UNIVERSITY OF CAMBRIDGE MUSEUMS & BOTANIC GARDEN

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University of Cambridge Museums Digital Maker Residency End of Project Report

Project Team

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Sara Steele and Roz Wade (The Museum of Zoology)

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Rosanna Evans (The Whipple Museum of the History of Science)

Guy Underwood, Chris Richards and staff (Great Abington Primary School, Cambridge)

Amanda Dakin and staff (St Andrews Primary School, Soham)

and all the staff, families and children who took part in the project

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Executive Summary

Overview

- The University of Cambridge Museums (UCM) Digital Maker in Residence took place between January and March 2018.
- The residency was developed by a digital engagement specialist and museum educators in partnership with a local makespace who provided support, advice, access to equipment and hosted our schools workshops.
- Digital artist and maker Katy Marshall helped us to design and run 6 new creative workshops and a range of other activities incorporating art, science and technology through different forms of making.
- Workshop themes related to the museum's collections and exhibitions.

What we did




Schools Workshops

* 4 workshops at The Fitzwilliam Museum and Makespace

*2 schools

*95 children *aged 9-10

* 2 hours at Makespace

* 1 hour Museum

Family Workshops

*6 workshops at The Fitzwilliam Museum and The Museum of Zoology

* 100 children

* aged 8-14

* 2 hour workshops

Staff Drop- ins

* 8 sessions at The Fitzwilliam Museum and Makespace

* 67 engagements (some repeated)

Adult Pop-ups

*2 after hours adult events at The Museum of Classical Archaeology and The Whipple Museum

What we wanted to find out

1. What is the potential for incorporating digital making into the UCM public programmes?
2. How can we support the development of staff digital skills and confidence?
3. How can we create a sustainable model for digital making activity across the UCMs?

What we found out

Opportunities children and young people	Opportunities for staff and the UCM
• There was a high interest in the residency • Feedback from the children indicated that they were excited, engaged and inspired by the workshops • Participants enjoyed making links between the collection and the making activities and these links were interesting, relevant and motivating • The digital making activities stimulated critical thinking and problem solving and encouraged collaborative learning • The supporting adults played a vital role in ensuring the success of the workshop • The feedback also demonstrated the high level of enjoyment and reward experienced when engaged in high quality creative activities • The Digital Maker provided a powerful role model to young people interested in a career in the creative technologies	• The project gave staff an opportunity to discuss and reflect on the role of technology within the UCMs • Many staff were excited by linking historic making processes with new technologies • There was lots of interest in digital making and makerspace membership from colleagues within conservation and exhibition design and display • The peer-to-peer learning opportunities the project facilitated were both inspiring and effective • The museum educators who worked alongside the digital maker to run workshops reported that they had developed new digital skills and confidence – several have subsequently led digital making sessions independently • There is interest within the UCM for developing further collaborative projects with local makers and the makerspace

Top tips for running a collaborative digital project

1. **Be Clever:** Do your research and find your allies both within your local community and within your organization. Think carefully about the links between your collections and your aims and objectives. We used logic models to help us to plan each strand of the programme and map out possibilities for practice sharing and development.

2. **Be Ambitious:** Think about how you can get maximum return on your investment by sharing learning and opportunities and setting challenges for your team, your partners and your audience to develop their skills and confidence.

3. **Be Playful:** Make space for the unexpected and be open to new ideas, conversations and encounters.

4. **Be Brave:** Take risks and don't be afraid of failure. Be honest and open with your audiences about the exploratory nature of the programmes and they will enjoy working with you to create something new and exciting.

5. **Be Generous:** Share the resources you have with colleagues and community partners and you will end up with something far greater then what you could have achieved on your own.

1. About the Project

Digital making involves *'learning about technology through making with it'* (Young Digital Makers, nesta, 2015)[1]. It brings together art and technology while providing tools which might allow anyone to become active creators. The University of Cambridge Museums (UCM) Digital Maker Residency ran between January and March 2018. Over the course of the residency 195 children took part in digital making workshops and there were 67 staff engagements with our bitesize and training programme.

We hoped that the project would inspire staff, teachers, parents and young people to become digital makers and enable us to explore ways in which we might integrate digital making into the museum experience. We were particularly interested in how digital technologies might come together with traditional creative processes and how we could support the development of skills, confidence and motivation to empower young people to make, design and use digital technologies. We also had a subsidiary question about how inter- disciplinary projects of this kind might extend and develop our professional practice.

1.1 What we did

The project was funded from our UCM digital, schools and families budgets. We offered a bursary of £5000 plus a £2000 production budget. We reached out to a community workshop in Cambridge called Makespace[2], who agreed to partner with us on the project and provide practical support and access to their creative spaces and equipment. Our next task was to find a digital maker. We put out an open call and circulated details through different channels, e.g. artist and maker networks, social media, as well as the Museums Computer Group[3], GEM[4] and through Makespace. We had lots of interest in the residency and interviewed some very talented artists and makers from across the UK. We were very lucky to find Katy Marshall[5], a digital artist, maker and tech educator based in Cambridge.

The UCM Digital Maker Residency enabled us to experiment with different materials, tools, and technologies, taking the museums and collections as inspiration. We programmed several different types of events to try and make the most of the time Katy spent with us and to explore a variety of formats and audiences. This also allowed Katy the opportunity to think about different ways to engage and use technologies as an artist and educator. At The Museum of Zoology, animals in the collection were the inspiration for 3D paper models which were brought alive with the addition of sound and movement using Micro:Bit. At The Fitzwilliam Museum, the Codebreakers Digital Making workshop gave young people the opportunity to visit the Codebreakers and Groundbreakers[6] exhibition, make their own puzzle box and then programme a secret code to unlock it using Makey Makey. At the Makespace school group designed their own 'Museum of the Future' by adding sound, light and movement to replica

[1] Quinlan, O (2015) Young Digital Makers: Surveying attitudes and opportunities for digital creativity across the UK, nesta
[2] http://makespace.org
[3] http://www.museumscomputergroup.org.uk/
[4] https://gem.org.uk/
[5] https://www.museums.cam.ac.uk/blog/2018/01/12/introducing-our-digital-maker-in-residence-katy-marshall/
[6] http://www.fitzmuseum.cam.ac.uk/calendar/whatson/codebreakers-and-groundbreakers

museum objects they had made at school. At The Museum of Classical Archaeology, adult visitors to a late 'Under the Fig Leaf[7]' event were respond creatively to the cast collection by using LEDs to embellish adult greetings cards. In order to make the residency as visible as possible to UCM staff and visitors we also had pop-up maker activities in the exhibition space at the Fitzwilliam Museum and Museum of Zoology. All these activities involved traditional art making and skills but a digital element extended the scope of the activity. The challenge of incorporating technology and tweaking it to make it work was perceived by participants to be both exciting and fun. Throughout the residency there were many examples of participants developing skills and confidence making with digital technology alongside more familiar art and craft processes.

