Learning, Education & Families

Nadia Azizan, Kunlei He, Seehee Park, Mehreen Masood, Zhenyao Cai, Ariel Han

Venues

CHI Subcommittee
Interaction Design and Children (IDC)
Learning@Scale
Other Journals

CHI Subcommittee - History

Before 2018

Specific Applications Areas

Example user groups: **children**, **families**, people in developing countries, employees, charities and third sector organisations.

Example application areas: **education**, home, sustainability, ICT4D, creativity

2018

Learning, Education, & Families

The “Learning and Education” component of this subcommittee is suitable for contributions that deepen our understanding of **how to design, build, deploy, and/or study technologies for learning processes and in educational settings.**

CHI Subcommittee

- **Growing Importance of Digital Learning**
  - Increasing impact of technology on learning and education
  - Evolution of digital learning platforms, educational software, online resources, and virtual classrooms
- **Increased Use of Technology in Families**
  - Rise in adoption of technologies within families for various activities
  - Tools developed for enhancing family interactions, leisure, and learning
- **Interdisciplinary Research**
  - Education intersecting with various fields such as psychology, sociology, cognitive science, etc.
  - A dedicated subcommittee fostering interdisciplinary collaboration on issues related to education

CHI Subcommittee

Learning and Education

- Focus: Designing, building, deploying, and studying technologies for learning and education.
- Topics: Intelligent tutoring systems, multimedia interfaces, learning analytics, collaborative learning systems, teacher-facing designs, tangible learning interfaces.
- Settings: Online learning, learning at scale, primary to higher education, informal learning environments.

Families

- Focus: Understanding and extending design of technology interactions within families.
- Topics: Health & well-being, social, psychological, and cultural phenomena related to family interaction with technology.

IDC (Interaction Design & Children)

- **Focus:** For researchers, educators, and practitioners to share the latest **research findings, innovative methodologies, and new technologies in the areas of inclusive child-centered design, learning, and interaction.**
- **Areas of interest:**
  - **Empirical Studies** - theoretical approaches to interaction design for children, empirical studies examining this interaction, and studies investigating the effects of technology on children's development and lives.
  - **Design method & process** - methods and techniques used in interaction design for children. It encompasses constructive design research involving children, and includes the active involvement of children in the design process itself.
  - **Innovative design & artifacts** - futuristic and sustainable design practices and the development of innovative interactive technology specifically for children. It involves the creation of novel artifacts and design that pave the way for the future of technology.
  - **Survey & vision** - reflective analyses on the field of child-computer interaction and interaction design. It includes future vision articles that discuss potential trends and directions for the field. It also examines matters of equity, diversity, inclusion, and social justice as they pertain to children.

L@S (Learning at Scale)

- **Focus:** The Learning at Scale community investigates **large-scale, technology-mediated learning environments** that typically have **many active learners and few experts** on hand to guide their progress or respond to individual needs.
- **Purpose:** Increase human potential, leveraging data collection, data analysis, human interaction, and varying forms of computational assessment, adaptation and guidance.

- **Topics:** Massive open online courses, mobile learning applications, intelligent tutoring systems, open courseware, learning games, citizen science communities, collaborative programming communities (e.g. Scratch), community tutorial systems (e.g. StackOverflow), shared critique communities (e.g. DeviantArt), and countless informal communities of learners (e.g. the Explain It Like I'm Five sub-Reddi

What are the major differences between these three venues (CHI subcommittee, IDC, & L@S)?

Which venue might be the most suitable for the research projects?

Using Information Visualization to Promote Students' Reflection on "Gaming the System" in Online Learning

L@S

ZooDesign: Methods for Understanding and Facilitating Children’s Education at Zoos

IDC

Visual StoryCoder: A Multimodal Programming Environment for Children’s Creation of Stories

CHI

Other disciplines

Psychology	Child Development, Journal of Educational Psychology
Educational Technology	Computers & Education, British Journal of Educational Technology, Educational Technology Research and Development (ETR&D), Learning Media and Technology
Learning Science	International Society of Learning Science, Journal of Learning Science
AI & Learning Analytics	Artificial Intelligence in Education (AIED), Learning Analytics Conference (LAK), Educational Data-mining Conference (EDM)

Framing Papers

1. Cooperative inquiry: developing new technologies for children with children

2. Another Decade of IDC Research: Examining and Reflecting on Values and Ethics

Cooperative inquiry: developing new technologies for children with children

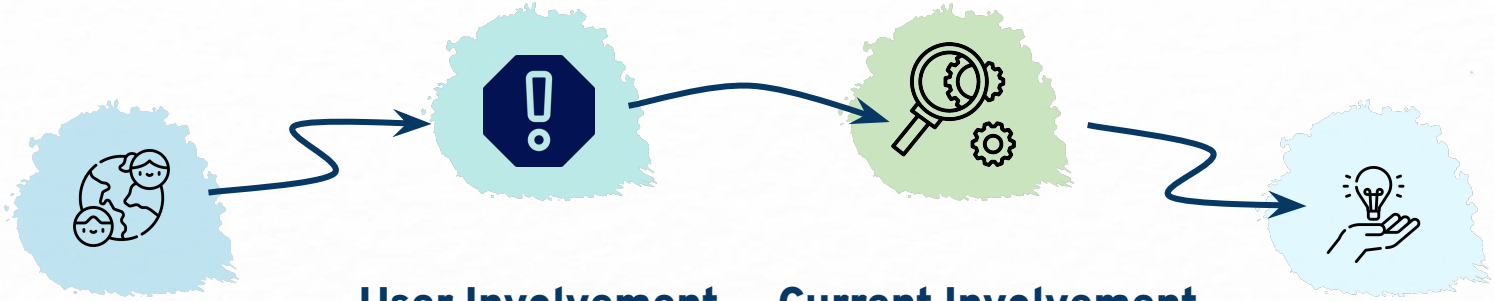
Making technology for kids without working directly with them is "like making clothes for someone you don't know the size of." – Thomas, KidsTeam Child Design Partner Alumni

Allison Druin CHI'99

Overview

- This article highlights the **research technique** (i.e., Cooperative Inquiry) that incorporates children as research partners and foster intergenerational communication to understand children's unique views from their context
- The article based on traditional **HCI research methods** (i.e., participatory study, field study- contextual inquiry) explores how it can be applied to working with children
- The author emphasizes that children should be considered **partners** in research (design) when developing new tools for children
- The author demonstrates findings from the **empirical studies** (i.e., KidPad and PETS), working with children as research partners, what children can do, and what adults need to consider

Children As Our Research Patterns



Children & Technology Use

Children are an important new consumer group for Technology.

User Involvement

Children are less commonly involved in the research process.

Current Involvement

Children most frequently asked to be technology testers in workshops or school settings.

Proposed Solution

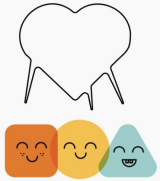
A method inclusive of child research partners: Cooperative Inquiry.

Just a Kid?

D4CR

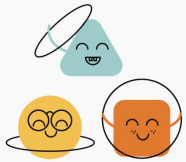
DESIGNING *for* CHILDREN'S RIGHTS GUIDE

Design for Inclusion



1. Gather and respect children's views

RIGHT TO PARTICIPATE & RIGHT TO BE HEARD



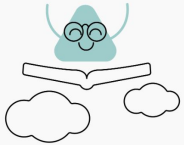
2. Everyone can use

NON-DISCRIMINATION

3. Use communication children can understand

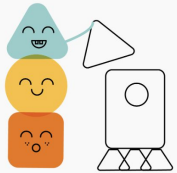
RIGHT TO INFORMATION

Design for Play & Learning



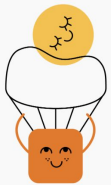
4. Allow and support exploration

RIGHT TO DEVELOPMENT & RIGHT TO LEARN



5. Encourage children to play with others

RIGHT TO DEVELOPMENT & RIGHT TO PARTICIPATE



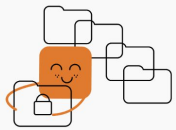
6. Create a balanced environment

RIGHT TO DEVELOPMENT, RIGHT TO LEARN & RIGHT TO LEISURE AND PLAY

Design for Safety & Sustainability

7. Keep children safe and protected

RIGHT TO BE PROTECTED



8. Do not misuse children's data

RIGHT TO PRIVACY

9. Help children recognise and understand commercial activities

RIGHT TO INFORMATION

10. Design for future

RIGHT TO LIFE & RIGHT TO INFORMATION

NOT Just a Kid!

In what ways do you think can researchers encourage and promote meaningful child participation in the research process while still respecting parental authority and guidance? How can we foster a collaborative approach that values both the child's autonomy and the parent's input?

