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

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ABSTRACT

Examining the values inherent in papers published at IDC provides a lens to our research community and informs the path of future research needs and opportunities. We conducted a content analysis of the values expressed in all full IDC papers between 2011 and 2019 and a survey with the first authors of 20% of these papers. We examine the types of IDC research contributions, the qualities and behaviors the research seeks to support in children, the role of the child and other stakeholders in the design process, the theories that inform IDC research, and the criteria that guide the technical design choices. We discuss the research contributions and the core value trends over the past two decades of IDC full published papers. We also present the ethical considerations central to the surveyed authors' work. Based on our analysis, we discuss implications and opportunities for future contributions, such as explicit attention to inclusivity in research, encouraging multidisciplinary collaborations, and expanding the qualities our community aims to support in children. These qualities include: focusing on children's sense of autonomy, agency, and empowerment; and children's participation in research as active creators of technology.

Author Keywords

Values in research; values in design; meta-analysis; IDC author's survey.

CSS CONCEPTS

•Human-centered computing~Human computer interaction (HCI)~Empirical studies in HCI

INTRODUCTION

The Interaction Design and Children (IDC) community actively reflects on the values and ethics of researching and designing with and for children [3,4,22]. By explicitly examining the values held by the research community, we can better understand our research choices, reflect on the design process, and motivate future designs that best meet children's needs [13].

Values are defined as the ideas we all hold about what is desirable in different situations, societies, and cultural contexts, that guide our actions, judgments, and decisions[5,8,22]. Values are embedded in every aspect of our design process and have been proposed as a focal concern in Human-Computer Interaction (HCI) [5,8]. This new paradigm in HCI that places human values at its core provides a lens to understand our relationship with technology [8]. These values directly influence the design outcome, which will in turn impact's people's activity and experiences with technologies. Yarosh et al. (2011) presented 'values' as an integral part of design and evaluation of the research published at IDC from 2002 to 2010 [22]. Examining IDC values has impacted IDC research published since 2011 (e.g., it is one of the top ten most cited IDC papers [24]. It offered the IDC community a lens to foreground some of the core values inherent in the published work of the first decade. It also discussed opportunities for future research that emerged as a result of the analytical and reflective process of stating our values and research motivations.

Because of the rapidly changing nature of technology, our increasing knowledge about ethical considerations, and further advancements in methods of working with children, it is important to regularly reflect on our community's work and update what has changed over the years. For example, in the years since Yarosh et al. [22] published their initial review, we have seen an explosion in the use of touch-screen technologies, new attention being paid to privacy and ethical concerns for children at IDC [3,4,19], younger children having access to easier-to-use technology, and an increasing role for parents. Thus, an updated look at IDC research practices and values is valuable for the community.

In this paper, we examine the values expressed in all the full-length papers during the second decade of IDC research (2011 to 2019). We replicate the analysis conducted by Yarosh et al. [22] for the new set of IDC full papers (220 papers total) and expand that work by identifying new value

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categories and considerations. We also reflect on how IDC values have changed between 2010 and 2019. Our work is driven by the following research questions:

1. What types of contributions do IDC papers make?
2. What behaviors and qualities does IDC research aspire to support in children?
3. What are the roles of the children and other stakeholders in the design and research process?
4. What theories, models, and frameworks inform IDC research?
5. What criteria inform IDC's technical design choices?
6. How has 2011-2019 work seized on the opportunities for IDC presented in Yarosh et al. [22]?

Our analysis makes key contributions to the IDC community by providing data to reflect on IDC core values evident in papers published between 2011 and 2019, identifying trends in values in the last two decades (2002–2019), and presenting author's ethical considerations regarding their work. Based on our analysis, we present the IDC community with an updated set of implications for future research.

METHOD AND ANALYSIS

A group of researchers from three different universities qualitatively reviewed and systematically coded the values expressed in the content of each full IDC paper published between 2011 through 2019. We also sent a survey to the first author of each paper to better understand the values and ethical considerations that authors imbue in their work that might not be explicitly expressed in the paper due to space limitations.

Review and Coding Process

Three teams at three different universities (3 faculty and 5 PhD, 4 Masters, and 2 undergraduate students) participated in reading, coding, and conducting a content analysis of the full text of 220 full papers. Team leads (faculty and PhD candidates) from all three universities developed the coding scheme. We developed initial codes based on our research questions and the findings presented Yarosh et al. [22], examining the values in the IDC published papers in the first decade. All team leads then applied these codes to one paper and discussed revisions and clarifications. Team leads then led their teams in applying the codes to four randomly selected papers and met to finalize the codebook. Next, pairs of researchers coded a random sample of 20% of the papers. Inter-rater reliability (IRR) for these papers was calculated with Cohen's kappa coefficient for each pair of responses within the sample. The resulting IRR value across 146 categories of codes 41 papers was 0.543, suggesting moderate agreement [15]. We discussed all disagreements to ensure accurate coding, we coded the remaining papers using a consensus process where two researchers on the same university team individually coded each paper and then met to reach consensus for the final codes. To facilitate communication and consistency across teams, team leads met weekly over video conferencing throughout the coding, analysis, and writing process.