1.2 Overview of the Report

This report gives an overview of the rationale behind the project before examining how successful it was at meeting its aims. With the focus on practitioner development within the project, the collating of key information, reflecting on the project and writing about our experiences has been an important part of this process. The project has been documented by collecting photographs, field notes, interviews with the digital maker, children's artwork and questionnaire data from UCM staff, parents, teachers and children.[8] We have tried to include both practical and theoretical details in the hope that this report might inspire and help others to run similar projects in the future.

[7] https://www.classics.cam.ac.uk/underthefigleaf

[8] Individual responses are anonymised within the report.

2. A Review of Digital Making in Museums and the Maker Movement

The Maker Movement started as a grassroots movement of backyard and kitchen tinkerers, hackers, designers, engineers, artists, DIYers and inventors. It emphasizes informal, self-directed, iterative and collaborative 'learning by doing.[9]' It is now a global movement and has been grown dramatically over the last few years.[10] The movement is well established and fast growing in the US there is a growing recognition within federal government of the importance of making to a competitive workforce and engaged citizenship. Since 2011, the Institute of Museum and Library Services has invested more than $10 million in learning through making in museums and libraries.

In our role as an Arts Council England funded Major Partner Museum, the UCM is committed to embedding digital into our strategy and activity planning, and this is one of the requirements of our funding agreement. In the UK the DCMS published guidelines in September 2018 on Libraries and Makerspaces[11] which are seen as a key feature of the UK Digital Strategy[12] to build digital capability and provide everyone with access to digital skills. The DCMS Culture is Digital Report[13] outlines the potential role of cultural organisations to use technology to engage audiences but also highlights the need to support the development of digital skills and capability. This project takes inspiration from the Maker Movement and explores how the UCM might be able to take inspiration from their collaborative and iterative approach to stimulate our own mini museum makerspace movement.

2.1 What do we know about makerspaces and museums?

The European MakEY project explored digital literacy and creativity in the Early Years and has carried out several international surveys investigating makerspaces in schools, libraries and museums. They found that museums were amongst the first institutions to get involved with the makerspace movement, particularly science focused museums. Many of the studies on makerspaces in museums focus on STEM learning. Most of the research on makerspaces in museums has been conducted outside of Europe and the MakEY project identified the need to develop tools and resources which can support European Museums' aspirations in this area. [14] (p 53)

The Tinkering Studio at the Exploratorium in San Francisco has developed a Learning Dimensions of Making and Tinkering Framework based on the careful observation and analysis of 50 individuals and groups within their studio. The framework can be seen in figure x and highlights the range of valuable

[9] https://www.imls.gov/sites/default/files/makerspaces_talking_points_final.pdf accessed 4-10-18

[10] Bevan, Gutwell, Petrich, Wilkinson (2014) Learning Through STEM-Rich Tinkering: Findings from a Jointly Negotiated Research Project Taken Up in Practice. *Science Education, 99 (1).* Pp.98-120

[11] https://www.gov.uk/government/publications/libraries-and-makerspaces/libraries-and-makerspaces accessed 4-10-18

[12] https://www.gov.uk/government/publications/uk-digital-strategy/2-digital-skills-and-inclusion-giving-everyone-access-to-the-digital-skills-they-need accessed 4-10-18

[13] https://www.gov.uk/government/publications/culture-is-digital accessed 4-10-18

[14] Marsh, J., Kumpulainen, K., Nisha, B., Velicu, A., Blum-Ross, A., Hyatt, D., Jónsdóttir, S.R., Levy, R., Little, S., Marusteru, G., Ólafsdóttir, M.E., Sandvik, K., Scott, F., Thestrup, K., Arnseth, H.C., Dýrfjörð, K., Jornet, A., Kjartansdóttir, S.H., Pahl, K., Pétursdóttir, S. and Thorsteinsson, G. (2017) Makerspaces in the Early Years: A Literature Review. University of Sheffield: MakEY Project

learning experiences offered by making activities. It will be worth considering this framework when planning and evaluating the work with children and young people in the digital making workshops.

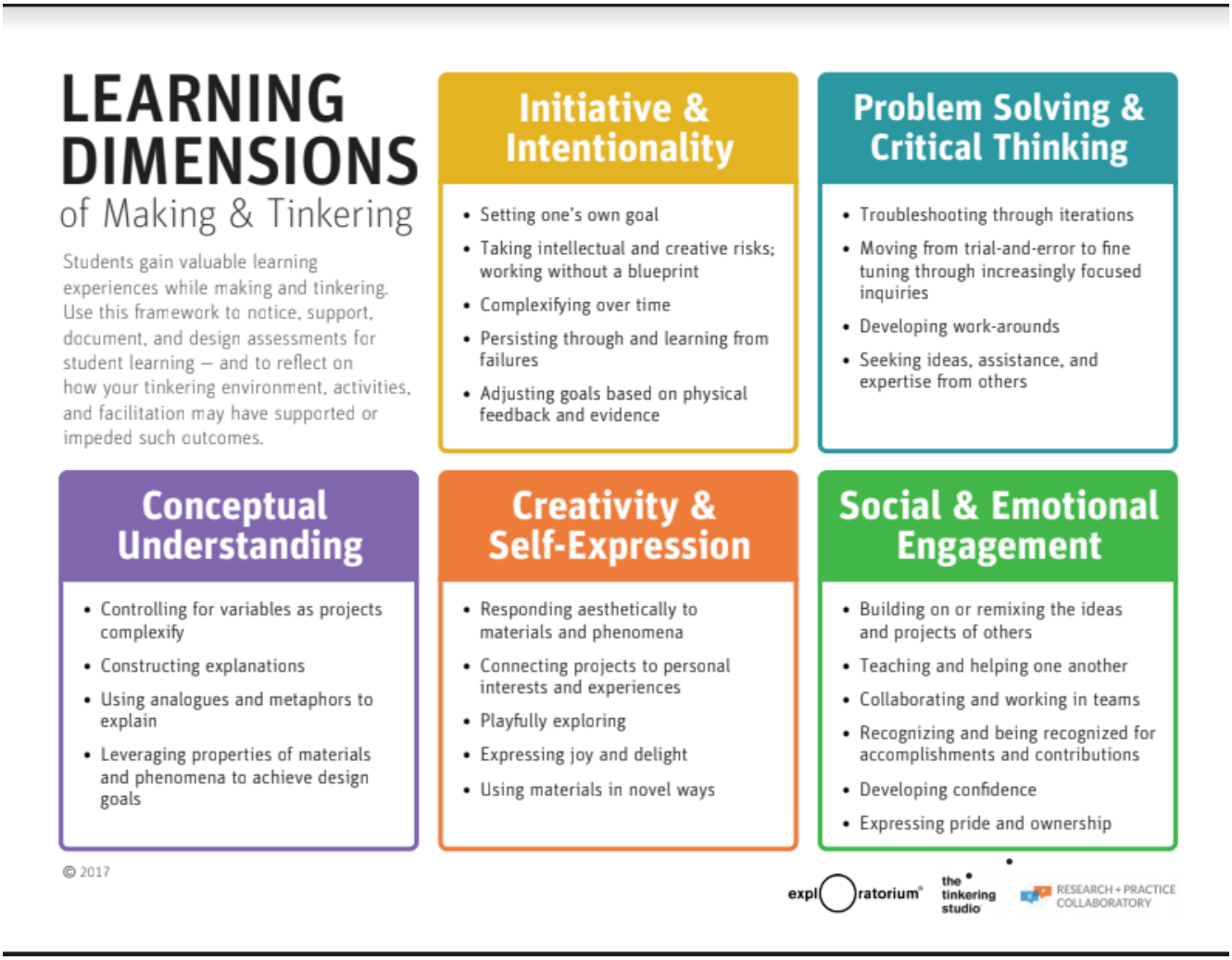


Figure 1 The Learning Dimensions of Making and Tinkering

In the UK, work is currently underway on the first UK Museum of Making at Derby Silk Mill.