Discussion

A Theoretical Framework


Creating Technology
FOR and WITH Children

Three Beliefs

1

Multidisciplinary Research Partnership with Users

2

Field Research: context, activities, and artifacts

3

Iterative Low-tech and High-tech Prototyping

Multidisciplinary Research Partnership with Users

Field Research: context, activities, and artifacts

Iterative Low-tech and High-tech Prototyping

Equal Footing

The Process

Contextual Inquiry

Participatory Design

Technology Immersion

Contextual Inquiry

- Method adapted for use with Children
- Here users are both Informants & Researchers
- Involves at least 2 note-takers and one interactor
- There are different note-taking methods for adult and child researchers
  - Adults → Detailed Text Descriptions
  - Children → Drawing
- Important for the interactor to be a participant observer
  - Both Children and Adults had a difficult time being interactors
  - Children → get too involved
  - Adults → power structures → wear informal clothing to look like a peer
  - Interactor needs to really be the interactor, not Interviewer
- Data collected by adult and child researchers is analysed differently in this step

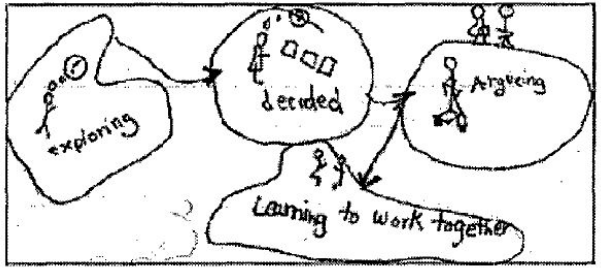


Figure 1: Contextual inquiry notes by a 7-year old child

Participatory Design

- Does not necessarily have to follow after Contextual Inquiry
- However, most useful when done after collecting data from Contextual Inquiry
- Children 7-10 years most effective prototyping partners
- Low-tech prototyping:
  - Some art supplies, Adults, and Children
  - Challenge: Adults relating to Children as design partners
  - Children and Adult must work and make design decisions together
- Choosing prototyping materials according to area of research is critical in participatory design

Technology Immersion

- Need: See how Children use large amounts of technology over a concentrated period of time
- Envisioning the future, not the present
- Used to establish a technology-rich and time-intensive environment for Children
  - Children need to be decision makers in that environment
  - Important to see activity patterns of children, independently of their parents/other adults
- Using observation techniques of Contextual Inquiry
- Most Difficult of the 3 Cooperative Inquiry Techniques
- Useful mostly after contextual inquiry and participatory design sessions are done but does not necessarily have to be part of the cooperative inquiry process

Design-Centered Learning

(1) I learned about the design process All team members discussed understanding the technology design process in new ways.
(2) I learned respect for my design partners Both adults and children discussed their mutual appreciation for the work that the other could accomplish.
(3) I learned to communicate and collaborate in a team Children and adults discussed the difficulties and the rewards of learning team communication and collaboration skills.
(4) I learned new technology skills and knowledge All team members mentioned technical skills they had come to learn (e.g., building robots, designing software).
(5) I learned new content knowledge In the case of the team working on the PETS project, children and adults discussed learning more about animals.

What are your thoughts on Cooperative Inquiry as a Research Method? How do you think has this method evolved over time?

Can you recall applying similar techniques in your research? If yes, how could you better adapt those for use with children?

Discussion

Relevance to today's learning & HCI

Keywords

April 2018

Using Co-Design to Examine How Children Conceptualize Intelligent Interfaces

CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in...

Julia Woodward, Zari McFadden, + 4

Total Downloads 1,323

6

May 2021

The Show Must Go On:: A Conceptual Model of Conducting Synchronous Participatory Design With Children...

CHI '21: Proceedings of the 2021 CHI Conference on Human Factors in...

Kung Jin Lee, Wendy Roldan, Tian Qi Zhu, + 6

Total Downloads 1,273

7

May 2016

The Evolution of Engagements and Social Bonds During Child-Parent Co-design

CHI '16: Proceedings of the 2016 CHI Conference on Human Factors in...

Jason C. Yip, Tamara Clegg, + 6

Total Downloads 1,250

RESEARCH-ARTICLE

Co-designing online privacy-related games and stories with children

Priya Kumar, Jessica Vitak, Marshini Chetty, Tamara L. Clegg, + 3

June 2018 • IDC '18: Proceedings of the 17th ACM Conference on Interaction Design and Children • https://doi.org/10.1145/3202185.3202735

RESEARCH-ARTICLE

Co-designing Mobile Online Safety Applications with Children

Brenna McNally, Priya Kumar, Chelsea Hordatt, + 6

April 2018 • CHI '18: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems • https://doi.org/10.1145/3173574.3174097

Another Decade of IDC Research: Examining and Reflecting on Values and Ethics

Saba Kawas, Ye Yuan, Akeiylah DeWitt, Qiao Jin, Susanne Kirchner, Abigail Bilger, Ethan Granthan, Julie A Kientz, Andrea Tartaro, Svetlana, Yarosh

Overview

- **This article reflects** on how IDC values have changed between **2011 and 2019**, identifying trends and values in the **last two decades (2002-2019)** and presenting what types of contributions IDC papers make, what behaviors and qualities IDC research aspires to support in children, and what theories, models, and frameworks inform IDC research.

- This article presents the **ethical considerations** central to the surveyed author's work to discuss implications for future contributions to expanding the qualities in the community aims to support children.

Main argument & Key findings

- Human **values are embedded in every aspect** of our design process and have been a concern in HCI.
- The rapidly changing nature of technology, our increasing knowledge about **ethical considerations, and further advancements in methods** of working with children, makes it important to regularly reflect on community's work and update what has changed over the years.
- **Authors sent a survey to the first authors** of papers published between 2011 and 2019.

Main argument & Key findings

RQ1) What types of contributions do IDC papers make?

- To compare primary contributions between the **first decade (2002–2010)**, and the **second decade (2011–2019)**, authors matched categories that shared similar definitions.
- In the second decade, most papers emphasized contributing empirical knowledge from both qualitative and quantitative studies, and 23% of papers contributed a novel artifact.
- Fewer papers focused on designing novel systems, and thus the artifact category seemed to show a strong declining trend over the past two decades.
- Authors found more papers consistently valued designing and evaluating technologies in the second decade.
- 17% of papers from 2011-2019 explicitly discussed reflecting and examining methods used to work with children, but 6% emphasized creating new knowledge.

Main argument & Key findings

RQ2) What behaviors and qualities does IDC research aspire to support in children?

- 41% aimed to support children in developing social skills, 35% collaborating with their peers to share knowledge and design in facilitating effective group work.
- Aimed to support more generative behaviors, like ability to construct narratives, creativity, and imagination to support children when expressing their personal ideas.

Main argument & Key findings

RQ3: What are the roles of the children and other stakeholders in the design and research process?

- IDC researchers still value children's participation in the technology design process, and more papers ensure that designs reflect children's voices from 2011-2019 (20%, as opposed to 14% from 2002-2010). However, fewer papers explicitly discuss the value of children as active agents in the design process.
- Authors examined papers from 2011-2019, 49% of papers included parents, 31% of papers included teachers, and 16% of papers included other professionals (doctors, therapists, administrators).
- Second decade, IDC have begun to design culturally appropriate interventions for children with different abilities and needs.

Main argument & Key findings

RQ4: What theories, models, and framework inform IDC research?

- Identified a much broader array of theories than in 2002-2010, including staged and other general developmental psychology theories.
- Found authors using design theories and frameworks to inform their work and participatory design.
- Social science theories to understand how children learn and develop is central to IDC work.

Main argument & Key findings

RQ5) What criteria inform IDC's technical design choices?

- IDC continues to value intrinsic motivation and engagement in new technologies, and increasingly values designing for the learner's experience in new technologies.
- IDC shared some similar design criteria with the broader HCI community, but the discussion on natural technology design seemed to decrease over the past two decades.
- IDC from the second decade rarely addressed concerns about technology negatives, but focused more on online safety and privacy, problematic app designs, datafication, and use of intelligent systems, AI, and voice agents.

Main argument & Key findings

RQ6) How has 2011-2019 work seized on the opportunities for IDC presented in Yarosh et al.?

- 75% of the 2011-2019 made explicit references to theories and models while fewer than half of papers from 2002-2009 used theory in their work.
- Investigated children younger than 5 and older than 12 in the recent years, however still relatively few papers specifically target teenagers or 2-3 year old children.

