Ideas, Technology and Skills: A taxonomy for digital projects

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Abstract

This paper seeks to develop the understanding of how young people engage with digital making projects. It proposes a simple taxonomy for thinking about the factors that are required or must be developed in order for young people to successfully complete a digital making project.

Open-ended projects addressing themes that young people care about are a compelling way of engaging with digital technologies and learning new skills. These projects can support young people's learning through a constructionist approach, where it is important that the supporting adults can facilitate exploratory and self-motivated learning without constraining the direction this takes. This can be challenging for adults as such projects inherently do not follow a set path, and areas in which support is needed are not always obvious, particularly to non-experts.

We visited two large showcasing events for digital making projects and interviewed young people who attended the events to share the projects they had made with others. The interviews were focused on young people's narratives of the process of working on the projects and what they had to learn in order to successfully complete them. Analysis of the interviews identified a number of key themes in these narratives. Although these themes were common, it was notable that different groups of young people had different starting points for their projects, with some being engaged initially by the technologies they wanted to use, others by the ideas or problems they wanted to explore, and some by the skills or capacities they wanted to learn more about.

For children working in an open-ended way on digital making projects there is a balance to be struck between three key factors. Projects are shaped by the ideas the children have, the technology they have available, and the skills that they have or have the capacity to learn in the course of the project. In a series of interviews at events for children to showcase their projects we found projects had a different emphasis on these factors depending on the starting point of the project and the context the children were working in.

The simple taxonomy developed in this work is designed to help adults supporting young people to create digital projects. It can be used to identify their starting points and the key factors they may need support with in order to develop their capacity to realise a finished project. We found that children's stories of the process often focused on one particular aspect of this taxonomy as a starting point, but that to develop a complete project they needed to consider all three. Support from adults may be best focused on identifying the area that is already a strong starting point, and facilitating children to further develop the other areas of the project.

We hope that this taxonomy will allow adults to more clearly identify the needs of young people, and support them to navigate open-ended digital projects successfully while learning new skills and capabilities. .

Keywords

projects, digital making, creativity, ideas

Introduction

Non-formal digital making and programming clubs such as those in the CoderDojo movement create opportunities for young people to work on open-ended digital projects, creating things they care about and learning skills as they do so. The open-ended nature of this process is key to the high levels of engagement, and the opportunity for constructionist learning as young people create their own projects and in turn construct new understandings of the tools and the contexts they are working in.

Existing research around the design and creation of projects stems back decades. Early research in project-based learning showed that projects were very motivating for young people (Blumenfeld et al,1991), embodying constructivist principles, and building bridges between principles and real-life experiences (Krajcik et al, 1994). More recently there has been a surge of interest in digital making projects, to a certain extent associated with the increase in programming education at K-12. The emergence of new, affordable, low entry physical computing devices has made digital making projects very accessible, and these have been shown to both engender creativity and provide challenge (Sentance and Schwiderski-Grosche, 2012, Sentance et al, 2017). Block-based programming languages such as Scratch (Resnick et al, 2009), with a huge community, and millions of uploaded projects, enable young people to generate ideas and develop them into an actual artefact, game or animation. In addition, the new landscape of clubs, hackathons, jams and other non-formal learning environments provide young people with places to go to participate and learn with others.

This kind of learning also takes place in what some researchers identify as non-formal learning environments, defined as taking place "in a planned but highly adaptable manner in institutions,organizations and situations beyond the spheres of formal or informal education" (Eshach, 2007, p.173). Non-formal learning is intentional although it takes place outside of the classroom, and adults are often not professional educators with access to formal teaching experience or training.

Facilitating and supporting open-ended projects is challenging, as is being able to understand the kinds of support young people need, the contexts that help them and the challenges they may face. To provide support for young people to effectively realise their ambitions, supporting adults have to be able to guide them to reach technical solutions they themselves may not have undertaken before, in novel contexts and with limited access to technologies. As these adults are often not formally trained educators, there is a need for support in terms of understanding how they can best facilitate learning while maintaining the interest led approach that non-formal learning contexts can provide.