> *Derby Silk Mill- Museum of Making will foster a spirit of experimentation, pursue mutual relationships with others, create conditions for learning and wellbeing.*
>
> *It will shape the way Derby is understood and appreciated and the way in which people from all places are inspired to see themselves as the next generation of innovators, makers and creators.*[15]

[15] Derby Silk Mill: Museum of Making: How we are making history (2014)

The Museum of Making will be based on the site of the world's first factory and links closely to the local heritage which is grounded in centuries of making, industry and social history. Their mission is to connect makers of the past with makers today and to empower the makers of the future. They believe that,

> *'museums should shift their focus from being didactic educators to 'co-creators' and that this will enable a more active and engaged role for the visitor.' (p14 ibid)*

This aligns with the maker movement which encourages individuals to share things they are passionate about, to connect with other makers and to create.

2.2 Why should the UCM be involved with digital making?

We have been thinking about how to provide opportunities for digital making and how to become more participant-led at the UCM for some time. Cambridge is a locus for digital and creative innovation and SME start-ups which is in part driven by the University of Cambridge, Anglia Ruskin University and the Silicon Fen phenomenon. When we started to research makerspaces and the maker movement we began to see some interesting parallels between the maker movement and the creative practice of our studio based workshops. There are strong art, design and technology and making strands within the learning programmes at the Fitzwilliam Museum. Workshops in the studio are designed to enable participants to experiment with different techniques, materials and approaches linked to the collection. Other collections such as the Whipple and the Polar Museum document how technology has been developed over time to further scientific exploration and discovery. The range of different themes within the UCM collections present many exciting opportunities to explore the relationship between art and science. From a digital engagement perspective, it was interesting to embed digital skills and develop a sustainable program, aligned with the principles of the maker movement.

At the Culture 24 Lets Get Real Conference[16] in March 2017, Oliver Quinlan from Raspberry Pi made a powerful analogy between new digital tools and more familiar resources educators work with every day to encourage creative responses. Oliver gave the example of the sand and water tray in Early Years settings. Adults and children play alongside one another to explore the properties of the materials, experiment with change, make structures and tunnels and learn about physics. Practitioners facilitate this learning every day regardless of whether or not they are trained scientists. Quinlan urged us to have the same approach with digital making. As practitioners we just need to be interested, ask questions and learn alongside them. We do not need to be experts, just to provide opportunities to explore. This realization empowered us to develop a participatory approach to our digital making programme, acknowledging our lack of expertise and working in partnership with local makers, museum colleagues and children and young people.

[16] https://weareculture24.org.uk/lets-get-real/

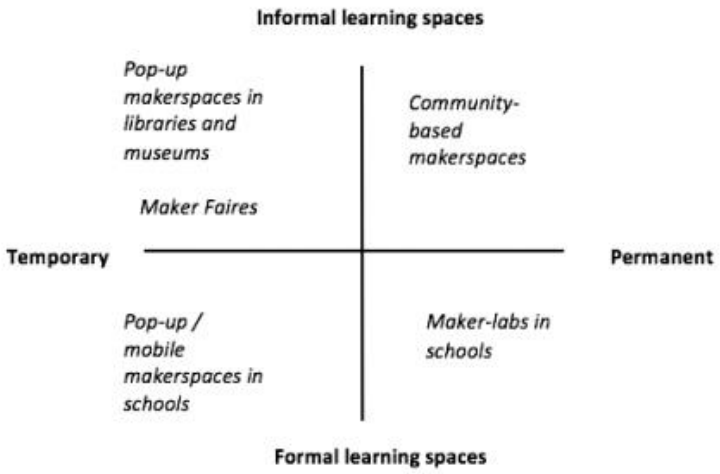


Figure 2 Types of makerspace from Marsh et al (2017)[17]

We do not have a dedicated makerspace at the UCM but we were keen to see if we could create informal pop-up spaces to encourage a more collaborative, iterative approach to making and to experiment with new approaches and technology in partnership with a digital maker and our audiences. This project has enabled us to test some of these ideas and approaches.

Prior to developing the residency, we explored different options, speaking to other makers and maker initiatives, exploring different models. It would have been easy to create a series of workshops, getting in freelancers to deliver the session. However this wouldn't have addressed all of the challenges and opportunities digital making offered us as an organisation. We wanted to develop and embed digital engagement approaches into museum practice across UCM's. Our initial conversations with UCM colleagues demonstrated that there was an interest in digital making across the museums and different departments, but also highlighted that confidence, skills and knowledge in this area was low.

The Digital Engagement programme at the UCM was focused on not just developing a digital programme, but also on supporting the development of staff skills to further embed digital ways of working into the museums and public programs. Therefore, it was important to find create a project which could provide a sustainable outcome and stimulate an ongoing conversation about the potential of digital technologies in museums. When we were planning the project we created logic models around the different strands of our programmes to help us to focus in on what we were trying to achieve and how to get there. We were very inspired by the Creative Museum[18] project which grew out of the maker principle of co-creation and co-learning. We recognised that it was important to not just to create a programme of activity for our audiences, but to generate opportunities for conversation and learning for our staff. This is where the residency was born.

[17] Marsh et al (2017) ibid
[18] http://creative-museum.net/

4. The Research Process: 'Thinking by Doing'

> *'So, how does enquiry through practice work? Firstly, questions are central alongside a willingness to explore and test ideas and knowledge, individually, as a team and in conjunction with participants in a programme and/or the visitors to the museum.'*[19] *Emily Pringle, PRAM blog*

As Digital Making was a new endeavor for the UCM we wanted to ensure it was evaluated properly to from the basis of informed decisions moving forward as part of the digital engagement programme. Practitioner development through reflection, observation, discussion and experimentation has been a crucial element of the project. Our work has been informed by the work of Emily Pringle at Tate, where '*the process is concerned with generating new insights about the work by doing it.'*[20] Research is seen to be a way of 'thinking-by-doing.'

