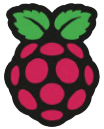
Computing education in non-formal settings

Research to practice

Rebecca Franks and Dr Tracy Gardner



Raspberry Pi
Foundation

This talk

- 321 Make - A research-informed framework for non-formal computing education
- Our non-formal computing literature review
- What next?

Who are we?

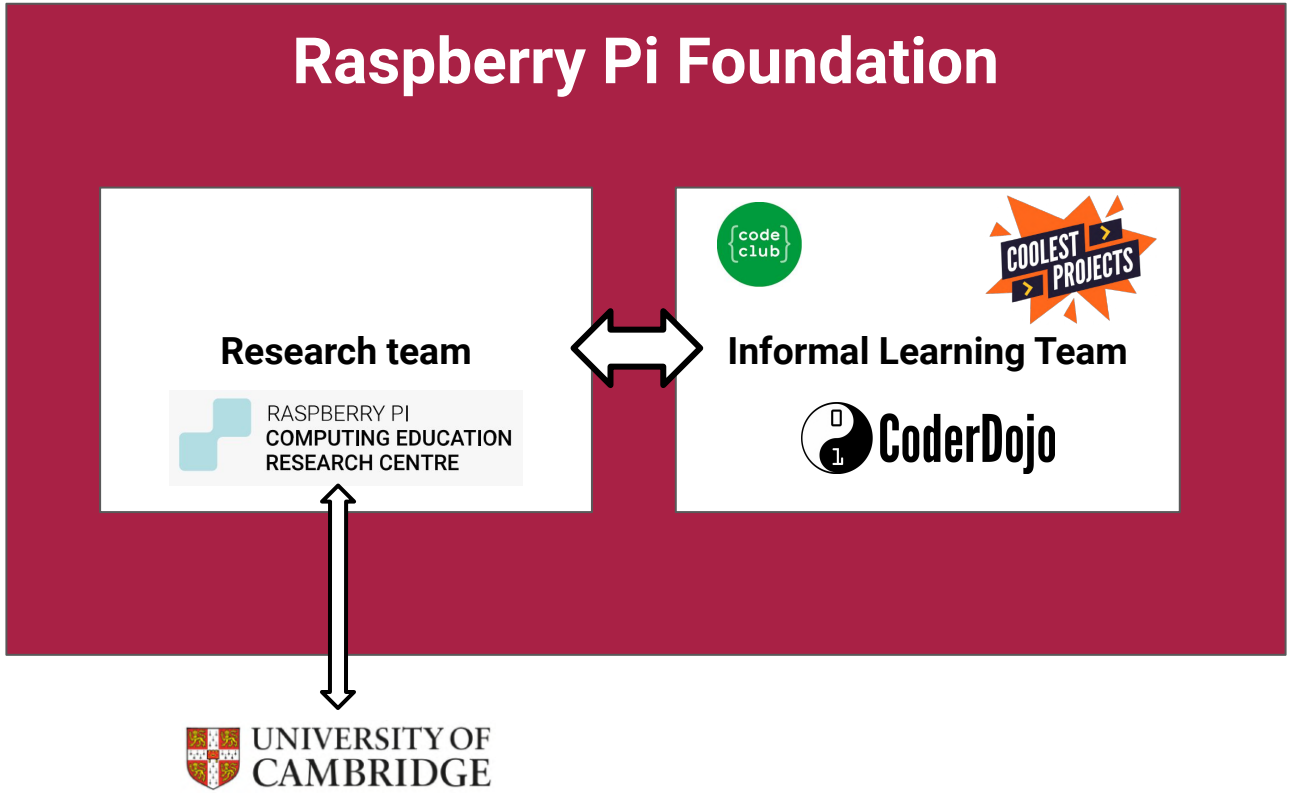
Rebecca Franks

- Secondary Computing teacher (and director) for over 15 years
- Pupil premium lead
- Co-chair of CAS Include
- Joined the foundation in 2019
- Developed resources for the Teach Computing Curriculum and Isaac CS
- Regular Hello World contributor and Raspberry Pi blog author
- Moved to the Informal Learning Team in 2021
- @FranksberryPi