The Study

In this project we set out to better understand the process that young people go through to create successful projects. We hoped that a clearer understanding of the processes involved with these projects could help adults to identify potential barriers to success in these kinds of projects, and support young people to navigate the process of creating a successfully finished project. Our research question was itself open-ended and exploratory. We aimed to collect narratives from young people showcasing their projects at a public event and explore the stories they told about their experience of making. Our research question is "*What starting point and initiators do young people use to stimulate their digital making projects?"*

Context

Coolest Projects is a series of showcasing events linked to the CoderDojo and Code Club networks of computing clubs. National events take place annually in the UK and the USA, with an international event taking place in Dublin every year. This research took place at the inaugural UK event in London in 2018 which was attended by around 40 teams or individuals and 65 children,

and the international event in Dublin in 2018 which was attended by around 700 teams or individuals and 1000 children from across the world.

At Coolest Projects events, young makers bring their projects to share with others in a 'science fair'–style exhibition. The emphasis is on sharing and learning from others, and gaining inspiration from the wide range of projects shown. Coolest Projects started as part of the CoderDojo movement, which has since become part of the Raspberry Pi Foundation. It is open to any young person across the world with a digital project.

The ethos of Coolest Projects is that young people create open-ended projects about problems or themes they care about. The problems or ideas the projects address are chosen by the young people, and they submit their projects in one of a series of categories that are largely related to the type of technology they use. The categories of projects at the events used in this research were:

- Games and Web Games
- Hardware
- Mobile Apps
- Websites
- Scratch
- Evolution (projects that had been shown at previous events but significantly developed since then, usually presented by older and more experienced participants).

During the event a panel of judges for each category circulate and discuss every project with the team who created it. Towards the end of the event there is an awards ceremony where prizes are given to the top projects in each category, as well as some other awards for achievements such as the 'best Dojo' represented at the event. Despite this competitive element, the event is designed to have a collegiate ethos, and participants are encouraged to look at and discuss other's projects in order to learn from and inspire each other.

Data collection and analysis

At the Coolest Project events in London (UK) and Dublin (International), we interviewed teams and individual presenters to find out about their projects, what they learnt, and their participation in the event. We interviewed 9 teams or individuals at each event.

Interviews were semi-structured and focused on the following themes:

- Context: Where they worked on their project such as a club or at home.
- Narrative: The story of their project, how they began, developed, and completed the project.
- Learning: What challenges they faced, how they overcame them and what they needed to learn to complete the project.

A shortlist of participating teams and individuals were selected before each event using the data collected as part of the application process. Participants were selected to give a representative sample of each of the available categories, and where possible including a range of geographical areas, genders of participants, and group and individual projects. On the day of the event researchers conducted interviews with nine of those who were present at the event. Due to the free flowing nature of the event some participants on our shortlist could not be located, and some did not attend, so our sampling was to some extent opportunistic.

Interviews with participants lasted for 20–30 minutes, using a semi-structured interview schedule, using a template for responses during the interview, with more detailed notes taken immediately afterwards.

Children and young people taking part in this event had already completed a consent form to take part in the public event which required permission from their parents. We explained to participants the nature of our research, and provided them with an information sheet with this information and how to opt out in case they or their parents were unhappy with taking part or changed their mind. All participants had a parent or guardian present, who gave their permission to speak to their children.

Interviews were analysed using a thematic analysis, creating a series of codes (Kuckartz, 2014). The notes were analysed inductively, identifying themes that emerged from the stories of the creation of projects the children described. A number of key themes were identified from this inductive coding which recurred in many of the children's narratives of their project creation.