Reflecting on IDC Values Over Two Decades

- More **empirical** vs artifact contributions: authors are more likely to build systems in service of **research questions** vs technical novelty
- Reflective and innovative methods: use of **theories and models** more common practice, researchers employ a **wider variety of theories**
- Supports children's **learning, development, and creative growth**, and **increasingly values play**
- Reflecting children's voices: recognizes the child as an **active agent** in the adoption of technology, and seeks to partner with **children as codesigners**
- IDC continues **designing systems that bridge the physical and the digital** with new technologies developed from 2010 - 2019

IDC holds core values while still learning and adapting to new knowledge: a healthy research community! :)

Opportunities For Future IDC Research: Empowering Children

- IDC is dedicated to **including children's voices**, promoting the **inclusion of their views**, and **protecting their rights** in participation research
- **Empowerment**: developing specific skills to increase self-efficacy, competence, perceived controls over one's life to enact change, and involvement in social systems
- IDC community can leverage perspectives from **empowerment** theory to **interpret insights from children's lived experiences** and provide implications for designing children's technologies that support their **autonomy** and **agency**

Opportunities For Future IDC Research: Empowering Children

Empowerment: developing specific skills to increase **self-efficacy**, **competence**, perceived **controls** over one's life to enact change, and involvement in **social systems**

1) Empowerment as a **quality of design** for children
2) Empowerment in the **research** process
3) **Data** empowerment

Opportunities For Future IDC Research:
Empowerment as a quality of design for children

- Explore the creation and design of technologies that foster children's sense of **autonomy** and **empowerment**
- Empower children through their diverse lived experiences by considering **how children desire to change** and facilitating **reflective opportunities**
- Support behaviors that foster children's **agency** and empowerment, like **self-management**, **reflective practices**, and **self-regulation**
- Utilize suitable **empowerment measures** and develop new child-appropriate measures when evaluating designs for children

Opportunities For Future IDC Research: Empowerment in the research process

- Extend children’s roles beyond the design process and into roles as **research collaborators** and **active creators**: support design skills in children.
- Ensure the inclusion of **children’s perspectives** within the design process and **children's contributions** in the research outcomes.
- **Positive experiences** for children in research: Explore practices of measuring how **participation** in studies affects children in the **short** and **long term**
- Reflect on **research motivation** and how it aligns with **children’s needs**

Opportunities For Future IDC Research: Data Empowerment

- **Data empowerment**: children's sense of **agency** over the **privacy**, **control**, and **security** of their data.
- Examine how researchers **inform children** about the **use** and **ownership** of their data
- Uphold privacy and safety for children during and after research is completed: Critically weigh the **benefits of children's participation** vs the research outcome
- Explore practices to ensure children **access** and **control** over their research data: age-appropriate controls for **reviewing** and **deleting** data if desired, allowing participants to follow up with researchers to **inquire** about their data

Opportunities For Future IDC Research: Diversity and Inclusion

- Extend research to include **marginalized communities**: children from diverse ethnic groups, low socioeconomic backgrounds, foster children, war refugees
- Expand collaborations to encompass **research partners** and their expertise: community leaders, social workers, therapists
- Base research on **children's lived experience**: create appropriate research methods and practices
- Attract and mentor **broader, global pool of researchers** to diversify the population the research community aims to support

Opportunities For Future IDC Research: Multidisciplinary Collaboration

- Integrate **findings**, **models**, and **theories** from **diverse disciplines**: education, social science, humanities
- Enhance **multidisciplinary collaboration** by **co-locating IDC with relevant conferences**: International Conference of the Learning Sciences (ICSL), Conference on Computer-Supported Collaborative Learning (CSCL), special topics meeting of the Society for Research in Child Development (SRCD), FabLearn, and computing education conferences (SIGCSE, ITiCSE)
- Co-locations could **broaden impact outside of IDC**, a desire reflected in responses to the author survey

Another Decade of IDC Research: Examining and Reflecting on Values and Ethics

- **Survey** contribution
- **Disciplines:** developmental psychology, education, design, humanities, social sciences
- **IDC ethics and values:** more empirical contributions; more theories and models from diverse disciplines; values children's learning, development, creativity, and play; committed to reflecting children's voices
- **Children's empowerment** in design, research, data
- **Diversity** and **Inclusion**
- **Multidisciplinary Collaboration**

Discussion

How do you approach empowerment within your own research? In what ways has your field sought to empower its research populations?

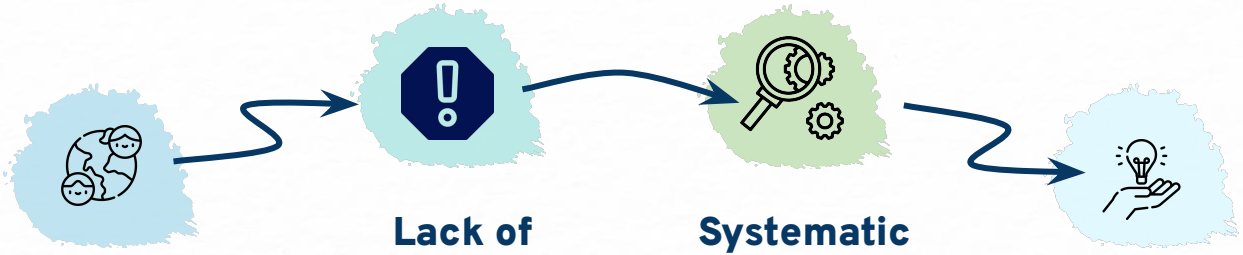
What do you think of the authors recommendations for children's empowerment as a quality of design, within the research process, and within data?


Thank you! Any questions?

12 Ways to Empower: Designing for Children's Digital Autonomy

Wang et al., 23

Overview



Children's Digital Autonomy

Growing research in this area since technology is now an essential part of Children's lives.

Lack of Consensus

Lack of consensus on the conceptualization of digital autonomy for children in the HCI community

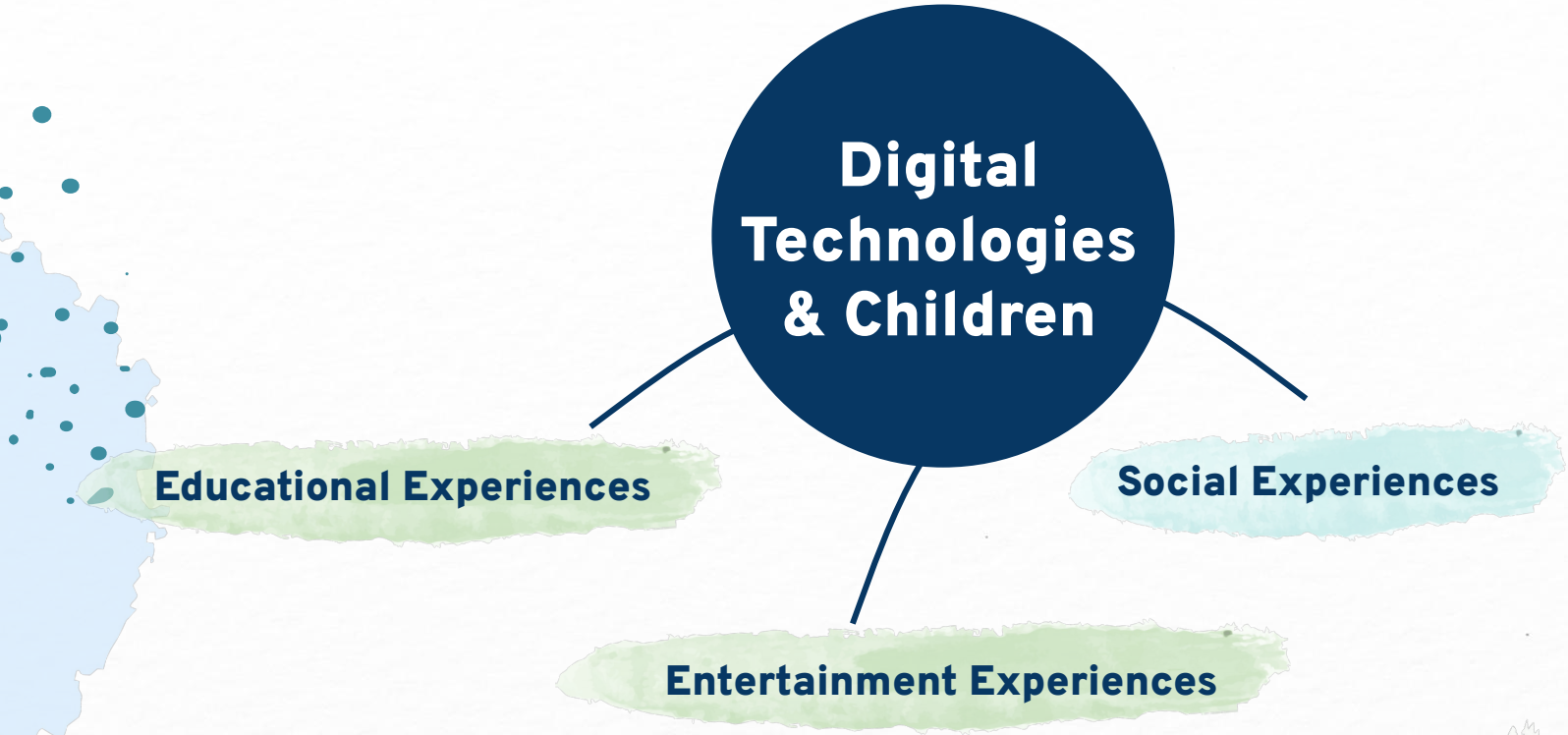
Systematic Review

Systematic review of autonomy supportive designs within HCI research

Contributions

- Landscape Overview
- Framework of 12 distinct design mechanisms
- Identification of 5 design considerations

Technology Use and Children



Not Optional, but Essential

Learn **Have Fun** **Grow**

Children of today are **‘digital natives’**

“This has raised concerns and questions about how digital environments including digital apps, systems, services, platforms and more, are affecting children’s wellbeing, and whether such environments adequately support their developmental needs”

Parents as Experts - is it true?