In total, we applied 146 individual codes to identify the following: the contribution(s) of the paper; children's behaviors and qualities supported by the research; the role of the child, researcher, and other stakeholders in the design process; co-design values explicitly described in the paper; consideration of children with special needs or abilities; the relationship of the approach to current practices; the theories, models, and frameworks informing the work; the technical design choices; and whether the paper responded to specific opportunities posed by Yarosh et al. [22]. In addition, the research team could add additional "other" codes throughout (e.g., behaviors encouraged by the designs, technical design choice, and stakeholders and their roles) and were asked to provide specific details on particular codes, which included: theories, frameworks, and models identified in the paper; the relationship of the research to current practices; whether children with special needs or abilities were included; and how papers responded to opportunities from Yarosh et al. [22]. These open-ended responses were qualitatively analyzed by pairs of researchers using data-driven thematic analysis [1] to identify new emerging themes discussed in the results. We also obtained the data set from Yarosh el al.'s work, which we used to analyze patterns over the two decades (2002-2019). We used Pearson correlation to analyze the trends over years for all the codes during 2011-2019, and for the codes used for both decades (2002-2019).

Author Survey

Our qualitative analysis could only identify values explicitly expressed in each paper. For deeper insights into the values and ethics that drove IDC papers, we conducted a survey sent to the first authors of papers published between 2011 and 2019. We used a Qualtrics survey tool and asked open-ended questions about: values authors described as inherent in their work, what motivated them to conduct their research, the impact they would like for their work to have in the world and the ethical considerations central to their work with children. We received responses for 44 papers (20% of the papers published at IDC between 2011-2019). Through data-driven thematic analysis [1], two researchers identified emerging themes reflecting authors' motivations (e.g., creating positive outcomes for children), values (e.g., reflecting on the role of technology), desired impact (e.g., raising awareness in applied practice) and ethical considerations (e.g., protecting children's privacy and safety from participating in research). Initially, two researchers independently coded survey responses for 10 papers and then met to discuss the coding themes, define inconsistencies, and create a codebook. Both researchers coded the remaining survey responses for consensus and met to discuss agreement and refine codes based on new emerging themes.

FINDINGS

In this section, we discuss our findings in six sections addressing the above research questions. Finally, we discuss author's survey response.

RQ1: What types of contributions do IDC papers make?

We developed a research contribution coding scheme based on prior work in HCI [21] and coded each paper with one of the seven primary research contribution types. To compare primary contributions between the first decade (2002–2010), and the second decade (2011–2019), we matched categories that shared similar definitions (Table 1). In Yarosh et al., authors reported contributions the emerged from open coding, thus we assume that in the 1st decade there might not have been methodological or theoretical contributions.

Most papers published in the second decade (2011–2019) (61%) emphasized contributing *empirical* knowledge from both qualitative and quantitative studies. 23% of papers contributed a novel *artifact* (e.g., a new innovation or system). Only 1% of the papers from the second decade focused on *reflection and discussion* as their primary contribution. Although *empirical* study and *artifact* contributions remained as the most common primary contributions in the second decade, there was a moderately increasing trend for *empirical* contributions compared to the first decade (see Table 1). Fewer papers focused on designing novel systems in the second decade, and thus the *artifact* category seemed to show a strong declining trend over the past two decades.

Table 1. Codes addressing primary contributions, the percent of papers that were tagged with this code, and trends over time.

Paper Primary Contribution						
Code	2002-2010		2011-2019		2002-2019	
	%	Trend	%	Trend	%	Trend
Contributes an Empirical Study	45	-0.14	61	0.34	55	0.46
Contributes an Artifact	43	0.64	23	-0.36	31	-0.51
Contributes a Method	-	-	6	0.28	-	-
Contributes a Theory	-	-	5	0.10	-	-
Contributes a Research Review	-	-	4	0.02	-	-
Contributes a Reflection	12	-0.38	1	0.02	5	-0.59
Contributes a Dataset Corpus	-	-	0	-	-	-
Paper Contribution Values						
Design and Evaluate in Context	7	-0.66	40	0.005	27	0.73
Understanding Children's Models	18	-0.12	39	-0.11	31	0.43
Examine our Methods	21	-0.73	17	0.17	18	-0.37
Makes an Explicit Appeal to IDC	11	-0.70	15	0.02	13	-0.09
Conflict between Goals and Methods	8	-0.34	8	0.23	8	-0.10

When examining papers' values contributions, we found more papers consistently valued designing and evaluating technologies in authentic contexts in the second decade (40% of the papers, as opposed to 7% in the first decade). Papers focusing on understanding children's models (39% in the first decade versus 18% in the second decade) showed a rising trend over the past two decades.

17% of papers from 2011-2019 explicitly discussed reflecting and examining methods used to work with children, and 6% of the papers emphasized creating new knowledge on how the IDC community does science or designs with children. Although IDC still values discussion and improvements of methods, it seems that there is a moderate decline in "examining our methods" over the past two decades.

We also examined where IDC work was carried out between 2011 and 2019 to understand who is represented by the IDC community. IDC authors listed their affiliations in 28 countries and reported conducting research in 30 countries. In general, the research was conducted in the same location as the author's institution with only 5% of research conducted in a different location. IDC paper are mostly from institutions in US (49%), European countries (38%), UK (10%) and Canada (4%). In contrast, the number of papers which authors from countries in Africa and South America is extremely small, with only one paper from Africa and two papers from South America. IDC authors from Asia and Oceania constitutes 6% and 1% of papers respectively.

RQ2: What kind of children's behaviors and qualities does IDC research aspire to support?

Through their designs and investigations, researchers expressed their motivation to support children through their interaction with technology and the world around them across several domains.