Dr Tracy Gardner

- Entered computing via an outreach program (first in family to get any qualifications)
- Computer Science PhD
- Career in industry as a software architect (IBM)
- Co-author of micro:bit in Wonderland
- Taught primary computing, ran a Code Club and CoderDojo, hack events
- Started writing Code Club projects in 2015
- picozero library co-developer

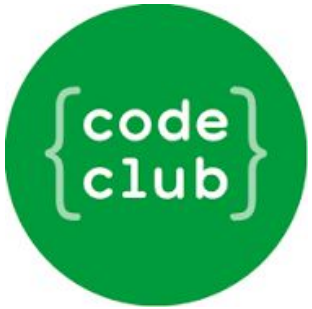
Where we fit in the Raspberry Pi Foundation

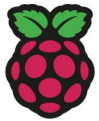


A definition of non-formal education

“institutionalised, **intentional and planned** by an **education provider**. The defining characteristic of non-formal education is that it is an addition, alternative and/or complement to formal education within the process of life-long learning of individuals"

(UNESCO, 2011, p11).





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Our programmes are global

- **Code club** A global network of free coding clubs for 9–13 year olds - 160 countries

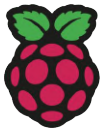
- **CoderDojo** The community of free, local programming clubs for young people age 7-17 - Over 100 countries

- **Coolest Projects** - The world's leading technology showcase for young people - Anywhere in the world.

321 Make!

Our framework

rpf.io/321-make



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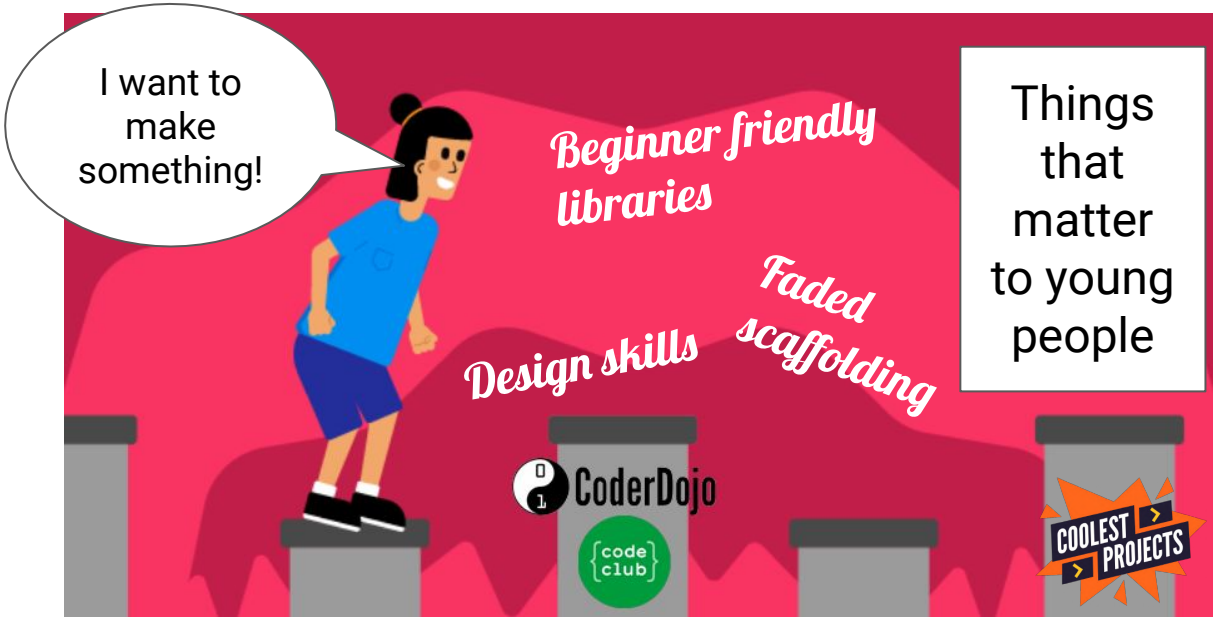
Supporting creators age 7-18 to make things that matter to them!

What problem are we trying to solve?

