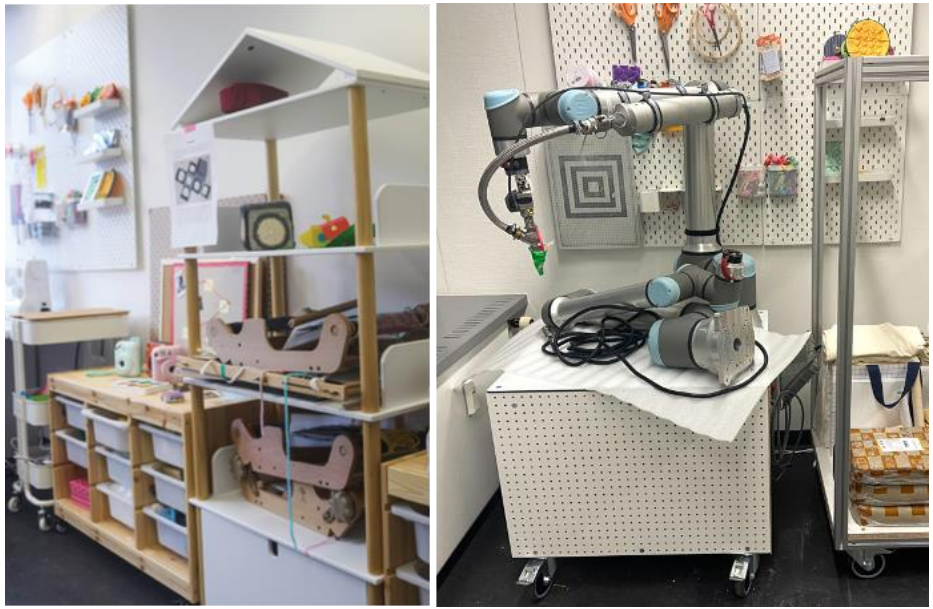
Designing learning environments for making, building, and broadening participation

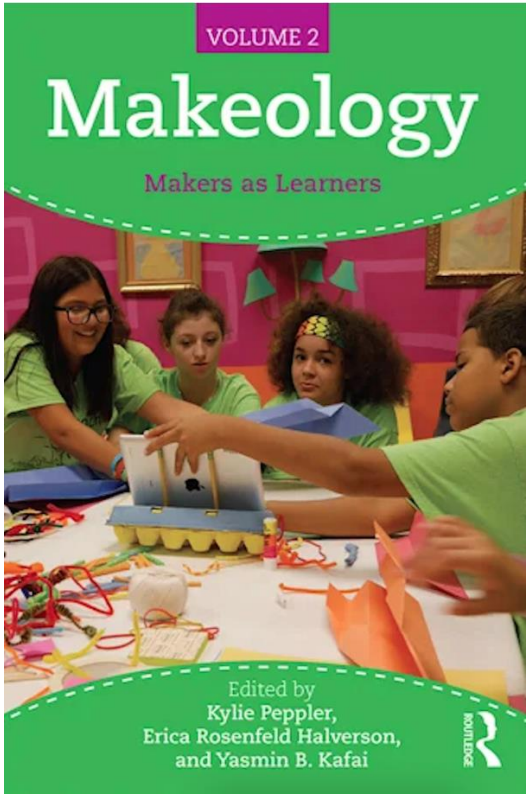


Prof. Dr. Anna Keune
Technical University of Munich

“MAKERSPACES and STE(A)M Education: Opportunities and challenges for implementation in real classrooms”
Nicosia, 07 December 2024

https://www.edu.sot.tum.de/en/lsdesign

Making to broaden participation



The Diverse Makerspaces

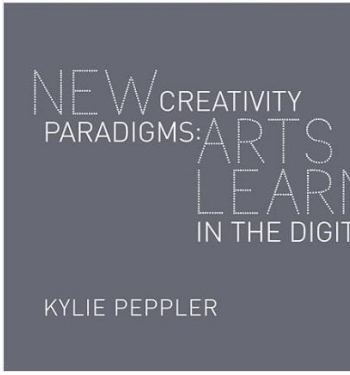
Once By Klaus Thestrup Again I am struck by the differences in what a makerspace might be. Here are some thoughts based on my memory. Around the globe In Perth in Australia at a

