Cultures of Participation in the Digital Age - Artificial and/or Human Intelligence: Nurturing Computational Fluency in the Digital Age

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Abstract

In the Middle Ages, most people were dependent on "scribes", who helped them write down their thoughts, ideas, and stories, as well as read the material written by other people. Many people today are in the same situation concerning digital media: they are unable to express themselves, explore problem spaces, and appropriate tools, and act as designers in *personally meaningful activities*. They must rely on "high-tech scribes". The workshop explores new conceptual frameworks and innovative computational environments for supporting *computational fluency* allowing people to become *independent* of "high-tech scribes".

Keywords

Meta-design, End-User Development, Human-Centered Artificial Intelligence, Computational Thinking, Design Thinking, Design Trade-Offs, Educational Nurturing

1. Introduction

The field of computational literacy focuses on the ability of ordinary users of digital tools to think and work with computational concepts and processes, including coding, algorithms, data analysis, and problem-solving. It involves understanding how computer programs work (e.g., to iteratively create and test code) and how humans can be supported with tools to create or modify software artifacts (e.g., edit code, customize applications, and build systems from higher-level components) to solve problems and create new tools. Computational literacy scholars argue it is not just about technical skills, but also about developing a mindset that is comfortable with complexity, abstraction, and modeling [1][2]. For example, diSessa believes that computational literacy is an essential skill for anyone who wants to be an active participant in modern society, and he suggests this skill be taught alongside traditional forms of literacy such as reading and writing. diSessa and his colleagues have developed Boxer, a programming environment for teaching computational literacy [3]. Contemporary end-user programmable environments in this tradition are NetLogo [4] and Scratch [5]. Thus, computational literacy is conceived as something that can be taught like reading and writing, and that people may learn and use for solving known problems. However, in the digital age, *Computational Fluency* is needed to pursue personal meaningful problems, often exploiting creativity that cannot be taught, but nurtured,

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encouraged, and supported. Computational Fluency is a richer concept than computational literacy and involves several aspects depicted in Figure 1.

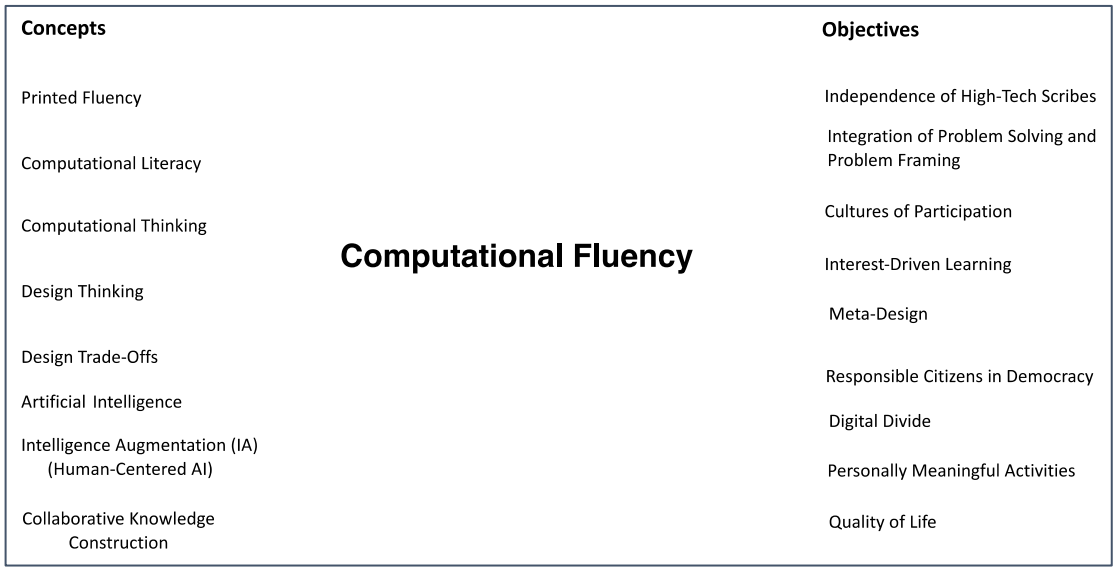

Figure 1: Concepts and objectives defining Computational Fluency

Digital media in support of Computational Fluency should not only be about new technology solutions and abstract skills but they must also