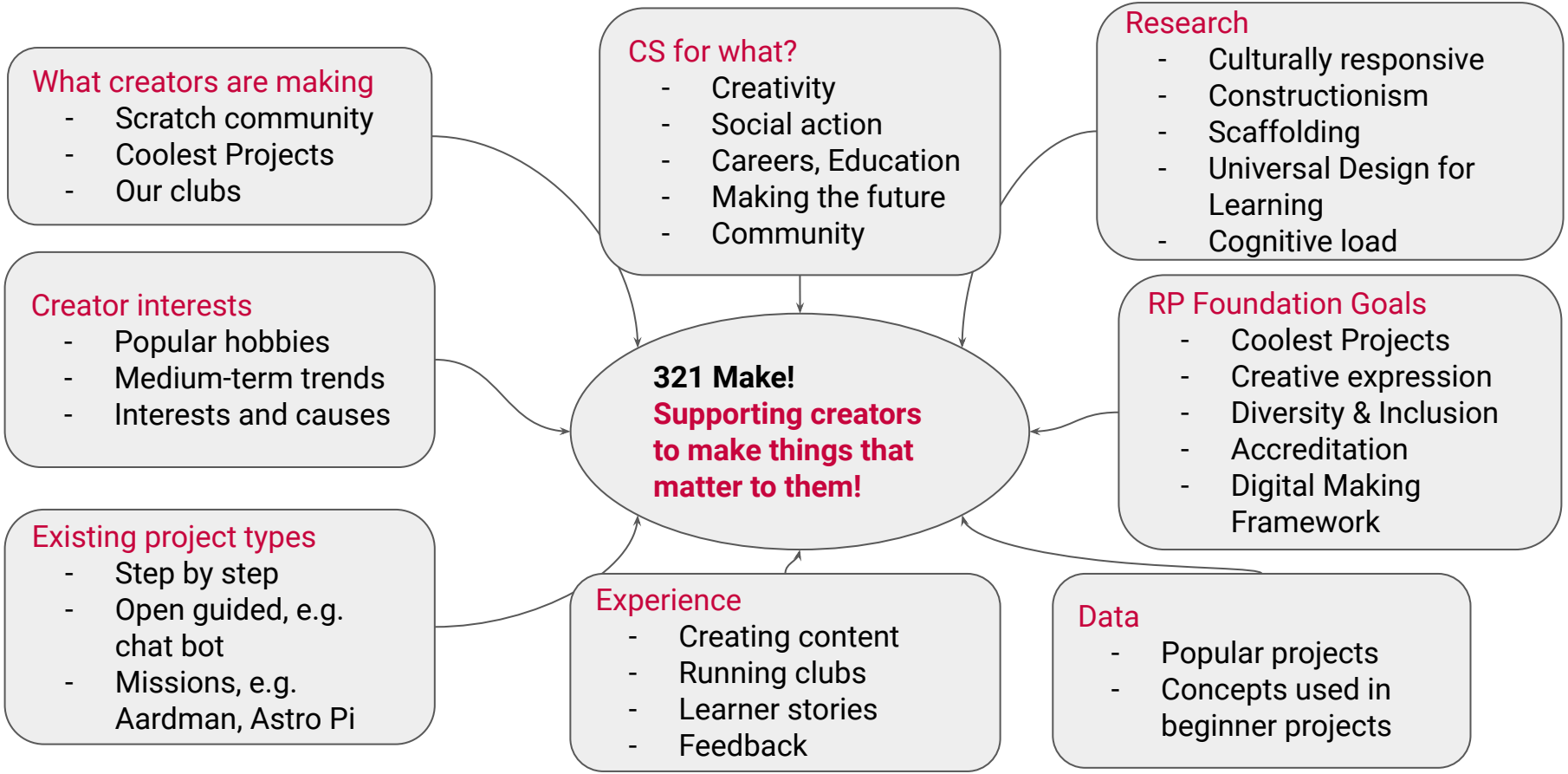
“Beware of the Turing tar-pit in which everything is possible but nothing of interest is easy.” Alan Perlis

What problem are we trying to solve?

