Enterprising Science

Inspiring science learning with teachers, students and families

Research into practice briefs from

# Enterprising Science

Paper 02

## Design-based research: A way to frame our collaborative process

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## Introduction

As a collaborative project Enterprising Science hinges on our ability to construct a mutually beneficial, clear and positive collaborative relationship between teams in two different institutions. Collaborations are notably subject to many interpretations, mixed expectations, overlaps and confusions and have been identified as a key issue in developing successful projects (Dawson, 2009; King & DeWitt, in press). This working paper suggests design based research processes could be used in the Enterprising Science project as a starting point for purposefully thinking about the collaborative process over the next 5 years. The cycle of design based research is outlined here in general and in relation to Enterprising Science more specifically.

## How could we work with design-based research in Enterprising Science?

The Enterprising Science project aims to develop science learning tools and techniques that are research led, based on research, tested in practice and redeveloped through collaboration between the Science Museum and King's College London. But how can research inform the design of science learning tools and techniques? Figure 1, below, shows how research and theory can be used to help design workshops, exhibits, events, programmes or lessons, which in turn, can be researched and fed back into the redesign of those activities and the research literature.

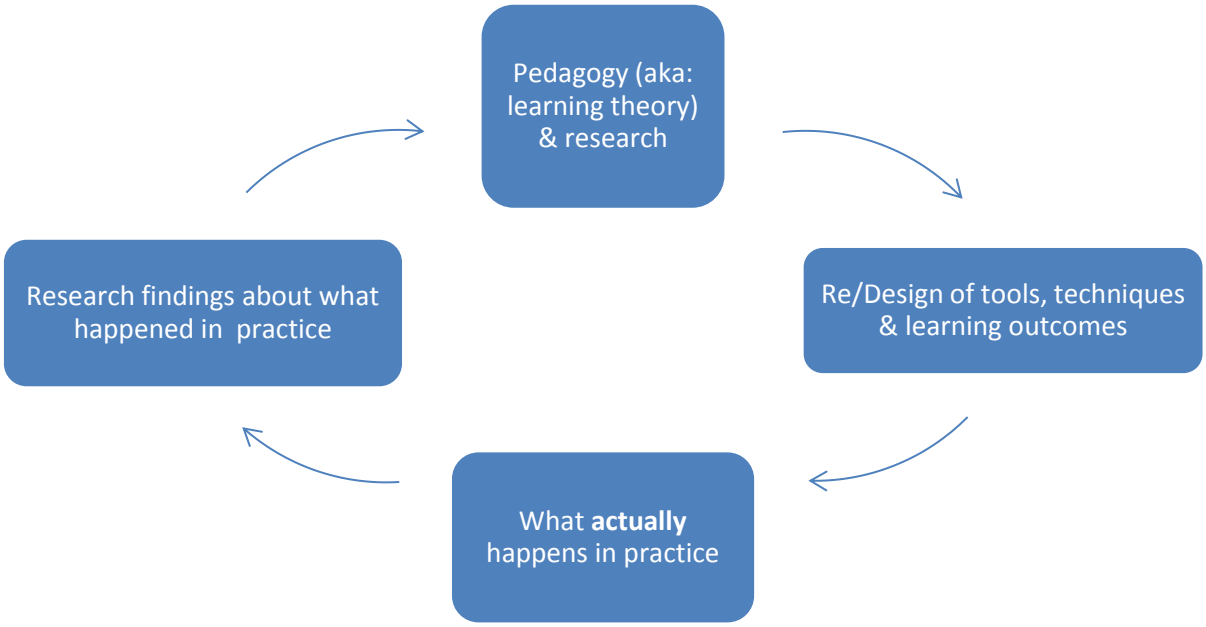


*Figure 1: The cycle of design-based research, or, research-based design*

For Enterprising Science following a design-based research approach would enable us to co-develop learning outcomes, tools and techniques based mutually on the ideas, resources and creativity of the Science Museum and the available research and theories on science education and engagement, provided by King's College London. An example of this cycle could be as follows in Figure 2:

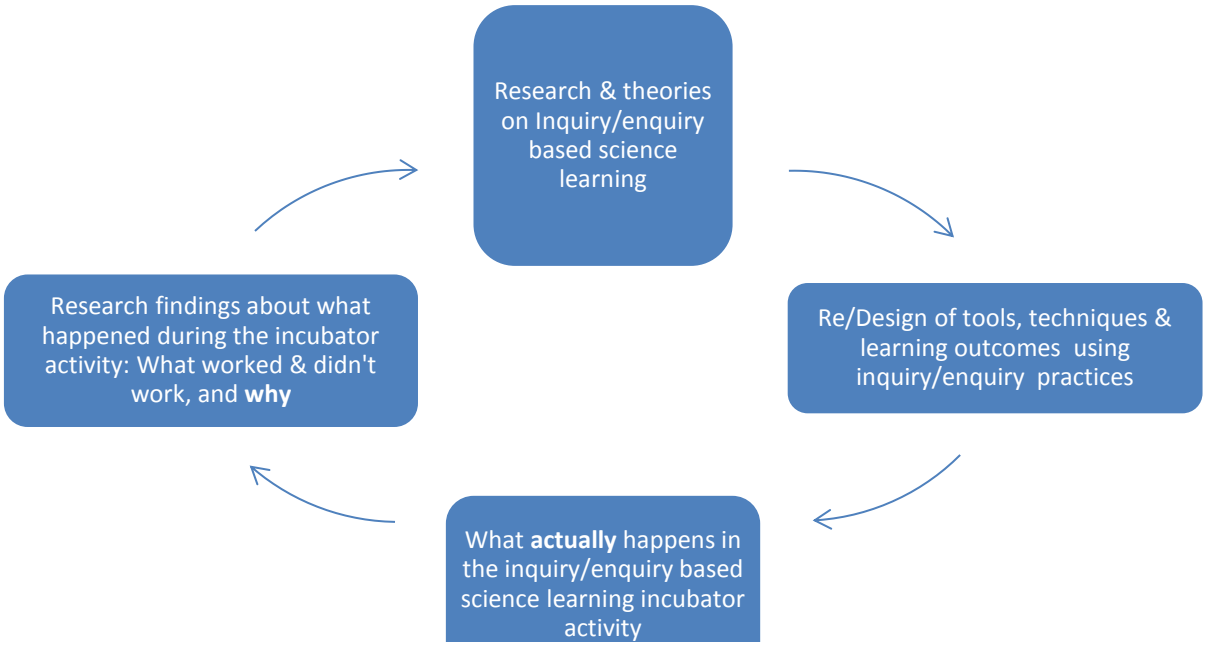


*Figure 2: A possible design-based research cycle with an example incubator activity*

**What is design-based research?**

Design-based research is a well-established practice. Conceived by Ann Brown (1992) and Allan Collins (1996), drawing on approaches used in engineering and product design, it is now often used in educational settings 'with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic settings' (Barab & Squire, 2004, p. 2). Such research involves creating innovative educational environments and studying the impact of those innovations. As such, it would seem ideally suited to Enterprising Science. Due to the complexity of the educational environments studied and the multiple factors involved, design research often utilises multiple sources and types of data in addressing multi-faceted questions (Brown, 1992), which is what we aim to do in the research surrounding the Enterprising Science incubators.

In terms of their characteristics, design-based studies:

- Occur in complex, messy, real-life settings

- Involve multiple dependent variables
- Focus on capturing the complexity of the situation
- Involve flexible design revision
- Involve complex social interaction
- Involve looking at multiple aspects of the design and developing a profile to characterise the design in practice (Barab & Squire, 2004).

Sound familiar? Put simply, design-based research is ideally suited for the types of complex situations that we are investigating in Enterprising Science. It also provides guidance for the way in which theory (and previous research) can inform the development of the intervention (aka: incubator) and the way in which outcomes of the research around the intervention can feed back into theory (in our case, surrounding science capital in particular, as well as specific areas such as inquiry-based learning or learning theories more broadly).

The naturalistic settings of Enterprising Science are necessarily messy and the need to study the intervention in such settings calls for a methodology with the capacity to reflect this complexity – to capture the multiple factors that may impact the success of the intervention. More precisely, we plan to collect various types of data (i.e. observations, interviews, surveys). This use of multiple methods is a key characteristic of design-based research (Brown, 1992).

Grounding in a strong theoretical framework (such as notions of science capital), is also a defining characteristic of design-based research more broadly. While design-based experiments incorporate pragmatic goals, such as improving a maths curriculum, integrating a computer learning environment into the classroom, or fostering a community of learners in the classroom (Brown & Campione, 1994), they also have the goal of informing and advancing theories concerning teaching and learning (Cobb, diSessa, Lehrer, & Schauble, 2003; The Design-Based Research Collective, 2003). In one such study (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005), Barab and his colleagues designed a multiuser virtual environment (Quest Atlantis) in which children participated in a series of tasks, connected to the curriculum, which incorporated both online and offline components. Qualitative data collected by researchers in the United States and other countries revealed the way in which the experience was educational (from a curricular standpoint), entertaining or engaging for students, and socially responsive (e.g., being responsive to girls' needs). However, this work not only had a local impact on students

who participated, but it also contributed to a larger body of theory about the relationship between playing and learning and about the importance of context in learning (Barab & Squire, 2004). In this way, design based research projects have the capacity to achieve pragmatic goals as well as informing broader theories.

