EDUCATE: Creating the Golden Triangle for research-informed industrial collaborations within education technology

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Abstract: EDUCATE is a London-based partnership that supports and promotes the use of research-based education technology, allowing entrepreneurs and start-ups to develop their products and services, and grow their companies in an evidence-informed manner. The EDUCATE process connects businesses with researchers who will mentor, guide and support them on their research journey. A key aspect of this research journey is the evaluation of the emerging technology being developed by each business that works with the EDUCATE programme. However, conducting impact evaluations of technology in education is challenging, particularly so for emerging technologies, as innovation and change are their essence. Here, we present a pragmatic approach to impact evaluations of emerging technologies in education which we use within the EDUCATE project. We illustrate the use of this process through exemplification in the shape of three case studies of educational technology businesses who have adopted the EDUCATE process.

Introduction

Innovation within the development of commercial educational technology is increasing rapidly. Large companies have their own in-house research teams to help them connect to existing research and create their own research projects and publications. However, there is a growing community of small and medium sized businesses across the globe, who are also using innovative technology to develop their educational technology products or services. These businesses find it hard to engage with the research community to access existing research that is relevant to their business, and to understand how best to generate evidence of their own.

EDUCATE (https://educate.london) is a unique project bringing together entrepreneurs and innovators, with academics, researchers and educators, to deliver world-class education technology products and services. We describe this linking of the three communities within the education technology ecosystem: developers, researchers and users (learners and/or educators) as the Golden Triangle (Luckin, 2016). EDUCATE is designed to 'fill the gap' for smaller businesses that cannot afford their own research labs. EDUCATE provides a rigorous and comprehensive training programme with a focus on pedagogical research and investigation of not only 'what works – but also when, how and why'? EDUCATE provides a physical and virtual working space for cohorts of EdTech Small and Medium Enterprises (SMEs), with training and support to help them to use research evidence to inform the design of their products and services. Businesses learn how to devise an effective evaluation for their product or service appropriate to its stage of development and scale.

Background

The impact of technology on learning and teaching is often at the forefront of demands, particularly from those who dictate the funding available to pay for technology within education systems. This is not an unreasonable expectation. However, as has been shown in numerous meta-level investigations (see for instance Cox et al., 2003) evaluation of the impact of technology on educational outcomes is a challenging task. This challenge is even greater when evaluating emerging innovative technologies. Today's emerging technologies include, but are not limited to, virtual reality implementations (Merchant et al., 2014), augmented reality implementations (Dunleavy, & Dede, 2014), mobile learning devices (Crompton, Diane, & Gregory, 2017), 'internet of things' hardware with sensors (Cukurova et al., 2018), and technologies that allow collaborative learning at a great scale (Cress, Moskaliuk, & Jeong, 2016). Change is at the core of these technologies both because they evolve over time, but also arguably their *raison d'être* is to transform the learners' experience (Cukurova, & Luckin, 2018).

The increased challenge is at least partially due to the connotation that, in traditional impact evaluations, evidence regarding the impact of an intervention is considered as *a shield against change*. The generation of scientifically robust evidence about the impact of an educational technology can therefore be taken as a message for the stakeholders of this technology to standardise it and scale it up. However, *change* is the essence of emerging technologies. For instance, three years after the original report reviewing emerging technology innovations in education (Luckin et al., 2012), there was evidence that only 39 of the 150 innovations were still

in active use. Therefore, in the context of emerging technologies, the value is to be found in the careful consideration of different types of evidence that are appropriate to the current state of the technology as well as in the use of robust methods to generate them. In this paper, we argue for a pragmatic approach to evaluate the impact of emerging technologies.