We have drawn on a methodology which was originally developed for the UCM Nursery in Residence project by Wallis et al (2018)[21]. Action research is conceptualised as a cycle moving through reflection, (re)planning, action and observation (see O'Brien and Moules, 2007[22]). However, in our experience as 'thinker do-ers'[23] we find that the situation is much less linear: we move backwards and forwards between our convictions as theoretical knowledge and practical activity enrich each other. Our position as practitioner-researchers requires us to engage reflexively: acknowledging our own pre-conceptions, biases and interests, and bringing these into dialogue with new experiences gained during the process rather than trying to eradicate them altogether.[24]

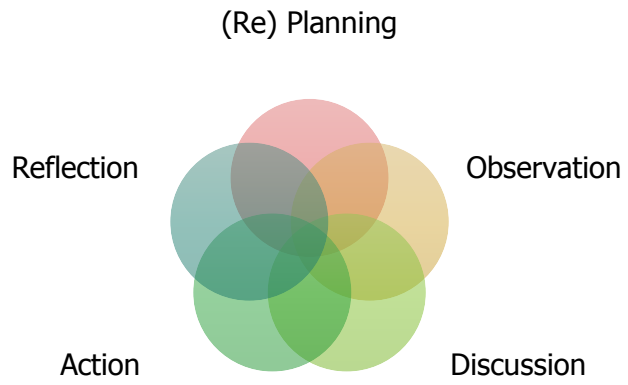


Figure 3 Action Research at UCM

[19] ibid
[20] https://practitionerresearchintheartmuseum.com/2018/04/20/enquiry-through-practice-at-tate/ accessed 4-10-18
[21] see Wallis, et al (2018) UCM Nursery in Residence End of Project Report, UCM
[22] O'Brien, N. and Moules, T (2007) *So round the spiral again: a reflective participatory research project with children and young people* in *Educational Action Research* (Vol. 15, No. 3)
[23] Pringle, E Reconceptualising Research in the Art Museum, PRAM blog accessed 4-10-18
[24] See Wallis op cit

3.1. Data Collection and Analysis

As this was an exploratory project it was important to document the project carefully so we collected lots of different kinds of data. These included:

- 95 post workshop questionnaires from students who took part in the schools workshops which were filled in at the end of each workshop[25]
- 100 post workshop questionnaires from children who took part in the family workshops which were filled in at the end of each workshop[26]
- 12 post-project questionnaires UCM staff[27] and teachers[28] administered via survey monkey and through email at the end of the project
- Post-it note comments from workshop sessions with museum staff
- Field notes, post-workshops debriefs and email exchanges with museum educators
- 150+ photographs taken by museum educators and UCM staff during the workshops
- Digital maker end of project interview and blog posts

As we are located within the project as researcher practitioners we acknowledge our bias and have tried to distance ourselves to be reflective and critical. We designed the surveys to capture both negative and positive feedback and tried to make the questions open ended as possible. We have included a copy of the post workshop questionnaires in the Appendices. When reviewing the data and writing the report we have been mindful to record the difficulties and challenges as well as the successes.

[25] School pupil feedback appears in yellow boxes
[26] Family workshop feedback appears appear in green boxes
[27] UCM staff feedback appears in orange boxes
[28] Teacher feedback appears in purple boxes

5. Intended Outcomes from the Residency Project[29]

Outcomes for Children and Young People

* Participants are excited, inspired and engaged by the programme (QP3)

* Participants have the opportunity to work alongside an expert in digital making (QP2)

* Teachers, children and young people are actively involved in the creation of new strands of programming (QP5)

Practitioner Outcomes

Improved understanding of:

* The potential of digital making programmes for children and young people at the UCM

* The role of technology as part of the museum experience

* Multi-disciplinary practice focusing in particular on the intersection between arts and science based creative learning and problem solving

* Improved digital skills, knowledge and confidence

University of Cambridge Museum Outcomes

* A new strand of programming around STEM and digital engagement

*Opportunities for creative exchange between museums and other partners

*Ideas for new sessions for children and young people

*New ways to engage with the museum and collections

*Research that can be shared with key stakeholders – parents, teachers, museum professionals, funding bodies and researchers

[29] Outcomes for Children and Young People are aligned with the Arts Council Quality Principles

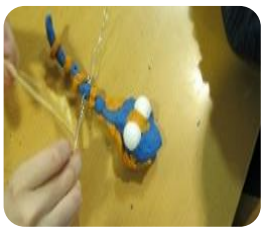
6. Outline of the Workshops

Codebreakers Workshop

- Family workshop at The Fitzwilliam Museum in response to the Codebreaker and Gorundbreaker Exhibition
- Making puzzle boxes
- Cracking the code on a Makey Makey to open the box

Zoology Crazy Creatures

- Family workshop at The Zoology Museum
- Making 3D models of favourite creatures from collection
- Programming a *Micro:Bit* to generate sound and make the models move



Sense It Family Workshop

- Family workshop at The Fitzwilliam Museum
- Inspired by flower paintings in Gallery 15
- Programming a *Micro:Bit* to create noisy and moving 3D models

Museum of the Future Schools Workshop

* Classes sent information about 5 objects to research and make
* Visit to The Fitzwilliam Museum to see the objects
* Digital workshop at Makespace Programming a *Micro:Bit* to make interactive displays for their replica objects

Adult Late Event

- Adult greeting card making activity at The Museum of Classical Archaeology
- Using LEDs to light up important features

Staff Programme

* Table set up with making activities in Fitz
* Short workshop events for staff introducing the Digital Maker, showing some of the equipment and reporting on project

7. Outcomes for Children and Young People

Figure 4 Photographs from Family Workshops

One of the aims of the UCM Digital Maker Residency was to develop a new strand of programming around STEM and digital engagement. The long list of workshops and activities we ran and the number of museum staff, teachers and young people who took part in digital making activities are evidence that this aim was met. In this part of the report we will look at the feedback from the young people who took part in the project to work out what the participants gained from the project and what worked well and what didn't.

6.1 Were children and young people excited, inspired and engaged by the programme?

The response to both the schools and families workshops was very positive. All workshops were fully booked within a few hours of being advertised and had long waiting lists. This demonstrates high demand for activities of this kind within the local area.

The photos we took to document the workshops show children deeply engaged in making, laughing, talking and listening to one another intently. In the questionnaire responses, the majority of children agreed or strongly agreed that they had fun at the workshops. Children who attended the schools workshop were more likely to strongly agree that they had fun. (see figure 5) They were also more likely to select strongly agree for 'I tried something new.' The reasons for this difference is not clear, but perhaps some of the family groups has some prior experience of digital making and so selected the activity for this reason. It is worth noting that the digital schools workshops happened towards the end of the residency when the project team were more confident and experienced running workshops of this kind. In some of the earlier sessions there were technical difficulties such as equipment not working, or templates not quite fitting as planned.

