A Model for Integrating Instructional Technology into Higher Education

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Abstract
This paper describes a model for integrating instructional technology into colleges and universities. The model is known as the RIPPLES Model because the main elements of the model are Resources, Infrastructure, People, Policies, Learning, Evaluation, and Support. The paper includes three main sections: a review of literature related to adoption and diffusion of innovations; results of a questionnaire sent to college Deans; and a brief discussion of the RIPPLES Model itself. The paper concludes with a discussion of the applicability of the model to other settings.

Background
Higher education, like many other areas of society, is beginning to make increased use of the rapidly increasing and expanding capabilities of technology. Communications and manufacturing technologies have had a profound impact on the missions of business and industry. Instructional technology has great potential to provide a similar impact on the teaching, research, and service missions of any college or university. However, as in most instances where organizations adopt new technology, there are numerous barriers to the integration of instructional technology in higher education. Even in colleges where integration has been relatively successful, the unintended consequences of technology and resistance to change among faculty, staff, and students have made the technology integration process a challenging and difficult one.

The paper describes a model for overcoming the barriers to integrating instructional technology into higher education. The elements of the model were developed by reviewing the relevant literature and by analyzing the results of a questionnaire sent to higher education Deans. The model described in this paper, like most models, has both descriptive and prescriptive applications. It describes the factors that facilitate the integration of technology and outlines specific steps administrators and other change agents can take to encourage technology integration. The current model is unique from most other technology integration models in that it includes facilitating factors that are specific to academic settings. While the model is focused on higher education, many of the elements in this model are useful to all organizations, both inside and outside of academe.

This paper has three main sections. The first section briefly describes the major literature related to the adoption, diffusion, and integration of technology into organizations, both academic and non-academic. The second section describes the results of a questionnaire
sent to Deans of Education at Carnegie I and II universities. The purpose of the questionnaire was to determine what education deans felt were the most important factors in technology integration. The third section describes a model for integrating instructional technology into higher education. The model, known as the RIPPLES Model, describes the seven major elements that administrators should account for when planning for technology integration. At the conclusion of the paper, I discuss how the model can be transferred to other settings and describe areas of potential research related to the integration of instructional technology into educational organizations.

This paper is important for four reasons. First, as more colleges and universities seek to use instructional technology, it will be important for administrators to have a framework for effectively integrating technology. Second, the model is important because it is transferable to other educational settings – such as community colleges and K-12 schools. Third, this paper contributes to the adoption and diffusion research field by presenting the results of a questionnaire and a literature review. Fourth, this paper is important because it describes areas of potential research related to the adoption, diffusion, and integration of technology into educational settings.

**Review of the Literature**

The first step in developing the model was to review the literature related to the adoption and diffusion of innovations. There is an extensive body of literature on this topic. One of the most interesting aspects of the diffusion literature is that there is no single, unified, universally accepted theory of adoption and diffusion. The literature is made up of numerous, unrelated theories, each addressing a different aspect of the diffusion process or a different type of innovation or organization. Because there are so many unrelated diffusion theories, it can be difficult to efficiently organize and discuss them. Surry and Farquhar (1997) divide diffusion theories into two broad categories – general diffusion theories, which are applicable to a wide range of organizations, and instructional technology diffusion theories, which are specific to innovations in instructional settings. Their taxonomy will be used to organize this review.

**General Diffusion Theory**

Everett Rogers is the most widely cited author in the area of general diffusion theory. Rogers' (1995) theories form the basis of most studies related to adoption and diffusion. Four of Rogers’ theories, in particular, seem to be common elements of most diffusion theories. These common elements are the diffusion process, adopter categories, innovation attributes, and rate of adoption.

The diffusion process outlined by Rodgers (1992) has five steps – knowledge, persuasion, decision, implementation, and confirmation. According to this theory, potential adopters of an innovation have to learn about an innovation and be persuaded to try it out before making a decision to adopt or reject the innovation. Following adoption and implementation, the adopters decide to either continue using the innovation or stop using it. This theory is very important because it shows that adoption is not a momentary, irrational act, but an ongoing process that can be studied, facilitated and supported.
Rogers’ theory of adopter categories is central to many theories of diffusion. According to this theory, members of a population vary greatly in their willingness to adopt a particular innovation. The distribution of innovativeness within a population will resemble a normal curve. “Innovators”, those who take the lead in adopting an innovation, make up about 2.5% of a population. “Early Adopters” make up approximately 13.5% of a population. Most people will fall into either the Early Majority (34%) or the Late Majority (34%) categories. “Laggards”, who will resist adopting an innovation as long as possible, comprise about 16% of a population. This theory is important because it shows the impossibility of having all members of a population adopt an innovation at the same time. Change agents should anticipate different responses to their innovations and develop plans for addressing the concerns of all groups from innovators to laggards.

