A Holistic Approach to Evaluation of Technology Effectiveness in Higher Education

Afandi, Waleed Saeed
King Abdulaziz University
Management Information System

Dr. Waleed Saeed Afandi
Management Information System
King Abdulaziz University
Saudi Arabia.

A Holistic Approach to Evaluation of Technology Effectiveness in Higher Education

Synopsis:

A holistic evaluation framework offers a better understanding of educational technology effectiveness in higher education. The framework treats technology as a part of a larger educational system that includes learners and pedagogical context.

A Holistic Approach to Evaluation of Technology Effectiveness in Higher Education

ABSTRACT

Educational technologies are being actively implemented in college and university settings today. However, studies showed that despite providing benefits for education, their impact on learning has been much weaker than probably expected. In order to use technology to its highest potential in the educational settings, it is essential to understand how effectively it is being used in order to determine the necessary steps for improvements. Unfortunately, the traditional methods for evaluation of technology effectiveness in educational settings cannot provide in-depth understanding of how and why technology contributes or does not contribute to learning improvements. This work presents a proposition of a holistic approach to evaluating educational technology. The proposed framework considers technology as a part of a pedagogical system that includes learners and educational context. Being flexible yet robust, the proposed model can help school administrators to achieve a thorough understanding of technology effect on learning and devise concrete strategies to enhance this effect.

1. INTRODUCTION

Technology has substantially altered the fabric of higher education in the recent decades. Computers, web-based tools, and mobile devices have changed the very nature of the learning process by establishing the new ways that students learn, perform assignments, and interact with the instructors and each other. Because of the perceived positive impact of technology on education, there may be a general belief among the college and university administrators that implementation of advanced technologies in their educational settings will lead to improved learning results.

Research in various educational settings in the recent decades has, indeed, demonstrated consistent benefits that technologies provide for education (e.g. Bayraktar, 2001; Camnalbur & Erdogan, 2008; Cassil, 2005; Chen, Lambert, & Guidri, 2010; Cheung & Slavin, 2011; Lee et al., 2013; Li & Ma, 2010; Ohuoha, 2007). However, the degree of reported positive effects has been relatively small. Moreover, experimental and quasi-experimental meta-studies show that pure technology-based interventions often produce lower improvements than non-technological approaches such as, for example, effect feedback and peer tutoring (Higgins, Xiao, & Katsipataki, 2012). This suggests that technology by itself is likely not make substantial difference in education; rather, it is how well the technology is used that creates noticeable positive changes.

In order to use technology to its highest potential in the educational settings, it is essential to understand how effectively it is being used in order to determine the necessary steps for improvements. Presented here is a holistic framework for measuring and evaluating effectiveness of technology uses in colleges and universities. The framework encourages a more systematic view on educational technology not as a mere artifact but as an integrative tool within educational environment.

2. HOW TO EVALUATE EDUCATIONAL TECHNOLOGY

Educational technology is a wide term that covers different tools, techniques, and processes used in educational settings to enhance teaching and learning. Generally, educational technology involves several distinctive areas:
- Computer assisted instruction;
- Programs and instruments such as games, simulations, computational and analytical software;
- Discourse supporting tools (Scardamalia, 2006).

Most of post-secondary education establishments today have these technologies to one degree or another. However, evaluation of these technologies' combined effect on the process of education is both difficult and not practically useful because it does not allow to determine the particular technological aspects that make positive impact. Therefore, evaluation studies often focus on a particular technology or its specific features. In their majority, these studies measure the technology effectiveness for teaching or its usability (Jenkinson, 2009). A major issue, however, is that the traditional evaluations are often unable to explain the role of technology in a transformative of the new knowledge creation. This is because technology benefits are often assessed on the basis of students' performance such as, for example, concepts knowledge. While such evaluations may help in determining the degree of education technology contribution to student success, they tell us nothing about what this contribution is or how the technology contributed to the positive changes. In similar manner, even if there is no change in students' performance, such evaluations will not indicate what needs to be done in order to improve technology's contribution to teaching and learning. Moreover, such studies often make it difficult to consider education technologies within the specific context they are applied and, therefore, evaluate contextual effects on technology use.

Recently, a growing number of educational researchers have been calling for a more flexible, fine grained method for evaluating education technology effects (Ainsworth, 2008; Amiel & Reeves, 2008; Jenkinson, 2009; Ploetzner & Lowe, 2004). The new efforts, they argue, should fully consider the *why* and *how* of technology effects on learning and the contextual framework within which technology effects are taking place. This would allow for a more meaningful, in-depth research of technology effects in particular settings. This, in turn, requires creation of the evaluation frameworks that would:
1. Be flexible enough to be useful in different contextual settings;
2. Be specific enough to address multiple aspects of technological effects;
3. Be scalable enough to include or reduce additional evaluation elements for the depth of evaluation.

