What is Education Research & Development

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What is Education Research & Development?

The term 'Education Research & Development' has gained steam over the last few years. It's one of those phrases that can hold multiple meanings, and runs the danger of people using the term to mean different things, but thinking they are in agreement. It's worth taking the time to outline what, precisely, Ed R&D could/does mean. This will allow us to engage in productive discourse to move educational research and development towards improved learning outcomes forward in a meaningful way.

What is Research?

Research refers to a complex set of knowledge-building activities, such as experiments, evaluations, and investigations. The goal of these activities is to elucidate how and why things work the way they do, and to build and refine generalizable theories. There are many degrees of research, from pure or basic research to more applied. Despite the variety, all focus on using various rigorous investigations and methodologies to uncover insights into how and why something works as it does.

What is Development?

Development refers to a complex set of solution/product building activities, such as ideation, prototyping, design, validation and testing, and developing a commercialization strategy including marketing. The aim is to have a positive societal impact (i.e. improved learning outcomes), typically through bringing a process into existence or a

commercially viable product to market. Development also refers to developing a policy, strategy or process for implementation, capacity building, or improvement. This conceptualization of development is wider than product development, but entails many of the same development steps. Henceforth, we will use the term 'solution' to inclusively refer to a wide range of things, such as a policy, process, experience, or product, that might be created through an R&D endeavor.

Development does not always take place with insights and tools from research, although it should. For example, instead of using the knowledge gained from research as a starting point, "other drivers, such as an idea for an unaddressed instructional problem or a sense that a certain technology has unrecognized importance, may trigger new product development and testing" (Finkelstein, 2021).

When development happens in conjunction with research, then we can call it "Research AND Development".

What is Research	What happens when R&D are done together	What is Development
➢ Using rigorous research methodologies in controlled environments to develop theory and gain generalizable knowledge about the world	➢ Disciplined, applied research in real-world environments focused on developing an effective solution[1] ➢ Theory use towards developing an effective product, solution, or tool	➢ Solution development uninformed by research findings and evidence, in selected real-world settings
➢ Results in knowledge about a tool or system that may or may not impact the learning results of the participating learners	➢ Results in the creation of a tool or system designed to solve the specific challenge, that impacted the learning results of the participating learners, and is usable and useful to those learners	➢ Results in the creation of a solution (product, service, or tool) that is attractive to a defined market
➢ Efficacy ➢ Focused on learning about a phenomenon in general ➢ Learning about what works generally, on average	➢ Efficacy & Usability ➢ Focused on solving a specific challenge ➢ Learning about what works in a specific context	➢ Usability ➢ Focused on commercial viability ➢ Learning about usability, not efficacy or learning outcomes
➢ Adherence to a pre-specified	➢ Iterative and rigorous methods, adapting hypotheses and approaches as we learn	➢ Iterative validation and testing methods

research plan	➢ Research methodologies are implemented in authentic learning environments to develop and evaluate the impact of ed products/solutions/tools in real-world settings.[1] ➢ [From NSF Defs below] Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.	

[1] Global EdTech Trialing Network, United States, Tenets & Principles and EdTech Trialing Networks & Environments within the US, Version 1.0

What is Research AND Development?

Research provides you with the necessary information and insights to inform and guide your product design. Development helps you bring ideas to life: to validate them, and then build and scale them. The result is even more powerful if you use tools from each approach together.

R&D can progress linearly, by picking up existing research findings, and then leveraging them in development. However, an arguably more powerful way to do this work is to have research and development happen concurrently in an integrated fashion. Even when the concept is inspired by research, establishing its practical applicability and impact is itself a research endeavor, requiring an array of development activities. Using the theoretical underpinnings and methodological toolkit of research within your development activities will increase not just the rigor, but also the impact of your development work.

