

(image credit: Dailymail.co.uk, ways astronauts prepared for historic moon landing in 1969)

19th CIRN Conference 2021
COMMUNITIES, TECHNOLOGY AND THIS MOMENT
Wednesday, 8 – 12 Nov 2021
Virtual Conference

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BACKGROUND TO THE CONFERENCE

Since the founding colloquium in 2003, the CIRN (Community Informatics Researchers Network) conferences have been marked by informality, collegiality and interdisciplinary thinking, bringing together people from many different countries in an ideal Italian setting.

Themes have ranged across issues such as privilege, gender & sexual identities, forms of knowledge, documentation, participation & community-based research, power, ideals & reality, measurement, and the applied arts. While we have a particular theme each year we also seek papers (that include referred, work-in-progress, and non-refereed), presentations, posters, and graduate student work related to any aspect of Community Informatics, Community Archiving, Development Informatics, Art, Archives Memories, and ICTs field.

We are particularly interested in papers from researchers and practitioners that can address the challenges of locating community-focussed research within wider theoretical and practice frameworks. We also have a research student (masters and doctorate) presence and encourage the submission of current or planned work in colloquium sessions. This is a great opportunity for interaction with other students in an international setting. More generally, CIRN conference is a highly social event in a small and culturally-rich part of Italy.

OUR (INTER-)DISCIPLINARY FRAME & APPROACH

Community Informatics is primarily concerned with improving the well-being of people and their communities through more effective use of ICTs. Community Informatics foregrounds social change and transformative action in emergent social-technical relationships rather than prediction and control and likewise, Development Informatics or ICT4D is concerned with ICTs in the international development context. This orientation also has much in common with **Community Archiving**.

Community-centric archival research, education and practice are concerned with empowering communities in support of such desirable objectives as democracy, human and civil rights, self-determination, sustainable development, and social inclusion. Recordkeeping and archiving are fundamental infrastructural components supporting community information, self-knowledge and memory needs, thus contributing to resilient communities and cultures and supporting reconciliation and recovery in the aftermath of conflict, oppression.

Development Informatics (also called ICT4D) is involved with the use of ICTs in international development settings. The purpose of International Development is heavily contested, and thus, the use and interpretations of ICTs in that space is also subject to a wide variety of interpretations. More recently, those in the Art, and Archives Memories and ICTs have been participating with us in an exploration of how the media, dance and other forms of arts interested in ICTs intersect with community development, community memory and archives.

[For the proceedings past events, archives etc, please see <https://www.monash.edu/it/hcc/dedt/prato-conferences>. For past websites/events (services have closed down, no one hand-crafts sites anymore. 😞) look for ccnr.net between 2002 - 2010 as well as cirn.wikispaces.com 2009-1018 on archive.org.]

2021 THEME: COMMUNITIES, TECHNOLOGY AND THIS MOMENT

ABOUT THE THEME: The theme of the 2021 conference, “Communities, Technology and this moment” aims to bring together the rich knowledge, experience, and practice of Community Informatics, Community Archives, and Development Informatics with a focus on data justice, digital equity, and community informatics response to this moment in history. The 2021 CIRN conference will provide a virtual space to explore how researchers and practitioners ethically collect information, including what happens when community information is intentionally left uncollected, and how information systems can be designed in harmony with communities.

CIRN is an annual conference that normally takes place in the wonderful atmosphere at Monash University's campus in Prato, Italy. This year it is online because of pandemic restrictions. It is focused on sharing lessons, learning together, and developing strategies to build more inclusive, just, and equitable communities. CIRN welcomes researchers and practitioners working towards human and civil rights, self-determination, sustainable development, and social justice to submit a proposal to this year's CIRN conference. The conference call is now closed Follow the links above on submitting a paper or proposal, costs, and other matters.

WHO IS IN ATTENDANCE: This year's conference welcomes academics, practitioners, and researchers working in Community Informatics, Information & Communication Technologies for Development (ICT4D) Informatics, Participatory Information Governance, Recordkeeping Informatics, Community Archives, Cultural Informatics, and beyond (e.g., Health Informatics) to listen, learn, and discuss research and practice in international and domestic politics, policy, and advocacy.

2021 CONFERENCE COMMITTEE

Gillian Oliver, Monash University, Chair
Nova Ahmed, North South University, Bangladesh
Mark Gaved, Open University, UK
Aldo de Moor CommunitySense, Netherlands
Manuela Farinosi, Udine University, Italy
Khalid Hossain, Monash University
Ming Hu, Nanjing University, China
Peter Johnson, University of Waterloo, Canada
Caroline Khene, De Montfort University, UK
Ian A. Lubin, Independent Scholar, USA
Mario Marais, CSIR, South Africa
Jan Lena Meissner, Newcastle University, UK
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Mauro Sarrica, Sapienza University, Italy
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Sara Vannini, University of Sheffield, UK
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Martin Wolske, University of Illinois, USA

CONFERENCE ORGANISERS

Larry Stillman, Monash University
Misita Anwar, Monash University
Tom Denison, Monash University
Colin Rhinesmith, Simmons University
Monisha Biswas, Monash University (PhD colloquium)

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Tom Denison, Monash University
Manuela Farinosi, University of Udine, Italy
Janis Meissner, Newcastle University, UK
Aldo de Moor, Community Sense, Netherlands
Gillian Oliver, Monash University
Colin Rhinesmith, Simmons University
Larry Stillman, Monash University
Martin Wolske, University of Illinois, USA

PEER REVIEW STATEMENT

The Conference Proceedings contains referred, non-refereed and PhD colloquium papers and Powerpoints from the conference.

All full papers in the refereed category were subject to blind peer review by at least two reviewers, and reviewers' comments returned to the authors. Authors were then required to make changes and if necessary, a further review conducted before final approval.

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CIRN PRATO 2021

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Non-refereed paper/practitioner report/talk

Biswas, Monisha. Monash University, Australia

RETHINKING RURAL WOMEN'S AGENCY IN COVID-19 ERA: SLF AS A DESIGNING MODEL

Keywords: ICT4D, Community informatics, SLF, empowerment/agency of rural women, contextual vulnerability including climate change

Rural women's physical mobility and information access in countries like Bangladesh are constrained by social vulnerability, unjust social structures and patriarchal social norms. These occur within the context of increased climate change and threats to food security and physical assets such as the villages themselves. The rural development model in development contexts like Bangladesh depends on direct services offered by local NGOs and government extension officials. That strategy is no longer valid for social distancing rules. The COVID-19 era provokes us to turn the situation into an opportunity to design hybrid setups and further explore the potential of ICT-based (particularly mobile technology) development interventions.

Drawing from my PhD research findings, I propose a modified version of the Sustainable Livelihood Framework (SLF) to analyze the vulnerability faced by marginalized communities and identify their informational capabilities and livelihood strategies to meet these complex challenges.

ABSTRACT ONLY

Non-refereed paper/practitioner report/talk

Buzzonetti, Flavia. FILE. Fondazione Italiana di Leniterapia

FILE'S CAPE

Keywords: palliative care; community art; ICTs; community creative & support under COVID

Every knitted stitch, sewn or embroidered, is intertwined with another, just as every life is intertwined with another. This is the inspiring principle of the project "the colors of life", launched by FILE's (Fondazione Italiana di Leniterapia) volunteers from Prato: to create a large and colorful hand sewn cape to raise awareness of palliative care.

Why a Cape?

The word 'palliative' from Latin pallium, cape, evokes the idea of protection. We can find this philosophy's roots in the cult of St. Martin and in a particular episode of his life: as a soldier of the Roman Empire, Martin shared his "pallium" with a beggar suffering from the cold during a night patrol. Therefore St. Martin's cape has become the symbol of caring, welcoming and protecting, just as palliative care welcomes and protects the seriously ill.

More than 1600 years later, the volunteers of FILE wanted to reproduce this gesture of protection and with the contribution of hundreds of people who took up their needles and crochet hooks, created over 2000 squares of colored wool. When joined together, the 2000 squares were transformed into a giant 250 square meters cape.

The cape was displayed in Piazza delle Carceri, Prato, the 30th of May 2021 coinciding with the National Day of Relief, an important day for FILE, which was founded to assist and support the terminally ill and their families. This engaging and joyful initiative resonated through social media and represented a different and innovative way to share our right to live a full and dignified life until the end of our days with the world.

ABSTRACT ONLY

Refereed Papers

Daraz, Lubna (1); Bouseh, Sheila (2); Chang, Bebe Swallayhah (3); Yassine, Yara (1); Yuan, Xiaojun {Jenny} (4); Othman, Roslina (5)

1: University of Montreal, School of Library and Information Science. Faculty of Arts and Sciences. Canada; 2: Independent Researcher; 3: Nova Southeastern University Libraries. Southeastern University. Florida. United States; 4: College of Emergency Preparedness, Homeland Security and Cybersecurity. University at Albany, State University of New York. USA; 5: Faculty of Information and Communication Technology International Islamic University of Malaysia. Kuala Lumpur, Malaysia

A RAPID SYSTEMATIC REVIEW TO IDENTIFY THE CURRENT STATE OF THE EVIDENCE ADDRESSING ISSUES RELATED TO COVID-19 AND INFORMATION.

Keywords: COVID-19, information, rapid review, misinformation, social media.

The novel coronavirus pandemic has claimed millions of human lives and has been a tremendous burden to our healthcare systems. Due to the characteristics of the virus, a lack of availability of treatments and uncertainties, people have become profoundly dependent on information to meet their needs. To understand the current state of the evidence and to identify research gaps regarding the issues related to COVID-19 and information, we have conducted a rapid systematic review. The review included 135 studies. The population for the included studies represented more females than men with a higher level of education (a bachelor or higher degree). The study findings demonstrated that people accessed numerous information sources, and social media was a commonly used platform which was reported in 76% of the studies. For contents, studies discussed general information relevant to COVID-19, information source, information-seeking behaviour, misinformation, health literacy, trust, and credibility. More research is needed to investigate the potential sources of misinformation and relationships with conspiracy theory, guidelines for appropriate dissemination of reliable information on social media platforms, and strategies to empower people to make informed decisions when faced with a significant public health crisis such as the coronavirus.

PAPER

Refereed Papers

Domínguez Ramirez, Derlis Joel (1); Parra Trepowski, Cristhian Daniel (2); Montanía, Claudia Vanessa (3); Cernuzzi, Luca Carlo (1)
1: Department of Electronics and Informatics (DEI), Catholic University Nuestra Señora of the Asunción, Paraguay; 2: Acceleration Laboratory UNDP (United Nations Development Programme); 3: Latin American Faculty of Social Sciences

PARTICIPATORY DESIGN OF COMMUNITY INFORMATION SYSTEMS TO PROMOTE COOPERATION AMONG WASTE PICKERS

Keywords: social informatics, participatory design, thinking aloud, recycling, waste pickers.

This paper presents lessons learned from engaging a community of waste pickers in the design of an information system that promotes cooperative practices among them and facilitates relevant information management of their daily work. We started by enabling a series of participatory mapping activities to document waste picking experiences during the Covid-19 pandemic, with the goal of understanding what practices are common and what barriers might exist in relation to trust and cooperation. Based on both qualitative and quantitative accounts of the routes, collection points, and other experiences that take place everyday while providing the city with recyclable waste picking services, a system was designed with the goal of making relevant information easy to manage and use, including weight of collected recyclables, the current market prices for different types of waste, and a memory of comments to guide fellow waste pickers on what to know when engaging with different intermediaries and recycling companies, among many others. As we progressively develop the first prototype of the system, thinking aloud sessions with waste pickers and other members of the community provide insights on what to refine, what to discard, and what is still missing to promote new forms of cooperation and increased trust in this community of waste pickers. We finish this paper with a discussion about the future of this work, including recommendations that can help other communities replicate this participatory design action research.

PAPER

Non-refereed paper/practitioner report/talk

Dutto, Matteo (1); Simeone, Luca (2); Ricatti, Francesco (1); Wilson, Rita (1)

1: Monash University, Australia; 2: Aalborg University, Denmark

YOUTH IN THE CITY – LA NOSTRA PRATO: DIGITAL STORYTELLING FOR TRANSCULTURAL LEADERSHIP

Keywords: digital creative practices, participatory research, social change, superdiversity, youth

Youth in the City is a research initiative led by Monash University that aims to foster leadership for social change through creative practices and digital projects within superdiverse cities across the world. We focus on initiatives centred around young people of different cultural and linguistic backgrounds that will foster the development of leadership and communicative skills and build communities of practice. In September 2019, we collaborated with 48 high-school students of different cultural and linguistic backgrounds to realise La Nostra Prato our first pilot project. Home to over 120 different nationalities, the city of Prato is one of the most studied cases of multiculturalism in Italy and has become over the years “a European ‘hotspot’ for migration and integration issues” (Baldassar et al. 2015b, 8). It is also a place where we witness first-hand how migration flows generate “transcultural edges”, that is, new and innovative spaces “where unevenly distributed different cultural systems, representation, imaginaries converge and give rise to new transcultural practices” (Vanni 2016, 7).

Against this background, La Nostra Prato project applied the YITC methodology to develop creative processes that could foster leadership skills and an enthusiasm for social change among 48 high school students, many of whom were of migrant background. These young people could play a vital role in bringing together their communities, fostering social cohesion and building socio-economic resilience. Their lived experiences across different cultures, languages and social contexts provide the potential for great leadership within increasingly complex, transcultural, and multilingual societies. Using the La Nostra Prato project as an illustrative example, we suggest an alternative model for understanding and engendering social and cultural change: one that focuses on the transdisciplinary and transcultural processes through which young people in superdiverse urban contexts develop leadership skills through creative and digital practices.

This presentation reflects on the methodology developed for this pilot study to map the possibilities and challenges that digital storytelling offers when working with multilingual and multicultural youth. We first explore how digital storytelling and participatory-action research can be used to engage with students across all levels of education to challenge mainstream narratives of national homogeneity and tradition. We then discuss the interactive storytelling experience and sets of educational guidelines that we produced as part of the project, discussing the critical role that replicability, accessibility and open-access play for cultural and research activities that aim to promote the active participation of transcultural youth in research and policy development. Finally, we reflect on how the YITC methodology and our approach to participatory-action research with migrant youth could be adapted for hybrid or virtual participatory-action workshops.

ABSTRACT ONLY

Non-refereed paper/practitioner report/talk

Evans, Joanne. Monash University, Australia

RELATIONAL RESEARCH: REFLECTIONS ON CO-DESIGN AS A RESEARCH METHODOLOGY

Keywords: Participatory research, Co-design; recordkeeping rights

Seven years ago I was successful in obtaining funding for the development of a research program to explore a participatory archival design methodology to harness new digital and networking capabilities in order to develop systems configured around community information, self-knowledge, memory and accountability needs and contribute to transformative changes in archival access and other recordkeeping services. In developing the proposal I had come across the concept of co-design and was intrigued with whether and how it could be used to address the complex social and technological challenges of recordkeeping and archiving in child welfare and protection contexts. It seemed to offer great promise for exploring the complexity of the problem space and the development of a collaborative and participatory dialog with potential solutions. Most importantly it had the potential to enable lived/living experience to be at the heart of transformative intervention to bring about systemic change.