3. A HOLISTIC FRAMEWORK
A holistic approach to technology evaluation can be understood as an approach that considers the technology as a part of the human-technology system rather than a separated learning tool. Such view, according to Vicente (2004), allows to fully capture the dynamics of the relationship between technology and those who use it. A holistic framework considers this relationship as an

emergent property that comes to life when its elements are combined and configured appropriately. Therefore, it assumes the presence of a desired state of the system that can be compared against the real world state. Consequently, a holistic evaluation of technology effect will require a multifaceted approach that centers on the learner and involves a wide range of measures.

Following the basic description of a holistic approach, the major difference between it and the traditional methods of technology evaluation is in the focus on interdependency with the learners and the effects associated with this interdependency. Multi-dimensionality is an essential feature of a holistic assessment. In the context of educational technology applications, it means evaluation based on a number of criteria. Multi-dimensionality is an important factor for educational technology evaluation because educational technology is almost never used as a standalone solution to improving learning. As a result, full extent of educational technology benefits can be understood only when it is considered within a larger framework of educational planning initiatives. Multidimensionality additionally brings the points of evaluation flexibility and scalability because the depth of dimensional analysis can be adjusted according to the needs of each evaluation. Therefore, a holistic approach allows to meet all three requirements of an effective evaluation framework discussed earlier.

The proposed holistic framework for educational technology evaluation is presented in Figure 1. The process of framework development includes 1) defining the key elements of the framework; 2) defining the key relevant characteristics of these elements; and 3) defining the interdependencies between these elements.
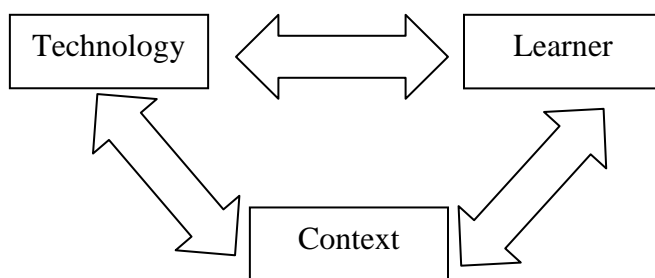

Figure 1. A Holistic Conceptual Framework for Educational Technology Evaluation

3.1. The Key Elements and Characteristics

In line with the discussion, the proposed holistic framework contains three major elements – technology, student, and context. Technology is defined as a technological tool or a process that is supposed to improve students' learning outcomes. The key technical characteristic of the technology within the proposed framework is its usability. Within the context of the framework, this characteristic is defined as the ability of a technology to accomplish its goals. This is self explanatory: if a technology cannot accomplish the tasks it was created to accomplish, then it is

useless for these particular purposes. For different technology types, these characteristic will be different. Examples could be the reduction of learner's cognitive load, increasing productivity in terms of covered material, enhanced visualization of the processes of study, etc.

Learner in the context of the proposed framework is defined as a student at whom the educational technology in question is directed. The key relevant learner characteristics are the degree of acceptance and adoption of the technology in question. Theoretical premises and importance of these characteristics are defined within the Technology Acceptance Model (Davis, 1989) and the Technology Diffusion Theory (Rogers, 1983). These are also logical characteristics: learners' familiarity with a technology and its acceptance as a useful tool for learning are likely to determine the degree of its use which is a precursor to effectiveness.

Finally, context within the proposed framework is defined as the environment within which learning and technology implementation takes place. The key context characteristic is the presence of an effective strategic plan for the technology implementation. The presence of such plan will determine whether technology is implemented haphazardly or in a thoughtful way. Consequently, it will influence technology effectiveness if corresponding tactics and elements are integrated for the technology implementation.

General evaluation of each element's characteristic will cover the issues presented in Table 1. Specific evaluation, however, will depend on the specific technology type and the goals it aims to accomplish.

Framework's Element	Element Characteristic	General Evaluation Points
Technology	Usability	Does the technology in its present form accomplish the tasks it is supposed to accomplish?
Learner	Technology Adoption	At what level of the technology adoption are the learners? What are the key missing elements in technology understanding?
	Technology Acceptance	How well is the technology accepted by learners? What technology features enable or slow its acceptance and use?
Context	Strategic Plan	Does the institution have an effective plan related to this particular technology? What strategic points were reached so far?

Table 1. Elements of the Holistic Framework, Their Characteristics and General Evaluation Points

3.2. The Key Interdependencies

The elements in the proposed holistic framework are considered parts of a system that reflects the holistic nature of technology evaluation by showing interdependencies between the key elements. Accordingly, the framework reflects the idea that technological effectiveness can depend not only on pure technological characteristics but also on how well it is integrated with the characteristics of the other two elements – learner and context. The rationale for considering the link between technology and learner is reflected in the notion that pure technical usability does not necessarily lead to better learning (Tselios, Avouris, & Komis, 2008). Nokelainen (2006) proposed that technical usability should be added by pedagogical usability, which in the context of the proposed framework can be defined as the degree to which technology corresponds with the learners' pedagogical and learning needs. Nokelainen offered a non-confined set of learner-focused criteria that allow to measure such link. Therefore, evaluators will be able to evaluate this interdependency in a flexible way by defining the relevant assessment criteria. Some general evaluation points are presented in Table 2.