The analysis of interviews was viewed through a socio-cultural lens (Lave & Wenger, 1991). When identifying codes the existing knowledge and motivations that children were bringing to their activity was considered. The children's activities towards developing their project was mediated by the social environment of non formal learning clubs, spaces that can be construed as communities of practice. In identifying themes we considered how children interacted with these environments, and how this influenced their acquisition of skills or competencies.

Theme	Description
Long, evolving engagement	Engagement often long and consisting of many episodes not easily quantify how long they had spent on their project.
Goals	Finishing a project to showcase at the events as a goal in itself.
Learning	Learning new skills and technologies. A wide range of skills identified depending on the context of the project.
Confidence	Confidence developed through being able to talk about projects at the events.
Team roles	Individuals took on different roles depending on their skills, experience and their interests.
Legitimate peripheral participation	Some children joined teams in a less involved role than others, but had clearly benefited from being part of the team. The effect on them is an area for further research.
Influence of adults	The skills adults were able to teach, or ways they were able to facilitate learning.
Interdisciplinarity	Projects brought together different areas of learning, particularly the interplay between the ideas or problems being addressed and the technology skills used to address them.
Technologies	The technologies available determining the direction of projects.
Primary school programming	Learning programming early in their education as an influence.

Challenges getting help	The challenges of finding age and skill level appropriate help and learning resources. The highly contextual nature of projects can make generic resources hard to locate and apply to challenges they are experiencing. Adult facilitation addressed this for some participants.
Power of seeing others' projects	Inspiration drawn from seeing other children like them sharing projects at the events.

Case studies were created for each project setting out the narratives of the projects, the key themes in terms of types of project, make-up of the teams, and the problems they were addressing. These have subsequently been shared with the community surrounding the events to help with understanding the engagement with the events and the impact of the activity they generate (Quinlan & Flóriánová, 2018).

The taxonomy

The themes identified from coding and the case studies were analysed to identify the key factors of: technology, idea/problem and skills that were used to create our model for understanding the narratives around the creation of the projects. Figure 1 shows the taxonomy developed to analyse the case studies.

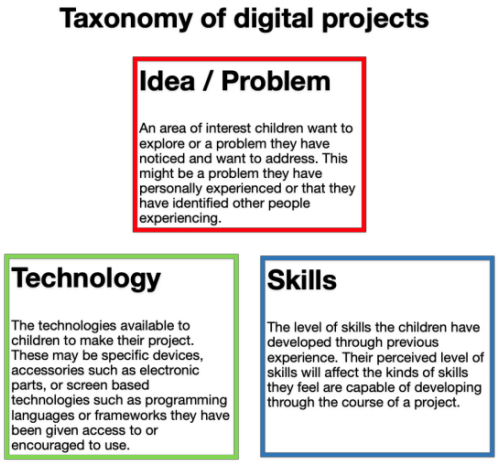

Figure 1. A taxonomy for supporting young people creating digital projects

The stories that children told us showed that there are different directions taken when choosing and developing a project. Some children start with an idea or a problem to be solved, and their project is driven by trying to address this. Others start with the technology they have at their disposal or that they want to explore. Still others start by looking at and reflecting on their own skills, and explore how to use these skills in interesting ways. Children have to balance the relationships between their ideas, the technology available, and their skills, in order to create a successful project.

If they are less focused on a particular area then this could make the development of a finished project difficult. The most obvious example, and something is often considered around digital learning, is the lack of access to appropriate technologies. Children may have ambitious ideas and the capability to develop skills, but there are some projects which will be very difficult or even impossible without access to certain technologies.

A lack of balance in the other areas can present challenges too. Access to an exciting piece of technology can be very motivating, but without a clear idea or problem to solve children may be less likely to formulate their activity into a cohesive project, with the learning benefits that a project based approach can bring.

A clear idea or problem and the appropriate technology can be held back by a lack of skills. Skills can be developed, and this may be a desirable area to be lacking in to begin with as it can encourage the learning of new skills.