When integrated, development is the phase of R&D where the team applies the theoretical knowledge discovered during research to design the product or solution. During the development phase, you can expect to discover more information about the solution you're designing. Such activities as evidence syntheses, expert review, prototyping, and field-testing become components of a series of studies — studying a strategy or tool's feasibility, usability, and impact (Finkelstein, 2021). Testing cycles follow to capture these learnings. Along the way, various elements of the strategy or tool are fine-tuned, minimized, or elaborated.

According to the National Science Foundation, "Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock

of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge".

The term R&D covers three types of activity:

> **Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
>
> **Applied research** is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.
>
> **Experimental development** is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.
>
> *Source, and for other definitions of R&D, see Definitions of Research and Development: An Annotated Compilation of Official Sources from the National Science Foundation.*

As an education research community, we are adept at conducting **basic and applied research**. Education research has a long history and has amassed a plethora of insights into the process of teaching and learning. This body of knowledge reflects, in part, the investment of IES over the last 20 years into applied research.

However, many of these ideas have yet to be translated into meaningful learning experiences used at scale. "The lack of a sophisticated, systematic, and well-funded approach to the "development" side of education R&D means that most of the opportunities uncovered in the research have not yet been seized (ALI Brief to the Senate Health, Education, Labor, and Pensions Committee, April 19, 2023)."

Moving forward, we seek to expand into **experimental development** work. The aim being to create new productions, solutions, and tools that move the needle on outcomes that matter for learners.

There already is a large development sector within education. Just think of the myriad education curriculum developers, professional development providers, and edtech companies out there. However, these groups are not always as well-connected to the research community as one might hope. The result is a marketplace of educational products that simply do not work. [Add cite]

Organizations like The EdTech Evidence Exchange are working to address this issue. For more information, see https://edtechevidence.org/

We can bring these communities together by increasing our focus (and funding) on Educational Research & Development. There should be an explicit focus on knowledge transfer, mobilization, and engagement including how to generate and use applied research, so we can be sure these insights impact on learning as we hoped they would *(ALI Task Force on State and Local R&D Infrastructure)*.

The promise of a robust education R&D ecosystem is both straightforward and transformative: shifting education to be driven by what the research tells us what works, for whom, under what conditions *(R&D for Education (Sept 22 Meeting Insights) (1).pdf, from S. Shapiro)*.

So what is **Education Research & Development**?

At a basic level, R&D is the set of activities an organization undertakes to innovate—using research techniques to solve problems or learn new things (EdSurge, 2021). Ed R&D can be thought of as the transfer of scientific knowledge into practices and products that we use to achieve national goals. It is disciplined, applied research in real-world environments focused on developing an effective solution. Simply put, Ed R&D uses research findings and methods to develop solutions (tools, products, features, or systems) to solve specific educational challenges in context.

This aligns nicely with the definition of experimental development described above: it is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

An Ed R&D Approach: Learning Engineering?

Education R&D has many similarities with the emerging field of Learning Engineering. Learning Engineering is the professional practice of applying the learning sciences to systematically design learning solutions, collect data needed to evaluate how well these solutions are performing and under what conditions, and refine them based on what is

learned from that data (Kolodner, 2023, p. 308). The IEEE ICICLE Learning Engineering community offers this definition:

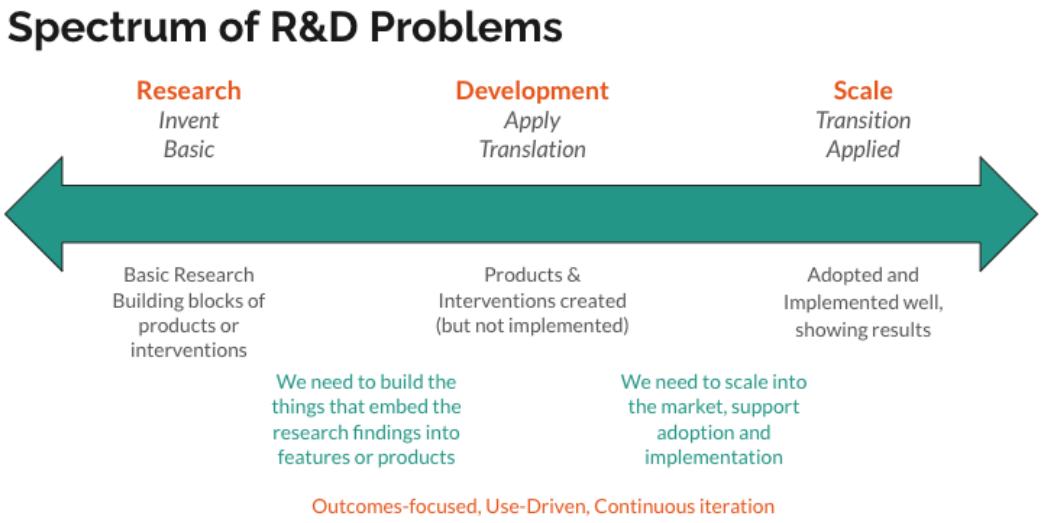
> Learning engineering is a process and practice that applies the learning sciences using human-centered engineering design methodologies and data-informed decision-making to support learners and their development. *(IEEE ICICLE Learning Engineering Community)*

A broad cross-community definition of Learning Engineering is that:

> …it is a process of designing, evaluating, and refining learning experiences, technologies, or environments, along with all the materials and resources for making them work, that target particular purposes and population *(Kolodner, 2023, p. 307).*

These definitions offer more specificity and context around what it means to conduct educational research & development.

WHEN do we use an R&D Approach?



Research findings don't instantly transfer into practice. They often must be packaged into solutions (such as products, features, or services). They also must maintain their positive impact on learning outcomes, and fit into the flow or work for the intended user. If the user cannot use the research-based experience as intended, there's no way that it can impact learning. Ed R&D is disciplined, applied research in real-world environments focused on developing an effective solution. Therefore, Ed R&D should take place when a finding from research is ready to be applied to new, real-world contexts.

Scaling up a research-based solution can often require building new features or interfaces, because they will be used in a stand-alone manner, and not administered by research teams. The development of these features or interfaces should be subject to the research testing process as well, because we want to ensure they have the same **impact on learning outcomes** as they did while administered in more controlled research settings. In addition, the integration of the research-based intervention or practice **into educator workflow or user experience** should also be subject to a research-like investigation.

The Importance of Efficacy: A focus on Learning Outcomes

Research should be done in conjunction with development to ensure a laser-focus on achieving learning outcomes. Insights from research can inform how to best support conceptual scientific understanding, for example, which should be developed into the learning solution. We must leverage the vast body of research knowledge about how students learn. Not doing so amounts to educational malpractice. Once a prototype of this solution is built, research methodologies should be employed to ensure the intended learning outcome, in this case, scientific conceptual knowledge, is actually gained by the user. Did the student actually learn what we intended? If not, what can we change to make it better? Learning outcomes must be the north star of this iterative development.

The Importance of Usability: A focus on Implementation

Usability is where so many research-based educational interventions fail. In order for learning to occur, it must take place in the real world, with real people, and real constraints within the environment, on time, etc. One must think of the learner and the instructor as users, who must be able to access the learning experience in an effective way. This access and implementation should also be a focus of a research-like endeavor. If the learners cannot access the learning, we certainly won't achieve our desired learning outcomes. Careful attention to how one accesses, uses and interacts with a learning experience is of utmost importance.

Ed R&D for Technical Infrastructure

Sometimes, internal infrastructure pieces must be built to enable Ed R&D, such as standards for data interoperability. These also should be done using research-based practice, but now the users include internal stakeholders, and perhaps not the end-users/learners themselves.

WHAT are the active ingredients of Effective Ed &RD?

Across all of these types of Ed R&D activities, there are a handful of common features that characterize them specifically as "Ed R&D". These active ingredients draw upon core practices within learning engineering.