Traditional Belief: Parents and Caretakers know better than Children and guide children about technology use

In today's digital age, this may not always be true.

Interacting with technology these days is almost second nature to children.

There is a generation gap between parents and children which poses limitations!

What Technology did your parents use?

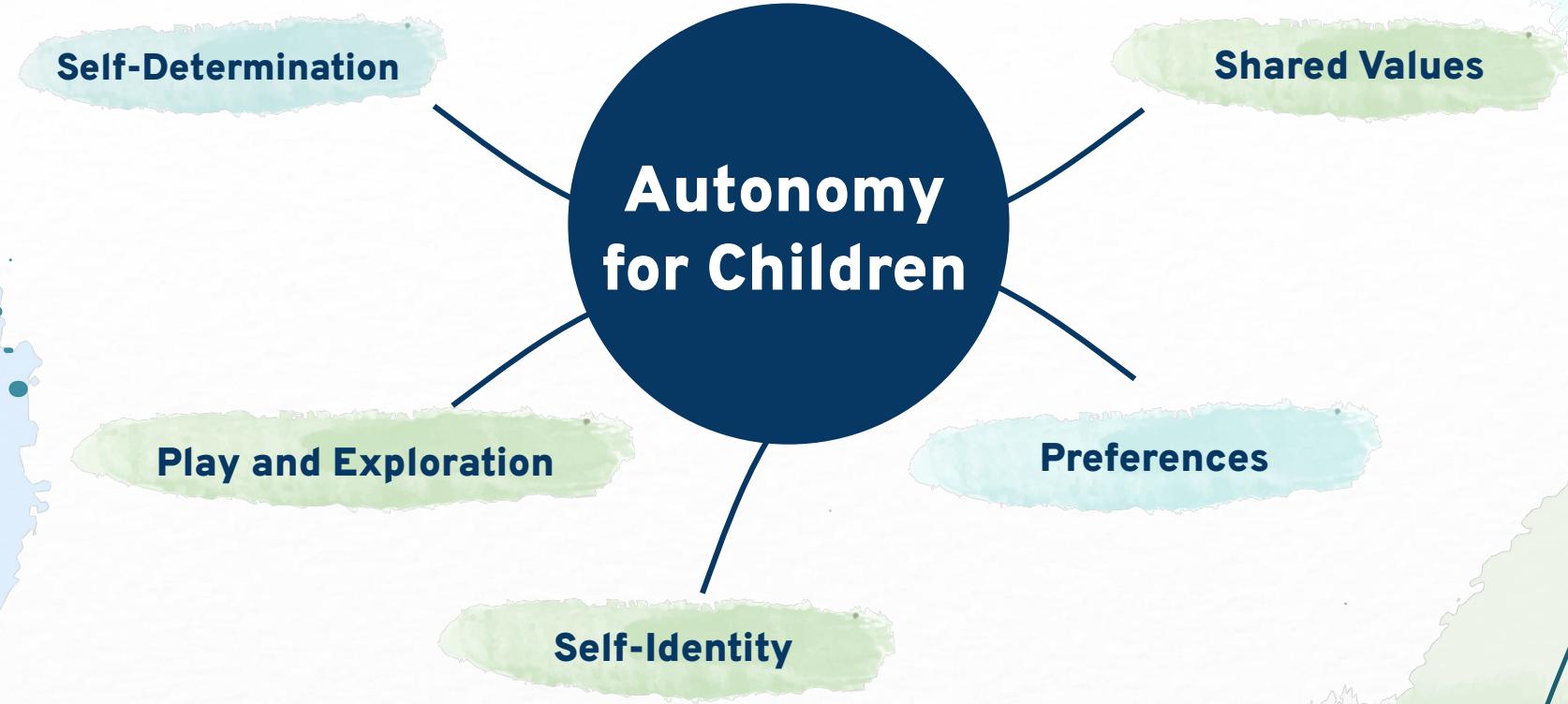
When Your Parents Don’t Understand Technology

The Shift to Digital Autonomy

Parent-led Teacher Perspective → **Child-Centered Approach**

Instructing Children → **Supporting Children's Experiences**

Importance of Digital Autonomy



HOWEVER

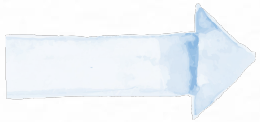
While research effort has been made in various domains of children's digital lives, the lack of a systematic understanding of what indeed counts towards children's digital autonomy and how designs could be implemented to support children's digital autonomy remains an open challenge in the community.

Research Questions

RQ1: How does the HCI literature conceptualise digital autonomy for children?

RQ2: What autonomy-supportive design mechanisms have been explored in apps and systems for children?

How does the paper argue that its topic is worthy of study?



"We argue that this clarity is critical for the current attention on developing better support for children, helping with their skill and autonomy development."

"Furthermore, it is crucial for us to recognise the landscape of how digital autonomy for children is currently supported, and identify any design patterns or gaps of attention."

Related Work

Autonomy for Children: Philosophical Underpinnings

Personal, Behavioral , Functional Autonomy

“In fact, one key element of the transition from adolescence to adulthood is the development of autonomy [68] — the stage of adolescence represents a period of dramatic change in children’s capabilities for self-awareness, self-reflection, self-regulation, self-control, self-efficacy, self-determination, decision making and independence [84, 105].”

HCI Research around Designing for Children’s Autonomy Online

Safeguarding considered job of parents and caretakers. However, times have changed.

“Children are the masters of technology, and for most of them, their parents could possess far less knowledgeable in this domain [51, 121].

This potential reverse in expertise calls for attention on the line of work around supporting children’s drive for autonomy and identity online.”

Discussion

How do you think does offline autonomy for children intersect with their autonomy in online, digital activities and decision-making processes?

What are some potential risks and challenges associated with empowering children digitally? How can we help children develop critical thinking skills to navigate the digital world safely and make informed decisions about their online activities?

Key findings

RQ1

Conceptualization of Digital Autonomy

RQ2

Autonomy Design Mechanisms

Conceptualization of Digital Autonomy

Intrinsic motivation
Self-regulation

"The ability to self-regulate, plan, set goals, and choose their own actions with intention."

Screen time
Children's right
Ownership

Critical thinking
Informed decisions

"The ability to critically make their own decisions about what information to disclose online,"

Gender stereotypes
Harmful contents
Cyberbullying

Computational thinking
Literacy development

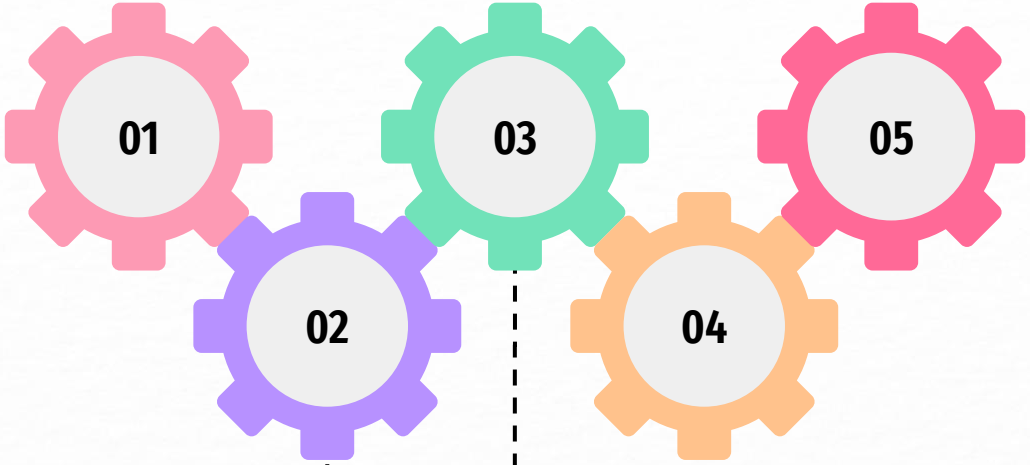
"Internalize the knowledge and understanding to evaluate thoughts"

Digital literacy
Data literacy
AI literacy

Autonomy Design Mechanisms

Scaffolding

Just in-time Prompt
Informative
Interaction



Nudging

Default Options
Creating Fiction
Fear Alert
Social Feedback

Decomposing

Storytelling
Gamification

Peer support

Collaboration
Comparison

Digital playground

Neptune is the farthest planet from the Sun

01 Scaffolding

Scaffolding
Giving children support when they need it and help them move through their gaps of knowledge

Just-in-time Prompt

Give children "the support just when they need it" through introducing information and help buttons.