Social Interaction & Connectedness

Researchers aimed to support children in developing social skills, collaborating with their peers to share knowledge and design, and cultivating environments where peers could freely interact with one another (e.g. facilitating effective group work). In this decade, 41% of papers were tagged as supporting social interaction, 35% of papers were tagged as supporting collaboration, and only two papers aimed at supporting competition. While many of these papers focused primarily on social interaction within peer groups, 7% of papers explored social interaction between children and their families. Researchers have persisted with their motivation to support collaborative behaviors in children, with an increase in papers that supported collaboration (see Table 2).

Learning

IDC continues to value behaviors related to learning, including literacy, inquiry and reflection. Many researchers designed technologies and conducted investigations concerned with understanding how these factors can contribute to children's learning. Researchers examined reflection (12% of the papers) as an opportunity to facilitate learning and developed technologies that supported children in their ability to reflect on events and situate their reflections within the broader context. Researchers also investigated learning as an opportunity to support cognitive development in children, increasing from 7% of papers in the last decade to 16% of papers in the current decade. Broadly, researchers aimed to support children in their exploration of the world and ability to grasp age-appropriate academic concepts. Exploration (in both academic and non-academic contexts) rose as a supported behavior, growing from 15% of papers in the last decade to 30% of papers this decade. Several researchers utilized theories related to exploration (*e.g.,* Inquiry-based Learning) to

inform the design of technologies, and support knowledge inquiry across a variety of contexts.

Expression

Researchers also aimed to support more generative behaviors, like ability to construct narratives, creativity, and imagination. As in the first decade review, researchers were motivated to support children when expressing their personal ideas, beliefs, and motives and all three of these categories continued to be well-represented between 2011 and 2019 (see Table 2).

Play

Compared with 2002-2010, more 2011-2019 papers aimed to support students in play and playfulness (10% vs. 31%). Additionally, 11% of papers examined physical activity as an opportunity to engage students in play events (Table 2).

Table 2. Codes addressing qualities IDC aspires to support in children, the percent of papers that were tagged with this code, and trends over time.

Social Interaction & Connectedness						
Code	2002-2010		2011-2019		2002-2019	
	%	Trend	%	Trend	%	Trend
Social Interaction	41	0.45	41	0.77	41	0.29
Collaboration	28	0.44	35	-0.21	32	0.38
Family Connectedness	4	0.56	7	0.19	6	0.39
Competition	4	0.06	0.5	0	2	-0.24
Learning						
Learning	14	-0.11	56	-0.32	40	0.66
Exploration	15	-0.17	30	-0.52	24	0.26
Fluency with Technology	9	-0.12	17	0.16	14	0.37
Support Cognitive Development	7	0.72	16	0.25	13	0.72
Inquiry	7	-0.03	14	-0.42	11	0.23
Programming/Coding	12	0.17	12	-0.08	12	-0.04
Reflection	7	0.06	12	0.15	10	0.35
Literacy	9	-0.51	8	-0.03	8	-0.31
Learning Real World Skills	6	-0.36	7	0.69	7	0.09
Expression						
Self-Expression	18	-0.62	20	0.05	20	-0.01
Creativity	17	0.01	20	0.43	19	0.15
Narratives	18	-0.02	11	0.46	14	-0.35
Imagination	7	0.52	7	0.50	7	0.22
Play						
Playfulness	10	0.36	31	-0.09	23	0.75
Physical Activity	9	0.57	11	0.12	10	0.34
Personal Growth						
Attitude & Motivation	4	-0.07	16	0.35	11	0.65
Equity of Participation	5	-0.46	12	-0.31	9	0.31
Autonomy	-	-	12	0.63	-	-
Identity	-	-	4	0.62	-	-
Morality & Ethics	3	-0.41	3	-0.50	3	-0.17
Autonomy & Identity	7	-0.59	-	-	-	-
Health & Well-being						
Health/Well-being	-	-	12	0.59	-	-
Other						
Have Children Buy Products	1	-0.13	0	-	1	-0.35

Personal growth

Several papers in this decade of research intended to support personal growth in children. Compared to the prior decade (7%), 16% of papers explored the benefits technology can afford when supporting children as they develop their own identities and sense of autonomy in the world. For example, papers tagged with "equity of participation" increased from 5% to 12%. Additionally, more papers aspired to support children's "attitude and motivation" (4% vs. 16%).

Health and well-being

While this category did not emerge in the first decade review, "health and well-being" was a significant category in the 2011-2019 literature (12% of the papers, Table 2). Future IDC research may explore health and well-being further and support children through their experiences.

Emerging Categories of Supported Behaviors and Qualities

Several categories of 'other' child behaviors emerged alongside the preexisting child behavior codes. These categories varied across facets of executive function, connectedness with the community and design for privacy and security. Specifically, 14 new qualities and behaviors emerged from the 'other' codes in 64 papers. For example, 7% of all papers promoted the value of supporting executive functions including self-regulation, planning, attention, and memory. Many of the papers also pursued supporting healthy emotional development. 9% of papers aspired to support social and emotional skills through emotion regulation and supporting positive (affect) emotion states. Fewer papers (5%) aimed to support mental health and therapy. Alongside explicitly supporting autonomy, we also observed 6% of papers aimed to support children's self-advocacy and empowerment. In contrast, direct mention of inclusive practices within the research was uncommon. Only 2% of papers presented work that explicitly upheld inclusive practices (e.g. inclusive learning or inclusive play).