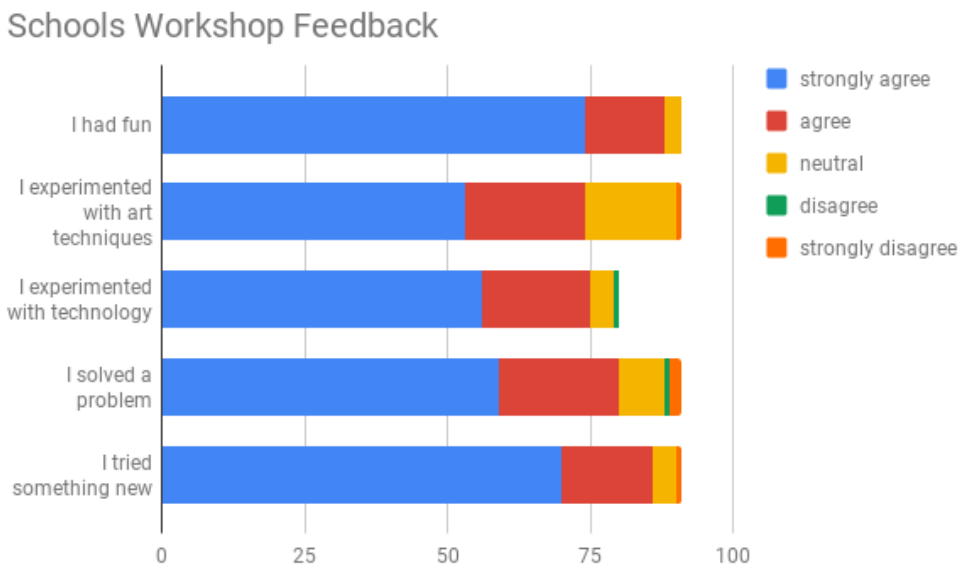


Figure 5 Feedback from the Schools Workshops (n=95)

There was a large variation in the prior experience of the children involved. In several of the family sessions there were children who were able to write their own code and progammes and so the microbit activity was too simple for them. A small number of children in the school groups had previous experience of working with microbits through coding clubs or out of school activities. All children in the schools groups had experience of scratch which is very similar to the microbit coding interface. Some of the home educated children who attended the family workshops had more limited experience of using computers and needed support using the mouse and constructing the circuit. Many of the children had studied circuits at school and this knowledge helped them with the activity.

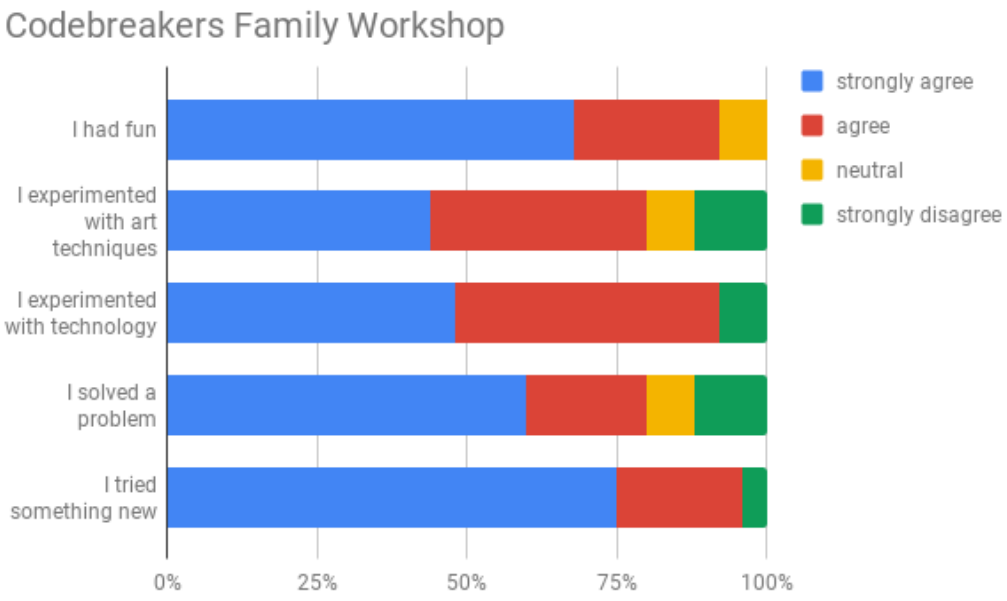


Figure 6 Feedback from the Codebreakers Workshops (n=32)

6.2 What did the participants enjoy?

Qualitative feedback indicated that participants enjoyed the workshops for a variety of different reasons. Responses included mentions of both the digital making activity itself (*I like the microbit, I love building, designing the message, I enjoyed making the shark move*) and the experience of exploring the museum (*I enjoyed looking at the art, looking at pictures, the military cross, I enjoyed coming to the zoology museum*.) It is interesting to see that feedback frequently refer to both specific objects and the digital making activity which shows how important it is to make clear links between the two. It could be that enjoyment and excitement for one activity encouraged participation in the other. Several of the responses to the schools workshop indicated that they would like to come back and 'explore more of the museum.' One of the teachers stated that the children talked about the workshop afterwards which is an indication that it was an engaging experience for them.

We were interested to see how children linked the digital making activities to the collections and if there was more positive feedback about the practical making activities than the museum visit or collection. The responses to the question, 'what did you enjoy the most?' revealed that they enjoyed working with the museum objects too,

Looking at pictures because I learnt new things

The armour because it looked shiny

The military cross- it's fascinating

Designing the message because I got to know about the hoard

I enjoyed looking at the art because it they were all interesting

It's really good for learning about the past

Next time I would like to… *Explore more of the museum*

Next time I would like to… *Look at everything again/ look at the whole museum*

(feedback from schools workshops)

I liked everything -especially seeing the exhibition

Going round the museum

(feedback from 'Codebreakers' Family Workshop)

The children really enjoyed working on the museum task. I broke it into three specific jobs, researching and creating interactive information about the object, planning and designing a security system for it, creating a replica of it. The children self-selected groups depending on the artefact they were most interesting.

(feedback from teacher)

We planned the workshops carefully to ensure that we made strong links to themes and objects within the museums and collections. This feedback indicates that the digital making activities enhanced and encouraged children to interpret, experience and respond to the exhibitions and collections rather then distracting them away from the museum objects. In the schools workshops groups were encouraged to design an interactive display for their objects in The Museum of the Future. These are important findings as they demonstrate the potential of digital making activities to excite, inspire and engage children in museum collections.