Evidence-informed emerging technologies in education

In the past, due to limitations of technology and its use in education, impact evaluations were often completed through straightforward questions such as "what are the effects of this physics teaching software on students' understanding of the concept of gravity?" or "Is there an impact of students' understanding of chemical bonding after engaging with this simulation?" The evaluations were also undertaken with traditional methods such as pre- and post-test evaluations (Cox, 2008). However, in the case of emerging technologies, the aim is often to transform students' experience of traditional education. Therefore, the exact nature of the intended experience, including the expected outcome measures and contextual factors, should be clearly defined as the initial step of the impact evaluation process. This may be conceptualised as a 'logic model' or 'theory of change' for the innovation. If we take the position that a person's context is the sum of their interactions in ther world (Luckin, 2010), then the context in which the impact is to be measured, should be as transparent as possible. This transparency of context is required to identify the outcome measure(s) which the impact evaluation will study (Cukurova, Luckin, & Baines, 2017). The complex design of emerging educational technologies requires much more understanding of human-computer interactions (Cox, 2005) as well the wider learning context in which they are being implemented.

In addition, emerging technologies vary enormously and multiple researchers have made clear that the design and use of an educational technology plays a big role in its impact on educational outcomes (see for instance Reeves, 2008; Pilkington, 2008). Not all emerging technologies are equal in their potential to afford efficacy. Any kind of impact evaluation in educational technology research, therefore, requires detailed knowledge of the nature of the evaluated technology, their different representations and the ways in which they may contribute to learning (Pilkington, 2008). Here we present one method of bringing transparency to the evaluation of emerging technologies and their contexts.

A theory of change for emerging technologies

Change is the essense of emerging educational technologies. This involves changes in the emerging technology itself due to its agile and iterative nature, as well as changes in the experiences of learners. According to the idea of a theory of change (see for example, Kellogg Foundation, 2004), until a change occurs, a state of equilibrium exists in which any forces that might drive change are equal to the forces that drive a resistance to change. For change to happen, the balance in the equilibrium needs to be upset (Fullan, 1983). This imbalance can be achieved either by strengthening the driving forces behind the change, or by removing the barriers that resist the change (Fullan, 2001). In the context of emerging technologies, a theory of change can essentially be represented as a diagram that explains how an emerging technology might have an impact on its users. There are five main steps in the process if creating a theory of change for a particular intervention, such as an emerging technology:

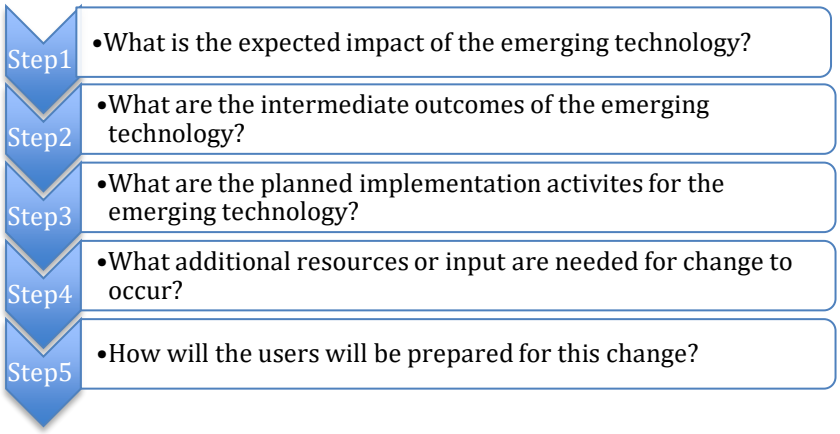

Figure 1: Theory of Change Diagram Steps for Emerging Educational Technologies

A pragmatic approach to impact evaluations

Impact evaluations of any emerging technology require the generation of evidence regarding any effects arising from an educational intervention involving that emerging technology. However, views about what constitutes "evidence" may vary considerably among and between stakeholders. It is important to note here that the type of evidence does not necessarily reflect the quality of the evidence, and different types of evidence have different advantages and disadvantages (Marshall, & Cox, 2008). There are 4 main categories of evidence: *anecdotal*, *descriptive*, *correlational*, and *causal* evidence. It is increasingly clear that different types of evidence have different advantages and disadvantages. Therefore, relying on one study or one type of evidence is unlikely to provide enough reliable evidence to judge the impact of an emerging educational technology due to the complexity and diversity of the educational landscape.