A sound theoretical framework also provides a stronger basis for generalisation of the research findings themselves. When an intervention is rooted in theory, the design experiment becomes a test of the theory (rather than simply of the particular intervention). To the extent that the research provides evidence in support of the theory, it becomes possible to generalise based on theoretical grounds, rather than solely on the basis of similarities between situations (Barab & Squire, 2004; Collins, Joseph, & Bielaczyc, 2004).

Enterprising Science shares the primary strengths of design-based research projects: its iterative nature and its connection to theory (and previous research). That is, by being informed by research and theory, the tools and techniques developed for the incubators will be strengthened by this connection and their likelihood of success increased. The connection to theory also means that findings could be applied to other situations, thus increasing the impact of the project. Finally, the iterative nature of the process – in which tools and techniques are researched and the findings fed back into subsequent versions of the tools (which are, in turn, researched) – means that development will be continually improving, leading to far stronger outputs than might be possible otherwise.

**Additional research areas to inform Enterprising Science?**

There are a number of areas of research (in addition to work on capital) that may be useful in informing the development of tools and techniques within Enterprising Science. These potentially include:

- inquiry based learning
- mentors & role models
- 'real' scientists & their role in public engagement/learning activities
- learning theories (obviously a broad field of work, but we may want to think about what areas within this might be valuable for this project)
- role of families in informal learning environments & how best to support their learning
- role of objects in science learning & how best to use them to support students learning
- role of teachers in relation to working with students & informal learning institutions

Some of these have been addressed already in research briefings (e.g. research on families) and we think there are others that would be of interest to the Science Museum team. Identification of areas of interest by members of the team (both at the Science Museum and at King's) would be valuable at this stage, whether research from the Science Museum that the King's team should know about or vice versa, or any research area team members have identified as potentially useful. We may also want to think about how to design our 'exchanges of research' in order to maximise their usefulness. For example, are short research briefings (like this) useful or would it be better to devise an alternative format?

**Relationship issues to think about in a research-informed collaboration**

Sharing research is not the only important step in building collaborations. As suggested above, design-based research requires teams of individuals – researchers and practitioners – to contribute to a project in combination. It is important then to think about the process of relationship management in a collaboration of this type. Again, research on collaboration provides further insight into how this collaboration between King's and the Science Museum might work in practice. Previous research on collaborations between people involved in science engagement practice and academic design researchers has noted two models of collaboration; one-sided collaboration and collaboration as co-production (Dawson, 2009).

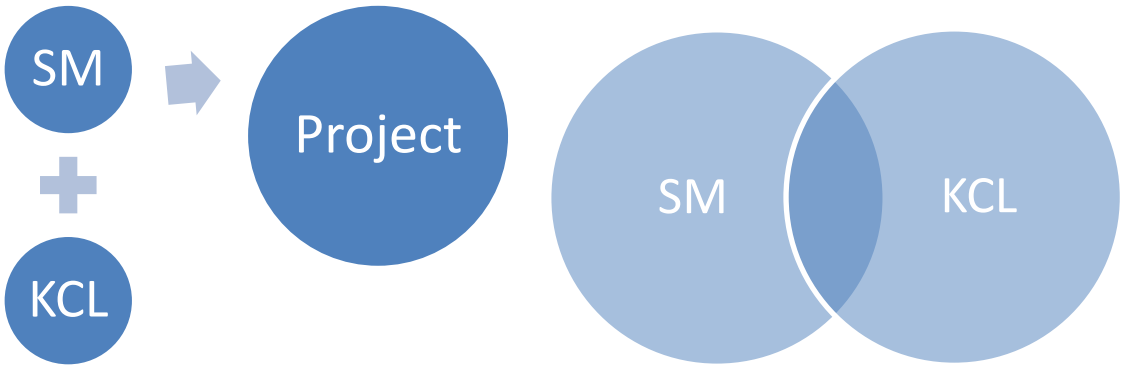


*Figure 3: Two models of collaboration; One-sided collaboration & collaboration as co-production*

In the first model, one-sided collaboration, one project partner works to inform the other project partner, who in turn, delivers the project, with limited feedback to or from the first

partner. In the second model, collaboration as co-production, both partners work together to deliver a project that is mutually beneficial, thus the project lies in the overlap between them. Interestingly, what Huxham & Vagen (2005) suggest is that the collaboration as co-production model can produce more advantages than the one-sided collaboration mode. As such we may want to think about how to manage the relationships involved in order to promote a co-production model. For example, as King & DeWitt (in press) have noted, managing such relationships requires time, careful planning and clear communication strategies.

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