- Cope with *wicked problems* that cannot be delegated because they require the *integration of problem framing* and *problem solving* [6].
- Support a discourse at the level of *problem domains* and not just at the computer domain allowing people to work on their tasks and activities, rather than requiring them to focus their intellectual resources on the medium itself.
- Be objects of critical reflection, open to adjustment and tweaking, and supported by *critiquing components* that *analyze work products* and increase the "back-talk" of an artifact by presenting a reasoned opinion about it.
- Support unintended and subversive uses (not just anticipated ones) requiring end-user development with the support of meta-design ("designers for user-designers") [7].

Numerous countries (including Finland, Germany, and Norway) are in the process of introducing computer science courses into (high) school curricula without a deep understanding of the objectives to be achieved and the trade-offs to be explored. For example, the term computational or algorithmic thinking has received broad interest in the K-12 education sector in the Nordic countries, conflating it with five to seven core concepts not yet aligned with core concepts in established subject domains or curricular practices, creating tensions among teachers, school leaders, and policy [8].

Recognition that as more complex skills become essential, our society must equitably educate people to learn the skills. Consequently, in what ways Computational Fluency should be introduced and nurtured becomes a crucial question in the digital age. Meta-design [9], End-User Development [10], and Human-Centered Artificial Intelligence [11] taken together might contribute to an answer to this question.

The hype and underestimation of different Artificial Intelligence (AI) technologies need to be deeply understood by exploring the *design trade-offs* associated with

- AI (replace human beings) versus Intelligence Augmentation (IA) (empower human beings):
  - Strengths: free humans from tedious and complicated tasks — AI and automation may be able to perform certain knowledge-based tasks more efficiently than humans, potentially reducing the need for some knowledge workers
  - Pitfalls: many of the AI systems (relying on immense data sets) are inscrutable and remain black boxes resisting explanations

- One-size-fits-all versus personalization
  - Strengths: reducing the information overload
  - Pitfalls: group think in filter bubbles, privacy violation
- Individual cognition versus distributed cognition
  - Strengths: spreading knowledge, favoring collective intelligence
  - Pitfalls: not focused knowledge, knowledge remains on the surface

Deepening these topics helps explore the validity of widely made claims such as: "ChatGPT* is a significant advancement that can produce articles in response to open-ended questions that are comparable to good high school essays" (positive claim) or "ChatGPT is just another entry in the artificial intelligence hype cycle and deprives learners of acquiring important skills" (negative claim).

2. Workshop objectives

The IS-EUD 2023 workshop is the 7th CoPDA workshop, in continuity with the edition held in 2022 in Frascati (Rome) focused on the relationship between AI and Human-Centered Design [12] (see Figure 2). An important challenge for the researchers getting together in the workshop this year is to explore the foundational idea(s) that these workshops have pursued and how they are related to each other. A particular objective of all previous CoPDA workshops has been to *collectively identify important and interesting themes for future workshops* and our hope and expectation is that this happens again this year by exploring *conceptual frameworks and socio-technical environments* making Computational Fluency a desirable and reachable goal for all citizens.

A student who has proficient skills in Computational Fluency would be able to use strategies together with the facts he or she knows how to identify a more challenging problem or another representation of the solution. This is a step beyond Digital Literacy, which focuses on mastering the tool in use (e.g.: keyboarding, surfing the internet, proficiency with digital environments for reading, writing, calculating, and communication), and beyond Computational Literacy, which focuses on solving known problems in efficient ways, including using coding. Digital Literacy and Computational Literacy (at least some parts) are a prerequisite for Computational Fluency, which emphasizes pursuing personal meaningful problems and shared meaningful activities. Computational Fluency shows mastery and appropriation of computational concepts by allowing one to address new and wicked problems creatively. These abilities cannot be formally taught but can be nurtured, encouraged, and supported with socio-technical environments and education programs that foster reflection, creativity, and sharing.