Similarly to the technology-learner interdependency, the proposed holistic framework also establishes the links between context and learner and context and technology. Within the proposed framework, the relationship between context and technology is defined as how well the technology is integrated with the available pedagogical tools and processes. At the same time, the relationship between context and learner is defined as how conducive the environment is to effective technology use by the students. These definitions are close in their nature to the concepts of context "milieu" introduced by Brousseau (1998) to encompass material and non-material dimensions of pedagogical intentions. Both technology and learner interdependencies with context contain certain general characteristics presented in Table 2. Once again, however, these are example points of evaluation that can be adjusted to match each particular evaluation project.

Interdependency	General Evaluation Points
Technology-Learner	To what degree can the technology be tailored to particular learner needs? To what degree does the technology enable learner's autonomy of learning, effective communication, research collaboration etc.? To what degree is the technology adaptable to learner's characteristics?
Technology-Context	Does the technology fit well with the existing curriculum? To what degree does the technology fit with the existing school infrastructure? To what degree does the technology is integrated with other learning tools?
Learner-Context	What is instructors' level of the technology

	proficiency? How consistently is the technology used/recommended by the instructors? Does the school offer clear policy regarding the technology use? Does the school offer workshops for learners to familiarize with the technology?

Table 2. Interdependencies within the Holistic Framework and General Points of Their Evaluation

4. A PROCESS OF HOLISTIC EVALUATION

The process of holistic evaluation of educational technology based on the proposed holistic framework will include several stages. During the first stage, evaluators will need to identify the general and specific characteristics of the three major elements of the framework. During the second stage, the key evaluation points will be developed for the major elements and their interdependencies. After the evaluation points are completed, actual data collection can begin. Considering the nature of the questions asked over the course of evaluation a mixed methods approach to data collection and analysis will be the most appropriate. A case study design with a combination of quantitative and qualitative data collection techniques will ensure a thorough approach and a robust data presentation and analysis. To answer the questions how and why education technology contributes to learning, the evaluators will look at the data regarding the framework's elements and their interdependencies to identify the systematic points where contribution to learning is evident and where improvements are needed. Appropriate focused intervention strategies then can be developed to improve the technology's contribution to learning. It is important that such evaluations are conducted repeatedly in order to ensure that all elements within the holistic system remain well integrated.
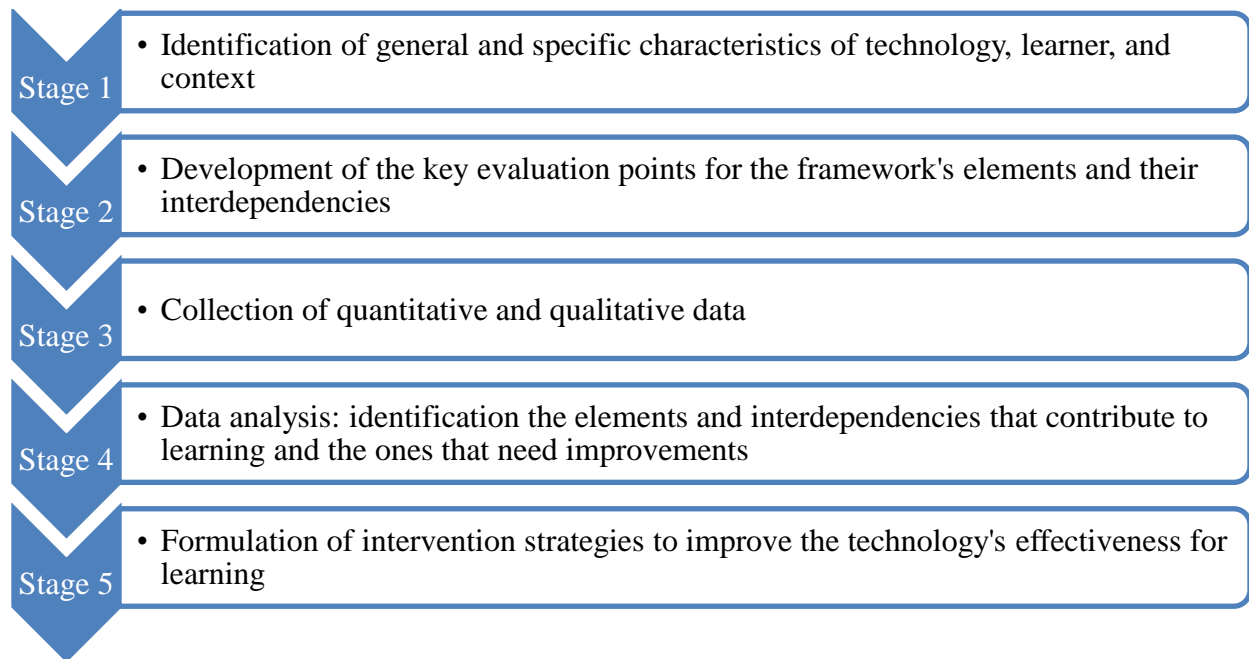
Figure 2. A Process of Holistic Evaluation of Educational Technology