Researchers also championed children's design skills and fabrication of new technologies instead of simply generating ideas to design for existing ones. In 5% of papers, researchers encouraged fabrication activities (e.g. making, crafting, tinkering) for children. While papers did encourage engagement with different technologies, no papers involved in this analysis encouraged children to purchase products or asserted advertising to children.

RQ3: What is the role of the child and other stakeholders in the design process?

IDC researchers still value children's participation in the technology design process. More papers ensure that designs reflect children's voices from 2011-2019 (20%, as opposed to 14% from 2002-2010). When specifically examining children's role in the design process, we found more papers involved children as informant (13%) in the second decade, where children inform the design process at various stages (e.g., being observed with existing technologies, asked to sketch new ideas). There seems to be a moderate trend indicating the increase of children as informants in the recent decade as well as over the two decades (Table 3).

However, fewer papers explicitly discuss the value of children as active agents in the design process in the recent decade (15% of the papers, as opposed to 20% of the papers from 2002-2010). Only 12% of the papers involved children as design partners in their design process, compared to 29% of the papers from the first decade. Children as design partners

shows a strong decline trend over the two decades (Table 3). This might indicate a shift in children's role in IDC, where researchers see children beyond co-designers in their studies(e.g., child as protagonist [11]). Despite this declining trend, IDC authors reported valuing child-centered research process. According to the author survey, authors emphasized creating a positive experience when having children participate in research and advocated for making sure children's perspectives are represented in the desired outcome (e.g., artifact or intervention).

We also examined adult stakeholders' roles in the design process. 52% of the papers from the 2011-2019 includes adult stakeholders in their investigations. Among these papers, 49% of these papers include parents, 31% of these papers include teachers, and 16% of these papers include other professionals (e.g., therapist, doctors, administrators) in their studies. Researchers mostly include parents as users (33%), and testers (30%). In 19% of papers, parents were informants. In several investigations, parents were design partners (7%) and test facilitators (7%). One potential explanation for parents' role in the design process might be that IDC as a community often designs for both children and their families.

Table 3. Codes addressing for whom IDC designs, the percent of papers that were tagged with this code, and trends over time.

Code	2002-2010		2011-2019		2002-2019	
	%	Trend	%	Trend	%	Trend
Role of Child in Design						
Tester	39	0.86	35	-0.11	37	0.06
User	-	-	29	-0.31	-	-
Informant	8	0.08	13	0.37	11	0.36
Design Partner	29	-0.82	12	0.25	18	-0.70
None	-	-	9	0.14	-	-
Role of School						
Including Teachers	5	-0.42	18	0.01	13	0.60
Curricular Integration	14	-0.05	15	-0.13	15	-0.01
Balance Multiple Stakeholder	9	-0.50	13	0.15	11	0.14
Whole Class Activities	2	0.67	12	-0.37	8	0.73
Codesign Values						
Reflect Children's Voices	14	-0.79	20	0.39	18	0.12
Children as Active Agents	20	0.07	15	0.18	17	-0.12
Equalize Power btw Child & Researcher	9	-0.67	6	0.21	7	-0.30
Diversity Values						
Design for Special Needs	12	0.75	15	-0.02	14	0.28
Engaging the Underserved	7	0.17	12	0.27	10	0.39
Gender Awareness	11	-0.39	8	0.48	9	-0.27
Design for MultiInteraction Styles	15	-0.24	5	-0.22	8	-0.59
Culturally-Appropriate	4	0.01	5	0.63	5	0.22
Design for All Genders	6	-0.65	2	-0.45	3	-0.52

When examining the role of school in the design process, we found including teachers seems to have a strong increasing trend over the two decades. Also, there seems to be a strong increasing trend in designing for whole class activities in the two decades. When teachers are included in investigations, the majority (53%) of studies included the teachers as informants. Other roles for teachers include users (20%), design partners (20%), testers (13%), test facilitators (13%), and evaluators (7%). The emphasis on roles that directly affect designs suggest that researchers leverage teachers' expertise in children's learning and development when designing technology systems.

IDC authors continue to support children with different abilities and needs and engage the underserved communities in their investigations. Compared to the first decade, *designing culturally appropriate interventions* seems to be a strong increasing trend in the second decade. Both *designing for multiple interactions styles* and *design for all genders* seem to decline strongly over the two decades, which might indicate less explicit discussion about these diversity values that may be assumed in the design process.

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

Yarosh et al. identified "more widespread and more explicit use of theories and models" as an opportunity for IDC [22]. Our results suggest the community has embraced this directive (Table 6). 75% of 2010–2019 papers identified theories that informed the research, and the breadth of theories used appears to be much broader (Table 4). 5% of papers make a specific theoretical contribution (Table 1).

Yarosh et al.'s analysis identified developmental theory, the cognitive theory of Embodiment (cognition is entwined with the body's interactions in the environment), Piaget's Constructivism (children's knowledge is self-constructed from their experiences), and Papert's Constructionism (based in Constructivism, learning occurs while constructing artifacts) as the key theoretical trends from 2002–2010. They also looked specifically at approaches used in learning papers and identified "learning through play" (15% in 2002-2010, 3% in 2011-2019), "games for learning" (1-% in 2002-2010, 4% in 2011-2019), "in-situ learning" (9% in 2002-2010, 2% in 2011-2019), and "learning through embodied interaction" (9% in 2002-2010, 10% in 2011-2019 (along with the specific theories of Constructivism and Constructionism), as trends informing the designs. Comparative analysis is detailed in Table 1.