Results

Technology as an entry point

Of the participants we interviewed, Linear Equation, Security System, and Zombie Defence System were among those who were initially driven by a particular available technology, and explored possibilities to define an idea for a project. These tended to follow existing examples of what a project could look like, although with their own modifications.

The young person who created Linear Equation had the **technology** of line following robots as their starting point, as shown in Figure 2. They were clearly intrigued by this technology and had access to the component parts needed to realise it. They developed their skills in order to implement this technology and create their own robot. The problem or idea that the project addressed had clearly come later, although their suggested use of the robot to assist people in carrying heavy objects showed an intention that the project had a purpose beyond their own process of creation and learning. This project started in the area of technology, and as it progressed it moved into the area of skills development, with a consideration of the problem it could be used to address coming later. All three areas were addressed to different degrees to constitute a project that the young person was proud to present at the event.

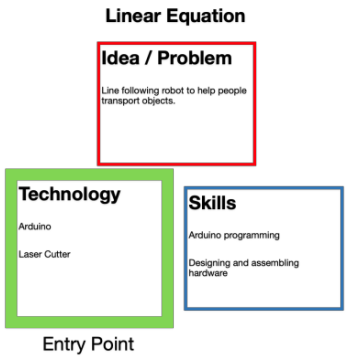

Figure 2: Linear Equation – showing Technology as an entry point.

Ideas as an entry point

Dragon King, Healthy and IOT Project to Track Pets were driven by strong **ideas** first. In some cases these were very ambitious, and the participants had designed and researched their idea but not yet fully implemented it.

The creator of ‘Healthy’ was drawn to creating a project around the theme of healthy eating. The children had identified that this was a social issue to be addressed, and that the solution could be to provide personalised information on how to eat healthily. They had explored the problem they wanted to address comprehensively, however their technical skills were not yet sophisticated enough to fully realise a working prototype of this idea. Therefore, they found an app design and prototyping platform that allowed them to demonstrate this ambitious idea without having to develop the considerable programming skills to create a working app. Programming a full app would have been a considerable undertaking in terms of skills development, and their zone of proximal development (Vygotsky, 1978) at that time was more suited to learning the design tools

to create a demonstration of their ideas. Figure 3 shows the importance of ideas in the Healthy project.

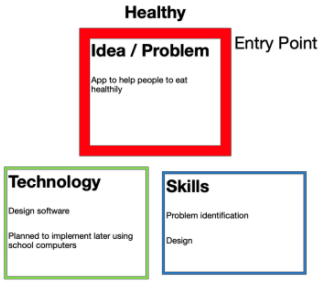

Figure 3: The Healthy project with the idea as an entry point

Skills as an entry point

Fewer projects were driven by the primary consideration of **skills**. This was perhaps the case with some of the simpler Scratch projects, but also one of the most sophisticated projects, Intelligentia, depicted in Figure 4. This maker had spent some time developing skills in facial recognition and machine learning, and decided to deploy them to solve the problem of locating missing persons. Their project used a mobile app to implement the skills they had learned in facial recognition to scan photos on a users phone and match faces against a photo of a missing personal that could be officially released by the police. They also had other applications of these skills in mind for the future, showing a 'skills first' approach to projects.

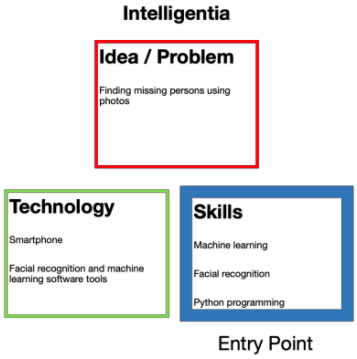

Figure 4: Intelligentia project shows skills as an entry point

Discussion

There is often a complex relationship between the idea or problem, the technology, and the children's skills, which children and their mentors must negotiate. Children who start entirely focused on a problem that interests them have the challenge of understanding what skills they need to address it and acquiring the appropriate technologies to do so. Indeed, most children interviewed said that they improved their skills to realise their project. To do this successfully they need to take account of the level of challenge and realistic skills development within the timeframe of the project. Where children start with a focus on doing something interesting with a given technology, they have to consider what problems this might be applicable to.