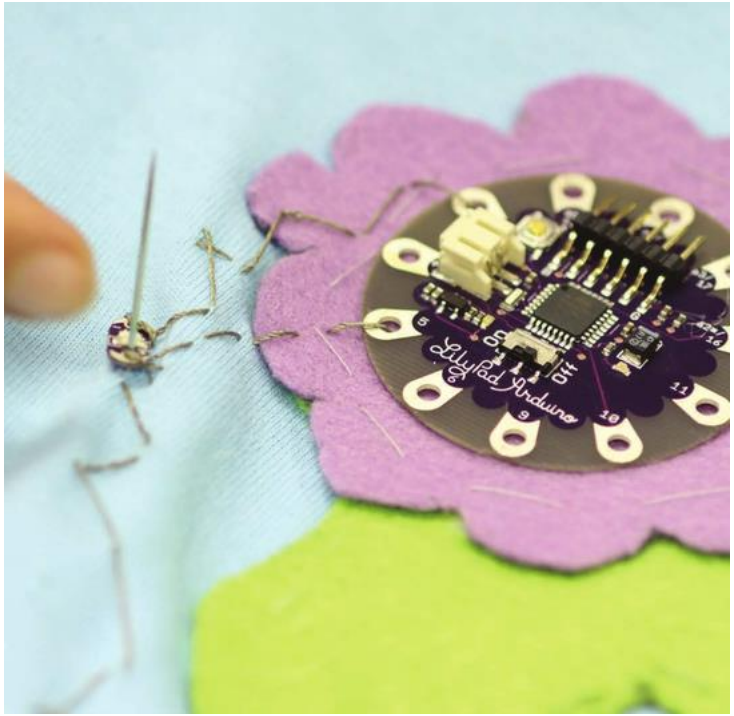
READ MORE

Making in Berlin

Sabine Little, University of Sheffield I spent a month on secondment in Berlin – an interesting experience, as a native German who hasn't lived in the country for well over 20

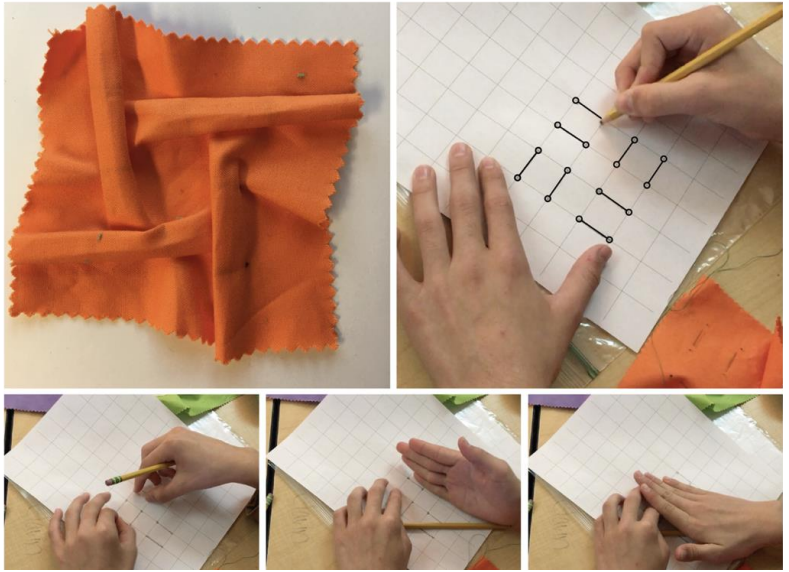
READ MORE





Source: Peppler (2013)

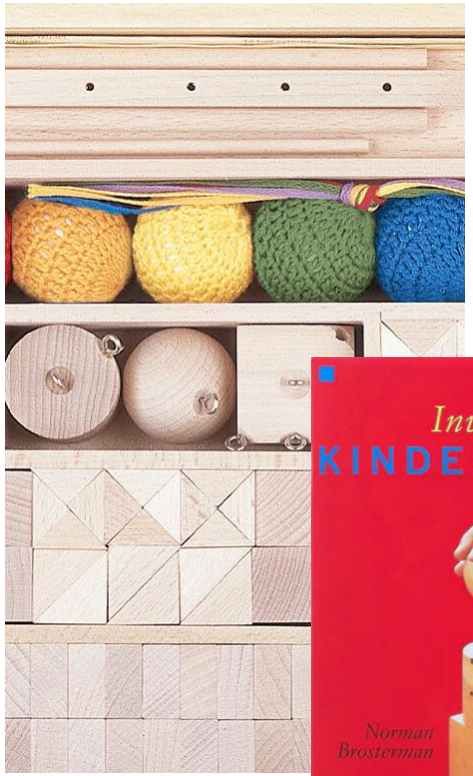
“You can actually feel it happening, like feel the change in the shape, and on [block-based programming] you just see it and look at it.”