In this paper I will reflect on co-design as a research methodology, considering the constraints, the

conundrums and the contradictions in applying it to research into participatory recordkeeping frameworks for Out-of-Home Care. I will consider what I got right, what got wrong and what have learnt about research, advocacy and relational work.

ABSTRACT ONLY

Refereed Papers

Farinosi, Manuela; Cirulli, Adriano; Fortunati, Leopoldina
University of Udine, Italy

THE IMPACT OF THE PANDEMIC ON FACE-TO-FACE AND MEDIATED COMMUNICATION IN LOCAL GOVERNANCE SYSTEMS: THE CASE OF THE MUNICIPALITY OF PECCIOLI

Keywords: Local Communities, Small Scale, Peccioli, Face-to-face Communication, Communication Infrastructure

The COVID-19 pandemic has fostered the increasing use of digitally mediated communication, which has substituted a large part of the face-to face encounters, work, political, social, and leisure activities, made impossible during the long period of lockdown. What did this entail in small villages, in respect to both citizens and local government, where face-to-face communication has been more resistant to the sirens of the digital? This study aimed to explore the changes seen in institutional communication and, more generally, in the everyday life of citizens and their relationship with local administrators during the first lockdown in Italy. The context explored was the small-scale local community of Peccioli (Tuscany), a village where we have conducted research over several years and where we always observed that face-to face communication usually played a pivotal role in the interaction between local government and citizenship. This small village represents a good point of observation to understand whether, in contexts such as this, there has been a change in the balance between different modes of communication similar to that seen in more urban environments.

More specifically, the paper presents the main findings emerging from a study exploring, on the one hand, the attitudes and opinions of local administrators regarding institutional communication, and, on the other, the evaluations by citizens of the initiatives and the communication by local government and an analysis of their information behaviors. In the first case, a qualitative approach was used, based on 10 semi-structured interviews with local administrators; in the second case, a quantitative approach was adopted based on a survey conducted with a representative sample of Peccioli's citizens.

This study has reached several interesting findings, among which we report two of them as being particularly significant: 1) the pandemic has been faced by these citizens reverting especially to word of mouth and thus indicating that, contrary to what is generally believed, not all communication has become automatically digital during COVID-19; 2) local administrators, contrary to the national government decision to shift public administration to smart working, decided to continue working in the City Hall in order to send their citizens a strong signal that during this emergency the state was there for them.

ABSTRACT ONLY

Refereed Papers

Fink, Alexander; VeLure Roholt, Ross
University of Minnesota, United States of America

SURFACING DATA USE PRACTICES IN YOUTH-SERVING ORGANIZATIONS: THE INFRASTRUCTURING OF DATA INJUSTICE

Keywords: education, youth, data, justice, infrastructure

In the work we do as a program evaluators for youth-serving organizations, many new contracts begin by being told: "We need more data about our kids." Recently, we began asking, "Why?" - as if the answer were less obvious than our new employers assumed it should be. This typically prompts the response, "so we can tell funders how successful we are with them." However, further prompting unfurls myriad other reasons: "we want to track kids so we can understand attendance patterns," or, "we want to know which kids are

falling through the cracks,” or, “we want to know where to focus our resources.” (Quantitative) tracking data has become synonymous with all evidence and data, and therefore also the foundation of good decision-making (example: “13 percent [of nonprofits] said they rarely use data, or not at all (gasp!). Excuse our language, but we consider rarely or not using data at all to be downright ugly. Using data to know what works and what doesn’t can help drive changes to your website, email, marketing tactics and so much more,” (Everyaction, n.d.). If we dig deeply enough, the desire to have more “data” is justified with the above reasons, but seems to be prompted more by a nonprofit zeitgeist than an evidence-based logic (Barbrook & Cameron, 1996; NTEN, 2012). Indeed, as a field we know very little about how and whether this data actually helps organizations make better decisions, and thus improve the efficacy or efficiency of youth programs in addressing their stated goals.

As evaluators, our role is to help organizations make sense of their successes (and challenges), and more importantly, to fit data use practices in a framework of the change the organization is trying to make (often a logic model or theory of change). This prompted further questions: how do youth-serving organizations use data? What do they use it for and are they successful in this use? What does this use of data accomplish? This line of inquiry prompted the following study - an attempt to develop a preliminary framework describing data use practices in youth work.

This study builds on three years of participant observation as program evaluators in youth-serving programs around the world. It also included a national study of youth-serving organizations with a strong focus on data use (Fink, 2018). Finally, it includes interviews with program staff in youth-serving organizations and focus group data with young people. Triangulating from this dataset, we surface the emergent infrastructuring of data injustices within youth-serving organizations and their funders, drawing to the fore salient questions for those invested in supporting the just use of data and technology for our communities.

ABSTRACT ONLY

Refereed Papers

Frutos, Raquel (1); Parra, Cristhian (2); Crnucci, Luca (1); Monatania, Claudia (2)

1: Catholic University "Nuestra Señora de la Asunción", Paraguay;

2: ACCLAB Py - United Nations Programme Acceleration Laboratory

ICTS TO STRENGTHEN SOCIAL CAPITAL: RECOMMENDATIONS FROM CASE STUDIES IN VULNERABLE COMMUNITIES OF ASUNCIÓN DURING COVID19

Keywords: ICT, social capital, vulnerability, community networks.

The purpose of this research is to analyze and describe the solidarity networks in vulnerable communities of Asunción and the role that ICTs play in the activation of these networks. In particular, this study focuses on case studies of "ollas populares" (community soup kitchens), an initiative that emerged as a local response to the lack of food security exacerbated by the pandemic. Based on these case studies, we seek to determine whether ICTs helped mitigate the food security problems generated by the COVID-19 pandemic.

The conceptual framework used in this analysis is based on the theory of social capital, defined as the set of interpersonal and trust networks that are built around individuals and groups in society, and that influence the collective action and resilience of communities. Specifically, we propose to analyze the patterns of use of ICTs as tools to develop and strengthen ties within the studied communities in Asunción. Therefore, we aim to identify use and design criteria to guide future ICT-based strategies to enhance or complement community responses to similar crises, contributing to the field of interdisciplinary studies of Social Informatics.

PAPER

Refereed Papers

Han, Yingying (1); Markazi, Daniela M. (1); Narang, Samuel (2)

1: School of Information Sciences, University of Illinois at Urbana-Champaign; 2: Amazon

OUTLINING A DESIGN JUSTICE-BASED SOCIAL MEDIA WEBSITE FOR UNIVERSITY STUDENTS IN THE AGE OF COVID-19

Keywords: design justice, website design, FERPA, color-blind, COVID-19

The University of Illinois Urbana-Champaign (UIUC) discontinued in-person classes in favor of online instruction in March 2020 due to the COVID-19 pandemic. The sudden shift to online courses was challenging for university students who have experienced the logistical and emotional upheaval of the abrupt disruption. In such a scenario, this project aims to design a social media website that serves the UIUC student community to be updated with campus information and stay connected during and after the COVID-19 pandemic. Together with six undergraduate students, the researchers brainstormed their information needs for the website. Meanwhile, the researchers had deep and ongoing reflections on how their racial and cultural backgrounds can impact the design process. Based on these reflections and to design a more inclusive and privacy-focused website, this project focuses on users with color blindness while prioritizing FERPA compliance. To do this, the researchers conducted a preliminary literature review, including a comprehensive survey of the works published relating to FERPA-compliant website design and optimization of a website for users who are color blind. The review provides the foundation of an effective user interface, highlighting how future research and participatory design are needed to further this study.

PAPER

Graduate Paper or Presentation

Haniya, Iyad (1); Haniya, Samaa (2)

1: Rashad El-Shawwa High School, Palestine; 2: Pepperdine University, USA

EMERGENCY REMOTE LEARNING IN THE ARAB WORLD: A CASE STUDY

Keywords: COVID-19, Remote Learning, Digital Equity

The recent COVID-19 pandemic has caused a significant disruption to the education system nationally and globally forcing all schools and universities to move online quickly without previous preparation. According to a data report released by UNESCO (2020), there are nearly 1.38 billion learners impacted by school closure around the world. With this sudden, unplanned and rapid move to online learning, different schools in different countries rushed to adapt a new remote learning model to continue teaching and learning using recent technology innovations and eLearning tools. Yet, other developing countries are being left behind in the digital divide with very limited internet connection or frequent power outage to move online, such as Palestine. A question may rise, how the Palestinian schools continued to learn in the time of Covid-19 with limited resources, how their remote learning model(s) look like? What are the challenges and the opportunities associated with these models? This chapter will discuss a case study of the remote learning model in Palestine and articulate its impact on learners. The overall goal is to raise awareness about emergency learning in different countries across the globe.

ABSTRACT ONLY

Non-refereed paper/practitioner report/talk

Hossain, Md Khalid. Monash University, Australia

ROLE OF ENVIRONMENTAL INFORMATICS IN CONSERVATION PLANNING: THE CASE OF BANGLADESH

Keywords: Environment, Conservation, Bangladesh, Informatics

Environmental Informatics, as defined by Hilty et al. (2006: 1517), is a special discipline combining 'computer science topics such as database systems, geographic information systems and simulation modelling with respect to their application to environmental research and protection'. Earth observation and monitoring, environmental modelling and simulation, applications of geographical information systems, development of environmental information systems and disaster risk modelling and assessment are some of the major areas under environmental informatics. Besides, to make the knowledge grounded and triangulated, integration of citizen science has been emphasized in environmental informatics similar to the attention it gets in community informatics. Consequently, over the years, environmental informatics has become an important tool for environmental planning and actions for the government and other environmental organizations across the world. However, it has also been observed that the term 'Environmental Informatics' has not yet been widely mainstreamed in the field of environmental planning and management despite the usage of different

environmental informatics tools in planning and management. Besides, use of environmental informatics tools has remained ad hoc in the planning and management process in some countries. In those countries, environmental informatics professionals are not also strongly visible in the policy advocacy space and their role is observed as purely technical in many instances. Since Bangladesh is pursuing a 'Vision 2021' termed as 'Digital Bangladesh' with a goal to ensure delivery of government services to citizens through maximization of digital technology, environmental informatics is highly relevant for Bangladesh considering numerous environmental and biodiversity conservation challenges including severe climate change impacts the country has been tackling. It is therefore important to explore how environmental informatics is embedded in conservation planning of Bangladesh with a future outlook. This paper aims to explore this issue through reviewing a number of conservation strategy and actions plans of the Bangladesh Government where environmental informatics is highly relevant. By following a case study research design based on secondary information, the paper advances some recommendations in relation to strengthening the role of environmental informatics in conservation planning of Bangladesh. The paper will have contribution to the body of literature on environmental informatics by linking use of environmental informatics to conservation planning in an emerging nature-dependent economy addressing different societal challenges.

ABSTRACT ONLY

Graduate Paper or Presentation

Lange, Carina. Universität der Künste, Berlin, Germany

DESIGNING AGENCY - COMMUNITY LEARNING APPROACHES IN VULNERABLE CONTEXTS

Keywords: Development, post-colonial, agency, community learning, Participatory Action Research

Context: Theoretically, the internet as a global knowledge resource is accessible to anyone. In practice, most people in developing countries do not have access to it due to a lack of infrastructure, tools and techniques to use it as a resource. I am designing a methodology that bridges this gap and takes into account the technological and spatial dimensions of learning. It is a pivotal element to close the digital divide: infrastructure alone does not solve the challenge. One cannot use the potentials of the internet without the mindset, habit, and digital literacy. Having worked +5 years in development cooperation, I am convinced that community as a lever for change is underused. In my PhD in design research, I am designing a methodology that aims to make a change.

Outline: Referring to William H. Sewell, I define structure as recurrent schemes or patterns that influence and restrict the choices and opportunities available to actors. Cultural schemas and resources foster or inhibit action by agents within the system who, through their action, reinforce the system. Structure is thus allowing agents to act as much as it is inhibiting them from doing so. Agency is the capacity of individuals or a collective to act independently and make their own free choices. (Sewell 1992)

Agency in the context of education in the context of development cooperation is consequently undermined. Two examples: (1) Current narratives on "education in Africa" are paralysing (being left behind, having lost global rhythm, lack of innovation, old school, not equipped enough). (2) Digitalisation is disrupting the traditional way of delivering education and presumably democratising access to knowledge and learning. However, only very few offers exist for the development context, and online courses have low completion rates.

Capacity for agency - for desiring, for forming intentions, and for acting creatively - is inherent in all humans. It is formed by a specific range of cultural schemas and resources available in a person's particular social milieu. (see Sewell, 1992). Consequently, communities can be a powerful lever for fostering healthy and sustainable learning environments.

Peloušková (2020) shows how design practices can open up spaces for agency. Power and dominating ideologies determine who is part of a design process and who holds agency and thus takes profit (Irwin et al. 2016, Constanza-Chock 2020). An example is the digital transformation in Togo where agency is very low. Citizens thus become recipients of input (here: devices and software) rather than agents who are active part of the design process. Transformational change is not taking place as solutions are not anchored and driven by communities (UN, 2021). Tinkering and creativity as key human skills are underused, while communities are maintained in a deficit ideology. (see Cárdenas et al. 2019)

This is something I have often observed in my practical work. I designed approaches such as - an offline community network approach based on Raspberry Pis/MAZI (2019/2020)

- hackathons (2020,2021)
- a community learning approach based on ancestral knowledge (2021)

The empowerment of marginalised communities is not a process that can simply be kicked off and then runs by itself. Yet, I am getting closer to an approach that uses the power of technology to foster scalable community-driven change. It would be an honour to develop this further at #CIRN2021 and present my methodological approach in an interactive way.

ABSTRACT ONLY

Non-refereed paper/practitioner report/talk

Lev-on, Azi. Ariel University, Israel

CLUSTERING OF DELIBERATIVE AND PARTICIPATORY ACTIVISTS IN SOCIAL MEDIA

Keywords: collective action, online communities, participation

This paper demonstrates how online social media activism cluster into distinct deliberative and participatory arenas, by using the Israeli online activity for justice for Roman Zadorov as a case study (Zadorov was convicted of the murder and sentenced for life in prison;. Still an overwhelming majority of Israelis support his innocence, through a large number of online communities).

I demonstrate that the online activity for justice for Zadorov is composed of two distinct clusters. The first, which can be labeled "deliberative" is characteristic of groups led by admins who think the activities should aim at reaching the truth through exposing relevant information and conducting fact-based deliberation. Typically, the precision of information is considered more important than the number of discussants. It is crucial that the information is reliable and not based on rumors or trajectories; spreading of fake-news is considered harmful as it presents the activists as less earnest.

Another cluster, which can be labeled "participatory" is characteristic of groups led by admins who believe that whatever they say will not be taken seriously by decision-makers and hence the activities should aim solely at raising public awareness. The character of their activities typically aims at generating more attention and engagement by the general public. In such groups, one can regularly find inaccurate and even fake content as well as stories by fortune tellers, based on dreams and so forth.