The theory of innovation attributes is another of Rogers’ ideas that has been incorporated into many other diffusion theories. According to this theory, potential adopters decide to adopt or reject an innovation based, in part, upon their perceptions of the innovation’s attributes. The attributes of an innovation are trialability, compatibility, complexity, relative advantage, and observability. In simple terms, an innovation is more likely to be adopted if potential adopters perceive the innovation to be something they can try out before adopting, is compatible with their personal and professional goals, is not too complex, is better than another innovation (or the status quo), and has some observable benefits. The theory of innovation attributes is important because it stresses that the perceptions of potential adopters play a pivotal role in the adoption process.

Rate of adoption, or the “S-Curve theory”, is another widely cited theory. This theory states that any successful innovation goes through a period of relatively slow growth before experiencing a sharp increase in adoption, and then leveling off. Plotted on a graph, this slow growth, rapid expansion, and leveling off will approximate the shape of the letter S. This theory is important because it shows that even successful innovations start out slowly and don’t become widely adopted until a critical mass develops. As a result, change agents should recognize and develop the supporting services and technologies needed for an innovation to become widely adopted.

**Instructional Technology Diffusion Theories**

Many researchers within the field of instructional technology have developed diffusion theories that apply specifically to innovations in educational settings. Ernest Burkman (1987) was one of the first to take concepts from general diffusion theory and apply them to instructional technology. Burkman’s User Oriented Instructional Development model stresses the importance of determining the perceptions of potential adopters and designing instructional products that take those perceptions into account.

Perhaps the most widely discussed model for educational change is the Concerns Based Adoption Model (CBAM) developed by Hall & Hord (1987). Hall & Hord’s seminal work on change in schools focuses on the role that people within an organization play in facilitating change. The two most commonly discussed elements of the CBAM are “stages of concern” and “levels of use.”
Hall and Hord write that people within an organization will fall into one of seven stages of concern ranging from awareness to refocusing. People will have different concerns about technology depending upon which stage they are in. For example, people in the third stage (“personal”) will want to know how using an innovation will affect them while those in the sixth stage (“collaboration”) will want to know how they can collaborate with others to maximize the innovation’s potential. There are eight levels of use according to Hall and Hord. These levels range from “non-use” to “renewal.” Taken together, these two elements of the CBAM show that change agents have to be prepared to address the concerns of all members of an organization and to support members who are in different use levels.

Donald P. Ely is perhaps the most widely cited researcher related to the implementation of instructional innovations. Ely (1999) has developed a strategy for implementing instructional technology innovations. He contends that implementation, the phase after adoption and before confirmation in Rodgers’ model, is an essential and often overlooked part of the innovation process. Ely's strategy goes beyond adoption and diffusion to describe the conditions that must be present in order for an innovation to be successfully implemented and eventually institutionalized within an organization. Ely’s conditions that facilitate the implementation of an innovation are:

**Dissatisfaction with the status quo**
**Knowledge and skills exist**
**Availability of resources**
**Availability of time**
**Rewards and/or incentives exist**
**Participation**
**Commitment**
**Leadership**

One of the most comprehensive and useful instructional technology diffusion theories is the Critical Factors in Adoption Checklist developed by Stockdill & Morehouse (1992). The Stockdill & Morehouse checklist provides a comprehensive overview of the factors that facilitate adoption of innovations in educational settings. The five categories of the checklist are educational need, user characteristics, content characteristics, technology considerations, and organizational capacity.

The concept of adoption analysis developed by Farquhar and Surry (1994) incorporates many of the other theories discussed in this literature review. Farquhar and Surry describe four categories of factors that affect adoption. The first category, User Characteristics, looks at the personal traits of the people within an organization and includes motivation, anxiety, and skill level. The second category, Perceived Attributes, includes Rogers’ five attributes of an innovation. The third category, Physical Environment, looks at an organization’s technology infrastructure and includes facilities and patterns of use. The fourth category, Support Environment, looks at the resources available to support and maintain an innovation and includes production, storage, and delivery services.
College of Education Deans’ Questionnaire

The second step in developing the model for integrating technology into higher education was to send a questionnaire to college Deans. The purpose of the questionnaire was to determine the deans’ opinions about the factors effecting technology integration. We used an anonymous questionnaire to collect information. The questionnaire was sent to Deans of Education at Carnegie Research I and Research II universities. The survey contained 27 questions. Surveys were sent to Deans of Education at all 126 Carnegie Research I and Research II Universities in the United States.