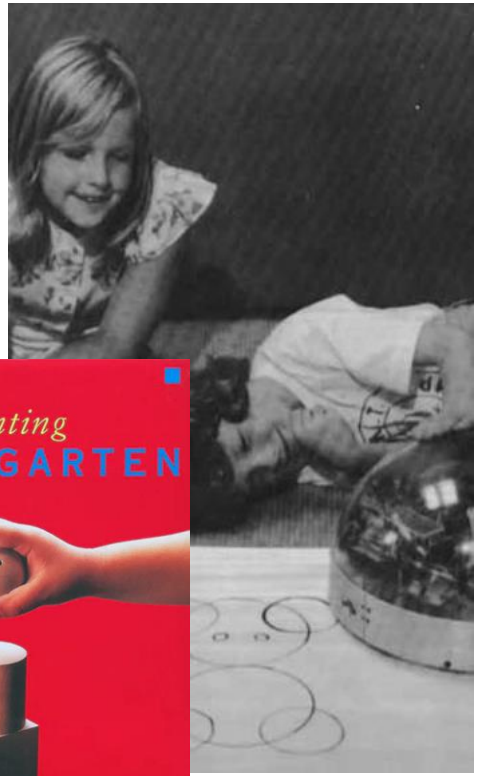


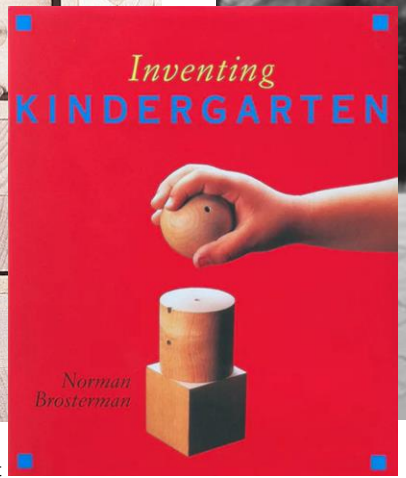
Keune (2024)

Keune (2022)

Materiality as cutting across







Source https://sina-spielzeug.de/produkt/froebel-gift-set

Source: https://www.researchgate.net

- A strong tradition of considering how digital and tangible materials contribute to learning (Kolodner, 2004).
- Materials as *"objects-to-think-with"*: Discover formal systems by exploring the properties of materials in design (Papert, 1980).
- Digital and tangible materials are often considered mediators of learning (Carvalho et al., 2019; Davidsen & Ryberg, 2017; Overdijk et al., 2012).

Most maker education research has taken humanist perspectives on learning with rippling impacts on learning theory, design, and methods.

A (re)take on materials

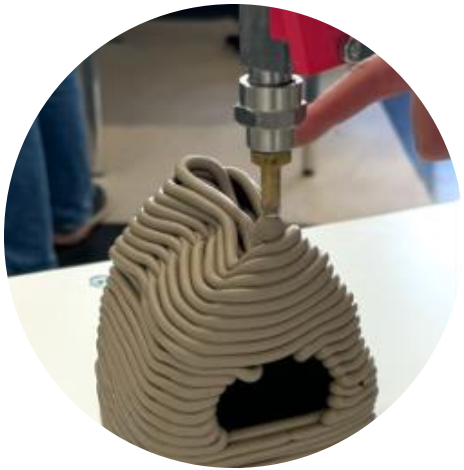
- Expanded the role of materials in learning (Arnseth & Krange, 2016; Seitamaa-Hakkarainen et al., 2022; Keune, 2022).
- Rupture the traditional focus on humans to highlight how knowledge production and materiality are bound together (Fenwick et al., 2011; Kuby & Rowsell, 2017; Taylor et al., 2012).
- Capturing learning requires detailed analyses of intra-actions among humans and materials (jointness of parts, changing physical shapes; Keune, 2023; Kuby, 2017; Wohlwend & Thiel, 2019).

Disrupting the materiality that maintains educational systems offers potential for transformation.

Fenwick et al., 2010

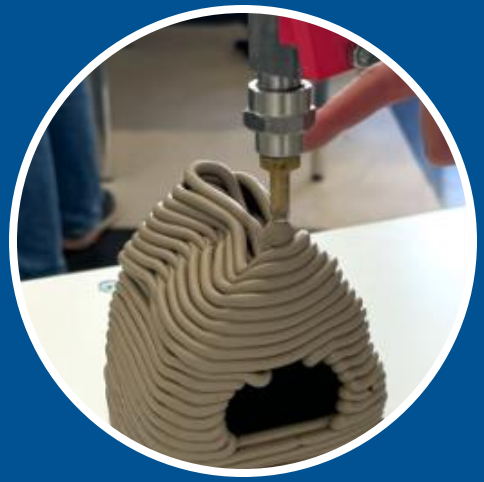
Sustainability as reason to focus on materials

Two examples



Robotic clay extrusion for built environments

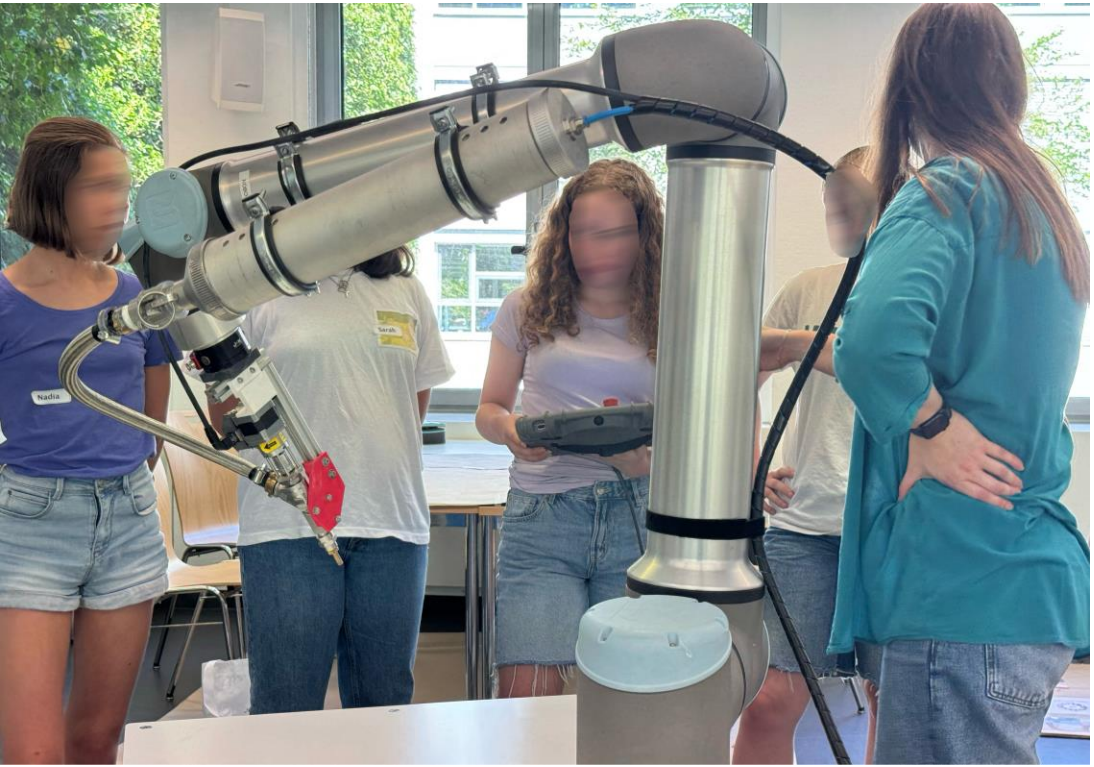
AI ethics literacy through material and digital design