“Beware of the Turing tar-pit in which everything is possible but nothing of interest is easy.” Alan Perlis

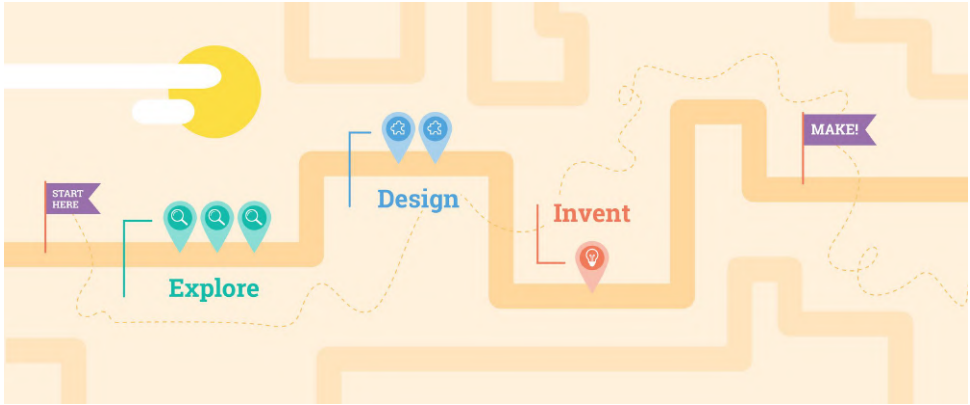


Research (industry, community) to practice



321 Make!

Discover introduces creators to new technologies so they can find out if they are interested and ready for more.



3 Explore projects introduce them to new skills.

2 Design projects invite them to practise their new skills and bring in their own interests.

1 Invent project asks them to use the skills they've practised to meet a project brief.

Make is where creators use their independence to create something totally unique. This could then be entered into Coolest Projects.

COOLEST PROJECTS

rpf.io/scratch-intro

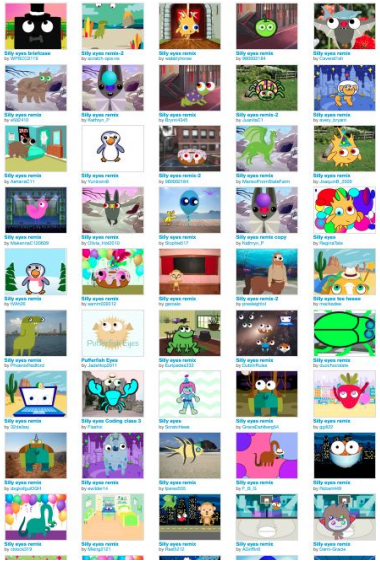
321 Make! (A Scratch example)

Explore

- Learn new skills
- Some personalisation

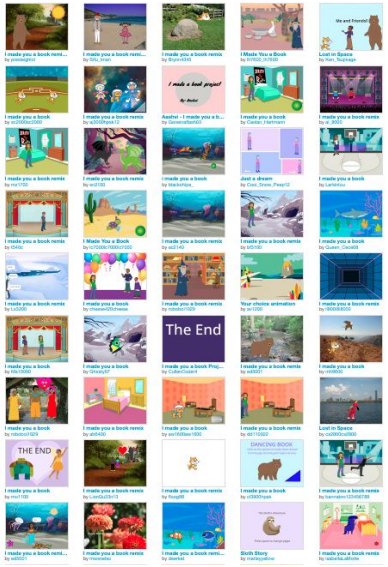
Design

- Practise skills
- Make design choices



Invent

- Combine skills
- Design for your audience/passion



My personal 321 Make! journey - Unity

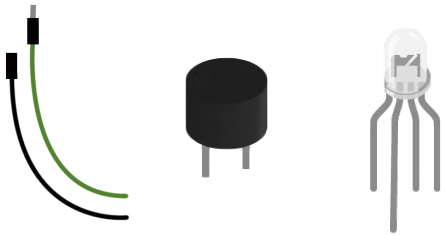
- No prior exposure to:
  - C#
  - Unity
  - Creating 3D worlds
- Relatable to my own experiences (particles, collecting, non-player characters)
- By the end, I knew where to look to build the thing that mattered to me!