Our analysis identified a much broader array of theories. As part of our coding process (described above), we had researchers list any theories authors used to explicitly inform the research, and then two researchers further analyzed and categorized the identified theories. Authors still cited staged and other general developmental psychology theories (14%, compared to 15% in 2002-2010). Constructionism (11%, vs. 15%), Constructivism (10%, vs. 24%), and Embodiment (6%, vs. 22%) are still specific theories central to the community. We also identified a number of theories that we categorized as "learning theories" (those that discuss pedagogy or how learning occurs) or "social theories" (e.g., Vygotsky or socio-cultural theories). Though our results could be interpreted as indicating a decreasing trend with respect to Constructivism and Embodiment, many of the new theories we identified have roots in these theories, further specifying how children construct knowledge and engage their environment.

Table 4. Codes addressing theories and models, the percent of papers that were tagged with this code, and trends over time.

Theories						
2011-2019 Code	2002-2010		2011-2019		2002-2019	
	%	Trend	%	Trend	%	Trend
Developmental Theory	15	0.71	14	-0.45	14	0.10
Constructionism	15	0.25	11	0.21	13	-0.17
Constructivism	24	0.28	10	-0.49	15	-0.38
Embodiment	22	0.40	6	-0.75	13	-0.43
Learning Theories	-	-	17	0.17	-	-
Social Theory	-	-	15	-0.04	-	-
Design/Interaction Theories	-	-	14	-0.18	-	-
Humanities	-	-	5	-0.15	-	-
Other	-	-	16	0.55	-	-
Learning Philosophies/Approaches						
Learning through Embodied Interaction	9	0.12	10	-0.73	10	-0.07
Games for Learning	10	0.26	4	-0.22	6	-0.34
Learning through Play	15	0.11	3	-0.73	8	-0.60
In Situ Learning	9	0.16	2	-0.06	5	-0.35

We also saw authors using design theories and frameworks to inform their work. For example, Horn et al. [10] use Lee's "cultural modeling design framework" [14] to inform their design process. Some authors discuss Participatory Design, a method for working with users, as a theory or framework informing their work. In addition, we noted emerging use of theories from the Humanities, such as feminist theory, theories on cultures, and literary theories. These critical theories are an interesting complement to IDC's traditional social science lens. Finally, our "Other" category encompassed a range of other theories that did not fall into those above such as additional cognitive (e.g., cognitive load, memory), communication, behavior change, or computational theories.

In sum, social science theories related to how children learn and develop is central to IDC work, and researchers are using more specific theories to understand designs for children. The community is also applying non-social science theoretical lenses. Future work could look in more detail at *how* theory is being used to inform IDC work, such as motivation, design features, and evaluation.

RQ5: What criteria inform design choices?

Similar to papers from 2002-2010, IDC continues to view intrinsic motivation and engagement as important design criteria for new technologies. In the second decade, 20% of the papers valued enjoyment of their designed technologies and 36% of the papers discussed engagement with the technology in their system design (Table 5). Although we observed a higher percentage of technology engagement discussion in the papers from the second decade, the discussion was decreasing in recent years. One reason for this decrease could be that researchers have moved beyond engagement and want to support wider range of attributes.

IDC papers increasingly value designing for learner's experience in new technologies, with 21% of the papers emphasizing learner-centered design and 15% of the papers mentioning designing for the experience in their technology design criteria. The discussion about learner-centered design and designing for the experience seemed to increase over the past two decades (Table 5). Unlike typical technology evaluations, IDC papers focus less on efficiency, task completion, or cost effectiveness when designing technologies. Fewer papers appear to discuss these criteria in the second decade.

IDC shares some similar design criteria with the broader HCI community: papers from the 2011-2019 emphasized feedback (14%), customizability (10%), engaging multiple senses (6%) and naturalness (i.e., intuitiveness) (5%) in their designs (Table 5). However, the discussion on intuitive or natural technology design seemed to decrease over the past two decades.

Table 5. Codes addressing values in the technical design, the percent of papers that were tagged with this code, and trends over time.

Attributes Valued						
Code	2002-2010		2011-2019		2002-2019	
	%	Trend	%	Trend	%	Trend
Engagement	24	0.69	36	-0.51	32	0.57
Learner-Centered Design	4	0.27	21	-0.10	14	0.65
Enjoyment	24	-0.30	20	0.23	22	-0.21
Designing for the Experience	4	-0.18	15	-0.28	10	0.46
Feedback	9	0.12	14	0.06	12	0.31
Customizability	4	0.42	10	-0.67	8	0.56
Simplicity	4	0.29	10	0.01	8	0.42
Desirability	14	-0.55	8	-0.07	10	-0.44
Multiple Senses	4	0.08	6	0.53	5	0.12
Naturalness (Intuitive)	20	0.12	5	-0.08	11	-0.55
Challenge	7	0.17	5	-0.43	5	-0.19
Efficiency or Task Completion	6	0.50	5	-0.80	5	-0.08
Cost Effectiveness	3	0.50	4	-0.16	4	0.19
Engagement in the Long Term	3	0.24	3	-0.40	3	0.01
Aesthetics	3	0.15	2	0.02	2	-0.14
Technical Choices						
Tangibles	26	0.30	20	-0.18	22	-0.28
Bridging Physical and Digital	11	0.54	15	-0.61	14	0.28
Innovate and Explore Novel Technologies	8	-0.51	7	-0.30	8	-0.23
Mixed Reality	15	0.58	5	0.02	9	-0.17
Platform						
Tangibles & Smart Objects	-	-	20	-0.21	-	-
Mobile Technologies	-	-	19	-0.25	-	-
Personal Computer	-	-	13	-0.76	-	-
Shared interactive surfaces, tabletops	-	-	8	-0.70	-	-
Sensor-based and Wearable	-	-	6	0.16	-	-
Virtual & Augmented Reality	-	-	4	0.71	-	-
Multisensory Environments	-	-	2	0.06	-	-
Natural User Interfaces	-	-	2	0.63	-	-
Robotics	-	-	0	-	-	-
Relation to Current Practices						
Leverage Current Practices	12	-0.29	49	0.09	34	0.76
Transform Current Practices	2	0.07	23	-0.38	15	0.51
Concerns about Technology Negatives	5	0.22	6	0.48	6	0.23

