Don't Forget the "R" In R&D! Lessons From A Research Partnership for Inclusive Edtech Design

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Abstract

In this talk we outline the role of comprehensive research in the development of inclusive educational technologies. Increased availability of technology at home and in school has led to the proliferation of software and hardware designed to improve learning outcomes, but evidence of real impact is inconsistent. Part of the reason that educational technologies fail to effect substantial improvements in cognition and learning is a disconnect between intended product outcomes and real user experience. This is even more true for individuals whose needs differ from the average user. By documenting and analyzing the mechanisms through which users learn from educational technology, formative research efforts can inform more inclusive product development. Partnerships between researchers and developers form a foundation for thoughtful, evidence-based design that can channel educational technology efforts toward real learning improvements for all. We use an example from WestEd's research partnership with Twin Cities Public Television, focused on understanding edtech needs for young learners with special needs, to illustrate each element of the research-development cycle.

Keywords

Education, research design, formative research, partnership, and education technology.

INTRODUCTION: THE EDTECH-IMPACT DISCONNECT

Technological innovations over the past few decades have dramatically changed the education landscape. In the United States, the market for pre-K-12 education technology (edtech) software alone exceeds $8 billion (Software & Information Industry Association, 2015). Not only do these technologies provide opportunities for enhanced inquiry and interaction, they also have the potential to expand access to education for learners from diverse backgrounds. Free online games and books, for example, provide resources for students who might not otherwise have access. Touchscreens and smart speakers provide interfaces that are more navigable than a computer for students with limited motor skills.

Despite widespread availability of edtech hardware and software, however, there is limited evidence that these technologies are improving cognitive and learning outcomes for students. In an extensive review of rigorous studies on edtech impact, Escueta, Quan, Nickow, & Oreopoulos, (2017) found most causal research on edtech efficacy to show no substantial impact on learning outcomes. The most demonstrable influence of edtech they identified was for what they call computer-assisted learning programs – software that targets specific skills and uses machine learning or advanced algorithms to adapt content and activities to the user. This kind of personalized learning has many parents and educators excited, since it allows for content delivery and activities to be more tailored to what individual students need. But, as Aaron Chatterji (2018) notes, research around personalized learning still fails to confirm any consistent impact on outcomes. One reason for this, he explains, is that edtech is not always implemented as designed. Another reason may be that personalized learning is not actually as personalized as it means to be; the user experience ultimately differs from what the developers intended. Both of these issues can preclude the intended impact of edtech products, especially for users with specific or unique needs.

In the sections that follow, we describe how edtech research-development partnerships can improve product usability, increase accessibility and inclusion of edtech design, and ultimately improve product impact. We also provide an example of a formative research study we conducted on edtech considerations for children with special needs.

THE RESEARCH-DEVELOPMENT PARTNERSHIP

To address the disconnect between intended product implementation, actual user experience, and, ultimately, product impact, edtech developers would benefit from comprehensive, iterative research throughout the development process. While many edtech developers engage in some amount of research to inform their product, most companies lack the internal capacity to implement rigorous research agendas.

Effective research-development partnerships will iterate the design-test-reflect-redesign process, making modifications with each cycle. Research questions may be developed to determine:

- Needs of users, which can help development teams with product design (formative research)
- How the product is implemented by intended users in authentic settings (implementation research)

- The degree of product impact (impact research)

The direction of the research will be different at each stage of product development. Close communication between the research and development teams is crucial so that research agendas precisely align with development needs so that findings are clearly communicated and incorporated into further design considerations. It is the iterative, cyclical nature of this partnership that ultimately improves product design.

In Practice: Our Research Partnership

WestEd's research on edtech for young children with special needs grew out of our partnership with Twin Cities PBS (TPT) through their Department of Education grant to develop a series of television shows and online games to support early academic skills. From the initial phases of planning characters and stories for this "trans-media suite," our teams have worked together in asking, "What do we need to know to create an effective, inclusive product?"

LOGIC MODEL

Drafting a detailed logic model is an important way to map out the mechanisms through which a product is intended to achieve impact. As Kao, Matlen, Tiu, and Lin (2017) point out, the logic model is a "living document" which will likely change throughout the product development process but should consistently guide development and research. Kao et al. explain that "logic models are read as a series of conditionals." *If* the features are used, *then* the outputs should occur. *If* the outputs occur, *then* the outcomes should ensue.

Research efforts seek to determine whether features *do* lead to outputs, or if outcomes *do* lead to impact – causal relationships indicated by the black arrows in the diagram above.

In practice: Our Logic Model

One area for research that TPT identified early in the development process centered around edtech access for children with special needs. In this case, one of the inputs in the TPT logic model was the user characteristic of having special needs or disabilities. TPT wanted to know, given this *input*, what their *features* should include (See arrow #1, Figure 1)). In conversation with TPT, WestEd developed a research design to explore this area.

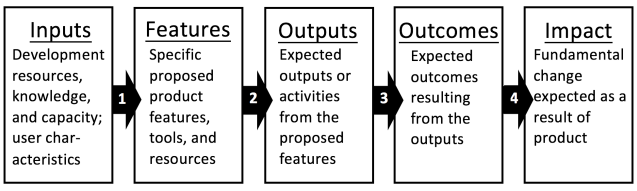

Figure 1. The TPT Logic Model

SELECTING RESEARCH DESIGN

Selecting the appropriate research design for various stages of the development process is vital to responsible, actionable research. In early phases of product development – like TPT's focus at the time of the study discussed here – research will likely focus on the first and second arrows in the logic model shown above. Research to assess outcomes and impact should only occur once a stable, evidence-based product design has been achieved. Kao et al. provide recommendations for research design at different phases of product development. Those recommendations are summarized below for each piece of the TPT logic model (See Figure 1).