rpf.io/scramble-trail

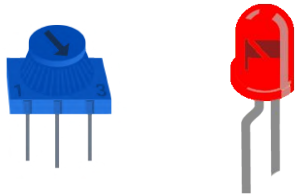
Raspberry Pi Pico Path overview

LED firefly

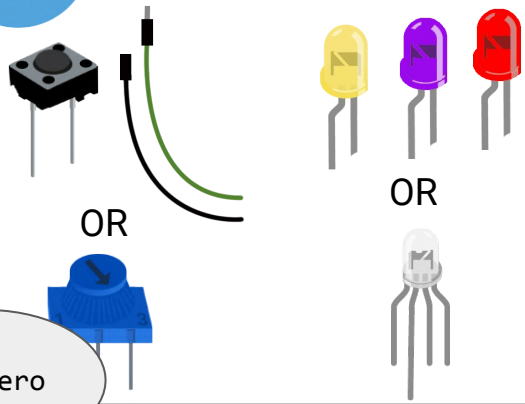
Party popper



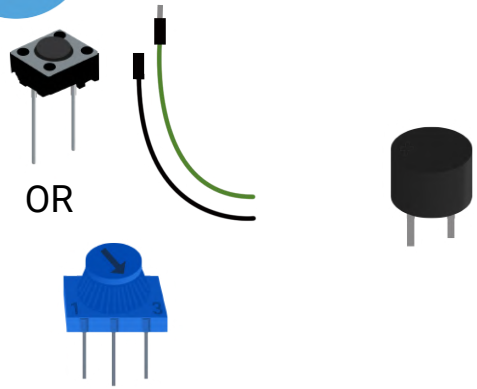
Beating heart



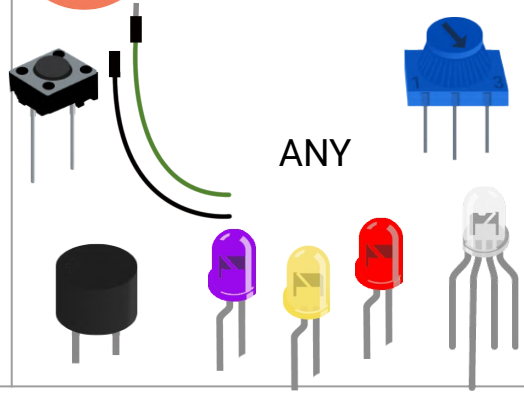
Mood indicator



Sound machine



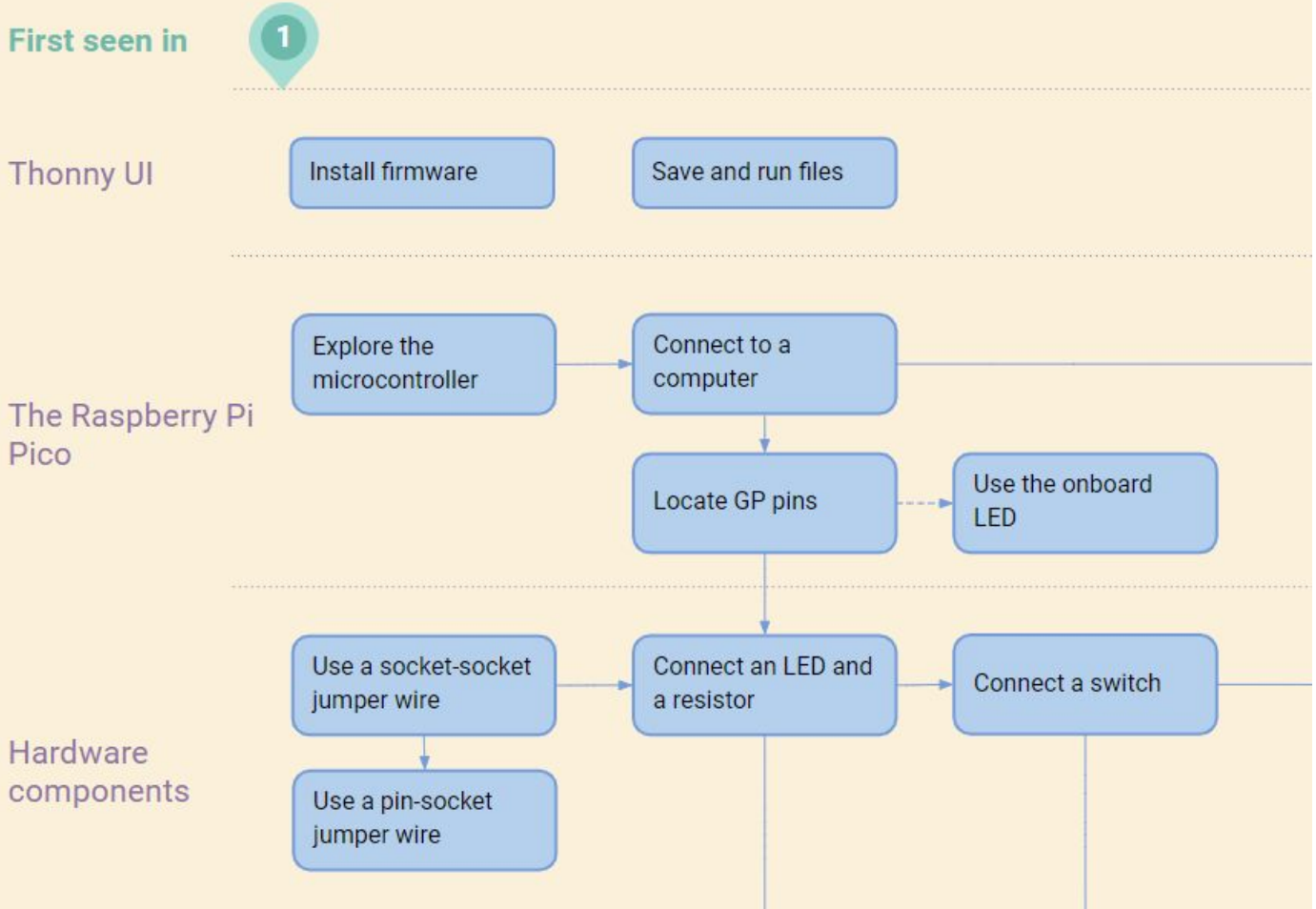
Sensory gadget



picozero

Learning graph: **Introduction to the Raspberry Pi Pico**

rpf.io/pico-graph



321 Make!

- Scratch
- Python
- Raspberry Pi Pico
- Unity
- Web

rpf.io/paths

Introduction to Scratch: sprites, scripts, and loops

Introduction to Python: Variables, functions, and loops

Introduction to web: HTML, CSS, and animations

Introduction to Raspberry Pi Pico: LEDs, buzzers, switches, and dials

Introduction to Unity: 3D Objects, Character Controllers, Co… Text and Buttons

Other levels available!

We aren’t done yet!

More research

More tools

More libraries

Greater accessibility

What do We Know about Computing Education for K-12 in Non-formal Settings?

Systematic Literature Review of Recent Research
https://rpf.io/nfc (Open Access)

Tracy Gardner, Hayley C. Leonard, Jane Waite, Sue Sentance

18th ACM **Conference** on **International Computing Education Research** ICER 2022