In order to categorize the Colleges of Education, we used the 1994 Classification of Institutions of Higher Education developed by the Carnegie Foundation. The Carnegie Foundation classifies universities based, in part, on the range of degrees offered and the amount of federal support they receive. For this study, we only included Colleges of Education at Research Universities I and Research Universities II. These universities receive more than $15.5 million annually in federal funds and award 50 or more doctoral degrees annually [http://www.carnegiefoundation.org/].

A total of 61 questionnaires were returned. Six of the returned questionnaires contained incomplete data and were excluded from the sample. A total of 55 returned questionnaires were included in the study. All questionnaires were returned anonymously. Several respondents who wished to be informed of the results of the study included business cards with their returned questionnaires. These business cards we kept separately from the questionnaires. The 55 questionnaires used in the study represent a response/inclusion rate of 43.7%. Forty-nine of the included questionnaires (89%) were from public universities while 6 were from private universities. Thirty-five of the included questionnaires (64%) were from Research I universities while 13 were from Research II universities. Seven respondents did not know their Carnegie research classification.

Both descriptive and inferential statistics were used to analyze the results of the questionnaires. Items on the questionnaire instrument were divided into 5 categories: Planning and Support; Infrastructure; Expenditures; Integration, and Overall Impressions.

As part of the statistical analysis, 13 pairs of factors were analyzed to determine if they were correlated. Five of the 13 pairs of factors were determined to be significantly correlated. The first significant correlation was between a college’s technology infrastructure and the technological competency of recent graduates (see Table 1). Deans who felt their colleges had an adequate technology infrastructure were significantly more satisfied with how well their recent education graduates could use technology than deans who felt their colleges had an inadequate technology infrastructure. This finding suggests that access and exposure to technology is an important factor in whether or not students learn to use the technology.
Table 1
Correlation Between Deans' Satisfaction with Technology Infrastructure and Technology Competency of Recent Graduates

<table>
<thead>
<tr>
<th></th>
<th>INFRA</th>
<th>GRADS</th>
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<tbody>
<tr>
<td>Infrastructure</td>
<td>Pearson Correlation</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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</tr>
<tr>
<td></td>
<td>N</td>
<td>55</td>
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<tr>
<td>Competency of Graduates</td>
<td>Pearson Correlation</td>
<td>.601</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
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<td></td>
<td>N</td>
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** Correlation is significant at the 0.01 level (2-tailed).

The second significant correlation discovered on the questionnaire was between a college’s technology infrastructure and faculty efforts to integrate technology into their teaching (see Table 2). Deans who felt their colleges had an adequate technology infrastructure were significantly more satisfied with their faculty’s use of technology in the classroom than deans who felt their colleges had an inadequate technology infrastructure. This finding suggests that having an adequate technology infrastructure is an essential precursor to faculty integrating technology into the classroom.

Table 2
Correlation Between Deans' Satisfaction with Technology Infrastructure and Faculty Efforts to Integrate Technology into Their Teaching

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<tr>
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<tbody>
<tr>
<td>Infrastructure</td>
<td>Pearson Correlation</td>
<td>1.000</td>
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<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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<td></td>
<td>N</td>
<td>55</td>
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<tr>
<td>Integration</td>
<td>Pearson Correlation</td>
<td>.472</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
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<td></td>
<td>N</td>
<td>54</td>
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</table>

** Correlation is significant at the 0.01 level (2-tailed).

The third significant correlation was between technology expenditures and satisfaction with the college’s technology infrastructure (see Table 3). Simply stated, the more money deans spent on technology, the happier they were with their college’s infrastructure. This finding suggests that there is a fairly direct relationship between money and technology. It also suggests the important role that financial resources play in the process of technology integration.

The fourth significant correlation discovered in the questionnaire was between technology expenditures and faculty efforts to integrate technology into the classroom (see Table 4). The more money deans spent on technology, the happier they were with their faculty’s use of technology for teaching. This finding makes sense because expenditures and infrastructure are related (Table 3) and infrastructure and faculty efforts to integrate technology into the classroom are related (Table 2). This finding reinforces the importance of financial resources to the integration process.
Table 3
Correlation Between Technology Expenditures in the Current Fiscal Year and Deans’
Satisfaction with Technology Infrastructure

<table>
<thead>
<tr>
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<th>CYEAR</th>
<th>INFRA</th>
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<tbody>
<tr>
<td>Current Year</td>
<td>Pearson Correlation 1.000</td>
<td>.447</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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<tr>
<td></td>
<td>N</td>
<td>53</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Pearson Correlation .447</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.001</td>
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<tr>
<td></td>
<td>N</td>
<td>53</td>
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** Correlation is significant at the 0.01 level (2-tailed).