Informative Interaction

Initiating children's interactions and communication between their tutors, parents or even the technological prototype

Scaffold Choice of Own

Support children to become more aware and more responsible for their own activities online.

02 Decomposing

Decomposing

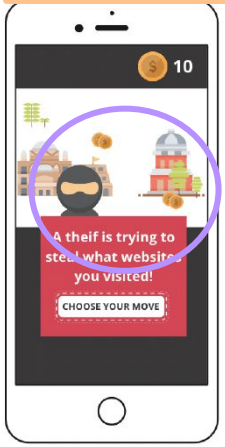
Break down somewhat complicated digital concepts into entities that are more approachable for children, and advocates child-centred discovery learning where children use what they already know, to acquire more knowledge

Storytelling

Support children to construct stories around digital concepts (e.g., elements of algorithm) based on concepts that they are familiar with.

Loopy Music, teaches that a *Loop* is "something that happens over and over again."

Gamification

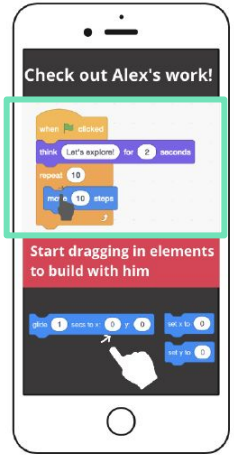


Breaking down digital concepts into game elements that children are more familiar with. Help children become familiar with digital concepts through game playing.

03 Peer Support

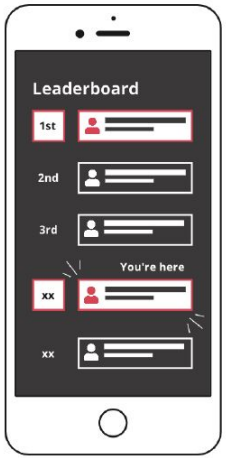
Peer Support
Encouraging social interaction between children and their peers in order to promote their digital autonomy.

Peer Collaboration



Encourage children to work together to solve problems, complete tasks, or learn new concepts.

Peer Comparison



Encourage children to compare their works/performance with others to support their development.

04 Digital Playground

Digital Playground
Encouraging children to freely interact with digital systems in more embodied ways, learning through playing.

Digital Playground

Support children to freely explore and interact with the physical artefacts around them, supporting children's learning through more embodied movement and activities.

05 Nudging

Nudging
Imposing subtle design changes that could alter children's behaviors and reinforce positive ones

Default Options

Setting users' pre-set goals as default options. These pre-sets goals include online/offline time, content they want to see etc.

Pre-set Goals
"Learn more Maths as watching YouTube videos"

Creating Friction

Use of extra activities or tasks to pause children's immediate next step.

Fear Alert

Use of fear messages to stop children - take protective measures or to refrain from activities that might harm themselves or others

Social Feedback

Attempt to alter children's behaviours based on the feedback or comment from others.

Design Considerations

Design Considerations	*Examples*
Identifying critical points of intervention ***(e.g. maximising impact or varying time of interventions)***	Hiniker et al. (#26) introduced a dialogue box "Return to Plan" when it is time to transition to next activity. Parker et al. (#6) displayed key questions such as "How is this ad trying to get your attention?" as children are ready to comment the online ads.
Promoting self-generated knowledge ***(e.g. based on data that children can connect to or relate to their own experiences)***	Lee et al. (#44) instructed children to create their own game rules, help them transform their tacit knowledge about game play into formal computational logic. Soleimani et al. (#32) encouraged children to connect stories to real life scenarios and their personal interests.
Translating short-term boosts into longitudinal benefits ***(e.g. exploring invoking deeper thinking or self-reflection)***	Alemany et al. (#19) first nudged children by displaying "The privacy risk of your post is HIGH", then introduced separate messages alongside the nudge, showing the exact users might see their posts, guiding children to think about what privacy means online.
Differentiation and Personalisation. ***(e.g. taking more explicit consideration of children's age, developmental needs and cultural backgrounds)***	Horn et al. (#37) made use of children's existing cultural forms to develop stories helping them make sense of digital literacy concepts. Ko et al. (#46) studied how their app (supporting participatory parental mediation) was perceived differently by families with different parenting styles.
Low Floor, High Ceiling ***(e.g. creating scaffolding, decomposing or nudging mechanisms catered for children's skills and ability, and permitting room for growth)***	Hitron et al. (#9) designed their system in a way to support learning experience that does not require any prior formal knowledge and allows immediate exploration. Flannery et al. (#35) designed their system to make if easy for children to get started on programming, then provide room for children to grow with concepts varying in complexity, but keep the tool manageable for the range of users.

Table 1: Future design considerations for more autonomy-supportive designs. #N represents paper number in Appendix.

Let's discuss!

What do you think we need to consider when implementing and designing new types of autonomy mechanisms for children in your study context?

How would you incorporate the 12 ways to empower children for digital autonomy into your own research?

https://tinyurl.com/mathkingdom

5:00

Research Contribution?

EMPIRICAL

ARTIFACT

THEORETICAL

SURVEY

METHODOLOGICAL

OPINION

Research Contribution

SURVEY **THEORETICAL**

Through systematic review of autonomy-supportive designs within HCI, the authors contribute:

1) A landscape **overview of** existing conceptualization of **digital autonomy for children** within HCI
2) A **framework of 12 design mechanisms** for supporting children's digital autonomy, organized into 5 categories based on their common mechanisms
3) **5 critical design considerations** for future support of children's digital autonomy