Multiple sources of evidence are needed in order to strengthen the argument that a particular technology intervention will be successful under a variety of conditions. Both quantitative and qualitative sources of evidence are valuable for the statistical power of their large sample sizes (correlational and causal evidence) and the explanatory power of more in-depth questioning (anecdotal and declarative evidence). It would be premature if decisions were taken about whether or not to implement an intervention based on one type of evidence only. A more holistic approach is needed in order to reach a complete picture regarding the impact of emerging technologies in education. All evidence types may shed light on why an intervention of an emerging technology succeeded or not, and in what circumstances. Rather than arguing about the overall superiority of one particular type of evidence or research approach over others, perhaps a more important question to ask is what type of evidence is the most appropriate type of evidence for this particular emerging technology innovation, and how can we design and implement interventions and strategies that might help us generate this type of evidence? Such questions are particularly important in domains with little prior research (Cobb et al., 2003) which is very often the case for emerging educational technologies' impact evaluations.

Innovation stages of emerging technologies

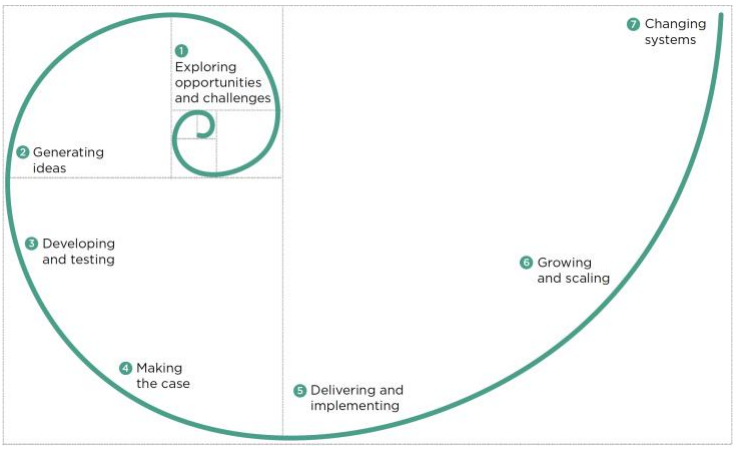

Figure 2: Innovation spiral as presented in Using Research Evidence: A Practical Guide (Nesta,2016)

The spiral above was developed by Nesta, one of the partners in the EDUCATE project, to capture the different stages of the innovation process and it can be used to identify the different innovation stages of an emerging technology. As argued by Brecton et al., (2016) different stages of innovation would require different types of evidence. For instance, during the initial stages of *exploring opportunities and challenges*, as well as *generating ideas*, it would be beneficial to focus on literature reviews and design principles, identifying what has worked or failed in the past in different contexts. This evidence can then be used in the design decisions made for the emerging technologies. These design principles and lessons can help both developers and users of emerging educational technologies follow strategies that are more likely to have an impact. During the *developing and testing stage*, rapid cycle evaluations that would generate anecdotal and descriptive evidence would be beneficial, whereas during the *making the case* stage it would be beneficial to undertake impact evaluations that would generate some correlational evidence. Once an emerging technology reaches a certain level of maturation through these stages, during the *delivery and implementation stage*, causal evidence may be required to prove its impact. The *growing, scaling and spreading stage* may require larger scale experimental evaluations. *System-level change* can only be provided through multiple big scale evaluations from various contexts with clear implementation manuals that would ensure impact in multiple places. It is interesting to note here, that by the

time an emerging technology reaches the stage of *changing systems*, a certain level of technological and system maturation will have been achieved and it will be valid to question the extent to which the educational technology remains *emerging* in nature.

The approach put forward by Nesta considers evidence in a holistic manner and recognises the value of different types of evidence at different stages in the emerging technology innovation cycle. This method contrasts with more traditional approaches that consider evidence to be of types organised in a hierarchical manner, with causal research evidence considered as the 'gold standard' and other types of evidence being undervalued as a consequence. We argue for a synergy of evidence types and research methodologies, which will generate different types of evidence for the impact measures used for emerging technology evaluation.