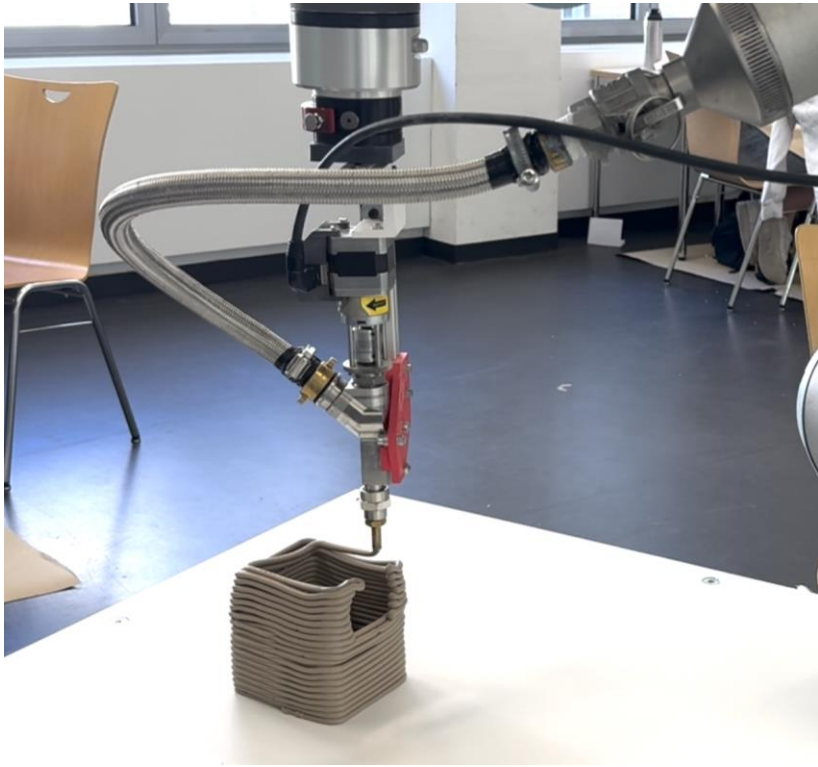


Robotic clay extrusion for built environments

AI Ethics through digital-material design

Robotic clay extrusion for built environments





VR AMC lab tours

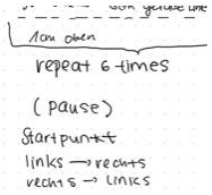
A guided walk: focused on building designs

Rediscover traditional building materials

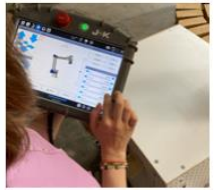
3D pen to identify basic geometric shapes

TinkerCad mondeling and hand-coiling

Piping bag extraction



Act like a robot: peforming the robot movements



3D printing with an UR10e

Sustainability of materials: different materials use and impact

Portfolio making

Research question

How do young people perform key aspects of sustainable construction through robotic clay printing while engaging in digital and tangible learning activities?