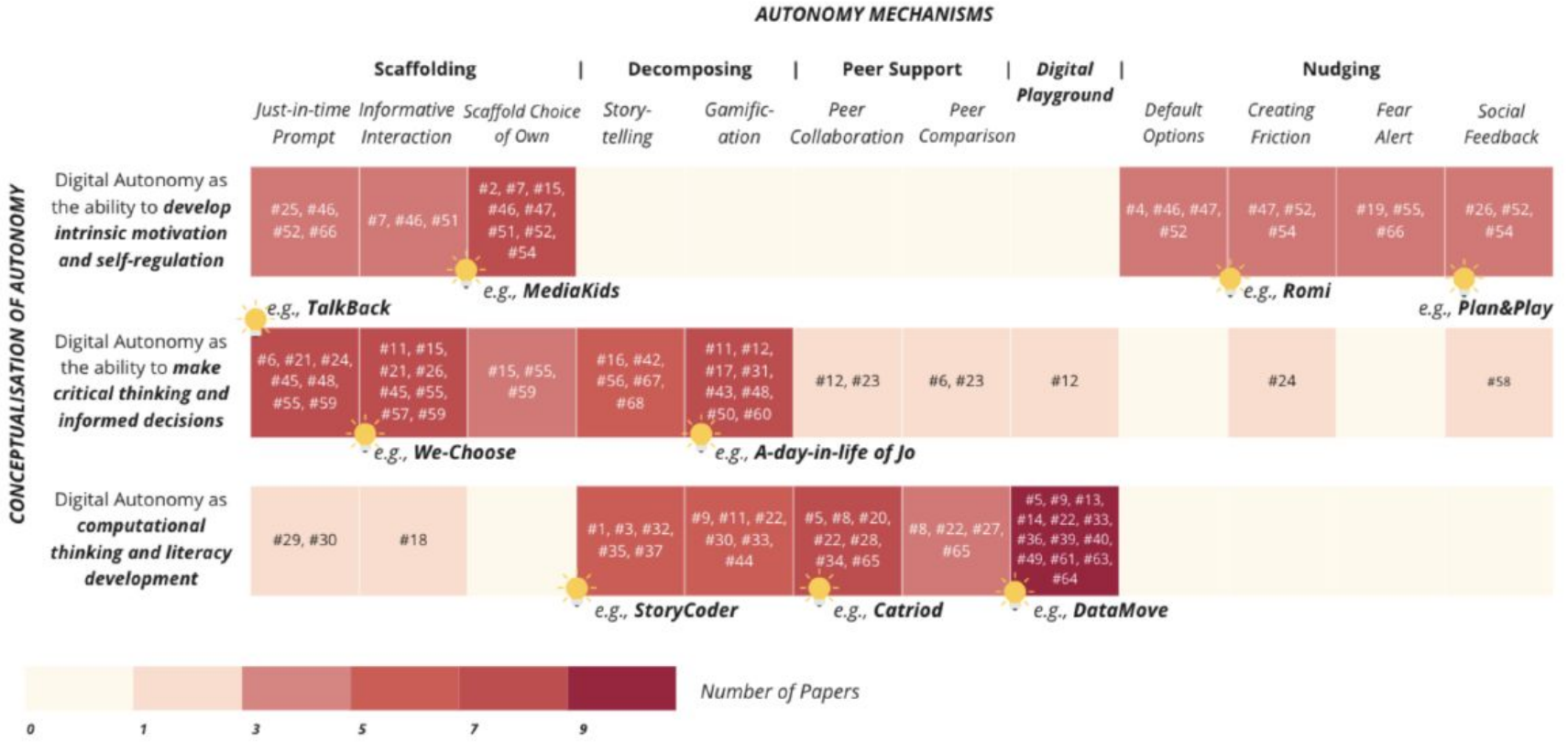


Figure 7: Crosstabulation between groups of conceptualisation of digital autonomy and the autonomy design mechanisms. #N represents paper number in Appendix.

Areas of Inquiry

Philosophy

Personal autonomy: to make decisions and goals based on one's own values

Behavioral autonomy: to take actions independently as satisfy those goals

Functional autonomy: motivations relating to lifestyle, self, image, or self esteem; the ability to conduct essential activities of daily living

Psychology

Self-determination theory: effective self-regulation; responding adaptively to the environment, and initiating, organizing and directing actions towards the achievement of needs

Development

Autonomy a key element of the **transition from adolescence to adulthood;** autonomy defined along three domains of *behavioral, emotional, and cognitive*

Education

Cognitive autonomy: ability to self-determine one's own action

Nursing

Cognitive autonomy: a belief one has control over one's life

Areas of Inquiry

Spear et al's **concept analysis of the term *autonomy* over 20 years of literature across multiple disciplines** defines the three forms of personal autonomy for children and adolescents as:

Cognitive autonomy: process of acquiring knowledge and understanding – to evaluate thought, voice opinions, make independent decision, and self-assess

Behavioral autonomy: ability to make decisions independently and follow through with actions (not simply following or copying others)

Emotional autonomy: ability to free oneself from emotional dependence

This definition emphasizes the **multi-dimensional** aspect of personal autonomy development for children (cognitive, social, behavioral). The authors use this as a **working definition** to a create a scope for conceptualizing digital autonomy within HCI literature.

Conceptualization of Digital Autonomy

Theme	Code	Description / *Example Definition*
Digital Autonomy as the ***ability to develop intrinsic motivation and self-regulation***	Encouraging children's right to their own digital space	• Highlight the importance of children's autonomy against parental monitoring and restrictions
	Fostering intrinsic motivation	• *"for children to regulate their behaviours and develop intrinsic motivation"* • *"Supporting autonomy as triggering intrinsic motivation, which in turn helps people to internalize rules and show a change in behavior"*
	Developing self-regulation based on intrinsic motivation	• *"the ability to self-regulate: plan, set goals, and choose their own actions with intention"* • *"the quality children need to develop into self-dependent adults"*
Digital Autonomy as the ***ability to make critical thinking and informed decisions***	Critically act on information	• *"for a child to make their own informed decisions about what information to disclose online""* • *"To make decisions and follow through at their own pace"*
	Form self-identity	• Cultivate children's critical thinking around their self-representation online and thus form self identity
Digital Autonomy as ***computational thinking and literacy development***	Internalise the literacy and skill sets	• Connects computer-based problems with their personal everyday scenarios as well as broader social issues and challenge
	Make meaningful contributions	• Children gaining the ability to voice and form their own opinions and conduct meaningful discussions based on literacy gained

Conceptualization of Digital Autonomy

Majority of HCI research defined digital autonomy from the **self-regulation perspective** – aligns closely with Spear's definition of "**behavioral autonomy**" (the ability to independent decisions)

More than half the articles explored digital autonomy through supporting children's **critical thinking and computational thinking abilities** – aligns with Spear's notion of **"cognitive autonomy"**

Computational thinking and **critically acting on information** are **equally important** as self-regulation or behavior change

HCI echoes support for **cognitive autonomy** and importance of **multidimensional** perspectives in developing digital autonomy

Critical gap in the HCI literature supporting children's development of **emotional digital autonomy:** the socio-emotional aspects under-explored

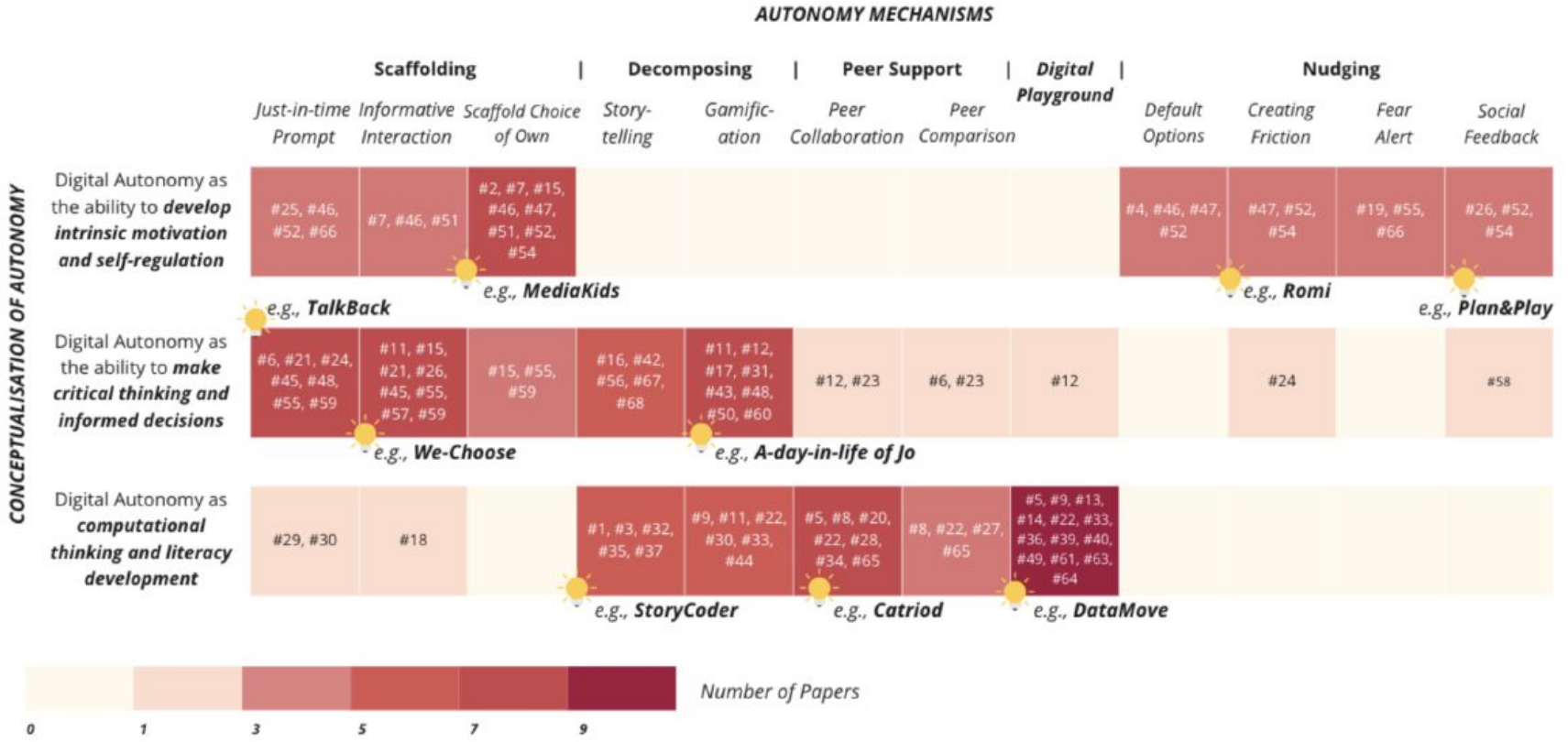


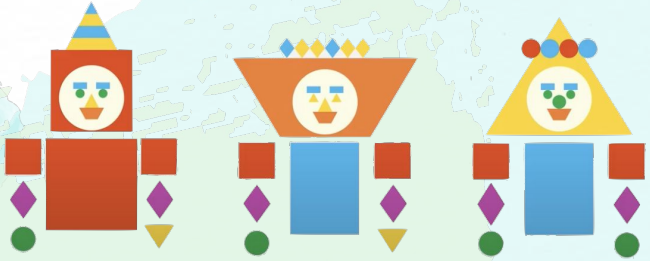
Figure 7: Crosstabulation between groups of conceptualisation of digital autonomy and the autonomy design mechanisms. #N represents paper number in Appendix.