ABSTRACT ONLY

Refereed Papers

Li, Erin; Li, Sean
Cherry Hill High School East, United States of America

THE IMPACT OF DIGITAL EQUITY ON EDUCATION: A SYSTEMATIC REVIEW

Keywords: digital equity, education, learning, digital divide

The Global Pandemic of COVID-19 has exposed issues of digital equity on education. This systematic review will mainly address the impact of digital equity on education. Specifically, the review revolves around three research questions (RQs), including (1) What is the impact of digital equity on education? (2) What are the factors that may affect digital equity? (3) What are the concerns accompanied with the designing of courses and activities that address digital equity in education?

Based on the PRISMA review framework, we performed three rounds of systematic selection in three databases: JSTOR, Web of Science (WOS), and IEEE Xplore. First, we searched predetermined keywords. On May 31, 2021, we searched the Title/Abstract in the JSTOR database for articles using the following three sets of keywords ("education") AND ("digital equity") and produced 3 results. We also searched the All Metadata in the IEEE Xplore and the Topic in the Web of Science databases using the same keywords and produced 42 and 1 articles respectively. A total of 46 non-duplicate results remained for round two screening.

Second, we screened the titles and abstracts using predetermined inclusion/exclusion criteria. The two authors each independently screened approximately 1/2 of the titles and abstracts of the 46 articles. This screening resulted in the removal of 13 articles and 33 articles remained for round three screening (full-text

screening). We selected English-written articles focusing on (1) the impact of digital equity on education, (2) theoretical, conceptual, and empirical studies, but excluded review articles.

Third, we screened the 33 full text of selected articles to ensure they were within the same inclusion/exclusion criteria. A total of 25 articles remained in the final sample.

This paper will present the results in terms of study aims, the issues or challenges and factors related to digital equity on education, and various methods to help improve digital equity in education. In addition, some conceptual frameworks relevant to the topic will be discussed. This review suggests that it is critical to consider the impact of digital equity on education and there is a research gap that needs to be addressed in the field.

PAPER

Refereed Papers

Liu, Yu; Yuan, Xiaojun
University at Albany, SUNY, United States of America

THE RELATION BETWEEN NEUTRAL USER-GENERATED CONTENT (UGC) AND USERS' VACCINATION BEHAVIOR OF COVID-19

Keywords: user-generated content, COVID-19, vaccination, sentiment analysis

User-generated content refers to media contents created by users to share information and/or opinions with other users (Tang, Fang, & Wang, 2014). We analyzed the COVID-19 comments about vaccines on Twitter in order to find out which kind of user-generated contents (UGC) were shared and identify the patterns of the comments. Three text datasets were collected. A sentiment analysis was conducted to determine the valence of each comment. Results indicate that neutral comments account for a high proportion in each of three datasets. However, users' attentions on neutral UGCs about three vaccines are different.

PAPER

Non-refereed paper/practitioner report/talk

Lowry, James (1); Gilliland, Anne (2)
1: City University of New York, United States of America; 2: University of California Los Angeles, United States of America

DISTRIBUTED RECORDS AND REDISTRIBUTED CAPITAL: BLOCKWEAVE AND HUMAN-CENTERED POST-CUSTODIALISM IN THE R-ARCHIVE

Keywords: Rohingya, refugees, blockweave, digital archives

In response to the Rohingya refugee crisis in which hundreds of thousands of people have been forced to flee targeted violence in Myanmar, the Rohingya Project and the Refugee Rights in Records (R3) Initiative is working with technology partners to create the R-Archive. This digital post-custodial archive secures copies of vital records such as land deeds and identity documentation carried into diaspora by Rohingya refugees, to help safeguard rights claims related to citizenship, family, property and security. Working within the Rights in Records framework, the R-Archive centers the autonomy of individuals, families and communities in the selection and digitization of records, the construction of narratives in metadata, the delimitation of access permissions and, importantly, through the use of blockweave, the R-Archive empowers the Rohingya diaspora to maintain the infrastructure of the archive. The project is working towards a financial model that could create a basic universal income for those with a stake in the archive. Yet critical issues remain: in global diasporas, how can distributed recordkeeping meet regulatory aspirations to the right to be forgotten? Do the affordances of blockweave technology offset the risk that archival autonomy is limited to creation and access? When distributed platforms render total deletion impossible, what do the mechanisms of encryption and decryption mean for compliance with international privacy laws? This paper will present the geopolitical and technological contexts for this work before considering what is at stake for refugee communities at this intersection of technologies and rights.

ABSTRACT ONLY

Workshop /Plenary proposals

Lubin, Ian A. (1); Salas-Pilco, Sdenka Zobeida (2); Schwartz, Daniel (3); Stanley, Colin (4); Stillman, Larry (5); Subramony, Deepak Prem (6); Thomas, Michael K. (7); Winschiers-Theophilus, Heike (4); Woo, David James (8); Anwar, Misita (5)

1: Independent Scholar, USA; 2: Central China Normal University, China; 3: Routledge, USA; 4: Namibia University of Science and Technology, Namibia; 5: Monash University, Australia; 6: Kansas State University, USA; 7: University of Illinois at Chicago, USA; 8: University of Hong Kong, China

INTERNATIONAL LEARNING ECOLOGIES: ICT, CULTURE, AND SUSTAINABILITY

Keywords: International learning ecologies, cultural sustainability, indigenous ecologies, cultural pluralism, ICT4D

Advances in the fields of design, technology, and learning allow us to better engage contemporary education and development challenges globally. Yet there is mounting evidence that despite our successes in laboratory and classroom settings the problem persists of how to scale up technology designs, research, and implementations for use in real-world community settings. It is the case that at present technology innovations are not shown to improve the quality of learning, especially in traditional, local, and indigenous communities and contexts, where they may in fact further exacerbate existing inequalities. The evidence instead points to cultural and ecological bankruptcy that results in only limited technology adoption or outright failure inside these communities of need. This remains the case even as ecological challenges (e.g. public health and environmental disasters, migration, and urbanization) seem to occur and persist with increasing frequency and scope. The current state of affairs calls for genuine and respectful engagement to ensure that our innovations promote freedom, human dignity, sustainability, and trust.

This panel convenes to discuss the themes and perspectives advanced in the newly published edited volume, "ICT and International Learning Ecologies." The discourse surrounds the contributions from an international group of scholars and researchers whose work promotes cultural plurality and human diversity in the use of information and communications technologies (ICT). We discuss how it may be possible to bring the information world into traditional and local spaces that seek sustainable solutions, and how to preserve and sustain existing ecologies rather than supplanting or colonizing them. The panel discusses the usefulness of an ecological framework that refocuses our attention on international education and development work with ICT. At the core of our research, policy, and practice is the belief that by recognizing the frontiers of local, traditional, and indigenous learning ecologies in international contexts in relation to a Western ecological frame, we may be able to arrive at greater moral and ethical realizations in our design practice and our technology advocacy.

In addition to examining the rich content of the volume, the panel will also discuss the challenges of conducting and publishing cultural and community-valued research that puts individuals and communities as well as learners' multiple identities at the forefront of technological success. It is hoped that the presentation and discussion of the works in this collection will be a catalyst for advancing genuine and long-lasting education and social change that meet the challenges of this moment.

ABSTRACT ONLY

Graduate Paper or Presentation

Markazi, Daniela M. (1); Margarit, Philip (2); Brunton, Ann M. (1); Shirin, Farzana (1); Ojeda-Matos, Glorynel (3); Funes-Leal, Victor (1); Sulisty, Sinta (3); Heemstra, Jill (1); Stablein, Michael (1); Reed, Samuel (2); Rodriguez, Luis F. (1)

1: University of Illinois Urbana-Champaign, United States of America; 2: University of Minnesota, Twin Cities, United States of America; 3: Arizona State University, United States of America

DISASTER RELIEF AND RESILIENCE: A CASE STUDY ON EMPOWERING PUERTO RICAN COMMUNITIES VIA NGO-ACADEMIA COLLABORATION

Keywords: community engagement, transdisciplinary research, citizen science, environmental action, empowerment

Puerto Rico's location makes the archipelago prone to experience compound disasters such as hurricanes and earthquakes on top of its ongoing socio-economic crises. While Puerto Rico is affiliated with the United

States as a U.S. territory, its separate culture and governance put this work with Puerto Rico in the space of international and marginalized community research. In September 2017, Puerto Rico was hit by two consecutive hurricanes that left residents in the midst of a humanitarian crisis. Disaster recovery can be described by three phases: emergency response, restoration, and reconstruction; while emergency response and restoration phases in Puerto Rico overlapped and have ended, the reconstruction processes are still lagging. Once these efforts concluded, local non-governmental organizations (NGOs) continued playing a pivotal role in reconstruction processes and building community and environmental resilience in underserved communities. In the midst of their pivotal role in post-restoration reconstruction processes, local NGOs can use support from academia to achieve organizational goals.

Caras con Causa, or "Faces with a Cause," was the NGO of collaboration in this qualitative case study conducted from October 2020 to April 2021 virtually during the COVID-19 pandemic. This Puerto Rican NGO works mainly with two disadvantaged, underdeveloped communities: Cataño and Guaynabo. Caras aims to uplift these areas by working with and for local youth to create educational, environmental, and economic opportunities. Through their two main programs, Community Laboratory and Urban Roots, Caras helps these Puerto Rican communities create environmental action to better their local ecosystems and generate meaningful environmental data through citizen science. Moreover, Caras provides STEAM (science, technology, engineering, arts, and math) outreach education and access to information and communications technology (ICT) along with running an environmental restoration program. These programs improve student engagement, foster environmental stewardship, and build community and environmental resilience to future disasters.

A four-year academic collaboration between the University of Illinois at Urbana-Champaign and this NGO has supported service-learning and research opportunities for students and, most recently, assistance for the NGO to achieve grant funding. While the NGO provides community context, the academic team builds its capacity. This NGO-academia collaboration demonstrates the empowerment of communities through many levels: from graduate students located across the United States to an organization in Puerto Rico to youth and wildlife located in Puerto Rican communities. Drawing inspiration from Wolske and Rhinesmith's *Critical Questions for Community Informatics in Practice from an Ethical Perspective* and Wolske's *A Person-Centered Guide to Demystifying Technology*, we present our design, methods, and findings from working with this NGO-academia collaboration to better local communities. We also create a framework for future community-focused NGO-academia collaborations. Our work explains how academics, in addition to performing traditional on-the-ground research, can leverage virtual tools, institutional information access, and their academic skills to help NGOs perform disaster reconstruction work. Such work between academics and NGOs supports educational, environmental, and economic opportunities in communities, for communities, and with communities.

ABSTRACT ONLY

Non-refereed paper/practitioner report/talk

**Meissner, Janis Lena (1,2); Bergmann, Nadja (3); Haselsteiner, Edeltraud (4); Pretterhofer, Nicolas (3)
1: Open Lab, Newcastle University, United Kingdom; 2: HCI Group, TU Wien, Austria; 3: L&R Social Research, Austria; 4: Urbanity, Austria**

THE HIDDEN TECHNOLOGICAL LABOUR OF THE HERO(IN)ES OF THE EVERYDAY

Keywords: hidden technological labour, female-dominated low-wage work, digital competencies, digital skills

Digitalisation has transformed work, jobs, and working environments. Research has paid a lot of attention to topics such as "industry 4.0", gig economy and digital employment. However, it is often overlooked how digitalisation has also affected the (often female-dominated and generally underpaid) occupations of the service sector. Which (hidden) technological labour do retail employees or mobile care workers perform on a daily basis?

This was the research question guiding an interdisciplinary research project in Vienna, Austria. Our project brought together feminist perspectives from social, spatial and technological sciences. We shared the aim to place explicit focus on the rarely visible technologies and digital competencies that service workers already employ in their service provision. By bringing their often hidden efforts to the frontstage, we seek to contribute to political debates on reevaluating these often underrated and underpaid occupations. Our work started at the same time as the pandemic hit central Europe. The lockdowns initially drew a lot of

attention to the very sector which we set out to investigate. Suddenly, the workers were classified “system-relevant”. However, the wave of gratitude and applause from the balconies faded soon again without initiating any actual benefits for the workers. On the contrary, we observed in our work several ways in which the pandemic put them not only in risk and under stress but also caused them additional technological labour.

This paper reports on our qualitative research findings that are directly related to the particular challenges of “this moment in history”. We reflect on the competencies that we saw frontline workers to employ in order to keep supermarkets and chemist’s shops open and to ensure that old people in the need of care receive services at their homes of best and risk-free quality as possible. Based on our data, we highlight the workers’ impressive degree of commitment, underestimated skill and technological adaptiveness. In the discussion we raise important questions about taking action and what might be needed to actually improve the status of the often female-dominated and generally underpaid system-relevant occupations of the service sector.

ABSTRACT ONLY

Workshop /Plenary proposals

**Meissner, Janis Lena (1,2); Bergmann, Nadja (3); Haselsteiner, Edeltraud (4); Pretterhofer, Nicolas (3)
1: Open Lab, Newcastle University, United Kingdom; 2: HCI Group, TU Wien, Austria; 3: L&R Social Research, Austria; 4: Urbanity, Austria**

TALKING ABOUT THE HIDDEN TECHNOLOGICAL LABOUR OF THE HERO(IN)ES OF THE EVERYDAY - ACTIONS FOR REVALUATION?

Keywords: hidden technological labour, female-dominated low-wage work

Following the presentation of our research findings on "The (Hidden) Technological Labour of the Hero(in)es of the Everyday" (submission 112), we organise an interactive panel discussion to address pressing questions of possible interventions: Now that we know how much (hidden) technological labour retail employees or mobile care workers perform on a daily basis, how can these results be used to enhance the status of these (often female-dominated and generally underpaid) occupations of the service sector? And more generally, how can we as democratic societies utilise critical research findings (like ours that uncovered the hidden underpaid technological work) for affecting actual change and increasing social justice?

This session approaches these difficult questions on different levels (such as policy, public awareness, practical tools for workers and employers, etc) and discusses them with invited panelists from Austria (where our work was conducted). However, we invite all CIRN delegates to actively participate in this discussion and share their international perspectives to transcend this geographical focus. In this way, we hope to collect ideas on diverse ways to make our findings actionable for policies and other interventions with the aim to improve the status of underpaid system-relevant professions.

ABSTRACT ONLY

Refereed Papers

Melchior, Claudio. Università di Udine, Italy

NEWS AND CLIMATE CHANGE: OPINIONS, DEGREE OF INFORMATION AND AWARENESS OF ITALIAN UNIVERSITY STUDENTS

Keywords: Climate Change, News, Media, Students, Awareness

The main purpose of the present study was better understanding opinions, beliefs and awareness of a group of Italian university students about (1) climate change; (2) trust about news and media and (3) their self-perception of the quality, accuracy and completeness of the information they have on the topic. A questionnaire was administered to 585 students of University of Udine, in order to understand (1) their relationship with the media/media consumption; (2) the main sources of information; (3) their degree of trust and their awareness regarding the different media; (4) their habits regarding the verification of sources and (5) how much they are really interested in, and informed on, the issues of climate change.