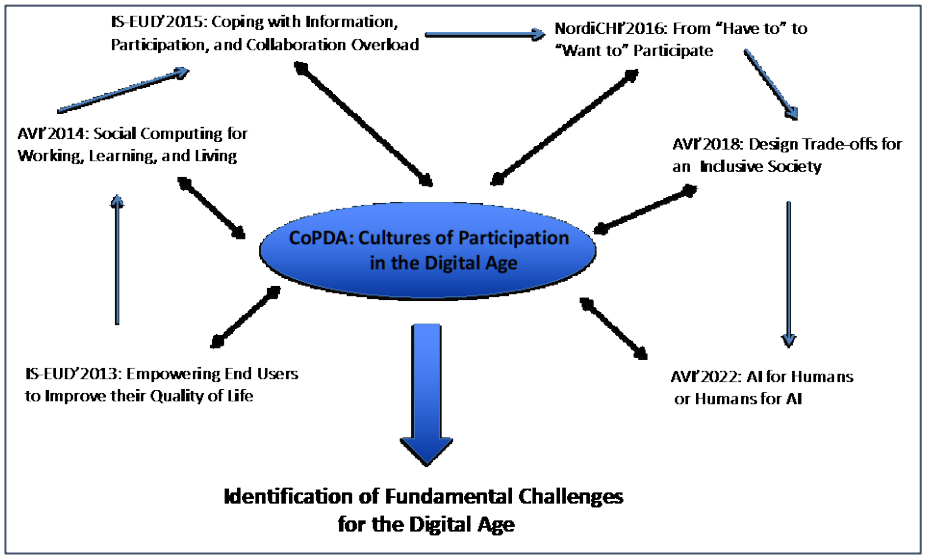

Figure 2: Overview of the previous CoPDA Workshops

*A conversational artificial intelligence program released recently by OpenAI

The workshop aims to discuss Computational Fluency in the Digital Age by considering several topics including (but not limited to):

- Computational Thinking
- Design Thinking
- Printed Fluency
- Digital Fluency
- Human-centered AI (HCAI)
- Explainability of AI-based decisions
- Evaluation of AI-based systems
- AI support in everyday work
- ChatGPT: Promises and Pitfalls
- Big data and privacy
- Adaptive, Adaptable, and Context-Aware Systems
- End-User Development and Meta-Design
- End-User Development for AI-based systems
- Design Trade-offs between AI and EUD
- Distributed cognition
- Cultures of participation
- Multi-dimensional aspects of learning
- Collaborative learning
- Educational nurturing

3. Target audience

This edition of the CoPDA workshop aimed to attract researchers and practitioners from various backgrounds and communities, such as designers and users of socio-technical environments, learning scientists, and educators, interested in discussing how to improve and foster Computational Fluency in the current society.

4. Workshop organization

Potential participants were required to submit a 6-page position paper addressing the topics and goals of the workshop. Each submission was reviewed by at least 2 members of the Program Committee, and the review process allowed us to select 9 papers for presentation at the workshop. The authors of accepted papers have been required to read all CoPDA 2023 contributions available online before the workshop day, to stimulate discussion during the workshop.

The workshop day has been structured as follows: 1) a brief round of presentations by each participant; 2) 15-minute slot for each paper presentation, followed by 10 minutes for questions and answers; 3) a plenary discussion about the new topics, ideas, and challenges that have emerged in pre-workshop activities, as well as those emerging after each presentation; 4) concluding remarks with proposals for future collaboration.