This decrease could be due to several factors: (1) increased rigor of IDC research that is published; (2) the shift in the goals of the designed technologies as the IDC aims to support other behaviors and qualities; and (3) an emphasis on involving children in the design process for new technologies, which ensures the intuitiveness of the designs.

Bridging the physical and digital still attracts IDC's interest compared to other technical choices (15 % of the papers), though there is a decreasing focus in recent years. Tangibles remains the most popular form of technologies researchers leveraged in their designs in the second decade (20% of the papers) and 5% of the papers encouraged mixed reality. As IDC aims to design for a larger variety of ages, researchers are leveraging more mobile and ubiquitous platforms: 19% of the papers designed with mobile technologies, 6% with sensor-based technologies and wearables, and 2% with natural user interfaces (e.g., gestures and speech) in the second decade. Design for personal computers seems to show a strong declining trend in the second decade (Table 5). This decline might be due to the wide spread of mobile technologies and smart devices (e.g. wearables).

IDC researchers often consider novel or innovative technology solutions as opportunities to support and transform activities that are not traditionally technology mediated. When examining the relation between technology and current practices, we found an increasing number of papers discussing technology designs that leverage current practices (49%, Table 5). Researchers also emphasized the importance of leveraging current research practices in the author survey, for example, following current participatory design techniques for having children involved in the design process. Papers that focused on transforming current practices have increased in the second decade as well, with 23% compared to 2% of papers in the first decade.

As in the first decade, IDC papers in the second decade rarely addressed concerns about technology negatives (only 6%). However, those that did covered a variety of concerns, such as online safety and privacy [12], problematic app designs [2], datafication [23], and use of intelligent systems, AI, and voice agents (e.g., [18]).

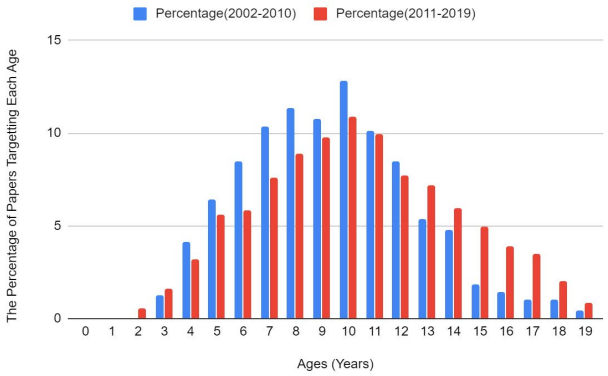
RQ6: How has 2011-2019 work seized on the opportunities for IDC presented in Yarosh et al.?

We specifically coded each paper from 2011–2019 based on the five opportunities (bolded in the text below) that Yarosh et al. proposed in their IDC 2011 paper.

Many authors ground their research in **theories or models** on how children learn, think and relate to others. While fewer than half of papers from 2002-2009 used theory, 75% of the 2011-2019 made explicit references to theories or models. Moreover, we identified 5% of IDC papers where theory is the primary contribution (Table 1), which was not a noted contribution category at all in the first decade.

More researchers in the recent years investigated **children younger than 5 or older than 12**. Although papers from the 2011-2019 still mostly target children between 7-12 years old, 53% of papers include wider range of older children (below 5 and over 12 years old) and children younger than 7 in their investigations (Figure 1).

Figure 1. The percentage of papers that involved studies or systems intended for children of each age (when an age range is given, each year in the range is counted).



However, still relatively few papers specifically target teenagers (13-19 years old) (e.g., [17]) or include 2- and 3-year-old children. (this might be due to the medical community discouraging screen time by children under the age of two [25].

Three other opportunities from Yarosh et al. received moderate or low uptake. Papers in our review gave more attention to children's **broader socio-cultural systems** rather than only focusing on the children and the technology–23% of the papers explicitly discuss a broader ecology. Researchers also **explicitly discuss the values** that drive their work (44%), though not necessarily in a formal "values" section as recommended by Yarosh et al. A few researchers (15%) focused on **long-term evaluations** rather than single-session studies (e.g., usability), though that number is still fairly low. Finally, we found papers with **miss-alignment between stated goals and measured outcomes** (e.g., designing a system to support learning only measuring engagement) at the same rate of 8% as the original review (Table 6).

Table 6. Opportunities for IDC proposed in the IDC 2011 paper, the percent of papers that were tagged with this code, and trend over time.

