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Keeping learning central: a model for implementing emerging technologies

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Felt problem: Technology integration continues to be a challenge for health science faculty. While students expect emerging technologies to be used in the classroom, faculty members desire a strategic process to incorporate technology for the students' benefit.

Our solution: We have developed a model that provides faculty a strategy for integrating emerging technologies into the classroom. The model is grounded in student learning and may be applied to any technology. We present the model alongside examples from faculty who have used it to incorporate technology into their health sciences classrooms.

Keywords: *technology integration*; *emerging technologies*

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Emerging technologies are more accessible, less expensive, and easier to learn than their predecessors. Nevertheless, incorporating them into education remains a challenge. Sometimes faculty members question the utility of new technologies and desire a strategic way to incorporate them into their classrooms that is effective, efficient, and worth their time and effort.

Technology integration is an issue at all levels of education, from one learning activity in one classroom to institution-wide programs (1). Table 1 summarizes a number of technology integration models and compares them to the emerging Technology Integration Model for Education (eTIME) we have developed. The first three columns provide the name of the model, a brief description, and the source. The next column indicates the level of education (for example, individual lesson and curriculum) for which the model is suited. The next three columns indicate whether or not the model contains the learning problem, references learning theory and/or assists with technology selection. The last column indicates whether there appears to be a link between the previous three elements within the model. Several of the models do not address learning theory and an understanding of how people learn. In our view, this is a critical flaw of technology integration models when the end goal is student learning. Several other models lack a strong connection between the choice of a particular technology and learning outcomes. We believe faculty members will have more difficulty using these models to select a technology rationally.

In contrast, eTIME explicitly includes the triad of problem, technology, and learning theory. We believe that matching the technology to the learning theory and the learning problem/goal is the critical first step in a strategic implementation effort. We have used eTIME each year in our technology in education course and have iteratively improved it to encompass the critical facets needed to consider when implementing a technology (Fig. 1).

eTIME begins by creating a preliminary solution through consideration of technology, theory, and problem. Instructional design methods are then applied to arrive at the final implementation. Real-world examples from health science educators are used throughout the paper. At the end of the paper we present an easy to use 'pocket guide' for health professionals who wish to strategically incorporate technology into teaching.

To arrive at a preliminary solution, consider these steps

Define a teaching or learning goal or problem to solve

Each time you make a change to instruction, you either have an implicit goal you are trying to achieve or a problem to solve. Clearly state the goal or the problem for yourself before even considering the technology.

For example, one of our projects has the goal of providing nutrition education for elementary school children in an after-school program (8). The curriculum initially relied heavily on instructor involvement and was

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Table 1. Comparison of technology integration models

Model	Brief description of model	References	Content level	Problem	Learning theory	Technology selection addressed	Comments
Assure	Analyze learners; state objectives; select media and materials; utilize media and materials; require learner participation; evaluate and revise	Heinich et al. (2)	All	x			Technology selection not linked to learning problem
ICARE	Introduce; connect; apply; reflect; extend	Hoffman and Ritchie (3)	Learning activity/ lesson	x		x	Technology selection not linked to learning problem
Generic	Considers pedagogy, social interaction, and technology	Wang (4)	Learning activity/ lesson	x		x	
Systematic planning	Linear model consists of problem statement; learning objectives; technology; rationale; strategies; assessment and reflection	Wang and Woo (5)	All	x		x	
3D	Consists of information; technology and instructional design	Liu and Johnson (1)	All	x		x	Technology selection not linked to learning problem or theory
RIPPLES	Considers resources; infrastructure; people; policies; learning; evaluation and support	Surrey (6)	All	x			
SECTIONS	Considers students, ease of use and reliability; cost; teaching and learning; interactivity; organizational issues; novelty; speed	Bates and Poole (7)	All	x	Partial	x	Technology selection not linked to learning theory
eTIME		Current Paper	Learning activity/lesson	x	x	x	Technology selection linked tightly to learning theory and problem

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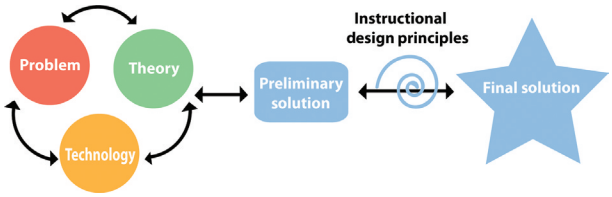

Fig. 1. The eTIME model.

difficult to implement and sustain. The problem was that children did not want to participate in a written curriculum after school because it was not fun and instructors were not interested in formal teaching in an after-school setting. Our solution was to design an online game to teach children about nutrition, solving both problems by making the learning fun and not heavily reliant on an instructor. (Other facets of the problem description included the content to be learned and how it might be taught.) By stating the learning goal and/or the problem you can go forward with a clear focus, referring back to it during the many design and implementation decisions.