Students declare (1) media consumption focused on new media (they declare themselves influenced about climate above all by the content of social media or by info available on the Internet); (2) a (theoretical) high

attention to the issue of climate change but also (3) a scarce frequency of active search for information on this issue. The students' responses also indicate a (4) general distrust of the various media, in particular about the media that they effectively use, both in general and in relation to the topic dealt with and, (5) although they declare that they often carry out source checks and are able to list numerous signs of recognition of a false or biased news, (6) their self-perception about the quality, accuracy and completeness of the information they have on the topic is quite low.

PAPER

Refereed Papers

Noguera, Ernesto (1); Parra, Cristhian Daniel (2); Cernuzzi, Luca Carlo (1); Montaña, Claudia Vanessa (3)

1: Universidad Católica Nuestra Señora de la Asunción, Paraguay; 2: ACCLAB PY - Laboratorio de Aceleración del Programa de las Naciones Unidas para el Desarrollo en Paraguay; 3: Facultad Latinoamericana de Ciencias Sociales

THE ROLE OF ICTS IN INTRODUCING GOOD RECYCLING PRACTICES AT HOME

Keywords: social informatics, waste sorting at origin, participatory design, human centered design

Municipal solid waste (MSW) is ever growing in volume, and in Paraguay, the lack of adequate infrastructure aggravates the problem of its management, generating various environmental problems. Sorting and classifying waste at its point of origin (our homes and places of work in our communities) is one of the many good practices that improve the quality of life in our communities.

The COVID-19 pandemic deepened our needs of well-designed and affordable ICTs in most of our communities and for most of our everyday activities. Enabling communication and training around the various issues related to MSW has been no exception. We used human centered design to create and experiment solutions that facilitate waste sorting at origin in ways that better respond to needs and capacities of the local context, informing also the design and use of ICTs that promote waste sorting at origin and help community members engage in these practices. This paper reflects upon the lessons we learned through this process about the role of ICTs in enabling a more sustainable waste management system in the city.

PAPER

Refereed Papers

Takaoka, Alicia

University of Hawaii at Hilo, United States of America

SEQUENTIAL MIXED METHODS AND FEMINIST DATA AS A METHODOLOGY IN COMMUNITY INFORMATICS RESEARCH

Keywords: community informatics methodology, sequential mixed methods, feminist data, multi-site/multi-stage research

Online communities have emerged around ideas, beliefs, and needs that are intrinsic to one's sense of self. Some communities have emerged to help members find a place of support and safety when they possess stigmas that do not have any visual evidence unless disclosed, also called concealable stigmas. This paper explores sequential mixed methods can enhance community informatics methodology for data collection and analysis. This is accomplished by using online global communities centered around the safety afforded by membership to evaluate local community perspectives about issues. By focusing on the intersection of information and communications technologies (ICTs) and social capital, community informatics (O'Neil 2002), sequential mixed methods (Tashakkori and Teddlie 1998), and feminist data (Gurumurthy 2011) allows for a more thorough understanding communities. It may also be possible to indirectly improve the well-being of members by respecting social context and shared values to modify or use existing social and technical systems.

This paper explores how community informatics, a feminist approach to data collection and analysis, and sequential mixed methods work together to develop research questions, instruments for data collection, information that should be included in data analysis, and findings. Community informatics is used to gather

the needs and issues of a community. Sequential mixed methods are employed because each stage builds on the previous stage's findings. Feminist data is used to identify the populations across all stages of the study, define the constructs, and craft the research questions. This unique approach to evaluating community needs and perceptions about the community align with the community informatics sentiments of expressing pluralistic voices and interdependence. This methodology can incorporate existing data and new data from social media and from study participants. It also allows for broad and complex statistical analysis and qualitative methods like thematic analysis, and open and axial coding, allowing for a wide range of application depending on the needs of the study. Employing this approach highlights many experiences and responses using easy to understand methods across all stages research.

The case study for this methodological approach will show how to use data gathered from global communities situated online to design localized studies. The case study gathered information from the voluntarily childless community in Facebook groups to inform a local study about social norms about childlessness. The needs and sentiments of the voluntarily childless community were used to evaluate existing perceptions, bias, and social norms around family and family planning. Social media platforms were scoured for keywords. After valence and lexicon analysis, qualitative and quantitative data collection was developed to evaluate perceptions about childlessness in two diverse local communities in Hawai'i. These communities were selected because of their diverse population demographics. However, these communities are external from the global Facebook community. This methodological approach was data rich, and over 30 findings about perceptions and social norms relating to family, family planning, and childless women were identified. These findings can be evaluated in future research about climate change, family planning, social media, and ethical AI.

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PAPER

Graduate Paper or Presentation

Wendelken, Seren. Monash University, Australia

NAVIGATING THE EVERYDAY – OBSERVATIONS OF RESEARCH AS DIALOGUE

Keywords: Everyday life, dialogue, interviews, reflexivity

This paper presents my observations of research as a dialogic process that enables both the researcher and participant to navigate their everyday lives. Taking the example of my research into the creation of learning support records in New Zealand primary schools, I demonstrate and discuss how a theorised approach to research praxis, based on Smith's institutional ethnographic method of inquiry (2005), intersects with an ethic of friendship (Tillmann-Healy, 2003) to develop relationships and points of connection and community between the researcher and participant. I focus on tangible acts of reflexivity, analysing my reflections on interview settings, both physical and virtual, to reveal how the quotidian and idiosyncratic help to shape an understanding of participants' multiple everyday lives. Through shared conversations across time, place and space, I consider how the research dialogic is part of a wider and negotiated process of story-making, where emotion and modes of silence in and through information-sharing play a role, and where both researcher and participant are visible and connected.

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ABSTRACT ONLY

A rapid systematic review to identify the current state of the evidence addressing issues related to COVID-19 and information.

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Abstract: The novel coronavirus pandemic has claimed millions of human lives and has been a tremendous burden to the healthcare systems. Due to the characteristics of the virus, a lack of availability of treatments and uncertainties, people have become profoundly dependent on information to meet their needs. To understand the current state of the evidence and to identify research gaps regarding the issues related to COVID-19 information, we have conducted a rapid systematic review. The review included 135 studies. The population for the included studies represented more females than men with a higher level of education (a bachelor or higher degree). The study findings demonstrated that people access numerous information sources, and social media is a commonly used platform reported in 76% of the studies. For contents, studies discussed general information relevant to COVID-19, information source, information seeking behaviour, misinformation, health literacy, trust, and credibility. More research is needed to investigate the potential sources of misinformation and relationships with conspiracy theory, guidelines for appropriate dissemination of reliable information on social media platforms, and strategies to empower people to make informed decisions when faced with a significant public health crisis such as the COVID-19.

Keywords: COVID-19, health information, rapid systematic review, information source, information content.

Introduction

SARS-CoV-2, commonly known as COVID-19, originated from Wuhan, China, in December 2019, has now spread worldwide. It is a highly infectious virus that quickly transmits from human to human if physical distancing and other recommended protective measures are not maintained. The virus can make some people very ill; others recover with mild symptoms ((WHO) 2021a). A total of 223 countries, areas or territories have been affected, with approximately 4,927,723 confirmed deaths along with a total of 242,348,657 confirmed cases as of October 21, 2021 ((WHO) 2021c). Specific vulnerable groups such as those older than 60 years old and people with certain pre-existing conditions such as lung or heart disease or a weak immune system or diabetes are more likely at risk than others ((WHO) 2021b; Clinic 2021; Singhal 2020).

Governments, scientists, clinicians, and public health professionals have struggled to fight the virus and minimize the harmful impacts on human health. It takes ample time to study and combat a deadly infectious disease like the coronavirus (Singhal 2020; He, Deng, and Li 2020; Atzrodt et al. 2020). Fortunately, due to the dedicated scientists and investments from governments, we have seen advances in vaccine developments to prevent the spread of the virus (Chakraborty et al. 2021; Oliver et al. 2020; Meo et al. 2021). However, it has been predicted that it will still take numerous efforts, time, and resources to completely control the virus (Nouvellet 2020; M 2020; Kissler et al. 2020). There are already reports of new strains of the virus for which we do not have enough information. Because of these uncertainties and a lack of reliable information, we have noticed a rise in the 'infodemic' or information overload about COVID-19 ((WHO) 2020a). People are desperate to know about the virus, its treatments, its impacts on their lives, and managing anxieties caused by the virus (Luo et al. 2020; Clements 2020; Barrett and Cheung 2021).

Due to the characteristic and severe impacts of the illness, people are advised to stay socially isolated as much as possible with essential lockdowns to prevent the spread of the virus. At the same time, many jobs have become remote, including closures of in-class education in schools and universities

and shutdowns of many businesses. As a result, rather than having face-to-face interaction, people have become more dependent on information sources such as online platforms, news channels, healthcare professionals, politicians, and other sources to find and understand information relevant to this virus (Brailovskaia et al. 2021; Varga et al. 2021; Khatri et al. 2020).

Undoubtedly, the pandemic of COVID-19 has led to the creation of unprecedented amounts of disinformation. Patients and the public have been bombarded with information from numerous sources, some of which may not be reliable. The World Health Organization (WHO) has thus introduced the concept of ‘infodemic’ to emphasize the importance of accurate information that can improve public knowledge, change behaviour, and improve adherence to preventive measures. At the same time, WHO wants to clearly warn about the potential of medical misinformation disseminated through the information channels ((WHO) 2020a, 2020b).

Health information that is not evidence-based may cost human lives and impose a tremendous burden on our healthcare systems. Due to a lack of access to accurate information, people have become dependent on information sources without assessing the source’s reliability, thus leading to conspiracy theories and misleading information. The Reuters Institute for the Study of Journalism at the University of Oxford surveyed six countries (United States, United Kingdom, Spain, South Korea, Germany, and Argentina) to study the reliability of information sources, people’s perception of misinformation, and their knowledge and attitude towards COVID-19. The study reported that one-third of the social media users saw false or misleading information on coronavirus (Nielsen RK 2020). Such results indicate the necessity of new strategies for fighting against the rise of ‘infodemic’ relevant to SARS-CoV-2.

To explore the current state of the evidence and determine the research gaps, as a first step to combating the unprecedented spread of misinformation, we have conducted a rapid systematic review. The objective of the review was to identify the current state of the evidence addressing issues relevant to COVID-19 information that are crucial to meeting people’s needs while seeking information on health and its management. More specifically, the research questions were:

- 1) What is the current state of the evidence that addresses issues relevant to COVID-19 information?
- 2) What are the content areas addressed in the literature relevant to COVID-19?
- 3) What are the information sources people use to access information relevant to COVID-19?
- 4) Is there a relationship between conspiracy theory and misinformation relevant to COVID-19?
- 5) What are the harms associated with misinformation relevant to COVID-19?
- 6) Does the literature represent a diverse population regarding their information seeking relevant to COVID-19?
- 7) What is the quality of information related to COVID-19 reported in the literature?

We will report our findings in a series of publications based on specific research questions of the review. In this manuscript, we will report our findings for research questions one to three.

Methods

Literature Search and Study Selection

The study team has conducted a comprehensive search on the following databases: Embase, EBM Reviews-Cochrane Register of Controlled Trials, EBM Reviews-Cochrane Central Register of Systematic Reviews, Ovid MEDLINE ® ALL, CINAHL, Library, Information Science & Technology Abstracts (EBSCO), Library, Literature & Information Science Index (EBSCO), Sociological Abstracts, ERIC (ProQuest), Library and Information Sciences Abstracts: LISA (ProQuest), Web of Science, and WHO. We have searched all study designs. In addition, we have conducted reference mining of relevant

publications to identify additional literature. A health sciences librarian at the University of Montreal Libraries developed and executed the search strategy in consultation with the review team.

Inclusion criteria

The review team included peer-reviewed articles that addressed topics relevant to COVID-19 and information. Study designs with no regional restrictions were included. Articles that were not published in English or French were excluded. Studies that addressed information relevant to COVID-19 diagnosis, treatment, prognosis, or health conditions were excluded. Editorials, letters, commentaries, abstracts, and studies that targeted healthcare professionals, medical students, other public health experts, or policymakers were excluded. Studies with a publication date from January 2020 to November 2020 were included. A complete search strategy is provided in the Appendix, developed and executed based on the research questions.

Independent reviewers screened the titles, abstracts, and the full text in duplicate to select eligible studies. Discrepancies among reviewers were resolved through discussions and consensus. The overview of the search process and study selection is presented in Figure 1.

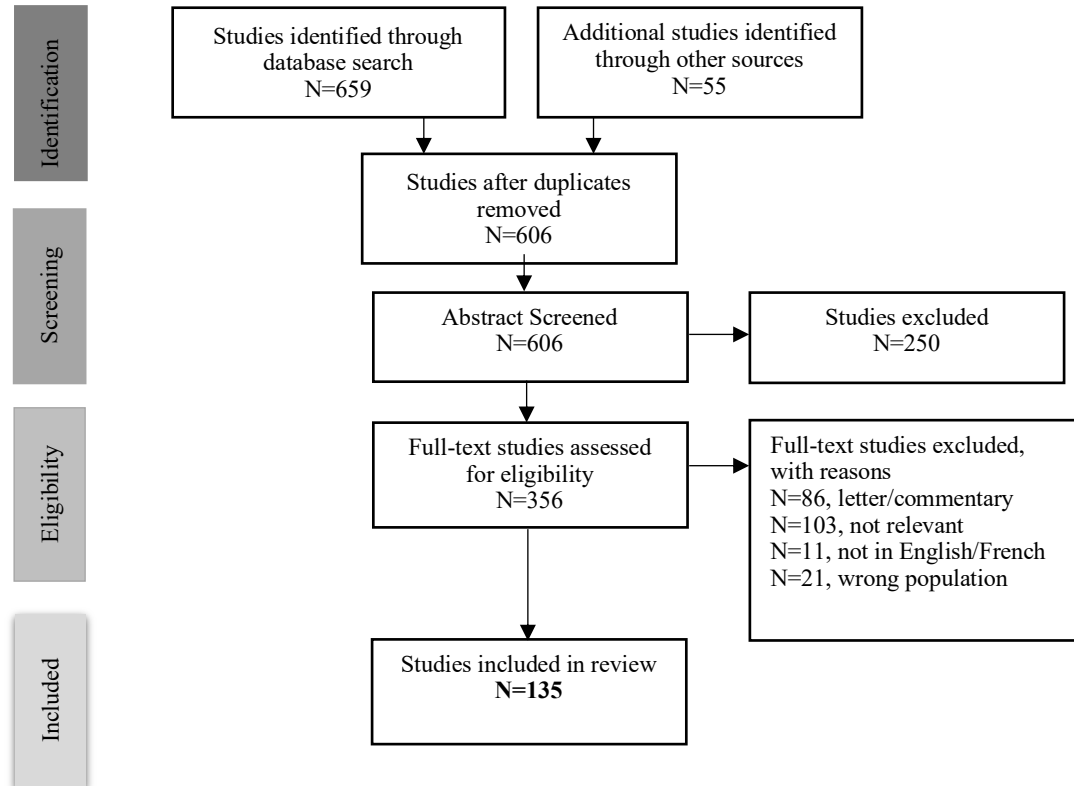


Figure 1. Flowchart of the Study Selection Process

Data Extraction

A data extraction form was developed, which was first pilot tested by the reviewers. For eligible studies, data extracted included: author, year, the origin of the study, country studied, objectives, study design, study population characteristics, content, sources of information, the impact of misinformation, tools developed, and study findings. In a study with a mixed population with healthcare providers or

experts, we have only collected population data for the non-expert population. Data extraction was completed by independent reviewers and audited by a second reviewer for completeness and accuracy.