Our suggestion is based on the view that kite-marking a certain technology as 'effective' based on 'gold standard' causal evidence, and in so doing encouraging its scaling might be a futile approach for emerging technologies. This futility is mainly due to the fact that change is a fundamental feature of emerging technologies. As mentioned in the introduction to this chapter, emerging technologies are constantly evolving and being implemented in different contexts with different populations. Therefore the value of previous experimental evaluations for an emerging technology is limited. In addition to which, meaningful large-scale positivist evaluations of emerging technologies are expensive and they take a long time to complete. There are various research methodologies that can produce valuable indicators of the *potential* impact of an emerging technology, and their use should be encouraged before engaging in large-scale trials.

Three Case Studies

To illustrate the EDUCATE particants' research journey three case studies are presented for companies that are at different stages in the innovation spiral (Figure 2). The first is at an early stage with a first prototype of the product. The second company is more established, with an existing group of users – giving the company access to existing research data and enabling them to have a more developed logic model. The third is a company that already has thousands of users, and is looking to utilise its extensive database to develop new AI algorithms to offer a more personalised user experience.

Case Study 1: LYRICAL KOMBAT is developing an EdTech product that is being designed to encourage and reward young people to re-imagine hip hop lyrics and poetry through the format of text battles. In so doing, it aims to connect a hip hop generation to the work of Shakespeare and beyond. This vision is captured in the logic model in Figure 3, which was developed and refined during the company's engagement within the EDUCATE programme.