Consider learning theory

Every faculty member holds some concepts about how to create a productive classroom environment. Yet, many faculty members do not articulate their ideas or compare them to those of others. Perusing established learning theories will help faculty name the concepts they hold and point out other ideas that may be helpful. When considering how to incorporate a new technology into their classrooms, it is useful to review what constructs are successful in supporting student learning so that the best decisions can be made about adding a role for technology.

A dental hygienist taking our technology in education course used Bandura's social learning theory as a theoretical foundation for her emerging technology project (9). She used streaming video to model patient care behaviors. By designing the video with social learning theory in mind, she tailored her actions in the video to encourage her students to imitate her behaviors. Grounding your technology selection in a theoretical framework will help you capitalize on others' best practices.

Match technology affordances to the problem

Affordance refers to the way a technology or software can be used and what it allows the user to do or not to do. All technologies have different affordances arising from their internal structure and functionalities. Table 2 lists several more established technologies along with some examples of their uses in education. For example, if your goal is for students to collaboratively create content, you may consider using a wiki. A wiki has the ability for all students to upload and contribute content in a format that is integrated and easily searchable. A wiki allows students to collaboratively edit content, but it would be a poor choice for real-time communication, for example, which may be another facet of collaboration.

On the other hand, if your goal is that students reflect on a series of learning experiences, a blog may be a more appropriate tool. A blog affords the learner a way to post or 'journal' and allows others to comment on each entry. The posts are presented in reverse chronological order so students can collaboratively reflect on their most recent experiences or scroll down to go back in time for review.

To determine technology affordances, look at the technology's functionality. Table 3 includes questions to think about related to both affordances and sustainability.

There are several ways to lower entry and sustainability barriers. Working with a group of colleagues who are committed to trying a new technology can spread the workload and has the advantage of leveraging the skills within the group. Group strategies might include asking for help from someone who already successfully used a technology or adapting a technology that is already part of someone's personal life. Team-teaching presents special challenges and opportunities. If you team-teach with other faculty, their technology experience and comfort level are important and can be an asset or a barrier to successful implementation.

An example of a technology being implemented based on its affordances was demonstrated by a dental faculty member in our technology course who created and evaluated the use of Flickr to share educational dental images (10). The project capitalized on this system's affordances of sharing images and of tagging images with information. Tagging adds keywords to images that allow searching. He created a standardized system for tagging the images to be useful for dental educators and shared this with his colleagues so they could tag, contribute images, and use the resources for teaching.

In contrast, one of the nursing faculty in the course created a video to teach fundal height measurements and Leopold's maneuvers to nurses in the undergraduate program. While the video format allowed students to watch and listen to each step of this procedure, updating the video because of changing guidelines would be time-consuming and problematic, making sustainability fairly time- and cost-intensive. An alternative way to create the video would be to break it into short segments, thus allowing a single segment to be swapped out if needed. While initially more time-consuming to create and edit, it would have made the video easier to update in the future.

As new technologies become available, questions regarding affordances and sustainability may have to be revisited. The act of changing technologies is never

Table 2. Emerging Technologies Table

Technology	Description	Examples	Educational example
Blog	A website by one (or more) authors with entries made in reverse-chronological order	WordPress	Blogs can foster reflective learning and critical thinking by allowing students to make the changes in their thinking visible
Social Network	An online community that supports the sharing of your persona, information and ideas	Facebook MySpace LinkedIn Ning	Social networks can foster community and a sense of belonging, may also support communication to improve learning
Wiki	A website authored by a community, highly interlinked and searchable, easy to contribute to	Wetpaint	A class may use a wiki as a collaboratively created repository for the knowledge students are learning
Microblogging	A microblogging text tool that sends broadcasts of under 140 characters	Twitter	Microblogging is useful for providing real-time updates, short pieces of content or quiz questions to students
Serious Games	Electronic games that teach in addition to being fun and motivating	Whyville (both game and virtual world) Army of One	Games can be used by all age groups to teach a variety of health science content
Virtual Worlds	An online environment where you are represented by an avatar and you can explore and communicate with others in the world	Second Life World of Warcraft (both game and virtual world)	Virtual worlds are great for simulating physical environments for learning, such as simulating a doctor/patient interaction in a virtual clinic
Content Sharing		Flickr YouTube Podcast	Allows for easy uploading and sharing of visual and/or auditory content

completely seamless; the best we can do is to minimize the disruption by choosing technologies today with an eye toward updating in the future.