Data Synthesis and Analysis

Descriptive statistics were used to synthesize the data. Using IBM SPSS Statistics 26, we have performed frequencies and percentages calculations to characterize studies' data which are presented in graphs and tables. For classifying information sources, we have used the following method based on established criteria (Daraz et al. 2011b; Daraz et al. 2019):

- 1) sources with “.gov” domains were classified as government,
- 2) sources with “.edu” domains or affiliated with universities, hospitals, clinics, or professional medical organizations were classified as academic/healthcare,
- 3) sources with “.org” domains and foundations, support groups, or societies were classified as not-for-profit,
- 4) sources with news portals were organized as mass media,
- 5) sources with websites and applications that allow users to create and share content were classified as social media,
- 6) a program or software through which users can search internet content is classified as search engine,
- 7) applications that offer real-time text transmission over the Internet were classified as instant messaging,
- 8) sources that imply persons' religious or spiritual beliefs or a person's association with a political party were classified as religious or political affiliation,
- 9) sources that suggest personal relationships or social interactions were classified as a social network,
- 10) sources that imply relationships with other professionals within the same career or other related fields were classified as a professional network,
- 11) websites that did not disclose affiliation, had commercial contents, or had an association to a private holder were classified as commercial or private, and
- 12) the rest were classified as other.

For classifying contents discussed in the included studies relevant to information, we have categorized them into nine groups: 1) general information pertinent to COVID-19, (2) trust in information sources, (3) misinformation/conspiracy theory, (4) information sources, (5) information-seeking behaviour, (6) credibility, (7) health literacy, (8) knowledge/behaviour/attitude, and (9) other content.

We have performed a sub-group analysis of the content types based on the studies conducted in different countries. We have categorized them into six continents: 1) North America, 2) South America, 3) Asia, 4) Oceania, 5) Europe, and 6) Africa (D 2020)

For classifying the level of education, we have categorized them into three groups: 1) high school or less, 2) bachelor's or some college, and 3) graduate or postgraduate. If we could not categorize any study sample's level of education, we have reported those data as per the study classification.

Only those studies that have reported a specific topic of interest for this review were included in the analysis. For example, about 15 studies did not indicate the countries they studied; thus, we were not able to classify those studies and did not include them in the sub-group analysis.

Results

Study Characteristics

The literature search yielded 714 references, of which 135 met the inclusion criteria. The process of study selection is depicted in Figure 1. The characteristics of the included studies are summarized in Supplementary Table 1 in the Appendix. The study designs for the included studies were cross-sectional, survey, qualitative, review, comparative, online market research, retrospective, observational, case study, empirical, cohort, systematic review, and mixed methods. Most of the studies used cross-sectional and survey study designs.

Due to the different methods used in the included studies, not all studies reported information about the population. As a result, in this article, we have only reported available data, such as sample size, gender, and education level (Table 1 in Appendix). In the subsequent article, we will report other population characteristics more relevant to the research question and the article's theme. And finally, the sample for the included studies represented more females than men, and the education level was a bachelor's or higher degree.

Information Sources

Figure 2 below shows the frequency of information sources people used or sources identified by a study for finding information related to COVID-19. Social media was most frequently used (76%) among all other information sources. This was followed by mass media (46%), academic or healthcare (29%), government (24%), instant messaging such as Skype, WhatsApp, Viber etc. at 13%, search engines such as Google at 12%, other sources at 21%, and the rest of the sources were used below 10%.

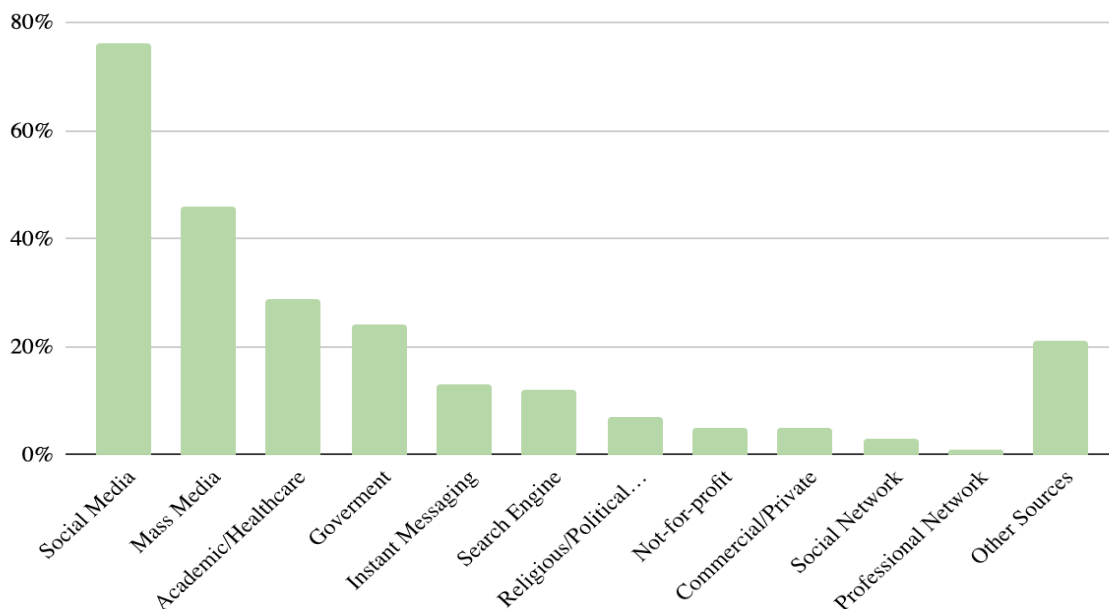


Figure 2. Frequency of Information Sources
Popular Social Media Platforms

A list of various social media platforms use was reported in 35.6% of the included studies. Twitter was used 27%, YouTube and Facebook 21%, Instagram 16%, WeChat 8%, Snapchat 6%, and Tiktok 1%.

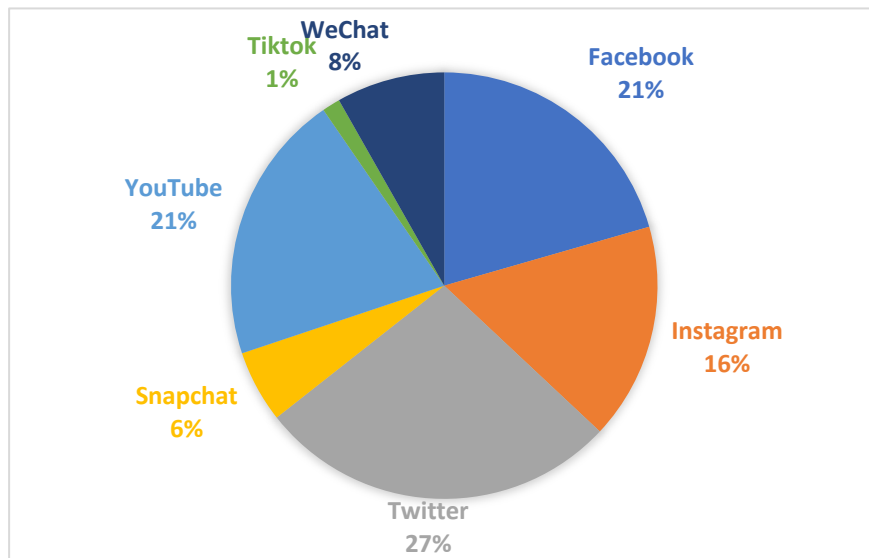


Figure 3: Frequency of the Use of Popular Social Media

Contents

Figure 4 shows the frequency of the types of contents that were discussed in the included studies. Among the contents, 36% of studies focused on general information relevant to COVID-19 and information sources. Information seeking behaviour was discussed 25%, misinformation or conspiracy theory 24%, knowledge, behaviour, or attitude 19%, health literacy 17%, trust in information sources 16%, and rest in 11% of the included studies. The least focused topic was the credibility (3%) of information related to COVID-19.

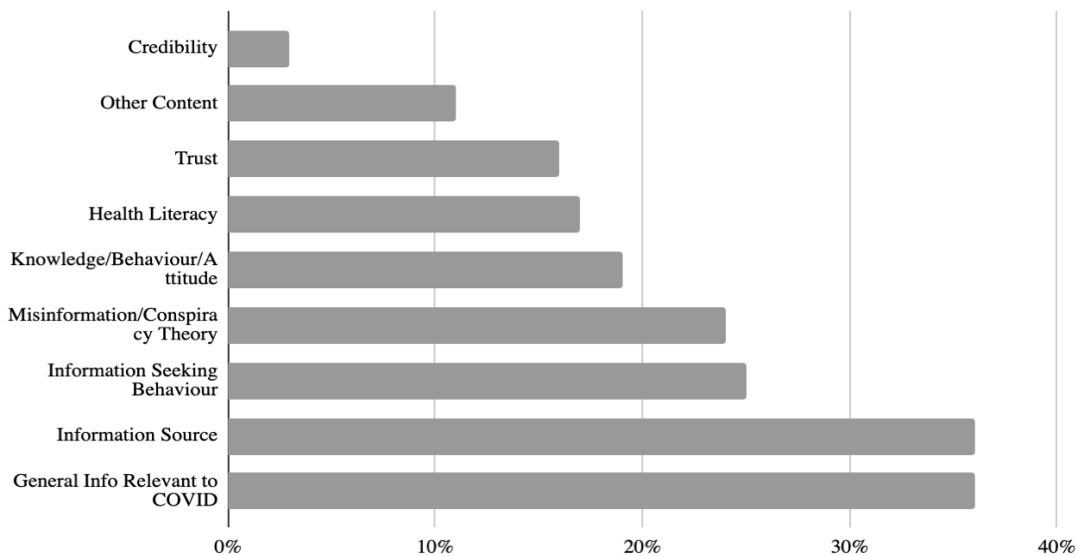


Figure 4. Frequency of Contents
Frequency of Content Based on Continents

A sub-group analysis of the distribution of the types of content shows that all the identified contents (Figure 4) predominantly represented studies from North America, Asia, and Europe (Figure 5). Among these, 62% of studies from North America and 55% of studies from Europe discussed misinformation and conspiracy theory. Issues around trust in information sources were equally addressed (52%) in studies from North America and Europe. Similarly, studies from Asia and Europe addressed topics about the credibility of information, both at 50%. Studies from South America, Oceania and Africa did not focus much on the selected topics identified by this review.

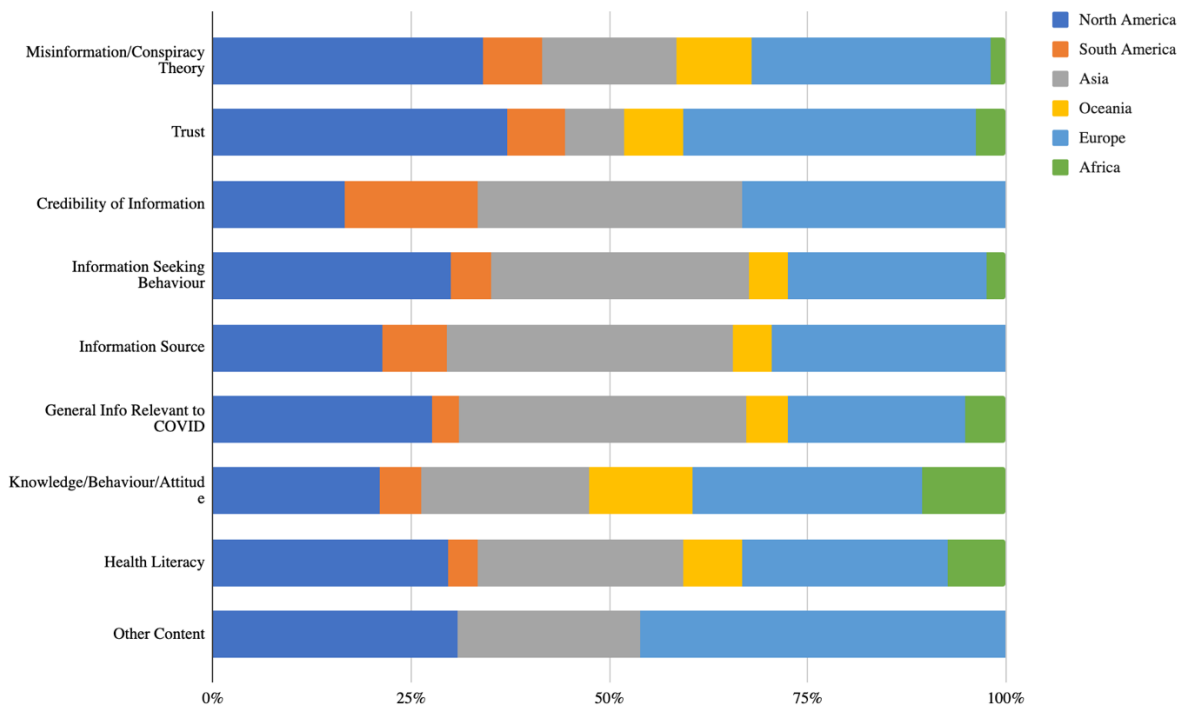


Figure 5. Frequency of Content Based on Continents

Discussion and Implications

This rapid systematic review evaluated the current state of the evidence addressing information issues (source, content, reliability, misinformation, access, use, health literacy etc.) related to COVID-19 and identifying research gaps. In total, 135 studies met the inclusion criteria and were included in the review. The review identified multiple areas of issues regarding COVID-19 information, which will be published in numerous articles. In this article, we have reported information sources, the extent to social media platforms, categories of content, and distribution of content in six continents relevant to COVID-19 information.

Our review demonstrated that people used numerous information sources to meet their information needs. Among these, social media was a commonly used platform reported in 76% of the studies. They have also used mass media and academic/healthcare organizations to access information related to the virus. In addition to social media, WhatsApp was a frequently used instant messaging service by information seekers. This finding was significant and consistent with the literature that people have become heavily dependent on these platforms to meet their information (i.e. health) needs (Eckler, Worsowicz, and Rayburn 2010; Mano 2014). This is a significant shift in people's behaviour to rely more on online platforms than their healthcare providers (Daraz et al. 2011a).