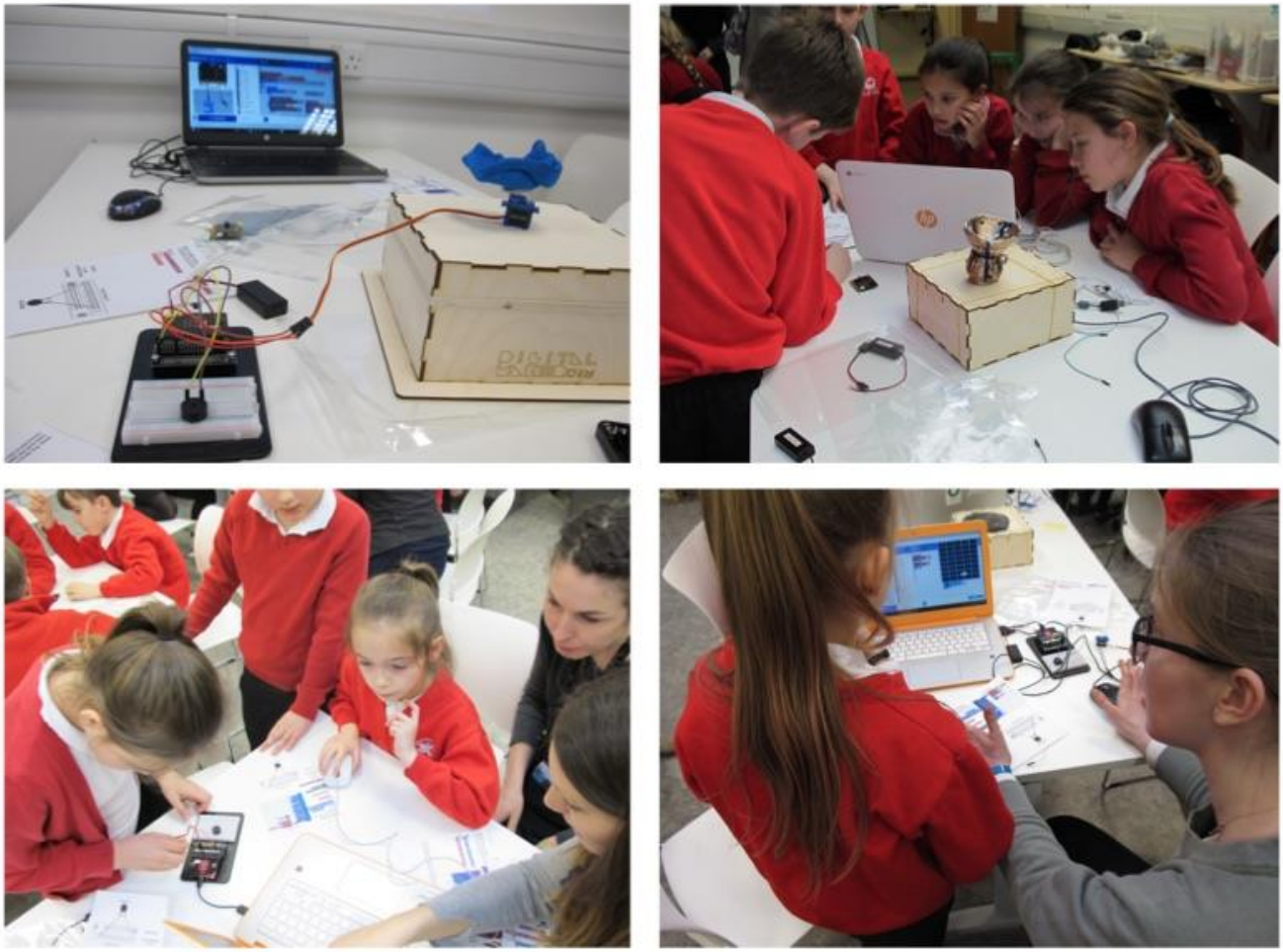


Figure 7 Photographs from Schools Workshops

6.3 'Fun, exciting and challenging': problem solving and critical thinking

It was interesting to note that on several evaluation forms children wrote that they were both frustrated and excited by the activities. The nature of the activities meant that they had to work hard to come up with their own creative solutions, often learning alongside parents, teachers and museum educators to develop new skills. The majority of feedback from both the schools and families workshops indicated that this was a positive experience,

It gets your brain working and it's really fun

It is brilliant and gets you working

Fun, exciting and challenging `(child feedback from schools workshops)

Putting it together because it was fun problem solving

Really fun and it teaches you new stuff every time.

What did you enjoy most? Making it, because it was challenging
What did you enjoy least? The problems, they were too challenging

(child feedback from 'Codebreakers' family workshop)

The activities were difficult to complete within the time allocated and so the group had to work together to find a solution as the photos demonstrate. This was seen by the teachers and museum educators to be a very positive outcome,

I definitely observed pupils solving problems by making the connections link to the object and microbit together (eg working out how to make the object move). Many of the pupils were also working out reasons why their coding might not have worked (was it the connection, was the latest version downloaded to the microbit, had the pressed the right input button), although most times it was challenging for them to solve the problem without adult support

(museum educator feedback)

It would be interesting to compare the data we collected to what happens in one of the existing creative workshops within the UCM public programmes.

The teachers we worked with indicated that there was a need locally for more opportunities of this kind to support schools and teachers to deliver the computing curriculum. Schools often to not have the budget to invest in digital equipment and training. This offer could be developed in partnership with other arts and cultural organisations.

6.5 The important role of the supporting adults

Feedback from several of the teachers and educators involved commented on the number of adults involved in the session and how crucial this was to the success of the workshop.

The groups had lots of adult attention as there were so many adults in on the session. My only worry for the success of future sessions would be how well they could run with far fewer adults. Particularly if the adults coming with the group were unsure of how to solve problems with code. (feedback from Museum Educator)

Group setup and collaborative nature worked very well. Additional adults to support worked well and enabled higher quality discussion for pupils. (Feedback from Teacher)

The adult support was essential as was some basic knowledge of how the microbit worked. The most successful workshops were run by colleagues who had been able to spend time playing with the equipment beforehand and had an understanding of how it worked. This was especially evident in the schools workshop with groups of 30 and lots of adult helpers coming from school as the comment above demonstrates. The family workshops ran with 10-15 participants and so were more manageable. This will be important to bear in mind when planning future workshops.

It was quite apparent that as the project progressed the museum educators gained in confidence and knowledge. At the first workshop (Codebreakers) none of the team had used a makey makey before and so they relied on the Digital Maker for support every time something went wrong. Some of the technology and equipment didn't work and this resulted in some frustration and negative feedback from parents and children. This is to be expected in an exploratory project of this kind and on the whole participants were understanding of this and the research project gave them the opportunity to leave comments and suggestions as to how it could be improved next time. However, by the end of the residency participants had a much more positive experience,

Everything was organised very well. I enjoyed it a lot.

It was amazing and the people doing it were really fun, and it was really fun making the animals and my servo worked

(feedback from participants 'Making Sense' Family Workshop)

This final session was run by museum educators and volunteers who had been new to digital making at the start of the residency which demonstrates how much their confidence and knowledge had developed as a result of the programme.

4.6 'Building it with my friend': Promoting collaborative enquiry led learning

The making activities stimulated lots of interesting conversations and provided exciting opportunities for collaboration and for sharing expertise and ideas. The feedback from the children indicated that this had been a positive experience for many of them,

Very fun. Showing everyone your own inventions would always be good!

I enjoyed working together as a group because it helps us to learn that you can share your ideas with each other

Working together as a group as it was cool to hear other people's ideas

(feedback from schools workshops)

What did you enjoy most? … Building it with my friend

I really enjoyed working with people who I didn't know

(feedback from 'Codebreakers' Family Workshop)

We decided early on in the project that we would organise the activities and resources in order to encourage children to work together. The workshop leaders made reference to this throughout the workshop and praised good team work, listening and problem solving. We also incorporated a sharing plenary into each workshop to invite the group to share and listen to other people's ideas. The museum educators and teachers commented on this as being a really important aspect of the workshops.

The feedback and sharing was lovely at the end of the session you could sense how proud everyone was of their new skills. Group work also provided opportunity for the different jobs to feed into each other and learn together.

Excellent plenary opportunity provided. Time 'could' have been given for a written evaluation of stages of the process. Again online would be good so it could be immediately shared with school. (feedback from Teacher)

This idea of online feedback would be worth exploring in future sessions. One of the groups of children from the schools workshop suggested that we made some 'how to' videos for other children to help them to work out how to make the code and get their object to spin around.