5. SUMMARY

As the various technologies are being actively integrated in colleges and universities, there is still much uncertainty regarding their effectiveness for learning. One of the reasons for this is the absence of a robust yet flexible approach that can help not only evaluate the technologies' impact but also answer the questions how and why these technologies contribute or not contribute to learning. The proposed holistic model for evaluating education technologies could be the first step in addressing this issue. The model's major contribution and difference from the traditional evaluation methods is in consideration of technology not as a standalone artifact but as a part of the system that integrates it with learners and educational context. The model offers a more flexible yet fine grained approach that allows to obtain an in-depth understanding of educational technologies' effects on learning. Used on a regular basis, it may help college administrators in devising specific strategies for utilizing the educational technologies in their settings to the highest potential.

6. REFERENCES

Ainsworth, S. (2008). How should we evaluate multimedia learning environments? In J. Rouet, R. Lowe, and W. Schnotz (Eds.). *Understanding multimedia documents.* Springer Science + Business Media, LLC, New York, pp 249–265.

Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: rethinking technology and the research agenda. *Educational Technology & Society, 11* (4), 29–40.

Bayraktar, S. (2000). A meta-analysis on the effectiveness of computer-assisted instruction in science education. *Journal of Research on Technology in Education*, *34*(2), 173-189.

Brousseau, G. (1998). *Theory of didactical situations*. London: Kluwer Academic.

Camnalbur, M., & Erdogan, Y. (2008). A meta analysis on the effectiveness of computer-assisted instruction: Turkey sample. *Educational Sciences: Theory and Practice*, *8*(2), 497-505.

Cassil, K.M. (2005). A *meta analysis: The effectiveness of the use of mobile computers on the attitude and academic outcomes of K–12 students* (Doctoral dissertation, Auburn, Alabama) ProQuest Dissertations and Theses.

Chen, P., Lambert, A., & Guidry, K. (2010). Engaging online learners: The impact of web-based learning technology on college student engagement. *Computers & Education, 54*(4), 1222-1232.

Cheung, A. C., & Slavin, R. E. (2011). *The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis*. Johns Hopkins University: Best Evidence Encyclopedia, Center for Data-Driven Reform in Education.

Davis, F. D. Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35,* 982–1003.

Higgins, S., Xiao, Z., & Katsipataki, M. (2012). The impact of digital technology on learning: A Summary for the education endowment foundation. Retrieved January 2, 2015, from http://educationendowmentfoundation.org.uk/uploads/pdf/The_Impact_of_Digital_Techn ology_on_Learning_-_Executive_Summary_%282012%29.pdf

Jenkinson, J. (2009). Measuring the effectiveness of educational technology: What are we attempting to measure? *Electronic Journal of e-Learning, 7*(3), 273-280.

Lee, Y.-H., Waxman. H., Wu, J.-Y., Michko, G., & Lin, G. (2013). Revisit the effect of teaching and learning with technology. *Educational Technology & Society*, *16* (1), 133–146.

Li, Q., & Ma, X. (2010). A meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review*, *22*(3), 215-243.

Nokelainen, P. (2006). An empirical assessment of pedagogical usability criteria for digital learning material with elementary school students. *Educational Technology & Society*, *9*(2), 178-197.

Onuoha, C. O. (2007). *Meta-analysis of the effectiveness of computer-based laboratory versus traditional hands-on laboratory in college and pre-college science instructions*. (Doctoral Dissertation Capella University, Minneapolis, MN.) ProQuest Dissertations and Theses.

Ploetzner, R., & Lowe, R. (2004). Dynamic visualisations and learning. *Learning and Instruction*, 14, 235–240.

Rogers, Everett M. (1983). *Diffusion of innovations*. New York, NY: Free Press.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 97-118). New York, NY: Cambridge University Press.

Tselios, N., Avouris, N., & Komis, V. (2008). The effective combination of hybrid usability methods in evaluating educational applications of ICT: Issues and challenges. *Education and Information Technologies, 13*, 55-76.

Vicente, K. (2004). *The human factor: Revolutionizing the way people live with technology*. New York, NY: Routledge.