Opportunities for IDC proposed in the IDC 2011 paper		
Code	**%**	**Trend**
Explicit Use of Theories and Models	75	-0.34
Design for a Larger Variety of Ages [child < 5 or > 12]	53	0.60
Explicitly Reveal Values that Drive the Work	44	-0.18
Designing for the Entire Socio-Cultural System	23	0.58
More Long-Term Evaluations	15	0.14
Miss-alignment of Motivation and Evaluation	8	0.23

AUTHOR SURVEY RESULTS

Authors of 20% of IDC papers published between 2011-2019 responded to our survey regarding the values that drove their work, motivations for conducting the research, the kind of impact authors intend from their research, and the ethical considerations central to their work.

Values Informing Author's IDC Work

Researchers shared their values reflecting desired outcomes for children and research practices.

Affording child agency and empowerment: Authors emphasized their desire to provide agency to and empower children through participation in research. Authors achieved this by providing children with opportunities to choose freely, considering the power dynamics prevalent in the research, and prioritizing the child's needs. Researchers valued empowering children to express their lived experiences. Authors also reflected on the role of technologies in addressing children's needs and called for awareness of technology serving to augment children's experiences and not replace them.

Child-centered research process: Similarly, authors highlighted the importance of putting the child first in the research process. Many emphasized creating positive experiences for children's participation in research and ensuring equity in partnership in the design process (*e.g.,* by ensuring each child's contributions are visibly represented in the design).

Encouraging broad participation: Furthermore, authors reported valuing making their research more inclusive and diverse, by working with a wider range of demographics and abilities. Some researchers particularly pointed out the value of basing their research on the diverse lived experience of children and the necessity of creating appropriate research methods.

Striving for research quality: As IDC matures as a scientific community, many specifically reflected on research quality as a value. This included establishing scientific rigor, integrating relevant outside expertise in the research process, and adhering to ethical guidelines.

What Motivated IDC Researchers to Conduct Their Work

IDC reported four motivations that guided them in selecting a particular research topic: (1) *achieving a specific desired outcome for children* (e.g. social-emotional skills); (2) *seizing opportunities by capitalizing on research gaps or available calls for funding*; (3) *bridging the research-practice gap* – researchers desired to make research insights available to practitioners and bring theories and IDC methods to influence industry design practices; and (4) *reflecting on methodological needs* – researchers are motivated by providing theoretical foundations and methodological concepts which can inform research and design practices.

Intended Research Impact on the World

Authors reported three main ways they hoped their research would have impact: (1) *Raising awareness* – to promote opportunity for more research to impact practice and advocate for cultural awareness; (2) *Supporting IDC community* – to promote a new models, methods or theories for future research in child interaction design; and (3) *Reaching beyond the research community* – to impact policymakers, parents and educators of their research outcomes.

Ethical Considerations of IDC Researchers

Researchers value adherence to ethical considerations that are explicit in nature (*e.g.,* consent process) as well as implicit in the structure of their research (*e.g.,* agency).

Beyond the Institutional Review Boards (IRBs): Researchers mentioned the importance of adhering to explicit guidelines such as creating equal opportunities in the recruitment process, extending transparency of the research aims, and, in addition to obtaining assent from the child and consent from the child's guardian (required by IRB), putting efforts into explaining consent to the child. Some called to extend ethical considerations beyond those required by IRB to consider the child's context-dependent needs currently not captured within IRB standards. One researcher described ethics as being a "moving target" since they experienced a gap between formal ethical requirements and what they had to consider in the field, especially when designing in sensitive design spaces.

Being aware of responsibility: Respondents further reflected on ethical guidelines to create an awareness of responsibility in providing longstanding benefits to participating children. Others called for considering potential sources for negative experiences during participation, such as research artifacts (*e.g.,* robots) prompting adverse reactions. Respondents further expressed surpassing the traditional standards of ethical research. For instance, when working in classroom settings, researchers found ways to engage students without guardian consent to avoid harm from exclusion during entire class activities. This topic was examined with regards to research designs and constant review of the ethics underlying their research practices.

Protecting privacy and safety: Upholding privacy and safety for children, both during and after research participation, was particularly salient theme across responses. This was expressed in relation to use of sensitive data as well as safeguarding children's wellbeing when participating in the research process.

DISCUSSION

We reflect on two decades of IDC core values and present opportunities for the future of the IDC community.

Reflecting on IDC Core Values Over Two Decades

Our analysis allowed us to foreground how our values have and have not changed since the original review:

- As a community, papers are now more likely to make empirical rather than artifact contributions. This may be because authors are more likely to build systems in service of research questions rather than to capitalize on technical novelty.
- IDC researchers remain reflective and innovative in the methods they employ. Use of theories and models has become a more common practice and researchers employ a wider variety of theories.

- IDC researchers continue to support children's learning, development, and creative growth, and increasingly value play.
- IDC authors continue their commitment to reflecting children's voices. Authors recognize the child as an active agent in the adoption of technology and seek to partner with children as co-designers.
- In terms of technologies, IDC continues designing systems that bridge the physical and the digital with new technologies leveraged for that purpose between 2010 and 2019.

These changes suggest that IDC has a solid core of values while still learning and adapting as new knowledge is generated, which is a sign of a healthy research community.

OPPORTUNITIES FOR THE FUTURE OF IDC RESEARCH

Based on the findings from our analysis, we discuss the opportunities for the IDC community.

Empowering Children in Research and Beyond

IDC is dedicated to including children's voices, promoting the inclusion of their views, and protecting their rights in participation in research. To fulfill this commitment, researchers could benefit from fully embracing "empowerment" as a critical value to our community. Empowerment theory offers insight for understanding children's experiences [6]. Theoretical perspectives define empowerment as developing specific skills to increase self-efficacy, competence, perceived control over one's life to enact change, and involvement in social systems [7]. The 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 [7]. We present three ways future IDC research can attend to children's empowerment.