Methods: Setting and participants

4-day summer workshop “sustainable future of construction” (6 hours per day)

- Day 1: introduction to architectural design and construction robotics
- Day 2: Digital and clay modeling techniques
- Day 3: Clay extrusion
- Day 4: Capturing and sharing design processes

Participants: 9 girls (self-identified; ages 13 - 15)

VR AMC lab tours

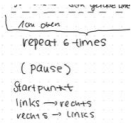
A guided walk: focused on building designs

Rediscover traditional building materials

3D pen to identify basic geometric shapes

TinkerCad mondeling and hand-coiling

Piping bag extraction



Act like a robot: peforming the robot movements (pseudo-code)

3D printing with an UR10e

Sustainability of materials: different materials use and impact

Portfolio making

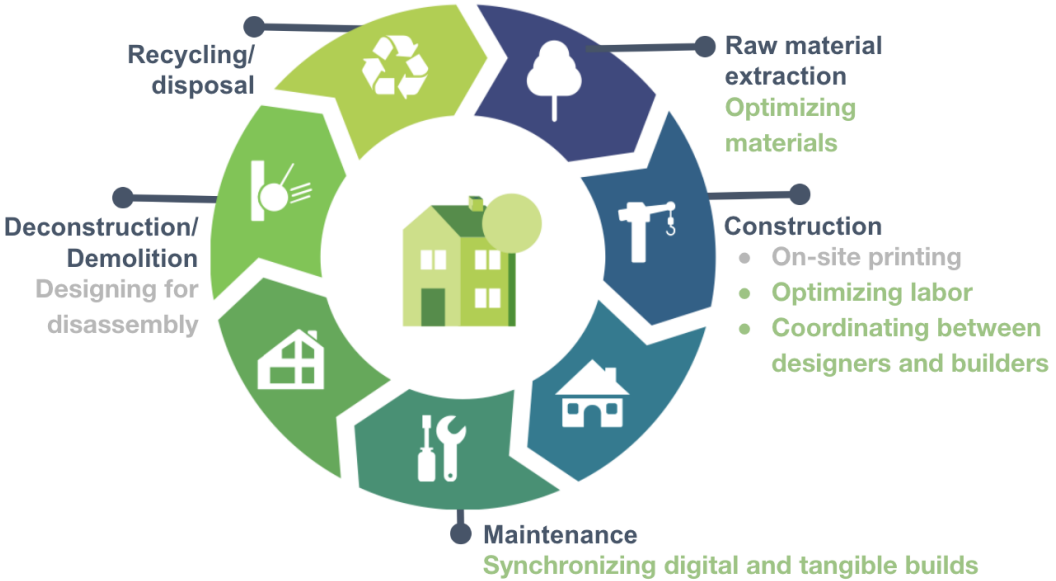
Methods: Data sources and analysis

Data sources

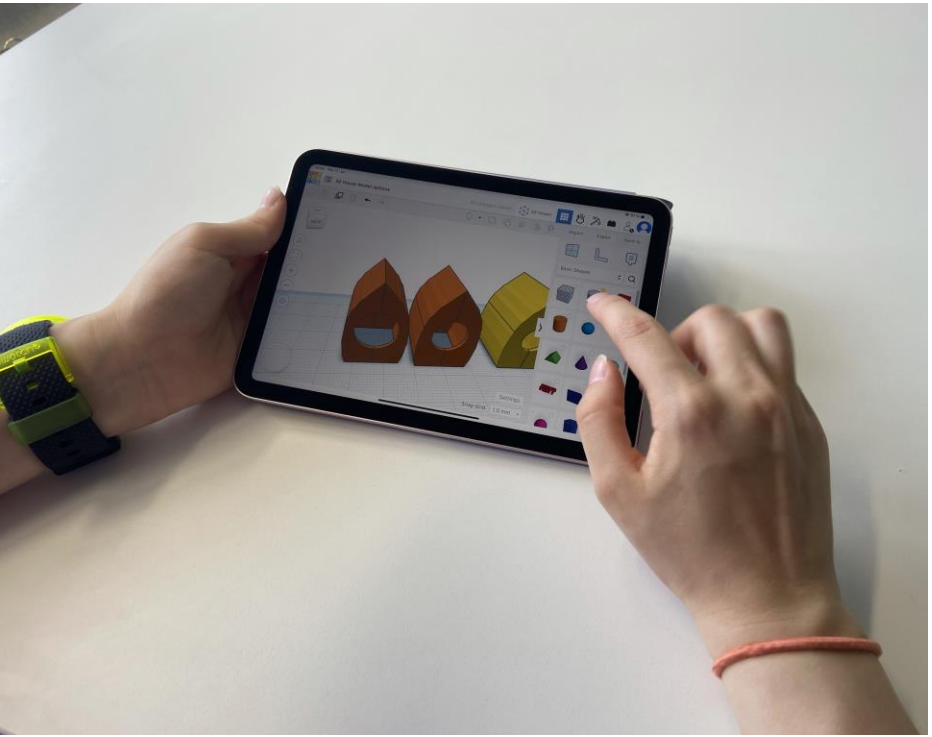
- 81 hours of video from four cameras (one per small group)
- 4 hours of screen recording

Data analysis

1. Optimizing materials
2. Synchonizing digital and tangible builds (digital twin)
3. Optimizing labor
4. Coordinating between designers and builders



Findings



Findings: Optimizing materials

“We started with a digital design because we thought we would have an overview...then went on to the clay to see if it would collapse or not.”

– Nora, age 13

Findings: Synchonizing digital and tangible builds

Luna builds a pyramid in clay.

Luna starts making the design in clay, by layering the coils, making a small square shape.

Coils are placed on the grid surface and secured on top of each other.

The coils are layered into several layers, the edges of the clay design are rounded.