Table 4
Correlation Between Technology Expenditures in the Current Fiscal Year and Faculty
Efforts to Integrate Technology into Their Teaching

<table>
<thead>
<tr>
<th></th>
<th>CYEAR</th>
<th>INTEG</th>
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<tbody>
<tr>
<td>Current Year</td>
<td>Pearson Correlation 1.000</td>
<td>.296</td>
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<td>Sig. (2-tailed)</td>
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<td>53</td>
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<tr>
<td>Integration</td>
<td>Pearson Correlation .296</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.033</td>
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</table>

* Correlation is significant at the 0.05 level (2-tailed).

The final significant correlation was between faculty use of technology and the
technology competency of recent graduates (see Table 5). The more faculty used
technology in their teaching, the more satisfied deans were with the technology
competency of their graduates. It’s interesting to note that we found no significant
correlation between having a required course on technology and the technological
competency of recent graduates. These findings suggest that students become more
competent in technology when faculty integrate technology throughout the curriculum
than when technology is taught in a single, separate course.

Table 5
Correlation Between Faculty Use of Technology and Technology Competency of Recent
Graduates

<table>
<thead>
<tr>
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<tr>
<td>Competency of Graduates</td>
<td>Pearson Correlation 1.000</td>
<td>.450</td>
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<td></td>
<td>Sig. (2-tailed)</td>
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<tr>
<td></td>
<td>N</td>
<td>55</td>
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<tr>
<td>Faculty Use of Technology</td>
<td>Pearson Correlation .450</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.001</td>
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<td>N</td>
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</table>

** Correlation is significant at the 0.01 level (2-tailed).
Results of the survey suggest that a college's technology infrastructure is the single most important factor in integrating technology into the curriculum. While this may seem like an obvious conclusion, it tends to contradict the prevailing wisdom that other "soft" factors such as technical support, faculty incentives, awareness, and training to use technology are the keys to successful technology integration. These soft factors are important to technology integration, of course, but this research suggests that infrastructure is the single most important consideration. This finding, taken a step further, leads to one important conclusion. Namely, that in order to have an effective technology infrastructure, colleges need money. The correlation between technology expenditures and satisfaction with technology infrastructure (Table 3) cannot be overemphasized.

**The RIPPLES Model**

Results from the review of the diffusion literature, the Dean’s questionnaire, and personal experiences with change in higher education were used in developing a model for integrating instructional technology into higher education. The model is referred to by the acronym RIPPLES. The elements of the model are: Resources, Infrastructure, People, Policies, Learning, Evaluation, and Support. Each element of the model is discussed in more detail in the following section.

*Elements of the Model*

**Resources**

The first element of the model, Resources, refers mainly to fiscal resources. The importance of fiscal resources was reinforced by responses on the dean’s questionnaire. It is interesting to note, however, that the adoption and diffusion literature includes very little discussion about the importance of money to the change process. One reason for this may be that most adoption and diffusion models assume that funding has already been secured and an innovation is available for adoption. Because this model is somewhat broader than most technology integration models, it begins with the premise that technology is expensive and colleges need to plan for adequate funding from the outset of the process in order to be able to acquire, utilize, maintain, and upgrade technology.

There are three factors related to resources that administrators have to consider when planning for the integration of technology. These factors are continuing resources (“hard money”), temporary resources (“soft money”) and resource allocation. Continuing resources refer to revenues that come from more or less permanent funding sources that can be counted on each year. Temporary resources refer mainly to grant funds or donations. Resource allocation refers to the process of matching revenues and expenditures. For example, finding the proper balance between technological and support personnel expenditures is an essential aspect of resource allocation. Resource allocation also has to account for the maintenance and support of technology as well as for purchase and upgrade.
Infrastructure
Infrastructure, the second element of the model, refers to the hardware, software, facilities, and network capabilities within the college. The crucial importance of infrastructure to technology integration was shown by both the dean’s questionnaire and the literature review. From the literature, Rodgers’ s-curve theory, the Stockdill and Morehouse checklist, and Farquhar and Surry’s adoption analysis place particular emphasis on infrastructure. A college’s technology infrastructure should include five components - teaching resources, production resources, communication resources, student resources, and administrative resources. Each of these resources can be delivered at the desktop, workgroup, or unit level.