6.7 Digital Making and Creativity

Each of the workshops incorporated more traditional art skills such as cutting, moulding, sticking and decorating. This encouraged participants to respond aesthetically to materials and ideas and to make connections with personal interests and experiences. In this way, they were able to start with something familiar and accessible before moving on to introduce the digital activity. The children's feedback demonstrated this was a useful approach,

Very fun and you get to code and try something new

Educational, fun and really cool, plus really creative

Lots of technology and experimenting

You're going to love it.

It was AWESOME!

Decorating my monkey and see it moving its arm. Because this movement makes it alive.

Putting all the electric pieces. I love building

These comments on the feedback questionnaires also capture the enjoyment that many of the children experienced whilst engaged in the act of making.

6.8 Working alongside the digital maker

We didn't capture any comments on the feedback forms specifically about working with the Digital Maker. However, this conversation captured whilst walking back to the museum from the makespace demonstrates a profound influence on one young participant.

Y5 girl: When I grow up I want to work somewhere like that and do coding. I want to code games. You know minecraft? That's a really big game and I want to code something like that. When I went to code club I was the only Year 5 girl there -all the rest were boys.

MT: I wonder why that was?

Yr5 girl: I don't know

Yr5 boy: That's the gender thing, isn't it?

Katy was a powerful role model for many of the young people we worked with. This added an interesting additional outcome around inspiring young people into coding. This is something which Katy is very passionate about as a young woman working in coding or other creative technologies and she also works as a STEM ambassador. This would be worth considering when planning future digital making programmes.

8. UCM and Practitioner Outcomes

I think what has been done so far shows that it is just the start - the residency showed the huge potential for creative new ways of engaging people and it should continue so that that potential can be tapped and so that colleagues are up skilled and feel more confident teaching and programming digital activities. (UCM staff feedback)

We hoped that the residency would create opportunities for creative exchange between museums and other partners and help us to develop ideas for new sessions for children and young people. In this section we will look at feedback from staff and teachers to see if this aim was met.

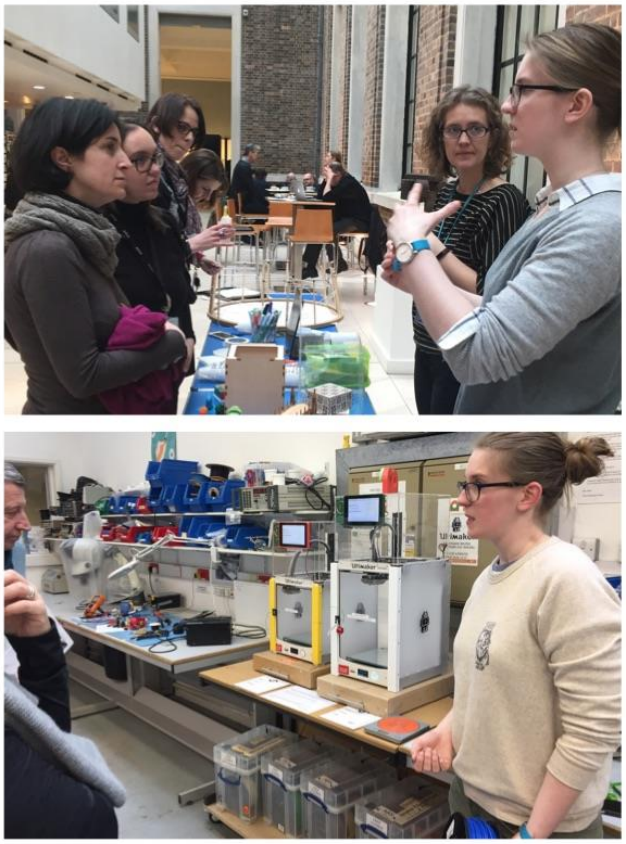


Figure 8 Photographs from staff sessions

7.1 Practitioner Outcomes: Supporting the development of digital skills

Feedback from museum educators and teachers demonstrated that the majority had very little or no experience of digital making before the start of the residency.

I wanted to be involved with this project because I can see that digital making is a growing area that interests many children, and as I have very limited knowledge about it I was hoping to learn more myself.

The residency did support the professional development of the staff directly involved in planning and running the workshops. Museum educators worked alongside the digital maker to plan and test ideas for workshops, engaging in the same iterative process that was encouraged in the workshops themselves,

I had practical hands on training session with Katy the digital artist in residence, a planning meeting with my team on how we would structure the sessions and then a follow up session with Katy (run through of how the session would play out, and checking everything worked) I also found Katy's hand out sheets produced for the children really helpful to take home and learn for myself in order to develop skills further than workshop level.

The bitesize events for staff encouraged sharing and provided inspiration for those who hadn't yet been involved.

> *Really encouraging to hear how staff at the Fitz have been able to grow in confidence enough to deliver digital making activities themselves -there's hope for us all! I haven't done so yet but I will be taking Fitz staff up on the kind offer of being able to take some kit home to play with to build up confidence.*

This feedback shows that it would be worth continuing to develop peer-to-peer learning opportunities when piloting or testing new ways of working.

7.2 Staff engagement with the project: Stimulating conversations and developing confidence

The training and staff introductory events were well attended by staff across different departments not only those directly involved in the learning programmes. Staff participants to the bitesize and drop in sessions were interested in both the potential digital making within the museum context and in the opportunity to make things themselves as part of the collaboration with makespace.

> *Definitely lots of potential for all specialism within conservation (including but also beyond technological, scientific) Keen to find out more*
>
> *Great to make links to historic making processes*
>
> *Very interesting want to see Makespace, lunchtime sessions would work, post news on intranet*
>
> *Thanks, really interested in having an introduction to the MakeSpace, very exciting*
>
> *(UCM staff feedback after bitesize)*

The residency has stimulated conversations about technology and digital making across the museums. Although this project was focused on programmes for children and young people the residency and partnership with Makespace enabled us to offer introductory sessions to Makespace, 3D printing and laser cutting brought together staff from many different departments and museums to share expertise and ideas. Staff from one of the smaller museums in the consortium commented on the advantages of working together in a cross- museums project.

> *I suppose for us as a small museum, we could be looking at finding a way to incorporate digital making into family and adult events more frequently -rather than a novelty we only did once or twice- which I think would be the most realistic aim for us. As for UCM-wide work, it is a fabulous addition to larger Arts Award and widening participation projects etc. Would be interested in working alongside other UCMs in offering digital making activities as part of bigger project as these are the sorts of things it's harder for us to do ourselves as a smaller museum. (UCM staff feedback surveymonkey)*

This is worth developing in future digital projects. Working together as a consortium of museums also allows sharing the expense of any equipment.

Staff have many useful suggestions as to how to develop the project. When asked what they would like to see happen next, several respondents said that they would be interested in exploring the potential of digital making in collaboration with colleagues from other departments in the museum and to develop the partnership with makespace.