Findings: Optimizing labor

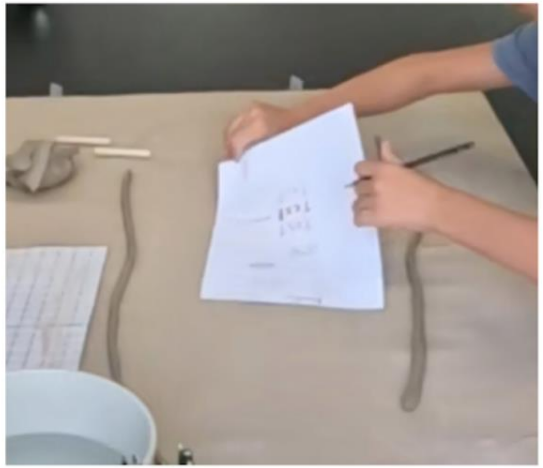
Sophia created the digital 3D model

Luna and Nora prepared clay coils to replicate the digital structure.

Findings: Coordinating between designers and builders

Screenshots of planned and implemented design adjustments.

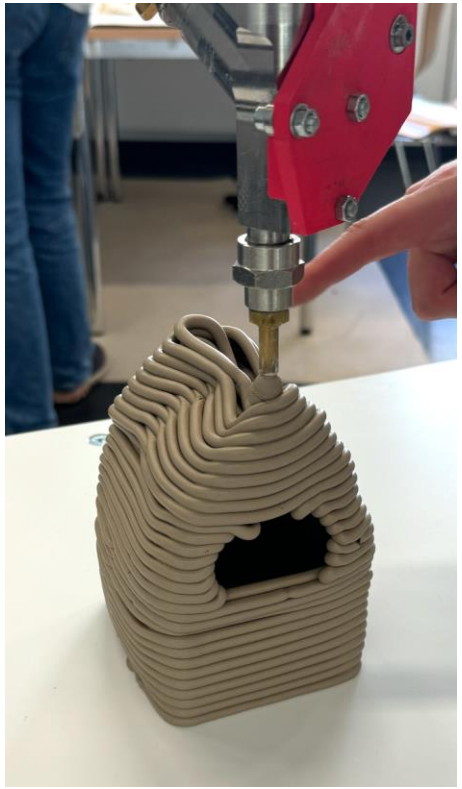
Nora makes a triangle gesture with her hands, saying: "You must go inward."

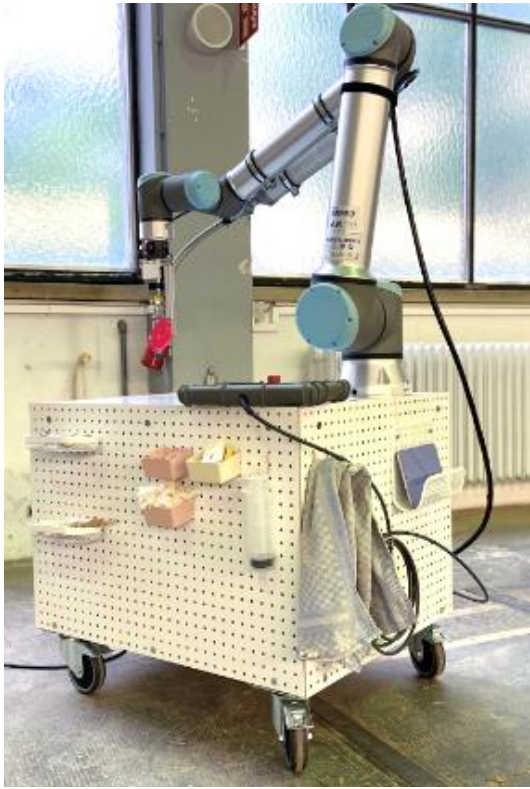


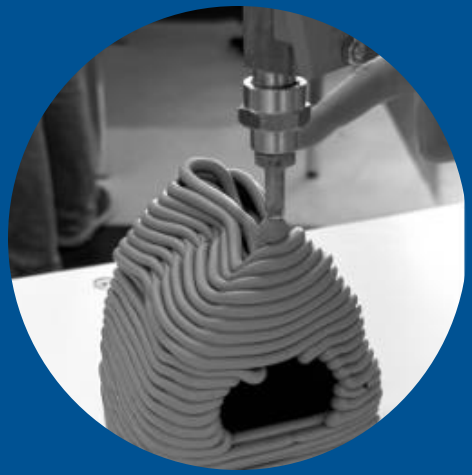
She places a piece of paper on the table.

Nora shares the new architectural plan by drawing four squares.