5. Program committee

Jose Abdelnour-Nocera (University of West London, United Kingdom)
Renate Andersen (Oslo Metropolitan University, Norway)
Torkil Clemmensen (Copenhagen Business School, Denmark)
Rosella Gennari (Free University of Bozen-Bolzano, Italy)
Angela Locoro (Università degli Studi dell'Insubria, Italy)
Monica Maceli (Pratt Institute, USA)
Maristella Matera (Politecnico di Milano, Italy)
Alessandra Melonio (University of Venice Ca Foscari, Italy)

Philippe Palanque (Université Paul Sabatier, France)
Fabio Paternò (ISTI-CNR, Italy)
Daniel Tetteroo (TU Eindhoven, The Netherlands)
Marco Winckler (Université Nice Sophia, France)

6. Organizers' bios

Barbara Rita Barricelli is Associate Professor at the Department of Information Engineering of Università degli Studi di Brescia (Italy). Her research interests are Human-Computer Interaction, Human Work Interaction Design, Socio-technical Design, End-User Development, Usability, and UX. She has been involved in several International and Italian projects in collaboration with universities, research institutes, and private companies. She is Chair of IFIP TC13.6 Working Group on Human Work Interaction Design.

Gerhard Fischer is a Professor Adjunct and Professor Emeritus of Computer Science, a Fellow of the Institute of Cognitive Science, and the Director of the Center for Lifelong Learning and Design (L3D) at the University of Colorado at Boulder. He is a member of the Computer-Human Interaction Academy (CHI; 2007), and a Fellow of the Association for Computing Machinery (ACM; 2009). His research has focused on new conceptual frameworks and media for learning, working, and collaborating, human-centered computing, and design. His recent work is centered on quality of life in the digital age, social creativity, meta-design, cultures of participation, design trade-offs, and rich landscapes for learning.

Daniela Fogli is Professor at the Department of Information Engineering, University of Brescia, Italy. Her research interests are in the field of Human-Computer Interaction and include meta-design, end-user development, universal design, conversational and multi-modal interfaces. She has performed her research activity in collaboration with several scholars from different universities and research centers. She is chair of the steering committee of the International Symposium on End-User Development.

Anders Mørch is Professor at the Department of Education (IPED), University of Oslo, Norway. He received his Ph.D. in informatics from the University of Oslo and an M.S. in computer science from the University of Colorado, Boulder. He developed Intelligent Tutoring Systems at NYNEX, New York. His research interests are in how tools and artifacts help people learn together (distance education, computer-based scaffolding, end-user tailoring); interfaces supporting learning (critiquing systems; pedagogical agents; learning analytics); domain-oriented design environments for classroom use (maker spaces, virtual worlds); new models of design-based collaborative learning.

Antonio Piccinno is Associate Professor at the Computer Science Department of University of Bari. He is a founding member of the IVU (Interaction, Visualization, Usability & UX) Lab of the University of Bari, where he coordinates research on the interplay between Human-Computer Interaction and Software Engineering through techniques of End-User Development. His research interests focus on Human-Computer Interaction, Software Engineering, End-User Development, the Internet of Things, Smart Environments, and Visual Interactive Systems. He is/has been Full Paper Co-Chair of INTERACT 2021 and 2023 and IS-EUD 2011, doctoral consortium co-chair of ACM CHItaly 2015 and IS-EUD 2017, and poster and demo papers co-chair of ACM AVI 2016.

Stefano Valtolina is Associate Professor at the Computer Science Department of Università degli Studi di Milano. He obtained his Ph.D. in 'Informatics' from University of Milan and an MSc in Computer Science from the same university. His research interests include Human-Computer Interaction (HCI), Creative Design, as well as studies in semantic, social, and cultural aspects of information technologies with an emphasis on the application of this knowledge to interaction design. His research activity is directed toward the study of aspects of Human-Computer Interaction and Database Management investigating methods, interactive systems, and tools for Knowledge Management and Fruition.

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