm. This is exemplified in a recent correspondence received by one of the authors.

An instructor (and educational developer) has been developing new instructional materials and has given presentations about their development. These presentations often result in requests for access to the materials, which the author has declined. Her reasoning was that the materials weren’t ready to share with others yet – she wanted them to be “finished” before she let others see them.

After hearing about our work and reflecting on the implications, the educational developer is rethinking her assumptions about when she should begin sharing the materials. This change in mindset has come from a realization that early interaction with potential adopters allows the developer to determine affordances and barriers for adoption early in the development process; allowing for the optimization of the former and minimization of the latter.
Conclusions

In this paper we have argued that widespread adoption of new educational strategies and teaching materials is hindered because efforts to develop and support broad adoption of these strategies occur within the dissemination paradigm. The dissemination paradigm focuses primarily on the innovation. This focus has been productive in developing many high quality innovations and amassing convincing evidence to support their efficacy. However, efforts within this paradigm have not led to widespread use of these innovations. We believe shifting to the propagation paradigm has the potential to achieve desired widespread adoption. The propagation paradigm is characterized by a focus on potential adopters and the fit of innovations. This includes involving adopters in development of innovations and supporting adopters in customizing these innovations for their instructional system.

Shifting paradigms is never easy and typically takes a long time; however, we have reasons for hope. Although we are not aware of anyone explicitly articulating the propagation paradigm, we are aware of movement in this direction. For example, as noted earlier, both funders and education developers have expressed dissatisfaction with the results of working within the dissemination paradigm. Similarly, funding agencies have begun to move away from programs that work within the dissemination paradigm and begun to develop program elements more consistent with the propagation paradigm.

We wrote this article to articulate and contrast these two paradigms to provide language and thus support conversations that speed transition towards the propagation paradigm. Over 20 years ago Barr and Tagg contrasted the instruction paradigm and the learning paradigm (Barr & Tagg, 1995). This framed and facilitated constructive conversations that are slowly creating a shift to the learning paradigm. Similarly, we hope articulating the propagation paradigm will help catalyze conversations to shift how education developers think about and engage in educational change.