Social media has become a major source for public health education, especially during the current pandemic. At the same time, concerns have been raised regarding the use of conspiracy theories and

misinformation disseminated through social media platforms (Press. 2020; Agley and Xiao 2021). Consequently, there is a need for research to define the role of social media in health matters. It is similarly crucial to develop policy and standards for disseminating reliable health information to inform and empower people seeking health knowledge on online platforms. At the same time, knowledge translation strategies can improve public health education to maximize the use of evidence-based information through social media platforms. We have also identified that Twitter, Facebook, and YouTube were frequently used to seek information relevant to coronavirus. This finding yields the need for research collaborations between public health providers and social media policymakers to develop standards for these popular platforms for disseminating evidence-based health information to the public.

To understand the types of information addressed in the included studies, we identified various topics related to COVID-19. Most of the studies (35%) reported that people were interested in knowing everything about COVID-19 and the information sources (35%) they used to access it. In contrast, only 16% of the studies discussed people's concerns about their trust in information sources, and a few 3% focused on the reliability of the information people received about COVID-19. Due to the unpredictable nature of the virus and a lack of effective treatments, people tend to search for any information from any sources to help them understand the condition (Ali et al. 2020; Moreno, Fuentes Lara, and Navarro 2020; Paul et al. 2020). Similarly, essential topics such as information-seeking behaviour of diverse populations, barriers to medical jargon, knowledge and attitude towards the virus, and public perception of the condition were also highlighted in the included studies. A significant issue regarding the relationship between conspiracy theory and the spread of misinformation was discussed in 24% of the studies. These findings also highlight the need for research to determine the factors contributing to trust in information sources and strategies to develop credible information by individuals and organizations. Our sub-group analysis showed that studies from 3 continents (North America, Asia, and Europe) discussed many of the topics compared to the rest. This is consistent with the global epidemiology of the virus ((WHO) 2020).

And finally, one of the significant findings of the rapid review was that it represented information needs and preferences of women with a higher level of education. This is consistent with the literature that women are the frequent health information searchers than men (Bidmon and Terlutter 2015; Ek 2015). Therefore, it is essential to study women's health information-seeking behaviour and strategies to facilitate their information needs and preferences to access evidence-based health information, possibly using mixed methods.

It was notable that our search retrieved many publications such as perspective, editorial, commentary, opinion, and letters to the editor that discussed issues regarding COVID-19 and information, health literacy, informatics, information dissemination, infodemic, and misinformation (Lenert and McSwain 2020; Probst 2020; Rathore and Farooq 2020; Hamaguchi, Nematollahi, and Minter 2020). These are essential aspects of public health outcomes and should be further investigated.

Coronavirus (COVID-19) that has begun in Wuhan, China, has become a global pandemic. According to WHO, millions of people have lost their lives to date, with a confirmed case of 242 million ((WHO) 2021c). Because of the highly contagious nature of the virus and the rapid spread, people are advised to stay isolated as much as possible and follow all public health preventive measures (Prevention 2021; Canada 2021; (WHO) 2021a). This isolation has caused people to be dependent on information to understand the seriousness of the situation and get actively involved in managing their health. Our findings demonstrated, people used numerous information sources, some traditional, some untraditional, to search for information to fight against COVID-19. At the same time, the spread of knowledge and misinformation progressed quickly on different platforms. As a result, people struggled with the rise of information overload. They were aware of misinformation and concerned with the potential consequences such as fake news, conspiracy theories, and severe consequences to their health. (Nielsen RK 2020). People are in dire need of information for prevention, to save their own and loved one's lives, and governments need strategies to limit resource waste to our healthcare systems. To address these challenges, we felt the need to explore the existing evidence to identify research gaps. More focus is needed to define social media's role in distributing information during a major public health crisis like the COVID-19. Also, future research should identify the potential sources of conspiracy theory, strategies to combat medical misinformation, ensure credibility of health information distributed via various channels,

and ways to build public trust in information and information sources to combat similar global public health crises.

Limitations

Due to the urgent need to answer our research questions, we have conducted a rapid systematic review. As a result, we were not able to perform a quality assessment of the included studies. As a result, the study quality for the included studies may be compromised. For the next step, we plan to conduct a comprehensive systematic review to investigate existing evidence in-depth to answer our research questions raised from this review. Also, the target populations for this review were patients and the public. As a result, we do not know the scope of the evidence of the information needs and preferences for the experts such as clinicians, public health professionals, and policymakers.

Conclusion

The pandemic of the coronavirus or COVID-19 has created an unprecedented information overload or 'infodemic' for the public and has been a tremendous resource waste. Patients and the public are struggling with a wave of information, including misinformation that has caused millions of human lives. More research is needed to investigate the potential sources of misinformation, the relationship between disinformation and conspiracy theory, policies to disseminate evidence-based health knowledge on social media platforms, and strategies to empower people to make informed decisions such as taking a vaccine as a preventive measure. In addition, governments, public health professionals, and healthcare providers must take quick and decisive actions to fight against the outbreak and save more human lives.

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Appendix

Table 1. Characteristics of Included Studies.

Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Abd-Alrazaq, 2020)	Cross sectional	n/a	n/a	n/a

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Agley, 2020)	Survey	242	Male: 58.3 Female: 41.7	High school or less: 27.2 Bachelor's or some college: 59.9 Graduate or postgraduate: 12.8
(Ahmad & Murad, 2020)	Survey	516	Male: 56.9 Female: 43.0	High school or less: 11.5 Bachelor or some college: 51.2 Graduate or postgraduate: 37.4
(Ahmed, López Seguí, 2020)	Cross sectional	n/a	n/a	n/a
(Ahmed, Vidal-Alaball, 2020)	Cross sectional	n/a	n/a	n/a
(S. H. Ali, 2020)	Cross sectional	11,242	Male: 41.0 Female: 59.0	High school or less: 13 Some college or associate degree: 34.2 Bachelor's degree or higher: 52.8
(K. F. Ali, 2020)	Cross sectional	5677	Male: 34.1 Female: 65.9	High school or less: 25.0 Bachelor's or some college: 75.0
(Allington, 2020)	Survey	949	Male: 31.5 Female: 8.3	n/r
(Allington, 2020)	Survey	2,250	Male: 48.2 Female: 51.3	n/r
(Allington, 2020)	Survey	2,254	Male: 49.7 Female: 49.8	n/r
(Anikwe, 2020)	Cross sectional	430	Female: 100.0	High school or less: 14 Bachelor's or some college: 36 Graduate or postgraduate: 50
(Ardèvol-Abreu, 2020)	Qualitative, Survey	502	Male: 50.1 Female: 49.9	n/r
(Badell-Grau, 2020)	Review	n/a	n/a	n/a
(Barattucci, 2020)	Survey	998	Male: 26.0 Female: 74.0	High school or less: 34.87 Bachelors or some college: 18.84 Graduate or postgraduate: 55.79
(Basch, 2020)	Review	n/a	n/a	n/a
(Bento, 2020)	Event	n/a	n/a	n/a
(Bowles, 2020)	Survey	864	Male: 55.0 Female: 45.0	n/r
(Brennen, 2020)	Cross sectional	n/a	n/a	n/a
(Campos-Castillo & Laestadius, 2020)	Survey	10,510	Male: 48.7 Female: 51.3	High school or less: 33.8 Bachelors or some college: 32.5 Graduate or postgraduate: 33.7
(Chesser, 2020)	Survey, Cross sectional	1,136	Male: 30.0 Female: 68.0	Bachelors or some college: 31.0 Graduate or postgraduate: 25.0
(Cinelli, 2020)	Comparative	n/a	n/a	n/a
(Clements, 2020)	Survey, Cross sectional	1,034	Male: 58.2 Female: 41.8	High school or less: 9.8 Bachelors or some college: 73.9 Graduate or postgraduate: 16.3
(Cuan-Baltazar, 2020)	Cross sectional	n/a	n/a	n/a

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Deursen, 2020)	Survey	1,733	Male: 50.4 Female: 49.6	Low: 29.9 Middle: 34.7 High: 35.3
(Dhanani & Franz, 2020)	Survey	1,141	Male: 52.1 Female: 46.9	High school or less: 22.3 Bachelors or some college: 60.5 Graduate or postgraduate: 17.3
(Drouin, 2020)	Survey	260	Male: 11.9 Female: 84.6	n/r
(Du, 2020)	Cross sectional	n/a	n/a	n/a
(Earnshaw, 2020)	Survey, Cross sectional	845	Male: 58.6 Female: 40.9	High school or less: 22.7 Bachelors or some college: 77.3
(Faasse & Newby, 2020)	Survey	2,174	Male: 23.1 Female: 75.2	High school or less: 24.6 Bachelors or some college: 50.2 Graduate or postgraduate: 25.0
(Falcone & Sapienza, 2020)	Survey	4,260	Male: 43.0 Female: 57.0	High school or less: 28.0 Bachelors or some college: 38.0 Graduate or postgraduate: 34.0
(Farooq, 2020)	Survey, Cross sectional	225	Male: 32.4 Female: 65.3	n/a
(Fridman, 2020)	Survey, Cross sectional	1, 243	Male: 46.7 Female: 52.1	n/r
(Geçer, 2020)	Survey	4, 624	Male: 30.0 Female: 70.0	High School or less: 10.8 Bachelors or some college: 63.4 Graduate or postgraduate: 25.8
(Geldsetzer, 2020)	Survey, Cross sectional	5, 974	Male: 49.1(US) Female: 50.9(US) Male: 48.8(UK) Female: 51.2(UK)	High school or less: 12.0 (US), 36.1(UK) Bachelors or some college: 70.2(US), 46.9 (UK) Graduate or postgraduate: 17.9(US), 17.0 (UK)
(Georgiou, 2020)	Survey	660	Male: 50.5 Female: 49.5	High school or less: 18.7 Some college: 22.8 University degree: 58.4
(Gozzi, 2020)	Cross sectional	n/a	n/a	n/a
(Gupta, 2020)	Survey	128	Male: 53.1 Female: 46.9	Graduate or postgraduate: 100
(Adella Halim, 2020)	Cross sectional	355	Male: 81.1 Female: 18.9	Bachelor's or higher: 44.2 Other: 55.8
(B. Han, 2020)	Survey, Cross sectional	9,764	Male: 33.6 Female: 66.4	High school or less: 18.4 Bachelors or some college: 56.8 Graduate or postgraduate: 24.8
(X. Han, 2020)	Cross sectional	n/a	n/a	n/a
(He, 2020)	Survey	476	Male: 33.2 Female: 66.8	High school or less: 14.7 Bachelors or some college: 61.8 Graduate or postgraduate: 23.5
(Hernández-García & Giménez-Júlvez, 2020b)	Cross sectional	n/a	n/a	n/a

Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Hernández-García & Giménez-Júlvez, 2020c)	Cross sectional	n/a	n/a	n/a
(Hernández-García & Giménez-Júlvez, 2020a)	Cross-sectional	n/a	n/a	n/a
(Hornik, 2020)	Survey	1,074	Male: 49.0 Female: 51.0	n/a
(Hou, 2020)	Cross-sectional	n/a	n/a	n/a
(C. Huang, 2020)	Cross sectional	485	Male: 49.9 Female: 50.1	n/a
(Y. Huang, 2020)	Survey	381	Male: 58.0 Female: 41.5	High school or less: 6.6 Bachelors or some college: 93.4
(Hwang, 2020)	Cross sectional	19,420	Male: 30.7 Female: 69.3	High school or less: 35.3 Bachelors or some college: 51.7 Graduate or postgraduate: 13.0
(Igartua, 2020)	Survey, Cross sectional, Cross-cultural	789	Male: 31.9 Female: 67.6	n/a
(Jovančević & Miličević, 2020)	Cross-cultural, Survey	412	Serbia Male: 14.4 Female: 85.6 Latin America Male: 20.8 Female: 79.2	Serbia High school or less: 34.2 Bachelors or some college: 41.5 Graduate or postgraduate: 24.3 Latin America High school or less: 9.2 Bachelors or some college: 76.7 Graduate or postgraduate: 14.2
(Kamenidou, 2020)	Survey	n/a	Male: 41.3 Female: 58.7	High school or less: 50.4 Bachelors or some college: 18.0 Graduate or postgraduate: 31.6
(Karmegam & Mapillairaju, 2020)	Cross-sectional	n/a	n/a	n/a
(Khatri, 2020)	Cross sectional	n/a	n/a	n/a
(Kim, 2020)	Survey	2,942	Male: 51.2 Female: 48.8	High school or less: United States 18.0 Singapore 15.2 South Korea 22.1 Bachelors or some college: United States 63.7 Singapore 73.9 South Korea 68.3 Graduate or postgraduate: United States 16.5 Singapore 10.9 South Korea 9.5
(Kudchadkar & Carroll, 2020)	Cross sectional	n/a	n/a	Graduate or postgraduate: 100
(Lai, 2020)	Cross sectional	n/a	n/a	n/a

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Lau, 2020)	Survey, Cross sectional	2, 224	Male: 7.3 Female: 92.7	High school or less: 80.8 Complete college or higher 2.3 Bachelors or some college: 7.4
(Le, 2020)	Survey, Cross sectional	341	Male: 34.3 Female: 65.7	High school or less: 22.0 Bachelors or some college: 54.0 Graduate or postgraduate: 24.1
(Lennon, 2020)	Survey, Cross sectional, mixed method	5,005	Male: 23.8 Female: 74.3	High school or less: 4.7 Bachelors or some college: 53.2 Graduate or postgraduate: 41.5
(Lep, 2020)	Survey, Cross sectional	1,718	Male: 17.83 Female: 81.70	High school or less: 2.0 Bachelors or some college: 33.2 Graduate or postgraduate: 64.8
(H. O. Y. Li, 2020)	Cross sectional	n/a	n/a	n/a
(J. Li., 2020)	Retrospective Observational	n/a	n/a	n/a
(L. F. Li, 2020)	Case Study	n/a	n/a	n/a
(Y. Li, 2020)	Cross sectional	n/a	n/a	n/a
(Lieberman-Cribbin, 2020)	Cross sectional	n/a	n/a	n/a
(Lin, 2020)	Cross sectional	n/a	n/a	n/a
(Liu, 2020)	Survey, Cross sectional	511	Male: 40.3 Female: 59.7	High school or less: 25.2 Bachelors or some college: 74.8
(Lobato, 2020)	Survey	296	Male: 60.1 Female: 39.5	n/r
(Luo, 2020)	Empirical	n/a	n/a	n/a
(Mayfield, 2020)	Cross sectional	48,063	n/r	n/r
(Meier, 2020)	Survey	9,796	Male: 29.5 Female: 70.2	High school or less: 10.9, Bachelors or some college: 20.9 Graduate or postgraduate: 68.2
(Mishra & Dexter, 2020)	Cross sectional	n/a	n/a	n/a
(Montesi, 2020)	Review	n/a	n/a	n/a
(Moon & Lee, 2020)	Cross sectional	n/a	n/a	n/a
(Moreno, 2020)	Survey	546	Male: 28.0 Female: 71.1	Bachelors or some college: 43.7 Graduate or postgraduate: 28.3
(Moscadelli, 2020)	Cross sectional	n/a	n/a	n/a
(Motta, 2020)	Cross sectional	8,914	n/r	n/r
(Mubeen, 2020)	Cross sectional	399	Male: 25 Female: 75	Bachelors or some college: 41.9 Graduate or postgraduate: 58.1
(Mututwa & Matsilele, 2020)	Qualitative	15	n/r	n/r
(Nazione, 2021)	Survey	698	Male: 45.1 Female: 53.7	High school or less: 10.0 College degree 69.4 Graduate or postgraduate: 20.5