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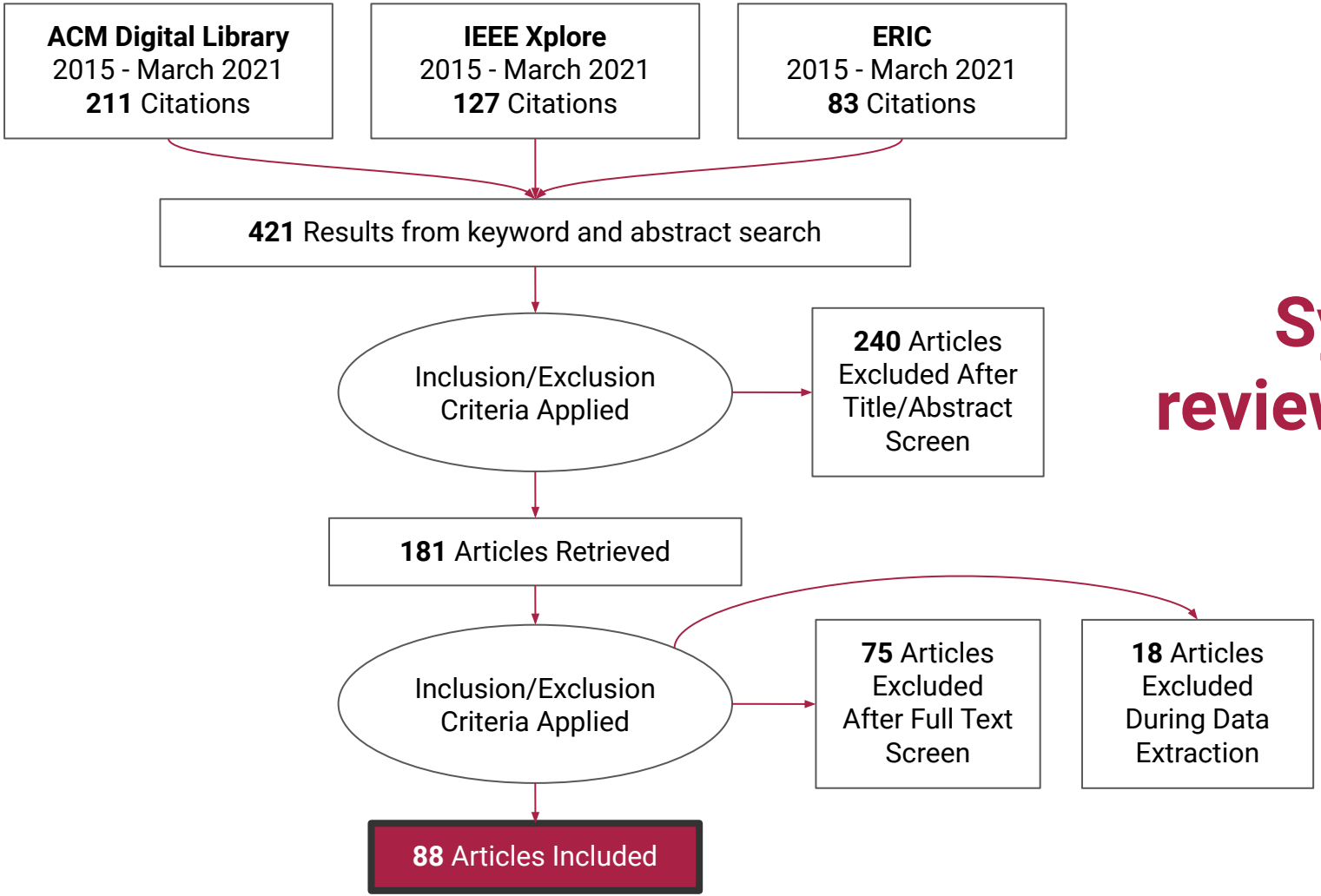
Aim: Provide an overview of recent research and provide a starting point for more rigorous research.

Scope and research questions

We included **88** papers 📑!

- ✓ Non-formal education
- ✓ Age 5-18
- ✓ At least 5 hours
- ✓ Physical setting
- ✓ Computing focus
- ✓ Substantive impact data
- ✓ 2015 - March 2021

- **RQ1**: What has been the **focus** of non-formal computing education research? Learners, providers, topics, measures.
- **RQ2**: What is the **impact** of non-formal computing education on learners? synthesis



Systematic review to avoid bias

Example included papers

Dynamics of emotion, problem solving, and identity: Portraits of three girl coders
Maggie Dahn & David DeLiema

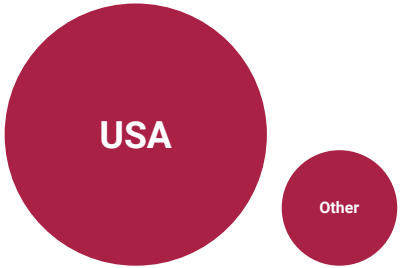
Identifying Pathways to Computer Science: The Long-Term Impact of Short-Term Game Programming Outreach Interventions
Antti-Jussi Lakanen and Tommi Kärkkäinen

Computing Education for Intercultural Learning: Lessons from the Nairobi Play Project
Ian Arawjo et al.

Making Apps: An Approach to Recruiting Youth to Computer Science
Jody Clarke-Midura and Chongning Sun, Katarina Pantic

Empowering middle school girls to create data-enabled social apps
Lijun Ni, Farzeen Harunani, Fred Martin

RQ1: What has been the **focus** of non-formal computing education research?



Mostly USA

Mostly middle school

More female only cohorts

Focus on broadening participation

Lack of detail on socio economic status

Lack of focus on disability

Learners

RQ1: What has been the **focus** of non-formal computing education research?

Most studies were university organised

Some studies by non-profit organisations, tech companies, makerspaces, etc.

Most common purposes: Broaden participation and interest development

Most studies took place in **immersive multi-day settings** (e.g. summer camps)

Providers and purpose

RQ1: What has been the **focus** of non-formal computing education research?

Game development

App development

Programming

Computing topics

RQ1: What has been the **focus** of non-formal computing education research?