> *Facilitate workshops between curatorial/learning/technician/conservation teams to enable sharing of ideas.*
>
> *Maybe have a research project in collaboration between a Digital Maker (artist?) and conservators and/or technicians to explore possibilities for display, conservation, preservation … for example using a 3D printer to restore missing parts of objects, using digital simulations of objects to get an idea of the original state of an object but without interfering with the materiality of the object, work with lighting and optical effects to offer multiple perceptions of one object, build bespoke display supports for awkward objects (explore possibilities of laser cutter, 3D printer, etc)… These are only a few ideas coming from my short visit at Makespace but I imagine that there would be so many more when seeing more examples of uses. (UCM staff feedback email survey)*

Feedback also demonstrated the different levels of digital confidence and expertise within the UCM. One of the participants in the makespace introductory session was already and member and so was disappointed that the sessions were not more detailed. It would be good to be more explicit about this in the future when advertising training events to staff. However, with such a variation in confidence and expertise some participants reported a significant increase their understanding of the potential of digital making with children and young people and their confidence to programme digital learning activities, as this feedback demonstrates,

> *I was full of trepidation before the session because of my own lack of skills in this area, but the children's enthusiasm, patience, persistence and kindness was an absolute joy to share in. I was also concerned that the activities seemed quite far removed from the issues around the museum collections, but I came to see that we could make these connections together - whether these were about the creative process, the trials of working with materials experimentally, or practical issues around access and communication that we deal with on a daily basis. Thanks to everyone involved for showing me these possibilities!*
>
> *It was brilliant and has inspired me to do a lot more engagement with digital learning.*
>
> *(UCM staff feedback surveymonkey)*

9. What we learnt and implications for future projects

The UCM Digital Maker Project inspired staff, teachers, parents and young people to become digital makers and provided the project team with the opportunity to explore the potential of digital making activities at the UCM. The digital maker in residence supported staff to design workshops and activities which used the museum collections as their starting point. We were able to investigate links between digital making and both science and art based collections. The digital maker residency also helped to develop our understanding of how inter- disciplinary projects of this kind might extend and develop our professional practice as museum educators. The following opportunities and challenges have emerged from the project:

Opportunities

- The UCM Digital Maker Residency inspired learning and engagement, encouraged problem solving, critical thinking and collaboration and stimulated children's creativity.
- Consideration should be given to the incorporation of digital making activities within the UCM Widening Participation offer. Several of the skills and capabilities identified in the outcomes feature in University of Cambridge Admissions Office Progression Framework for Key Stage 3 and Key Stage 4 Widening Participation activity.
- Time could be invested to refine and develop the digital making schools offer piloted during the programme to create a replicable offer for use in relation to different UCM collections.
- Digital making opportunities for other audiences could now be developed both within individual museums and as part of more ambitious cross-site interdisciplinary projects such as Cam Lates and Arts Award.
- It is worth continuing to develop and explore digital making opportunities for schools and families in partnership with the makespace other arts and cultural organisations.
- The residency developed the digital skills and confidence of the UCM staff who were directly involved with the workshops and stimulated conversations about digital technologies and making across staff, departments and museums.
- The next phase of the project could build upon these conversations but be led by colleagues from conservation or collections to help to further embed digital innovation and experimentation into the UCM.
- We should continue to develop links with the local makespace and maker community through both collaborative project and encouraging staff membership.

Challenges

- It is essential to establish who holds responsibility for developing the next phase of the UCM Digital Making programme and the place of digital making within the UCM staff structures and strategy. The project was initiated and supported by a full time Digital Engagement Specialist on a time-limited contract linked to fixed term funding. This funding and post have now come to an end leaving a gap in capacity, leadership and expertise. This effects our ability to build on skills, knowledge and experience developed during the project.
- This work has great potential but needs to be properly resourced and managed in order to progress. Training, equipping and supporting staff to do this work requires further investment of time and resources.
- The partnerships, resources and equipment collected over the course of the project need to be maintained and managed, and staff skills to use them kept current and passed on to new staff.

It is hoped that the digital maker residency will be a starting point for future projects and collaborations as we continue to explore digital technology and making at UCM through our learning programmes, exhibitions, displays, conservation work and other projects.

Appendix 1

Digital Making Workshop Evaluation

Age: **Boy or Girl**

Have you visited the [name of] museum before? Yes No

Have you been to a [name of] museum workshop before? Yes No

Please circle the picture that shows how you feel:

I had fun

I experimented with art techniques

I experimented with technology

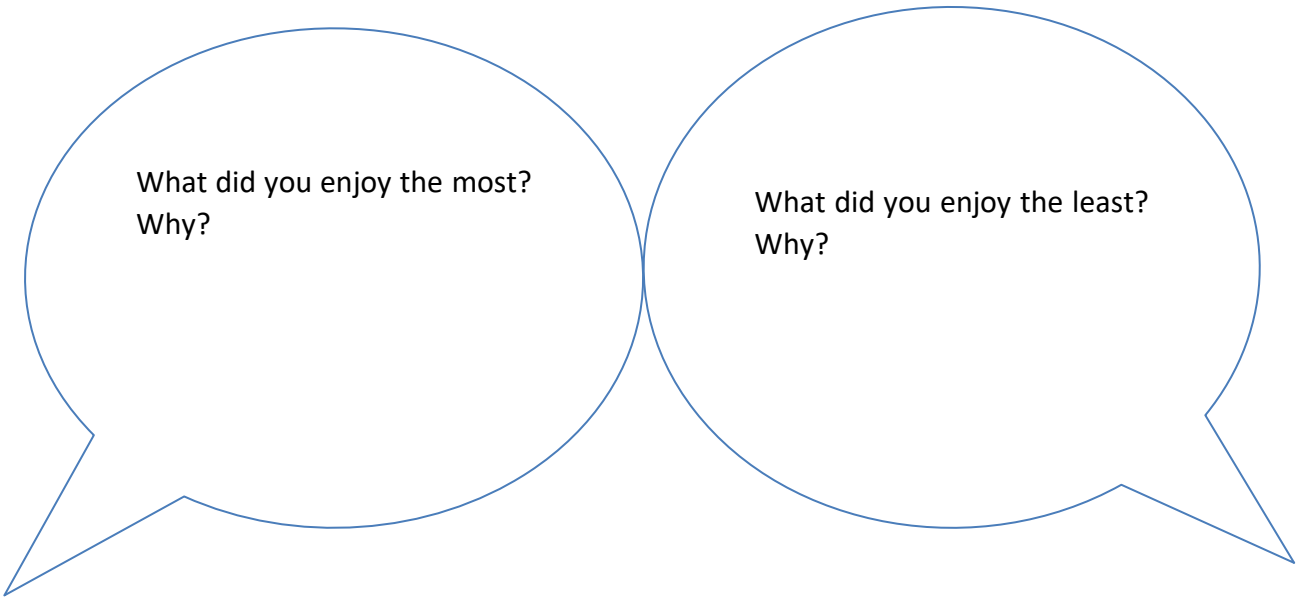
 

I solved a problem

I tried something new



How would you describe the workshop to other children?

We are always trying to think of fun ideas for workshops.

What would you like to do next time?

Do you have anything else that you would like to tell us?

Thank you!