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Nazir, 2020)	Cross sectional, Empirical	500	Male: 72.2 Female: 27.8	Postgraduate: 26.4 Diploma: 10.2 Other: 2.2
(Nagler, 2020)	Survey	1,007	Male: 48.6 Female: 51.4	High school or less: 36.3 Some college: 28.5 Bachelor's degree or above 35.3
(Ngai, 2020)	Cross sectional	n/a	n/a	n/a
(Nguyen, 2020)	Cross sectional	8,291	Male: 41 Female: 59	High school or less: 54.4 College/university or higher: 45.6
(Van Nhu, 2020)	Survey, Cross sectional	1,999	Male: 21.7 Female: 78.3	Undergraduate or post-graduate: 68.7 Other: 31.3
(Niu, 2020)	Cross sectional	2,949	Male: 48.8 Female: 51.2	High school or less: 24.7 Bachelor's or some college: 64.0 Graduate or postgraduate: 11.4
(O'Connor, 2020)	Longitudinal survey, Cohort	673	Male: 39.7 Female: 60.3	n/r
(Okan, 2020)	Cross sectional	1,153	n/r	High school or less: 59.0 University entrance qualification or university degree: 41.0
(Olaimat, 2020)	Cross sectional	2,083	Male: 24.5 Female: 75.5	Bachelor's or some college: 90.2 Graduate or postgraduate: 9.8
(Ölcer, 2020)	Qualitative	n/a	n/a	n/a
(Pagnini, 2020)	Survey	2,886	Male: 23.7 Female: 76.3	High school or less: 49.3 Bachelor's or some college: 22.8 Graduate or postgraduate: 28.0
(Park, 2020)	Cross sectional	n/a	n/a	n/a
(Paul, 2020)	Survey	1,589	Male: 60.5 Female: 39.5	High school or less: 4.2 University: 95.8
(Peng, 2020)	Cross sectional	442	n/a	n/a
(Pennycook, 2020)	Survey	Study 1: 853 Study 2: 856	Study 1: Male: 41.9 Female: 56.5 Study 2: Male: 45.0 Female: 54.1	n/r
(Pobiruchin, 2020)	Cross sectional, Inveillance	n/a	n/a	n/a
(Pulido, 2020)	Cross sectional	n/a	n/a	n/a
(Qazi, 2020)	Survey	210	Male: 41.0 Female: 59.0	High school or less: 7.0 Bachelors or some college: 28.0 Graduate or postgraduate: 65.0
(Rachul, 2020)	Cross sectional	n/a	n/a	n/a

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(Reddy, 2020)	Survey	55,823	Male: 47.9 Female: 52.1	n/a
(Riehm, 2020)	Survey	6,329	Male: 49.0 Female: 51.0	High school or less: 38.0 Bachelors or some college: 47.2 Graduate or postgraduate: 14.7
(Riiser, 2020)	Cross sectional	2,205	Male: 17.2 Female: 82.5	Higher education: Mothers: 68.1 Fathers: 58.1 Upper secondary/tertiary education: Mothers: 19.6 Fathers: 25.6 Below upper secondary education: Mothers: 3.8 Fathers: 5.8
(Rodriguez-Lonebear, 2020)	Cross sectional	287	Male: 48.65 Female: 51.35	Bachelors or higher: 11.9
(Romer & Jamieson, 2020)	Survey	Wave 1 1050 Wave 2 840	Wave 1 Male: 45.6 Female: 54.4 Wave 2 Male: 44.3 Female: 55.4	Wave 1 High school or less: 32.6 Bachelors or some college: 47.8 Graduate or postgraduate: 19.6 Wave 2 High school or less: 32.6 Bachelors or some college: 48.3 Graduate or postgraduate: 30.1
(Roozenbeek, 2020)	Survey	UK: 2,200 Ireland: 700 USA: 700 Spain: 700 Mexico: 700	Pooled data/na	Pooled data/na
(Rovetta & Bhagavathula, 2020b)	Cross sectional	n/a	n/a	n/a
(Rovetta & Bhagavathula, 2020a)	Cross sectional	n/a	n/a	n/a
(Saud, 2020)	Survey	348	Male: 28.7 Female: 71.3	High school or less: 16.1 Bachelors or some college: 75.3 Graduate or postgraduate: 8.6
(Selby, 2020)	Survey	807	Male: 76.0 Female: 24.0	High school or less: 35 University or professional school: 65
(Sengeh, 2020)	Survey	1,253	Male: 52.0 Female: 48.0	No formal: 32.0 Primary: 15.0 Secondary: 52.0
(Siebenhaar, 2020)	Survey	1,059	Male: 20.6 Female: 79.4	n/r
(Simione & Gnagnarella, 2020)	Cross sectional	186	Male: 29 Female: 70.97	n/r

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Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
(D. R. Singh, 2020)	Survey, Cross sectional	871	Male: 40.4 Female: 59.6	High school or less: 12.7 Bachelors or some college: 63.5 Graduate or postgraduate: 23.9
(A. K. Singh, 2020)	Cross sectional	522	Male: 61.5 Female: 38.5	High school or less: 7.0 Bachelors or some college: 32.0 Graduate or postgraduate: 61.0
(Strzelecki, 2020)	Cross sectional	n/a	n/a	n/a
(Sun, 2020)	Survey	556	Male: 42.3 Female: 57.7	High school or less: 47.1 Bachelors or some college: 45.9 Graduate or postgraduate: 7.0
(Szmuda, 2020)	Cross sectional	n/a	n/a	n/a
(Taberner, 2020)	Survey	1,324	Male: 25.6 Female: 74.4	n/r
(Tang & Zou, 2021)	Survey	17	Male: 47 Female: 53	High school or less: 23.5 Bachelors or some college: 35.3 Graduate or postgraduate: 41.2
(Tripathi, 2020)	Survey, Cross sectional	633	n/a	n/a
(Usman, 2020)	Survey, Cross sectional	248	Male: 37.9 Female: 62.1	High School or less: 31.4 Bachelors or some college: 54.0 Graduate or postgraduate: 14.5
(C. Wang, 2020)	Survey, Cross sectional	1,426	Male: 60.9 Female: 39.1	High School or less: 30.6 Some college: 11.4 Bachelor's or higher: 58.0
(P.-W. Wang, 2020)	Survey	1,904	Male: 32.7 Female: 67.3	High School or less: 11.1 University or above: 88.9
(Y. L. Wang, 2020)	Survey	17,876	Male: 28.3 Female: 71.7	Two- and three-year students: 51.6 Bachelors or some college: 45.8 Graduate or postgraduate: 2.6
(Wolf, 2020)	Survey, Cross sectional	630	Male: 40.3 Female: 59.7	n/r
(Wolka, 2020)	Qualitative	22	Male: 81.8 Female: 18.2	High School or less: 77.0 Bachelors or some college: 13.6 Graduate or postgraduate: 9.0
(Worrall, 2020)	Systematic review	n/a	n/a	n/a
(Yang & Xin, 2020)	Survey	1,074	Male: 50.5 Female: 49.5	High school or less: 33.3 Bachelors or some college: 53.2 Graduate or postgraduate: 13.5
(F. Yin, 2020)	Cross sectional, Mathematical model	n/a	n/a	n/a
(F. L. Yin, 2020)	Cross sectional,			

Author, Year	Study Design	Study Sample (N)	Gender (%)	Level of Education (%)
	Mathematical model	n/a	n/a	n/a
(Yousuf, 2020)	Survey	Diagnostic: 16,072 Post-campaign: 17,189	Diagnostic: Female: 53.2 Male 46.6% Post-campaign: Male 46.9 Female: 52.9	Diagnostic: High school or less: 52.4 Higher professional: 33.7 University: 13.8 Post-campaign: High school or less: 52.9 Higher professional: 33.1 University: 14.1
(Yu & Jiang, 2020)	Survey, Cross sectional	258	Male: 53.0 Female: 47.0	High school or less: 66.8 Some college or higher: 37.2
(Zhao, 2020)	Systematic review	4,840	Male: 51.4 Female: 49.6	High school or less: 35.8 Some college: 27.8 College or higher: 36.4
(Z.-H. Li, 2020)	Cross sectional	123,768	Male: 70.6 Female: 29.4	High school or less: 68.9 College degree or higher 31.1
(Zogning Makemjio, 2020)	Cross sectional	434	Male: 51.6 Female: 48.4	High school or less: 62.67 Bachelors or some college: 32.02 Graduate or postgraduate: 5.29

n/a: not applicable; n/r: not reported

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Search Strategy

Data bases: Embase, EBM Reviews-Cochrane Register of Controlled Trials, EBM Reviews-Cochrane Central Register of Systematic Reviews, Ovid MEDLINE ® ALL, CINAHL, Library, Information Science & Technology abstracts (EBSCO), Library, Literature & Information Science Index (EBSCO), Sociological abstracts, ERIC (Proquest), Library and Information Sciences Abstracts: LISA (ProQuest), Web of Science, WHO.

Dates: November 26 and 28.

Search strategy:

When proximity search is not possible:

(coronavirus OR covid-19 OR covid19 OR 2019-ncov OR corona virus OR sars-cov-2 OR novel coronavirus OR novel coronavirus 2019) AND ((information AND (seeking OR access OR need OR use* OR source OR quality OR credibility OR reliability OR literacy)) OR (health AND (information OR literacy)) OR misinformation) NOT (diagnosis OR Treatment OR Prognosis)

When proximity search is possible: (using either Near/ N or AdjN depending on the platform used to conduct the search)

(coronavirus OR covid-19 OR covid19 OR 2019-ncov OR corona virus OR sars-cov-2 OR novel coronavirus OR novel coronavirus 2019) AND ((information adj2 (seeking OR access OR need OR use* OR source OR quality OR credibility OR reliability OR literacy)) OR (health adj2 (information OR literacy)) OR misinformation) NOT (diagnosis OR Treatment OR Prognosis)

Note : The searches were done on these platforms.

Ovid: Embase (1974 to 2020 November 18 or Week 46), EBM Reviews- Cochrane Central Register of Controlled Trials, EBM Reviews-Cochrane Central Register of Systematic Reviews, Ovid MEDLINE ® ALL (which includes Ovid MEDLINE Epub Ahead of Print, In Process & Other Indexed Citations, and Ovid MEDLINE).

EBSCO: CINAHL, Library, Information Science & Technology abstracts (EBSCO), Library, Literature & Information Science Index (EBSCO), Sociological abstracts.

ProQuest: ERIC, Library and Information Sciences Abstracts: LISA (ProQuest).

Web of Science: searched all of the data bases in all languages.

WHO: Searched in all languages.

Community Action, Community Engagement:

Participatory design of community information systems to promote cooperation among waste pickers

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Abstract: This study presents lessons learned from engaging a community of waste pickers in the design of an information system that promotes cooperative practices among them and facilitates relevant information management of their daily work. We started by enabling a series of participatory mapping activities to document waste picking experiences during the COVID-19 pandemic, to understand what practices are common and what barriers might exist in relation to trust and cooperation. Based on both qualitative and quantitative analysis of the routes taken by the waste pickers, collection points, and other experiences that take place every day while providing the city with recyclable waste picking services, a system was designed. This system seeks to generate relevant information, easy to manage and use, which includes the weight of collected recyclables, the current market prices for different types of waste, and a memory of comments to guide fellow waste pickers on what to know when engaging with different intermediaries and recycling companies, among others. As we progressively develop the first prototype of the system, thinking aloud sessions with waste pickers and other members of the community provide insights on what to refine, what to discard, and what is still missing to promote new forms of cooperation and increased trust in this community of waste pickers. The study ends with a discussion about the future of this work, including recommendations that can help other communities to replicate this participatory design action research.

Keywords - social informatics, participatory design, thinking aloud, recycling, waste pickers.

Introduction

Roughly 1.2 Kg/day is the average amount of solid waste that every person generates in Asunción, Paraguay (MADES;PNUD;FMAM, 2020). In total, around 2,500 tons of urban solid waste are generated every day in Asunción and its Metropolitan Area (MADES;PNUD;FMAM, 2019). This large volume of waste has made its management a challenge of strategic importance for Paraguay's capital. Municipal solid waste (MSW) management, however, is an ever-increasing problem driven by population growth, which continuously increases the amount of waste generated, which, coupled with low quality urban cleaning services, institutional weakness, and low levels of health education and citizen participation, make it a complex challenge where no one solution is sufficient to create systemic change (Tavares, et al., 2004).

In Asunción and its Metropolitan Area, the lack of a good waste management system that incorporates sustainable practices, such as recycling, represents one of the most important issues of the city, causing or augmenting other problems such as the contamination of its water sources, increased risks of dangerous flash floods and reduced air quality. In this context, increasing the amount of recyclables that are recovered and recycled or reused is one the ways in which we can act on the system to start changing its practices and services. In Asunción, formal waste collection services lack differentiated recollection, which means households do not sort their waste. Recycling companies, in turn, struggle to access recyclables, limiting the amount of actual recycling and reuse of the system. Recycling does happen, however, thanks to a network of informal workers: the city waste pickers, who generate social value by addressing the needs of the system to recover recyclable materials from unsorted solid waste. An important actor of this network is San Francisco Neighborhood's Waste Pickers Association (ASO San Francisco) which is made up of fourteen members, located in the neighborhood that was built by the binational Itaipú of Paraguay and Brazil, on an area of approximately 20 hectares, located in the very heart of Zeballos Cué, next to the Botanical Garden and

a few minutes from the center of Asunción¹, inaugurated on December 12, 2017 where the first keys were handed over to the first families awarded by the government of the day², 1,000 homes were allocated to families residing in 5 flooded areas of the Bañado North of Asunción (Saint Peter, Saint George, Saint Vincent, Saint Felipe (Lower Zone) and Refuge), in addition to areas surrounding the project in Zeballos Cué. With its growing number of members³, they travel the city everyday recovering what the system can recycle and reuse.

In addition to environmental problems we mentioned before, the COVID-19 pandemic introduced challenges that affect public health, social and economic life. Necessary sanitary restrictions severely limited daily activities, affecting vulnerable sectors the most, including city waste pickers like the members of ASO San Francisco. Participatory practices that improve the daily work of this community, in a context of critical socio-economic constraints, represent a potential pathway towards improving waste picking and sorting practices. The work we discuss in this paper is framed within a broader participatory learning initiative, organized and facilitated by UNDP's "Asunción Green City of the Americas" project⁴, in collaboration with UNDP Accelerator Lab in Paraguay⁵. Through a series of participatory mapping exercises and other participatory action research activities, this project is working closely with the community to identify actions that could help in strengthening the Association.