Let's Discuss!

How have you seen **digital autonomy conceptualized** within your own research experience?
As **self-regulation**, **critical thinking**, **computational thinking**, or otherwise?

Have you seen any examples of the **autonomy mechanisms** in your field's literature?

scaffolding | decomposing | peer support | digital playground | nudging



MathKingdom: Teaching Children Mathematical Language Through Speaking at Home via a Voice-Guided Game

Wenjie Xu, Jiayi Ma, Jiayu Yao, Weija Lin, Chao Zhang, Xuanhe Xia, Nan Zhuang, Shitong Weng, Xiaoqian Xie, Shuyue Feng, Fangtian Ying, Preben Hansen, and Cheng Yao.

Overview

1 → **Formative Study**

2 → **Iterative System Design**

3 → **User Study**

Importance of Early Math

- Early math education in natural settings has a profound impact on later academic success.
- Early math learning often takes form of **playful activities**.
- Successful math activities are based on **effective math talks**.

However –

- Most designs focus on math skills without promoting math talks.

Math Language Development

- **Mathematical language** refers to the keywords and concepts required for mathematical activities.
- **Home learning and parental involvement** is crucial to children's early development.
- Home interventions promote math skills through math language.

However –

- No technology has been designed to support learning of math language at home.

Affordances of Voice Agents

- Conversational agents promotes children's **learning and engagement.**
- Conversational agents can engage both **parents and children**.

Therefore –

- The present study leverages conversational agents to promote math conversations between parents and children.

Formative Study

Participants

- 11 families with at least children aged 4-7.

Goals

- Understand parents' attitudes toward the mathematical language
- families' daily practices of mathematical language
- design opportunities that target the correct challenges.

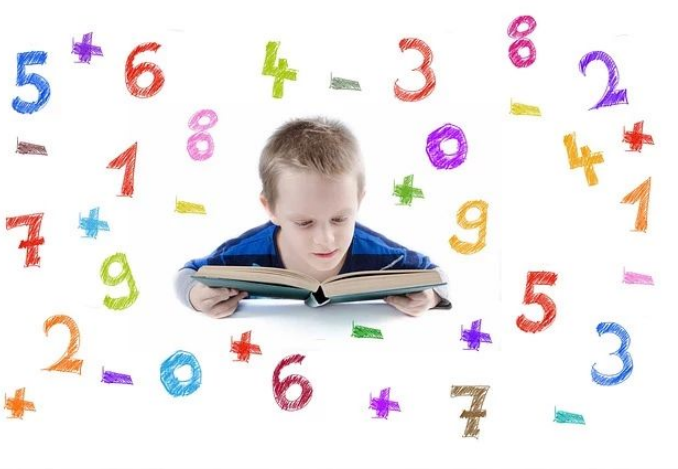
Verbal Engagement

- Children typically engage in math activities through verbal input.
- More input than output.

Therefore -

The design should encourage **the use of math language.**

Lack of Math Dialogues



- Parents felt a lack of opportunities to initiate math dialogues at home.
- Parents did not feel confident in guiding math conversations

Therefore -

The design need to creating **meaningful contexts.**

Low Quality Math Language

- Children's mathematical language at home was oftentimes incomplete.
- Parents lacked guidance on diverse and accurate math language practice for their children.

Therefore -

The design should prompt children to use **a rich variety of** math language and guide children toward more **coherent and accurate math language.**

Low Engagement in Math Talks

- Math dialogues at home were often initiated and led by parents
- Children were not motivated to engage in conversations related to math.

Therefore -

The design should increase children's agency to increase their motivation and engagement in math talks.

Design Goals

Increasing math talks

Using voice agents to guide children in speaking math language.

Fostering math dialogues

Promoting parent-child dialogue in mathematical language.

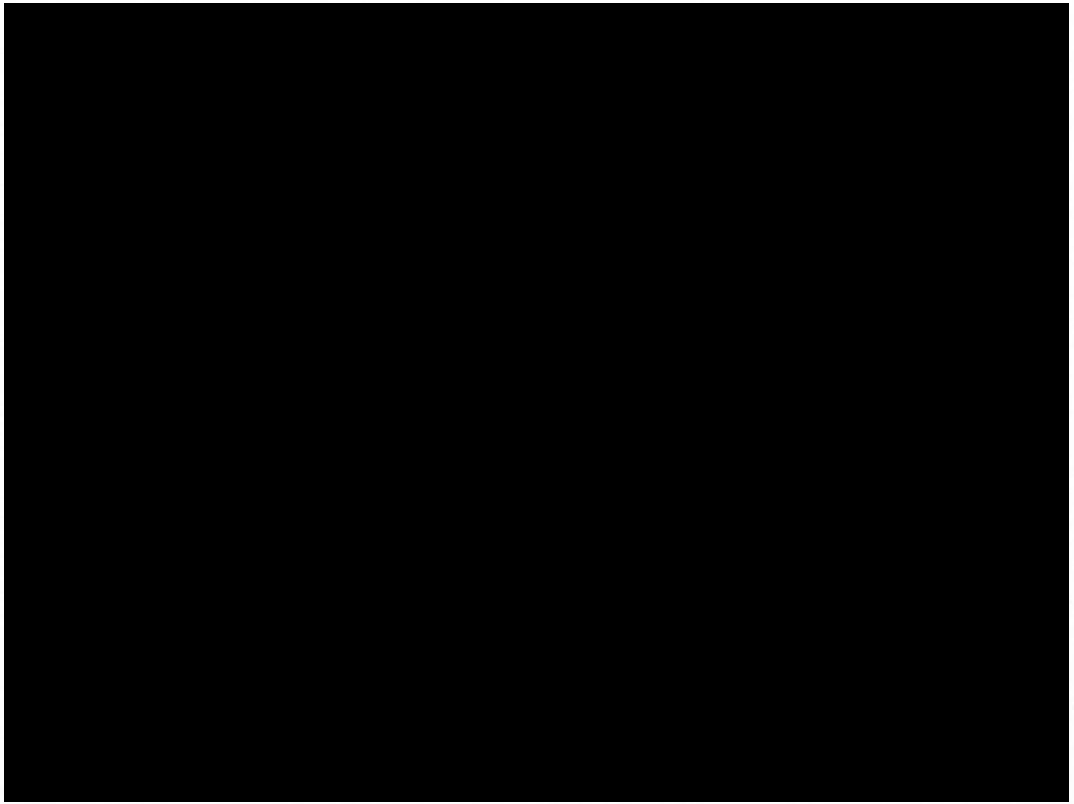
Learning math language

Guiding children to learn more accurate math language.

Sustained engagement

Increasing engagement by employing embodied interaction.

System Design



Main argument & Key findings

01 **Real time feedback**

Importance of
speech agents

02 **Addition Visual Clue**

Disassembling and
key connectives

03 **Suggestion for parents**

Interface for
parents

Wizard of Oz test

Discussion

- What do you think are the pros and cons of using WoZ test?

https://tinyurl.com/mathkingdom

Main argument & Key findings

Research Questions

RQ1: Do children find MathKingdom engaging?

RQ2: Can children successfully navigate the voice flow?

RQ3: Do children improve their mathematical language skills with MathKingdom?

RQ4: Can children improve their mathematical skills with MathKingdom?

RQ5: How do children and parents have mathematical dialogues in MathKingdom?