To arrive at the final implementation, also consider these steps

Formulate behavioral learning objectives

Explicitly stating your learning objectives will help frame the technology implementation and guide your evaluation. Learning objectives can fall in the cognitive, affective, and psychomotor domains (11–13). Stated course objectives are one source of learning goals. Other sources include program outcomes or certification/licensing guidelines. Often, interpersonal skills, such as team collaboration, are not explicitly stated as part of course objectives but are nonetheless valid and important goals to achieve. Once you have explicit learning goals, these can be referred back to on an ongoing basis during the design and implementation decisions. These objectives will be measured during evaluation of the project and student learning.

Determine learner characteristics

Taking the characteristics of your students into consideration is critical for the successful implementation of a new technology. There are a variety of factors that can have an impact on the success of your implementation,

Table 3. Considerations around affordances and sustainability

Category	Questions to ask
Affordances	● Is the technology synchronous or asynchronous? ● Can it be accessed and used by few or many people? ● Can it be loaded onto a mobile device or do you need a big screen? ● Will the users need to download programs or is it a web application?
Sustainability	● How easy is it to update the learning material? ● How widely used is this technology and who supports it? (In general, solutions supported by a user community or a large company are less likely to disappear than those created by small entrepreneurs.) ● Can content be exported into another technology if your current solution is no longer supported?

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including students' ability to access technologies, their comfort level with and preferences about technologies, and the classroom environment. Although the Pew Center for the Internet and American Life has many different questionnaires, no simple questionnaire applicable to the use of emerging technologies in education exists. An easy way to discover your students' characteristics is to use a short survey, possibly hosted by one of the free survey websites. Important questions, along with age and gender, that we have used include the following:

What technology devices do you have access to? (Include technologies you are considering using, for example an MP3 player if you are considering podcasts) Which technologies are you comfortable using? (Include technologies you are considering using, for example an MP3 player if you are considering podcasts)

Where do you learn the material? (Check all that apply) Home School Library Car Other

Do you have any barriers to using audio and video technology? Yes No If yes, please describe

After you've implemented, consider these steps

Evaluate the implementation

Evaluation is an integral part of incorporating anything into the classroom. Kirkpatrick (14) describes four sequential levels of evaluation, with information gained from each level informing the next level of evaluation. Level one focuses on participant reactions. Personal reflection, collegiate discussion, and perusal of students' comments on course evaluations are other ways to gauge reaction. Valenza et al. (10) examined usage data and reactions from faculty participants. Level two assesses whether learning is different between two different conditions. For example, you might consider administering the same exam to a class using the technology and a class not using the technology and then compare exam performance. Orientale et al. (15) compared physical exam performance of first-year medical students who had access to videos of specific skills to the historical performance of previous medical school classes. Level three addresses whether the students can transfer the behavior, attitude, knowledge, and/or skills learned to a new situation. Level four addresses bottom line results. Level four outcomes might include performance on licensing exams, acceptance into residency programs, or publication of a peer-reviewed paper. Prokhorov et al. (16) examined the impact of A Smoking Prevention Interactive Experience (ASPIRE) on smoking initiation, among other outcomes. In general, the time and energy required of the faculty member involved in evaluation increases with each level. However, performing at least a level-one evaluation is critical to inform the next iteration of technology implementation.

Another component of technology evaluation is looking at usability. Sample questions that could be evaluated relate to use, success with technology, learning, learning efficiency, and learning enjoyment.

Applying eTIME to your teaching situation – the pocket guide

Many health science fields use concise pocket guides, or cards, to remind practitioners of the most important facts and considerations in a particular situation. In the same spirit, we have created a pocket guide to make applying eTIME easier. Box 1 summarizes the parts of the model using action items. These are presented in a linear list with the understanding that technology implementation is an iterative process that can start at any step prior to evaluation.

Box 1. Pocket guide to implementing technologies.

* Define a learning goal or problem
* Consider learning theory
* Match technology affordance to the goal and theory
* Formulate learning objectives
* Determine learner characteristics
* Evaluate the implementation

Conclusion

The goal of this paper was to give health sciences instructors a review of topics to consider before implementing technology in their classrooms. Students in our technology course, many of whom are faculty themselves, were able to use these points in creating technology-based learning projects for their students.

In conclusion, we believe that learning needs to be at the center of any technology implementation. Using eTIME provides faculty with a strategic method for the successful implementation of new technologies into their classroom environment. It provides a framework for implementing and evaluating whatever technologies could emerge in the future.

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