Negotiating between the idea or problem, the technology to use, and the skills required is key to a successful project. Different participants have different entry points for their projects, usually focusing mainly on one of these aspects to begin with. To create a finished project they have to find a balance of all three, although this balance is not always equal and often has a stronger focus on the area they started with than the others.

A balance has to be found between a compelling idea, the technology that is to hand or can be acquired, and the skills that exist or can be developed. As mentors and supporting adults are often responsible for facilitating these kinds of processes in a non-formal learning context, support for them to negotiate this territory and guide children through it would be of value.

Conclusion and Implications

Through interviews with children presenting their project at these events we identified a number of key starting points and initiators young people use to stimulate their digital projects. These were combined into a taxonomy highlighting the areas of ideas or problems, technology and skills.

For practice in the area of non-formal clubs such as CoderDojo, this model of the key factors needed for a successful project can be used to help adults to tailor their support for young people to create such a project. This taxonomy can enable adults to identify where young people are starting from, the challenges they are likely to face and the decisions they will need to make in order to develop their starting point and area of interest into something that is complete.

Every year hundreds of young people feel confident enough in their projects to submit them to the Coolest Projects events, but given the numbers involved in the club networks there must be many more who begin working on ideas but find it difficult to address all of the aspects that are needed to develop these into a complete project. With guidance from adults with a clear understanding of the factors that make a completed project, many more may be able to reach the stage where they feel happy to exhibit their projects.

The proposed taxonomy provides a map of the narratives of what makes a successful project, but does not specify how this map should be followed or what order young people should consider the development of their project. It is carefully designed as a tool which adults and young people themselves can use as a guide to open-ended activity. More research is needed to expand and elaborate on the taxonomy, which currently only provides an outline structure for entry points.

We anticipate adults could use this taxonomy to inform their support of young people by discussing projects with them at an early stage and identifying the entry point that the young people are taking and how much they have engaged with the other areas of the taxonomy. As access to technology is the most immediate and tangible aspect, it is likely that adults already often consider this area and guide children towards making use of particular technologies that are available. However, this is just one aspect of a successful project. Children may need guidance to frame their interests into a cohesive idea or clearly identify a problem they want to address. They may need support to reflect on the skills they have already and those that would need to be developed in order to successfully make their ideas.

As a high level overview, this taxonomy is designed to encourage adults and children to reflect on the starting points for projects and the likely areas where support would be needed. The intention is that it can provide the space for children to develop their ideas in an open-ended way, but encourage support to be put into place to enable them to develop all aspects of a successful project. In order to best support volunteers and educators without experience in technical skills or in constructionist approaches to learning, it could be supplemented with more detailed resources and activities to address the areas identified. There is a comprehensive literature on design thinking approaches for educators (IDEO, 2013), which could be drawn on to facilitate the development of project ideas and addressable problems. In formal education there are many traditions of reflective approaches to learning and formative assessment that can be drawn on to identify current skills and the next steps for skills development (Wiliam and Black, 2006). There is also potential in developing it into materials that young people can use themselves to support their thinking. Care must be taken to develop resources that are appropriate to the non formal learning environments in which the subjects of this research were working, as over-formalising the ways of working could detract from many of the positive aspects of these environments. With the right balance, and feedback from adults and children participating in these environments, developing such resources is a promising area for future research.

The taxonomy of digital products presented here provides a structure to make visible the aspects needed for a successful project. We anticipate it can provide a framework for thinking about these projects andhelps adult facilitators and child learners as they plan and navigate the exploration of the ideas and problems that they care about when making digital projects.

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