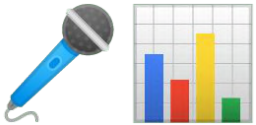
Cognitive

Constructs:
knowledge and **skill** development

Data: pre-post tests, artefact evaluation and focused case studies

Affective

Constructs: interest, **perception**, **engagement**, **self-efficacy**



Data: Surveys and interviews and focused case studies

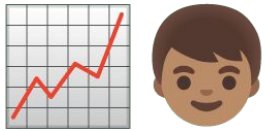
Outcome measures

RQ2: What is the **impact** of non-formal computing education on learners?

Cognitive - broadly positive

Some evidence regular settings were beneficial for knowledge development

Active teaching of problem solving skills can lead to independence



Learning gains were similar for male and female cohorts but some evidence of higher scores for boys

Case studies increase understanding of the *learning trajectory*.

RQ2: What is the **impact** of non-formal computing education on learners?

Affective mostly positive *in the short term*

Improved perception and awareness of computing

Improved confidence and self-efficacy unless mismatched with prior experience

Positive benefits from social factors: belonging, support, mentor relatability

Case studies increase understanding of the *emotional journey*.

Discussion: Affordances of non-formal computing

🚧 Access and awareness

🌍🌎🌏 Cultural relevance and equity

🔃 Practice and personalisation

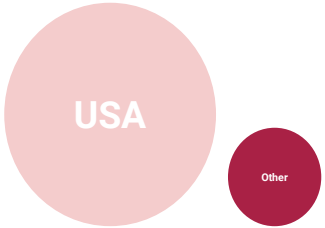
🎡 Fun and engagement

🏡 Community and 👩‍💻 identity

🎯 Immediate impact

Complements formal education

What **don't** We Know about Computing Education for K-12 in Non-formal Settings?



Non US settings

Primary/elementary school

Detailed demographic data

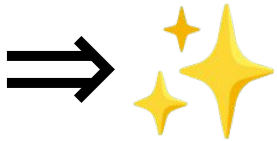
Regular meetups/sessions

Disability

What **don't** We Know about Computing Education for K-12 in Non-formal Settings?

Longitudinal studies measuring impact

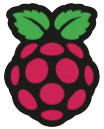
Computing beyond programming



Which specific factors contribute to positive outcomes

Replicable studies

What next?



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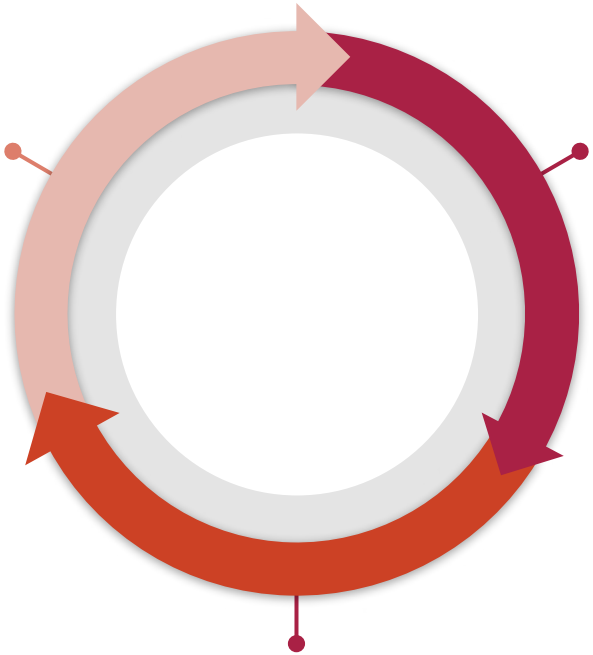
What next?

Research study

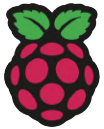
To help fill in the gaps



Research informed 321 Make!

321 Make! in practice

Discussions



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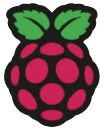
Discussion prompts

1. Should non-formal learning focus on making it easier to make things that matter to young people?

2. How can we better support young people in non-formal settings around the world with different cultural norms and education systems.

References



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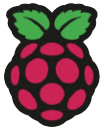
References

1. 321 Make! Paths
   rpf.io/paths

2. 321 Make! mentor guide
   rpf.io/321-make

3. What do We Know about Computing Education for K-12 in Non-formal Settings? A Systematic Literature Review of Recent Research
   rpf.io/nfc



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