Clay extrusion take aways





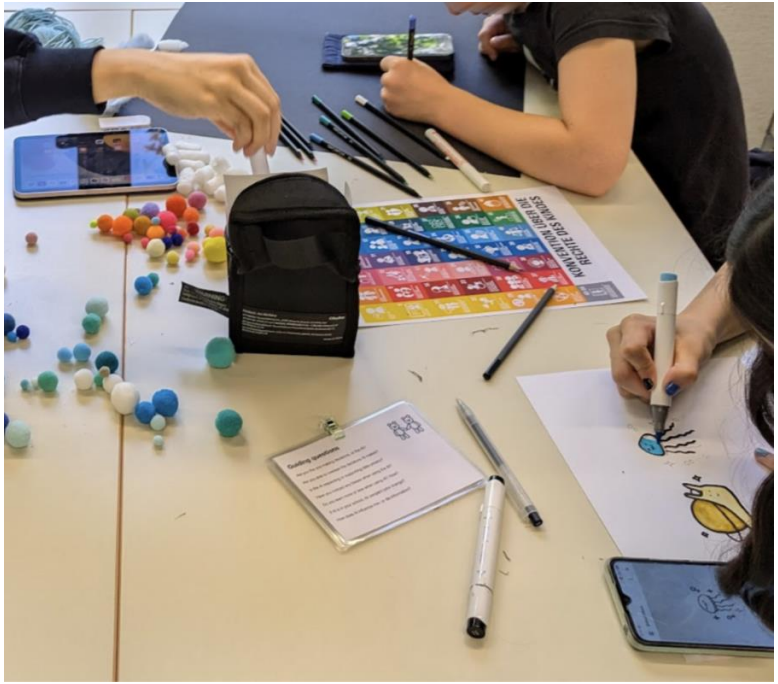


Robotic 3D printing of built environments with clay

AI Ethics through digital-material design

AI ethics literacy

- Increase of AI in education with ethical implications (Holmes et al., 2022; Morales-Navarro, 2023).
- Ethics issues can exacerbate inequities in learning (Adams et al., 2023).
- Promising directions: Digital and tangible modalities of AI literacy (Druga et al., 2019; Morales-Navarro et al., 2023).



Keune et al. (2024)

Peppler et al. (2021)

AI ethics literacy: Scenarios

Practicing AI Ethics Literacy: 10 scenarios for engaging with AI ethics in education



The 10 *Practicing AI Ethics Literacy* scenarios show examples of how AI technologies could be used in educational contexts and encourage engagement with AI ethics principles. The scenarios are based on selected reports of how AI technologies have been envisioned for educational settings in student-centered ways. We designed the scenarios as educational tools to facilitate much-needed conversations about ethical issues related to AI tools and technologies in educational settings. The *Practicing AI Ethics Literacy* scenarios are aimed at fostering AI ethics literacy in relation to a diverse set of AI technologies with different functionalities and associated ethical and legal risks for education.

Share feedback on the Practicing AI Ethics Literacy scenarios: Feedback on the Practicing AI Ethics Literacy scenarios.

AI ethics literacy: Learning activities

Creating an homage to a local artist

Editing drawings with cultural discourses

Drawing mixed with materials

Creating art with AI through expanding frames

AI ethics hero

Prototyping ethical AI

The time capsule

Research question

How do young people practice AI ethics through collaborative digital and tangible design with AI?

Methods: Participants and data sources

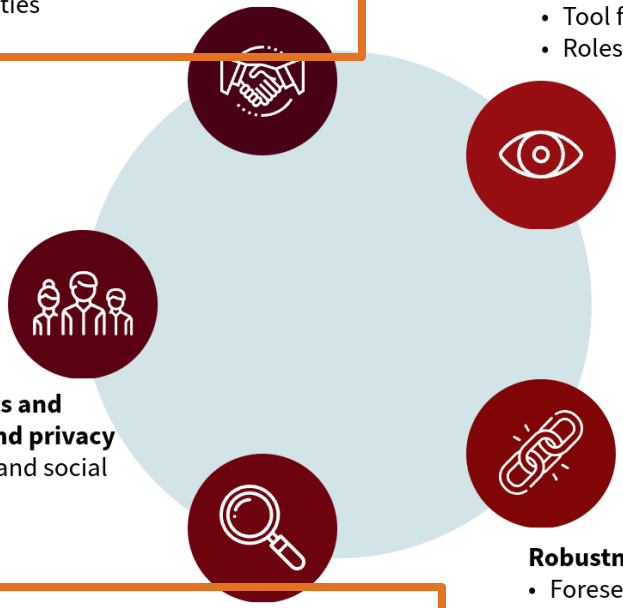
Participants and setting

- 12 girls (age 12-14)
- Summer camp: 4-day course
  - Day 1: Magazine cutouts
  - Day 2: Textures and expanded frames
  - Day 3: AI ethics hero comic
  - Day 4: Ethical AI app design

Data sources

- Video recorded small groups (45 hours)
- Semi-structured interviews (2.5 hours)
- 236 Photographs of youth projects

Methods: Analytical techniques



Inclusive growth, sustainable development and well-being
- Augmenting human capabilities
- Enhancing creativity

Accountability
- Tool features for ensuring AI ethics principles
- Roles for ensuring AI ethics principles

Respect for the rule of law, human rights and democratic values, including fairness and privacy
- Non-discrimination, equality, diversity, and social justice