- Arrow #1: To inform what features are feasible and appropriate given the inputs, needs assessments or expert reviews can be used. Needs assessments seek to collect information on user needs, context, and current efforts in the target area. Expert reviews call on specialists to conduct in-depth examinations of product content, scope, and delivery.
- Arrow #2: To determine if product features lead to intended outputs, usability or feasibility tests are appropriate. Usability tests focus on whether users interact with the product as intended. Feasibility tests focus on whether the product can be used successfully in intended settings.
- Arrow #3: To determine if product outputs lead to participant outcomes, single group studies or implementation studies are appropriate. These studies observe changes in participant outcomes but are typically not capable of measuring causal impact.
- Arrow #4: To measure impact, randomized trials or quasi-experimental studies are appropriate. Such studies can detect impact that is attributable directly to the product itself.

While randomized trials and other studies evaluating arrows #3 and #4 in the logic model receive a lot of attention, the formative research that comes early in the product development process is equally, if not more important in ensuring that products will be appropriate and effective for users. This is especially true for products intended for users with special needs, since creating a positive experience for those users requires more customization.

In Practice: Our Research Design

WestEd's research design for its study of edtech considerations for young learners with special needs is an example of formative research taking place very early in product design. In order to develop a product capable of producing inclusive outputs, outcomes, and impact, TPT first needed to know what kinds of product features would accommodate the needs of this population.

As a result, WestEd designed a needs assessment aimed at building a comprehensive understanding of the challenges faced by children with special needs when using edtech, as well as the edtech features or elements that would be most beneficial for these users.

During this needs assessment, researchers conducted in-depth interviews with a variety of stakeholders, including

parents and general education teachers of students with special needs, as well as school administrators, special education professionals, and informal educators who work with this group. In total, researchers interviewed 24 parents, 14 special education professionals, 12 general education teachers, 5 informal educators, and 4 school administrators from 16 different states. Data were rigorously analyzed using systematic coding and organization in order to construct findings about edtech needs for this population.

INTEGRATING RESEARCH FINDINGS

Once a research design has been selected, data collection and analysis proceed according to that design. Comprehensive findings are compiled and reports are written, but the research-development partnership is still far from over. Ongoing conversations between the research and development teams are crucial to interpreting findings correctly, and to ensuring that modifications to the product align with research recommendations. As evidence-based revisions are made to the product, developers and researchers alike may already be developing questions for the next round of research.

Often, multiple rounds of a single type of study will be required before the product is ready for the next phase of testing. As an example, a tablet game designed to help young children strengthen motor skills may go through several rounds of usability testing and product modifications before the product features consistently lead to the desired participant interactions with the game without barriers to use (arrow #2 in the logic model). Only then is it recommended to begin testing whether those outputs lead to the intended outcomes (arrow #3). In many ways, the close of one research study represents the beginning of the next product development cycle, in a constant, iterative process of design.

In Practice: Our findings and Implications

Findings from WestEd's needs assessment provided TPT with important information about the context of edtech use with children with special needs, including their own preferences and the supports they receive from those around them. From these findings, a thorough list of programming and accessibility recommendations was assembled to inform TPT's development of product features. A sample of these recommendations includes:

- Include a dashboard that allows parents to customize various game features (e.g., sound, visual array, incentive frequency, text size).
- Allow parents to turn off auditory feedback for incorrect answers.
- Avoid visual overcrowding; games that are simpler or more visually streamlined are often better for children with attention difficulties than games with lots of movement, sounds, or other distractors.
- Allow more opportunities for repetition of skills in different ways.
- Provide instructions for digital media programs via tutorials/demos if possible, rather than using auditory instructions with captions.

This round of formative research will contribute to TPT's development of edtech product features that increase access and usability of its trans-media suite for diverse users. As TPT's product design and development process progresses, WestEd will continue to evaluate product implementation and outcomes for learners with special needs, building on the foundation that the needs assessment provided. In the future, arrows #2, #3, and #4 of the logic model will call for additional research examining how TPT's trans-media suite supports cognitive and academic growth for this population.

SIGNIFICANCE

With the array of edtech programs and products growing rapidly, research is more important than ever – not only to help users make decisions about which products they should use, but also to inform developers about how to design edtech that can create real impact. Research-development partnerships can coordinate expert research capacity and product development responses to ensure that edtech features are accessible to intended users. Promoting equity of access to emerging edtech will require an intentional effort to develop products with universal design principles in mind. Appropriate research efforts will be vital to determine the efficacy of product design and development and support impactful edtech for diverse users.

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REFERENCES

Chatterji, A.K. (2018). Innovation and American K-12 education. *Innovation Policy and the Economy, 18*: 27-51.

Escueta, M. Quan, V., Nickow, A.J, & Oreopoulos, P. (2017). Education technology: An evidence-based review. National Bureau of Economic Research, Working Paper 23744. Retrieved from http://www.nber.org/papers/w23744.

Kao, Y., Matlen, B.J., Tiu, M. & Lin, L. (2017). Logic models as a framework for iterative user research in educational technology: Illustrative cases. In Roscoe, R.D., Craig, S.D. & Douglas, I. (Eds.) *End-User Considerations in Educational Technology Design*. Hershey, PA: IGI Global.

Software & Information Industry Association. (2015). Retrieved from: https://www.siia.net/Press/SIIA-Estimates-838-Billion-Dollars-US-Market-for-PreK-12-Educational-Software-and-Digital-Content