1) Empowerment as a quality of design for children: Future IDC research should continue to explore the creation and design of technologies that foster children's sense of autonomy and empowerment. New work should aim at empowering children through their diverse lived experiences by considering how children desire to change and facilitating reflective opportunities. To bridge these aspirations, future research should support a variety of children's qualities and behaviors that foster children's agency and empowerment, like self-management, reflective practices, and self-regulation. Researchers can leverage suitable empowerment measures (e.g., [20]) and develop new child-appropriate measures when evaluating designs for children.

2) Empowerment in the research process: Based on our research, the IDC community values empowering children when participating in research. Future work can explore extending children's roles beyond the design process and into roles as research collaborators and active creators (e.g., supporting design skills in children). This calls for new methods and practices to empower children in these new roles. For example, researchers have begun developing co-design methods that work for some of the youngest children, such as comicboarding [9]. Another ethical consideration is a need for new assent practices that ensure the inclusion of children's perspectives within the design process but also the representation of children's contributions in the research outcomes. IDC desires to support positive experiences for children's participation in research. Future work can explore practices of measuring how participation in studies affects children in the short-term and long-term. A strong example of this type of work is McNally et al.'s research that followed up with adults who had participated in co-design teams as children [16]. Our community can also benefit from reflecting on our research motivation and how it aligns with children's needs. The Human-Computer Interaction community, for example, values novelty and technological solutions, which may or may not be what children find useful and beneficial. There may be scenarios where a context is better supportive using existing tools or non-technical solutions such as policy changes or changes in caregiver training.

3) Data empowerment: another major facet of children's empowerment is their sense of agency over the privacy, control, and security of their data. There is an opportunity for researchers to examine how they inform children about the use and ownership of their data. Researchers also discussed upholding privacy and safety for children during active participation in research as well as after the research is completed, specifically related to the use of sensitive data and safeguarding children's well-being when participating in the research process. This calls for additional practices to critically weigh the benefits of children's participation and the research outcome. Future work can explore practices to ensure children access and control over their research data, such as including age-appropriate controls for reviewing and deleting data if desired and allowing for past participants to follow up with researchers to inquire about their data.

Diversity and Inclusion

IDC remains steadily committed to engaging populations with special needs and different abilities. However, there are opportunities to extend the research work to include broader marginalized communities, which include children from diverse ethnic groups and low socio-economic backgrounds, those in foster homes, and war refugees. Our results suggest an increasing interest in developing culturally appropriate interventions in the second decade of IDC research, but not a lot of work is currently acting on this interest. This opportunity demands expanding our collaborations to encompass research partners and incorporate their expertise (e.g. working closely with community leaders, social workers, or therapists). Researchers particularly pointed out the value of basing their research on the lived experience of people which calls for creating appropriate methods and research practices. Furthermore, our results have also revealed that the vast majority of publications come from the United States, European countries, and the United Kingdom. In the future, our community could focus on attracting and mentoring a broader

and more international pool of researchers, which might diversify the population our community aims to support.

Multidisciplinary Collaboration

As IDC has matured, it has grown beyond its initial focus on interaction design from the computing perspective. Our analysis revealed that the second decade of IDC focused less on building novel systems and more on empirical and theoretical contributions. Work was more likely to be informed by theory and these theories came from a diverse set of disciplinary sources. Our community benefits from integration of findings, models, and theories from these diverse sources, including education, social science, and humanities. One way that we may be able to enhance and encourage this trend as a community is by periodically collocating IDC with relevant conferences, such as International Conference of the Learning Sciences (ICSL), Conference On Computer-supported Collaborative Learning (CSCL), a special topics meeting of the Society for Research in Child Development (SRCD), FabLearn (a conference focusing on children as makers), and computing education conferences, such as SIGCSE and ITiCSE (Innovation and Technology in Computer Science Education). These periodic colocations could also serve to help achieve broader impact outside of our research community—a desire for broader impact is reflected in responses to our author survey.

LIMITATIONS

There are inherent limitations with our research and analysis approach. Child computer interaction publications have expanded beyond the IDC conference in the past decade. The coding process and interpretations provided are subjective and could be biased by researchers' epistemological stances. We tried to minimize the potential biases by having at least two coders for each paper. In the future, we would encourage researchers from different background to review, reflect, and build upon the findings presented in our work. Our author survey responses only represented 20% of papers and may have self-selection bias. To support more rigor in this kind of work in the future, we as a community could choose to leverage the ACM submission system to ask authors directly for the types of their work's contributions, method, the role of children, and values inherent in the work submitted at the camera-ready submission stage.

CONCLUSION

To understand the IDC community's values and inform opportunities for future research, we analyzed the values presented in all full IDC papers from 2011-2019, and surveyed authors of 20% these papers. We summarize our findings from 2011-2019 papers with respect to the categories of IDC research contributions, children's behaviors and qualities supported by research, children and other stakeholders' roles in research, theories and models referenced in the research, and research's technical design choices. We also analyzed IDC's values and trends over the past two decades (2002-2019). Given the insights from our content analysis and survey with authors, we present opportunities for guiding future IDC research. We encourage the IDC community to pay explicit attention to inclusivity, collaborate with multidisciplinary fields, and expand the ways the community support children's empowerment in research and beyond.

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SELECTION AND PARTICIPATION OF CHILDREN

No children directly participated in this research.

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