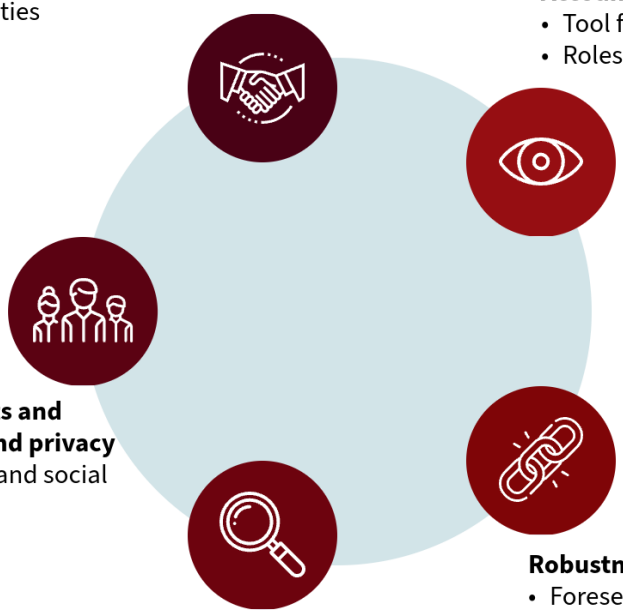
Robustness, security, and safety
- Foreseeable use
- Misuse or adverse conditions

Transparency and explainability
- Understanding outcomes of AI system

Methods: Analytical techniques

Inclusive growth, sustainable development and well-being
- Augmenting human capabilities
- Enhancing creativity

Accountability
- Tool features for ensuring AI ethics principles
- Roles for ensuring AI ethics principles



Respect for the rule of law, human rights and democratic values, including fairness and privacy
- Non-discrimination, equality, diversity, and social justice

Robustness, security, and safety
- Foreseeable use
- Misuse or adverse conditions

Transparency and explainability
- Understanding outcomes of AI system

Findings: Tangible techniques support AI Ethics literacy

Enhancing creativity

“[The AI] wasn’t very creative and it kinda stole our idea. If you see this here it’s almost similar to that one. [...] [The AI is] not really [helpful] because you already had that idea, and you are looking for new inspiration and you won’t get it from here.”

Findings: Tangible techniques support AI Ethics literacy

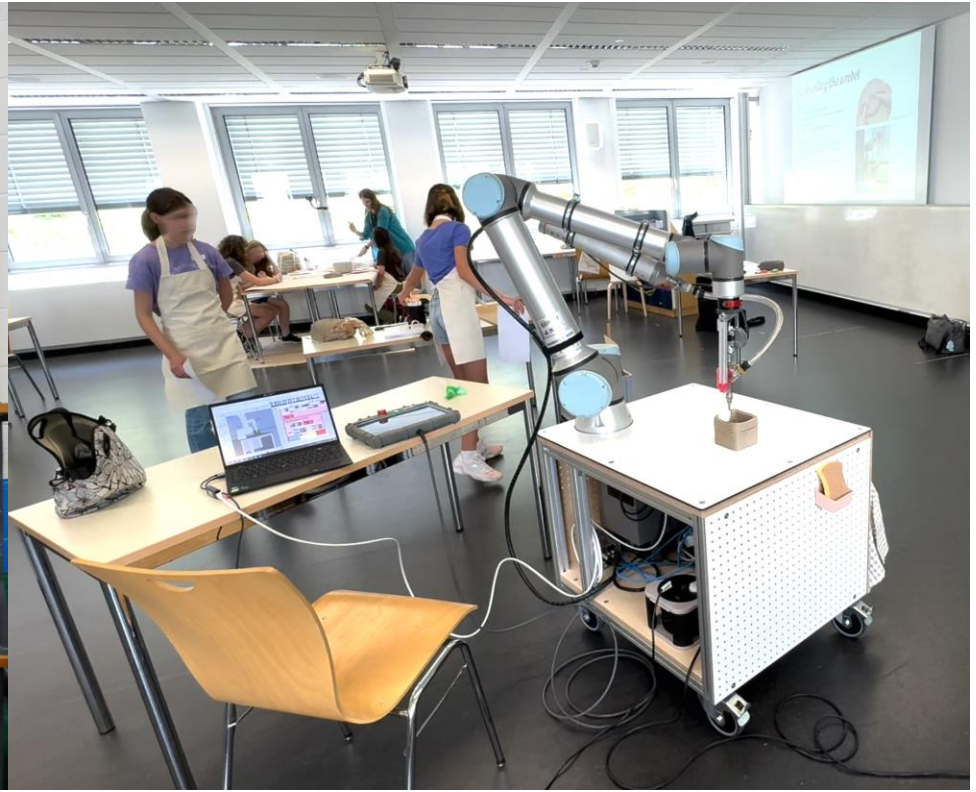
Understanding outcomes of AI & enhancing creativity
“It’s not what we imagined. [...] There were no steps which showed how it was produced. But there must be a process.”

AI ethics take aways

- Moving across digital and tangible materials fostered arts-based contexts that are rich in AI ethics.
- Familiar materials and techniques can deepen critical exploration of non-familiar digital tools and technologies.

Take aways for makerspaces

Take aways for makerspaces



Thank you.

Prof. Dr. Anna Keune
Technical University of Munich

“MAKERSPACES and STE(A)M Education: Opportunities and challenges for implementation in real classrooms”
Nicosia, 07 December 2024

https://www.edu.sot.tum.de/en/lsdesign