Main argument & Key findings

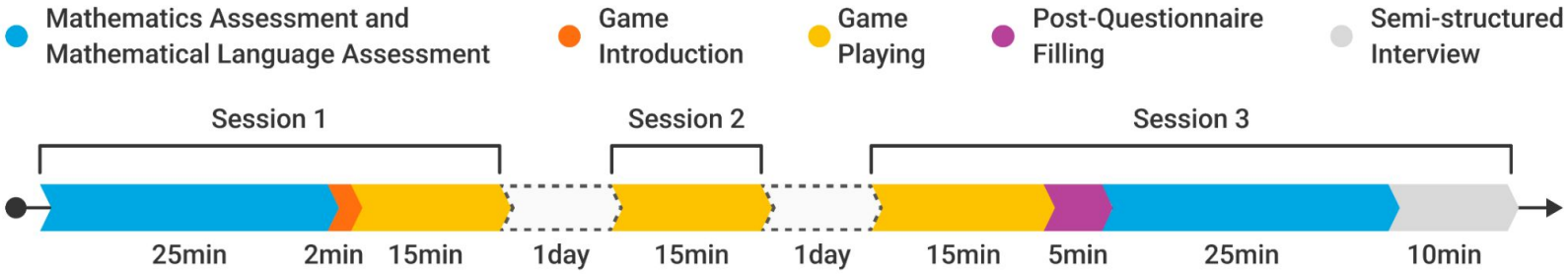


Figure 4: The flow chart for one pair of participants.

Measured

- Engagement Questionnaires
- Usability Assessment
- Mathematical Language Assessment
- Mathematics Assessment
- Coding

Main argument & Key findings

RQ1: Children engaged in MathKingdom actively

- “I enjoyed using MathKingdom,” , “MathKingdom was hard in a good way
- Observed that the avatars composed of transformable geometric shapes appealed to children.

1. Children engaged in MathKingdom actively.

RQ2: Children can successively be guided through the voice flow

- Authors counted the usability matrix for the first three flows.
- The data shows show that after three experiences with the system without improvement, it could understand children’s language output more effectively.

	Experimenter Help		Parent Help		Invalid Input		Machine Miscomprehension	
	session1	session3	session1	session3	session1	session3	session1	session3
Flow 1	0.11(0.31)	0.00(0.00)	1.28(1.10)	0.56(0.76)	0.39(0.59)	0.17(0.37)	0.28(0.45)	0.06(0.23)
Flow 2	0.22(0.42)	0.00(0.00)	1.56(1.17)	0.56(0.76)	1.39(0.89)	0.56(0.60)	0.22(0.41)	0.06(0.23)
Flow 3	0.06(0.23)	0.00(0.00)	1.06(1.08)	0.83(0.96)	0.83(0.96)	0.33(0.57)	0.11(0.31)	0.00(0.00)

Main argument & Key findings

RQ3: Using MathKingdom to develop children's mathematical language

- children were able to use more coherent and accurate mathematical language to describe mathematical features after our evaluation process.

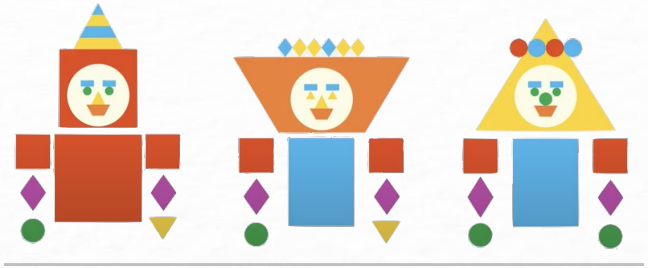
RQ4: Using MathKingdom to develop children's mathematical abilities

- During the interviews, all parents and children agreed that using the system improved mathematical skills. parent told us that she taught her child the concept of left and right in the first experiment session and that she found out that the child had acquired the taught concept.

RQ5: Promoting Mathematical Dialogues between Parents and Children

- observed that MathKingdom promoted mathematical dialogues between parents and children from the flow.
- Found that interaction between children and avatars could also promote and maintain communication.

	Mathematical Language		Mathematical Abilities	
	Number	Geometric	Number	Geometric
Before	5.17(0.79)	11.50(2.28)	9.18(1.72)	9.59(2.77)
After	5.61(0.92)	12.44(2.64)	10.06(1.55)	10.46(1.78)
p	0.002**	0.005**	0.004**	0.019*



Main Takeaway

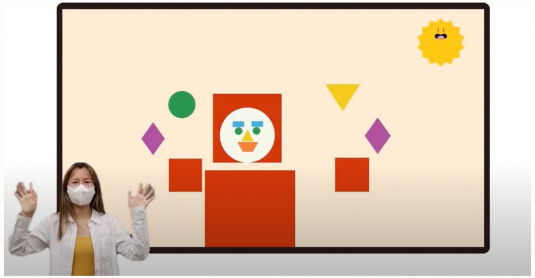
01 Math communication under multimodal interaction

Children use body movements as a supplement to communicate ideas

- The physicality of the body plays a central role in social meaning-making activities, particularly as children use body movements as a guiding function for vocabulary and meaning construction needs

Embodied self-reference promotes active participation

- The image mapped by the child was the common focus of the play and was completely controlled by the child, children had a heightened sense of ownership and motivation.



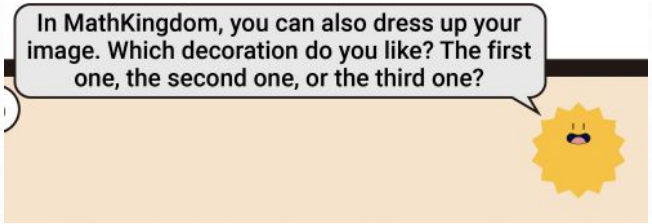
Main Takeaway

02 Role of Voice Agents in Family Education Activities

Children perceive the agent as a companion

- We chose a cartoon-like voice for it, and although it still acts as a guide for the game, it is more like a companion for the children

Parents perceive the agent as an assistant



Main Takeaway

03 Communication Patterns and Preferences of Different Families

Parent Scaffolding

- Parents enhance their child's potential achievement through appropriate guidance and scaffolding. This increases the child's sense of self-efficacy and promotes productive interactions.

Different Abilities, Different Approaches

- Children's mathematical communication patterns vary based on their ability levels. Those with lower ability tend to focus on shape identification and counting, while higher-ability children engage more holistically with the mathematical elements.

Research Contribution?

EMPIRICAL

ARTIFACT

THEORETICAL

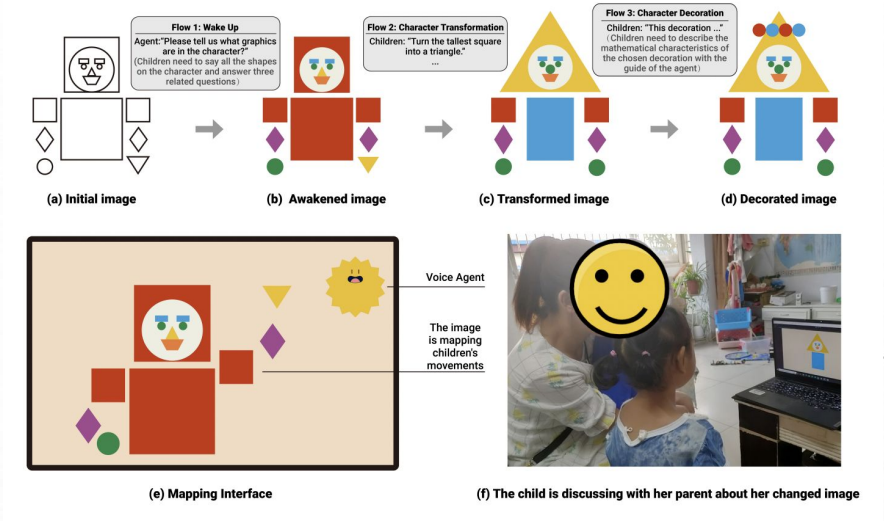
SURVEY

METHODOLOGICAL

OPINION

Contribution

Artifact contribution



Empirical contribution

- Formative study -> mathematical language and opportunities for mathematical dialogue
- User study -> how the artifact promotes mathematical skills and parent-child interaction

Areas of inquiry

Child Development

- Play
- Language development

Design learning technology in alignment with children's **natural tendency & behaviors**

Mathematics Education

- Math concepts
- Math assessment

Design the learning components and assessment **based on established frameworks**

Learning Theories

- Embodied learning
- Dialogic learning

Design the learning experiences that support **engaging and effective learning**

Areas of inquiry

HCI

- Formative study
- Wizard of oz

Design methods drawn from HCI for need finding and concept testing.

- Voice agent
- Embodiment

Technology methods to address the learning needs and implement the learning experiences**.**

How does the paper expand on those areas to make its contribution?

Mathematics Education

- Use of conversational technologies to support math communication & parent-child co-learning.

HCI

- Novel multimodal learning technology that combines voice agent & embodiment for math learning.

Discussion

How do you think MathKingdom can be improved?

- Design process
- Features
- Evaluation

https://tinyurl.com/mathkingdom

Thank you!