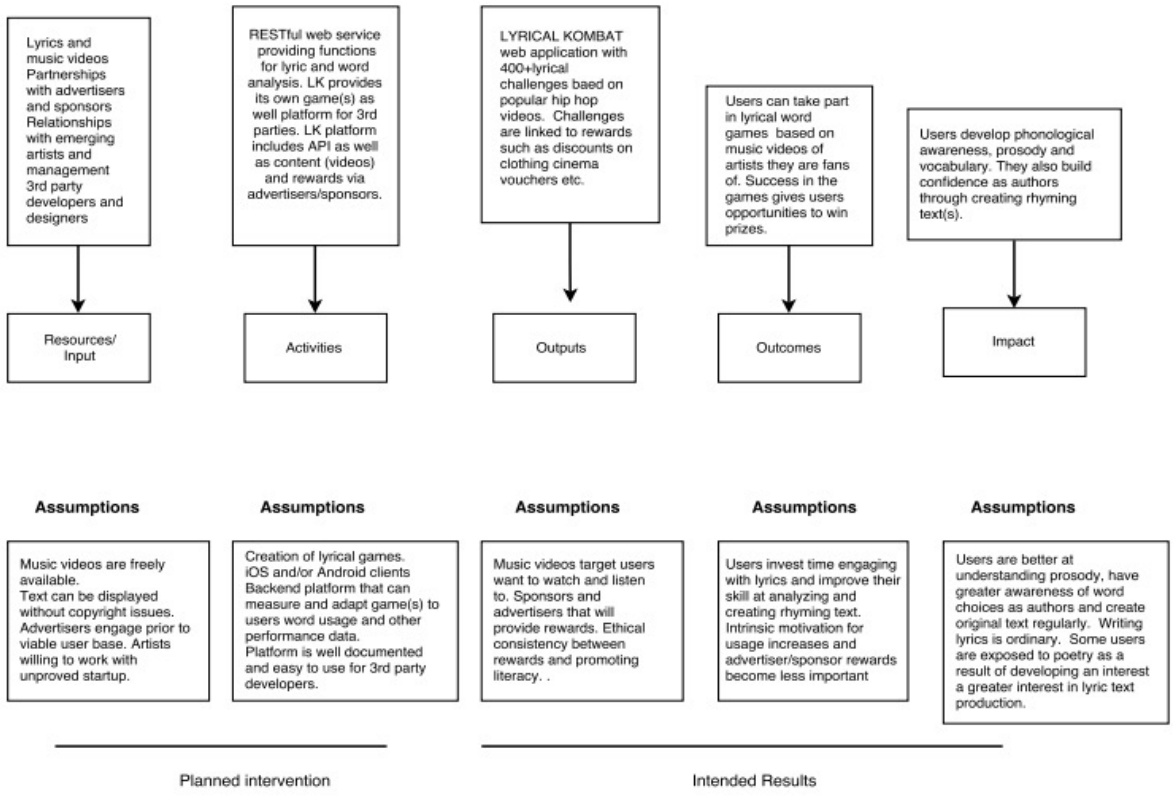

Figure 3 LYRICAL KOMBAT*: Logic model*

The founder of LYRICAL KOMBAT, in discussions with the EDUCATE research mentors, then proposed a research question that would form part of his research proposal that seeks to evaluate the impact of students' engagement with his product, "Is rhyme detection skill a predictor of ability for the production of rhyming text?". This reserach project is now being developed by the entreprenuer, with the support of their EDUCATE expert mentors. A participatory design research methodology is evolving through which the entrepreneur can begin to uncover the impact of his proptotype design, prior to committing to a costly product development and big scale evaluation studies.

Case Study 2: LinguapracticaVR

LinguapracticaVR offers a virtual reality (VR) immersive English language experience for second-language English learners. Teachers and students interact with, and contribute to, the learning platform. The VR resources aim to enable teachers to design more engaging lessons that are in turn motiviating for students to want to pursue learning English and impact positively on students' attainment.

LinguapracticaVR devised the following set of research questions, which are now being refined alongside collaborations with their EDUCATE expert research mentor:

- To what extent does task-based learning within immersive virtual environments ("VR") increase the ability of the EFL learners to express actions performed in the past?
- To what extent does task-based learning within VR increase a student's motivation to learn more English?
- To what extent does task-based learning within VR increase a teacher's ability to engage students better?

LinguapracticaVR has identified its sample of users, and is supporting both teachers and students to become familiar with the VR enrivonment, which includes the creation of contextualised teaching resources, prior to beginning a formal pilot study that will generate user data.

Case Study 3: Freeformers has an established blended learning programme that provides face to face and online training for business employees. The purpose is to grow and upskill the workforce, with a particular focus on developing mindset. In its engagement with EDUCATE, Freeformers is developing a research-informed new product that aims to measure changes in participants' mindset, skillset and behaviours. Freeformers is seeking to research hypothesis that their underlying training model develops user's mindsets and creates resultant changes in behaviour.

For this research question Freeformers has adopted a quasi-experimental research approach, as by examining the changes in user's responses to statements, they can test the effects of learning on user's mindsets. Their methodology involves surveys of a group of 81 existing users before, during and after a particular intervention. The survey will also be shared with a control group of representative colleagues who are not participating in the learning programme of the company. By monitoring resultant changes in behaviour, particularly frequency of certain actions, Freeformers aim to analyze the efficacy of their pedagogical method in the workplace.

Conclusions

Emerging technologies can disrupt and bring about unexpected change, the consequences of which must then be managed. Their evaluation is a key part of the way in which their impacts are effectively integrated into learning and teaching settings to bring the best benefit to learners and teachers. Through the EDUCATE process, we introduce entrepreneurs to an approach to evaluating impact with two main steps. First one is the creation of a clear theory of change to identify outcome measures and assumptions that are behind the expected impact of the emerging technology intervention. Secondly, the identification of the type of evidence and methods to generate it that are the most appropriate for the current innovation stage of the emerging technology.

The three case studies presented here provide exemplification of contrasting methodological approaches adopted by EDUCATE companies as they collaborated with us to develop their theory of change and outline a proposal for their own research study. As the case studies presented here exemplifies the value of the pragmatic approach we have taken, rather than focusing on a particular research methodology or paradigm for all companies engaged in the EDUCATE programme.

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