Educational R&D *(anchored around IEEE learning engineering definition)*:

- is a **process**,
    - A learning culture of continuous improvement
    - Cohesive multidisciplinary team with shared understandings and vocabulary
- applies the **learning sciences**,
    - Grounding in what we know about human learning, motivation, and identity already
- is **human-centered**,
    - Use of a human-centered design approach or similar, to assure use and fit
- is **engineering**,
    - Testing & iteration to learn what works, within a specific context that you care most about. Meaningfully closing the loop back on what works and why.
- **uses data** (instrumentation and analytics), and
    - Multi-dimensional evidence-gathering for both learning process and outcomes
    - Access to evidence and meaningful data systems
- is **ethical and inclusive**.
    - Centering on users and elevating community voice (ideally, diverse community)

At the heart of this is a focus on **learning and continuous improvement**. There is no R&D without the research-orientation on intentional learning, hypothesis testing, data use, and leveraging prior learnings (i.e. research findings) to make informed bets about what might work in context. See Gordon et al (2021) for more information.

What could Ed R&D Look like?

There are many activities that Education R&D could refer to. The R&D could be around an artifact, a process, or a system. The activities could also include testing and validation. Ed R&D activities could include:

- Developing **technology TOOLS or SYSTEMS** (products or features) that solve for educational challenges
    - E.g. Edtech apps

- Developing **socio-cultural SYSTEMS or PROCESSES** that solve for educational challenges
    - E.g. evidence-based embedded professional development on the science of reading
    - Policy-level standards development process (K-12 standards, HE credit transfer requirements)

- Developing **ecosystem-level infrastructure** tools and systems that enable and support educational R&D
    - E.g. SLDS, funding structures to conduct ed R&D, taxonomies of math misconceptions

- **Testing and validating** solutions in and across context
    - E.g. Terracotta (ManyClasses feedback testing, Indiana U)

- Developing tools and systems that **enable testing and validation**
    - Technological tools and systems
        - E.g. Learning platforms, interoperable data systems, AI-assisted data dashboards to support teacher instructional practice
    - Socio-cultural tools and systems
        - E.g. Team norms around data collection and improvement routines

Types of Ed R&D Projects

In no particular order, here are some examples of what R&D projects could look like:

Implementation efforts around practitioner practice

- Continuous improvement and improvement science efforts such as Networked Improvement Communities focused on a problem of practice (e.g. early literacy instruction)
- Design-based research or Research-Practitioner Partnerships focused on a use-driven problem of practice, that prioritizes solutions for educators
- Upskilling Faculty / Instructional Designers
- CHALK App - Coaching support app for Early Childhood practitioners
- Evidence-based work with families and communities to make use of their interests and affordances in learning environments
- After-school/non-school activities intended to support mindsets and identities important for academic advancement

EdTech or Product Development

- EdTech product or feature development (AI-based)
    - Directly instructionally focused (e.g. Khan Academy)
    - Wrap-around support (SEL support app)
    - Tools and systems (e.g. to support parent-teacher communication, or district-wide data dashboards)

Research-based curriculum development

- E.g. Everyday Math,
- Examples from Kolodner (2023): NetLogo, Mathia/Carnegie Learning, LEGO Mindstorms

Rapid-Cycle Research

- …

Collective R&D Infrastructure Building

- Data systems (interoperable, meaningful / SLDS, FERPA)

        - This includes data systems (e.g. SLDS) and
    - Research infrastructures
        - (e.g. competency frameworks, math misconception taxonomies)
    - Coalition building & upskilling

School & District level infrastructure innovation

- Teacher training, PD
    - Incorporating evidence-based professional development into products and services
- Funding models
- Nuts and bolts of how schools run (bus systems)

Policy Changes

- Policy-level work to support the Ed R&D Ecosystem
    - Increased funding for R&D
    - Increased training and upskilling
    - Increased evidence requirements for funding
    - Standards-setting
    - HE credits transfer

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