People
People, the third element of the model, refers to the essential role that the people within an organization play in the technology integration process. All of the literature reviewed for this paper stresses that the needs, hopes, values, skills, and experiences of the people who will use an innovation play a vital role in deciding if an innovation is successfully adopted. Hall and Hord’s CBAM is the most detailed and useful discussion of the need to include people when planning for technological change. The two essential components of this element are shared decision-making and communication between all stakeholders (Ely, 1999).

Policies
The fourth element of the model, Policies, refers to the need for organizational policies and procedures to adapt to new technologies. Many organizational policies, especially those in relatively stable, long-term businesses such as higher education, were developed before technology became a common tool in the workplace. As a result, many policies prevent, or at least inhibit, the successful integration of technology into the workplace. This is certainly true in higher education with the most obvious example being policies concerning the retention, tenure, and promotion of faculty. Adapting retention, tenure, and promotion policies to reward the use of technology is one of the most effective ways for motivating faculty to integrate technology into their teaching (Surry & Land, 2000). An interesting result of the dean’s questionnaire that hasn’t been discussed is that only 1 of the 55 respondents said that technological competency was currently a criterion for tenure and promotion in their college. Fourteen other respondents said that technological competency would likely be a criterion for tenure and promotion in the near future. Other policies that could be adapted in higher education to facilitate the integration of technology relate to grading, residency requirements, programs of study, and entrance or graduation requirements.

Learning
The fifth element of the model, Learning, refers to the need for technology to enhance the educational goals of the college. When planning for the integration of technology, administrators should view technology not as an end in itself, but as a means for accomplishing specific learning goals. In general, there are three ways that technology can enhance the instructional goals of a college. First, technology can have pedagogical benefits. Technology can allow teachers and students to interact in dynamic new ways,
resulting in increased cognitive or motivational outcomes. Second, technology can have access benefits. Technology can allow a college of education to reach new student populations or to serve current students in new ways. Third, technology can have cost benefits. Technology can allow a college to serve students in a more cost effective manner either by allowing for economies of scale or through reduced operating costs.

**Evaluation**
Evaluation, the sixth element of the model, refers to the need for continual assessment of the technology. There are four areas of evaluation that administrators should consider. First, there should be an evaluation of technology in relation to learning goals. The main evaluation question in this area would be “Is technology allowing us to do a better job teaching our students?” Second, there should be an evaluation of the technology itself. This evaluation would include an ongoing assessment of technology alternatives. Third, there should be an evaluation of the overall integration plan. This evaluation would determine the factors that have either facilitated or impeded integration of technology. And fourth, there should be a benefit/cost evaluation. Benefit/cost analysis would be used to determine the return on investment for any technology expenditures.

**Support**
Support, the seventh element of the model, refers to the need to have a support system in place for faculty, staff, and students who are using the technology. Support is a component common to most models of adoption and diffusion. The theories of Stockdill and Morehouse (1992), Surry and Land (2000), and Farquhar and Surry (1994), in particular, describe the importance of developing adequate support systems. From these theories, we can determine that there are four components of a support system. These components are training (both formal and informal), technical support, pedagogical support, and administrative leadership.

It should be noted that the RIPPLES model is not a linear model. The model is not intended to show that resources should come before infrastructure, for example. When planning for the integration of technology, administrators should consider all of the elements of the model throughout the integration process. A comprehensive technology integration plan will account for all of the elements of the model. The model in practice would likely more closely resemble the iterative diagram shown in Figure 1 than a static, linear model.

**Applicability of the Model to Other Settings**
While the RIPPLES model was developed specifically for colleges of education, we believe it has applicability to other settings. The model is most applicable to other colleges within a university. All of the elements of the current model are appropriate for use in other colleges. We believe the current model is also applicable to K-12 schools. Most of the elements of the model, particularly the need to address funding and infrastructure issues, and the importance of support and policy changes, are relevant to technology integration in K-12 schools. While the RIPPLES model is not directly applicable to corporate settings, we feel it could be easily adapted to account for the unique circumstances of those organizations.
Conclusion
At this point, the RIPPLES model has to be thought of as a prototype. While the elements of the model are adequately grounded in theory and practical experience, the overall model has not been tested. Future research in this area will focus on the refinement of the model. The short-term research goal is to disseminate the model and seek feedback about it. The plan is to send the model to deans of education, deans of other colleges, community college administrators, K-12 administrators, instructional technology specialists, and others interested in change in education. The model will be revised and updated based on the feedback received from these stakeholders. The long-term goal is to apply the model in an actual academic setting and study the results. The results of that study will be used to determine the validity and usefulness of the model as well as its applicability to other settings.

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References