Within this process, our research engaged with the mapping process, supporting its implementation while focusing on the potential information management needs that emerged from it. We then explored available ICT platforms that could cover those needs, with the goal of evaluating whether the adoption of these platforms or the adaptation and development of new tools based on our learnings are the best options to respond to the needs of the community. Building upon the key lessons from this process, we prototyped and tested an information system for ASO San Francisco. This paper presents the resulting prototype and discusses the lessons we learned throughout its participatory design process, with a special focus on their implications for this community and others with similar characteristics.

Participatory Recycling and ICTs Review

Our review of literature focused on participatory recycling methodologies and techniques, including how ICTs have been used in these spaces. One of the key insights arising from this literature is that it evidences the limitations and issues in Latin-American, where collection services are concentrated in central business districts and high/medium income neighborhoods (Lethbridge 2017). This review by Lethbridge also summarizes several national plans and strategies that place the development of a sustainable MSW management that is also socially inclusive with a high priority to improve these services. However, it is important to take into account that the inherent complexity of MSW management makes social dimension factors intertwine with each other, complicating the analysis of social dimensions (Jing & W., 2016).

Another fundamental characteristic of the studies that employ participatory recycling methodologies is the inclusion of waste pickers as main agents that contributes to reducing poverty, inequality, vulnerability, and the exclusion of people from society and from the formal labor markets (Rebehy, et al., 2017). Cooperative recycling has been studied as a poverty eradication strategy, with

¹ *San Francisco neighborhood*, retrieved on May 8, 2021 [Blog Message]. from <https://www.barriosanfrancisco.gov.py/es/node/364>

² *San Francisco neighborhood*, retrieved on May 8, 2021 [Blog Message]. from <https://www.barriosanfrancisco.gov.py/es/node/506>

³ *San Francisco neighborhood*, retrieved on May 8, 2021 [Blog Message]. from <https://www.barriosanfrancisco.gov.py/es/node/338>

⁴ More information about UNDP's project, available at this site:

<https://www.py.undp.org/content/paraguay/es/home/projects/proyecto--asuncion--ciudad-verde-de-las-americas--vias-a-la-sust.html>

⁵ <https://acceleratorlabs.undp.org/content/acceleratorlabs/en/home/>

participatory waste management as a way towards truly circular economies and more sustainable communities (Gutberlet, 2012).

GPS tracking techniques, web-based mapping, and mobile apps are all tools that have been touched in this literature to allow cooperatives and associations to collect, manage, and interpret spatial data on their own, and redesign their system in collaboration with others (Offenhuber & Lee, 2012).

Multiple platforms for real time data management and coordination with potential customers, through smartphones, websites, and text messages, have been developed. **ReciclApp**, for example, is a mobile application developed in Chile to connect anyone who wants to recycle with waste pickers who collect the materials from their homes, taking them to a accumulation place and valorization plant (Caballero, et al., 2016) ⁶. **Cataki** is another app used in Brazil and Colombia, with similar purposes. Cataki's goals are to connect waste producers, pickers and collectors and reduce mistakes in waste destinations (Cousin & Audebrand, 2020). Cataki also seeks to make the waste picker more visible to the city, enabling a community to have trusted waste picker, who is responsible for picking up the recyclables from the community⁷.

These two cases applied to Latin American regions suggest that connecting separation points such as homes, shops, hospitals, etc. with waste pickers can be done by creating collection points that save time on the rounds made by the waste pickers, generating a more efficient process. Our review also found no instance of information systems developed for the purpose of managing information from the perspective of a group of waste pickers interested in increasing their sales and productivity. Our work with ASO San Francisco therefore explores this, with the hypothesis that better information may also help them save time and money to perform their labor. In what follows, we present the research and design activities we undertook to explore this particular design space.

Community Design Research with ASO San Francisco

Within the context of the participatory mapping process organized by UNDP Paraguay, we started our research by supporting the mapping process from its initial engagements with the community through the implementation of the geo-referenced mapping of routes and experiences, using our participation in the mapping activities as opportunities for participant observations and interviews to waste pickers. As context, ASO San Francisco's waste pickers have access to a future recycling plant within the neighborhood, which today they use as a place to accumulate and sort waste. They also have access to three-wheelers that facilitate their daily tours. In general, the members make daily rounds around neighboring zones, taking different routes, looking for solid waste that could be sold to recycling plants or companies.

In this context, we established interactions with 12 active members, of the 14 of the association from September to October 2020, learning with them what their challenges and needs were in their daily work, with a focus on the needs of the information system.

Field Visits and Interviews

The following list presents our initial research activities along with the key insights that emerged from each:

Field visits

Our initial visits focused on getting to know the community and the future recycling plant. From these visits, we identified *infrastructure and organization needs related to the physical space* for optimizing waste sorting and accumulation activities. For example, there was plenty of vertical space for stacking of multiple big bags to take place, provided the right infrastructure. In addition, information about what

⁶ *RECICLAAPP*, retrieved on May 28, 2021 [Web page]. from <http://reciclapp.cl/>

⁷ *CATAKI*, retrieved on May 28, 2021 [Web page]. from <https://cataki.org/es/>

materials were collected, where to sell them or what to do with them was not available in any tangible form. Most of this information is informal knowledge that each waste picker has from their daily experience. When walking through the neighborhood, we observed a large number of *three-wheelers (motorcycle with bodywork)*, indicating that *A high percentage of families in the San Francisco neighborhood have recycling as their main source of income.* We also observe that most of the *waste pickers only have low-end smartphones and a low or inexistent internet access.*

Interviews

We carried out interviews with some of the members. In these interviews they mentioned a drastic decrease in their income due to *the total quarantine imposed by the government in March of 2020 to mitigate the spread of coronavirus.* The waste pickers also indicate that most of the income they had during the quarantine came from *the economic aids provided by the government.*

Another problem that they mentioned is *that there is no information about what type of waste is in demand in recycling plants or companies* at different periods of the year and what price is offered for the materials. This situation leads them to sell at lower prices with intermediaries. Moreover, *there is no knowledge about what to do with the products that are not sold for recycling:* wood removed in remodeling, old furniture, objects in disuse, glass, etc.

The lack of trust among some members was another issue that emerged in some of these interviews. Some occasional tensions over the best and largest spaces to accumulate recyclables within the recycling plant were also mentioned.

Finally, a need was mentioned by waste pickers for *a methodology to improve the volume and quality of recyclable waste sorted at origin, and for optimizing the time and cost* of their work.

Recycling and trust survey

We gathered socio-economic, employment, and trust information through a short survey to the members of ASO San Francisco. Although this is an exploratory activity, with a sample of only 12 members, we think the following key insights are interesting to understand their socio-economic situation during the pandemic:

1. 11 out of 12 of the waste pickers we worked with were working at the time of the survey. Only 1 of them was looking for a job and living on emergency aid received from the government.
2. 8 out of 12 of the group had waste-picking as a full time job. On average, they dedicate 7.18 hours per day to waste picking activities. Further exploration in a workshop conducted by UNDP revealed this number to be around actually above 10 hours per day (Parra et.al. 2021).
3. 10 out of 12 of the waste pickers experienced a decrease in their income during the pandemic, in some losing it all.
4. 9 out of 12 work throughout the week, 3 without having a fixed agenda and working a needs basis.
5. None of them have income on a monthly basis, 5 get their income on by-weekly basis, 3 weekly, 2 daily, and 2 do not have a steady flow of income.
6. 2 out of 12 have, once aggregated, an income above the official monthly minimum wage, albeit in both cases is much lower than 2 minimum wages.
7. Looking into trust scores revealed high levels of trust in other waste pickers and in the Association itself, but lower levels of trust to other people in general. This goes somewhat counter to some observations in interviews, which indicate that trust problems are particular and not general. This is connected to some other anecdotes they shared about how often people in the city are despective and do not value the environmental and social services they offer.

Participatory Mapping of Routes and Experiences

From December 2020 to February 2021, we supported the process of mapping with them their daily routes, experiences and collection points. The main goal of this participatory mapping activity was for collective intelligence to emerge from their daily experience and knowledge, represented in the

form of maps. We used a *user shadowing*⁸ technique, combined with GPS trackers, to document both quantitative (georeferenced routes and stopovers) and qualitative aspects (observations) of the daily routes. By analyzing these routes and later socializing and analyzing the resulting maps with waste pickers, challenges they face on a day-to-day basis are identified. Moreover, the information summarized in these maps can be used by waste pickers to reflect upon and improve their practices. This mapping process was opened to waste pickers from the neighborhood who are not members of the Association. In total, 10 routes were collected, 6 from ASO San Francisco and 4 from non-members. *Mi Ruta App* was used as a GPS tracker. All routes begin and end at the recycling plant in the San Francisco neighborhood. A complete analysis of this mapping process is beyond the scope of this paper, but is available in PNUD Paraguay/Exponencial (2021). Figure 1 shows the combined map of routes and collection stopovers, available in this extended report.



Figure 1. Map of combined routes. Source: PNUD Paraguay/Exponencial 2021

Some key insights from this mapping include:

1. Daily routes are not fixed, although some neighborhoods remain the same for the same people, configuring a territorial waste shed of the city areas attended by ASO San Francisco's waste pickers (see Figure 1). Methods, hours, and days of work change from one waste picker to the other. Some use three-wheelers, some work by foot with no other tool than their bare hands.
2. Coordination to share collective assets, such as three-wheelers, is one of the challenges to increase ASO San Francisco's productivity. Part of the coordination challenge is having better information about areas in which each member works, along with some information about the routes. In several routes we mapped, we observed some level of superposition among routes, therefore, coordinating the shared use of collective assets might be easier with a good information system that characterizes where members work every day.
3. Geo-referenced maps of their routes, areas of work and collection stopovers, produced through this process, was highly appreciated by associations' members. Several members went on to request an extension of the mapping process so that all members can have their routes and collection points displayed in the map, which was printed on cardboard and installed at the recycling plant.
4. In addition to knowing more about their own daily activities, having geo-referenced information about potentially high volume waste generators is another key information needed.
5. During mapping, the weight of collected recyclables during one day of work was registered in paper sheets. Managing a physical paper-based registry with the history of their collected materials was cumbersome and represents definitely one of the information challenges we observed.

Facilitating a digital archive that is easily accessible by all associations' members is another design space open for exploration.

6. Most waste pickers lack high-end smartphones or access to a good internet connection, which means offline modes of working with digital information could be key to the adoption of the system.

These insights all lead us to the need for designing and developing an information system from the point of view and experiences of waste pickers, managed by waste pickers. Our hypothesis is that, by providing relevant information in the appropriate format and at the right time, cooperative practices, or at least, individual decision-making, could greatly improve.

Prototype design and validation

Information System for Waste Pickers Concept

The concept we developed first was intended to address mainly the different information needs we have mentioned in the previous section. Considering waste pickers' limited access to high end smartphones and internet connectivity, either developing from scratch or adapting an existing mobile application for use on the go was discarded. Instead, the concept we started with consisted of a situated information system to be used mostly at the recycling plant, where connectivity is always available, and where waste pickers can upload and manage information that is produced during their daily work (e.g., collected recyclables types and weight) or that is relevant to their goals (e.g., market prices by type of recyclable material, location and criteria for buying recyclables of recycling companies, location of high volume waste generators, etc.).

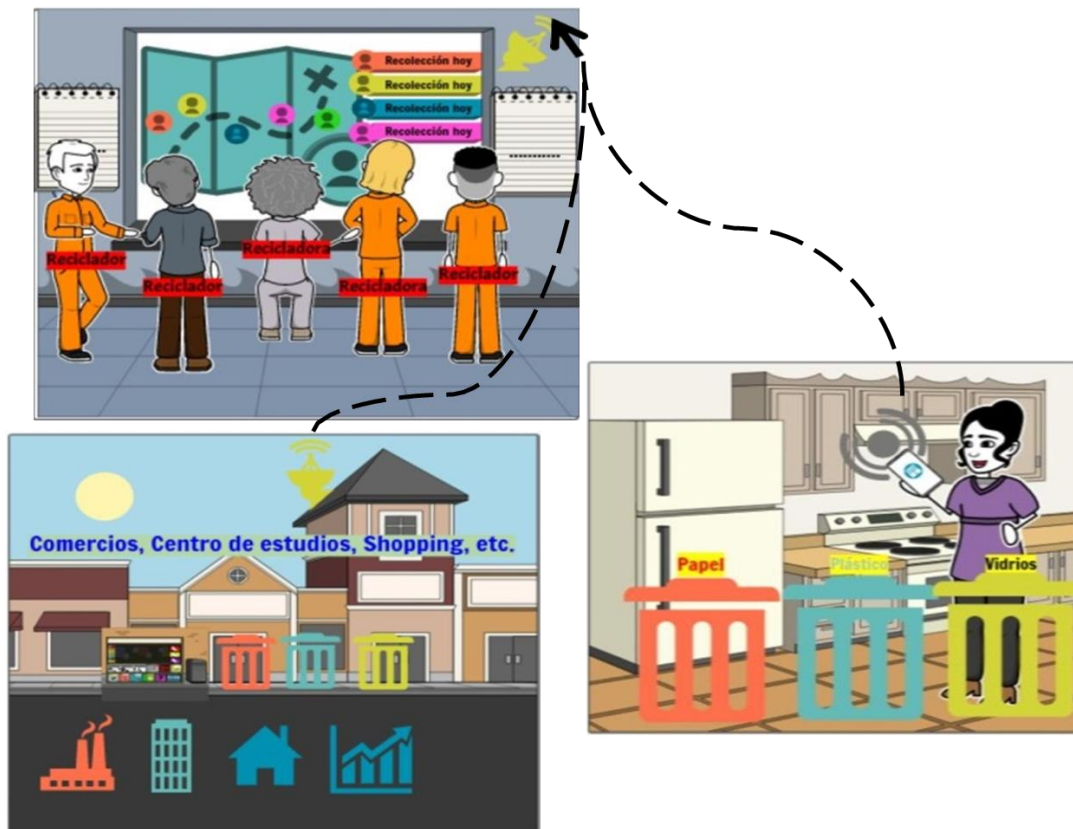


Figure 2. The Concept of an Information System for waste-pickers: a situated system for managing and visualizing maps, routes and other relevant information, along with a system that enables communication between waste pickers and the homes or businesses.

In this concept (see Figure 2), the need for connectivity is limited to the place where the system is used, and offline data collection technologies (such as KoboCollect) can be used to register information on the go, if needed, later uploading data once waste pickers arrive at the recycling plant or otherwise gain connectivity. Moreover, in this scenario, the system is always online and available for waste generators (homes or businesses) to connect remotely and either subscribe or interact with ASO San Francisco's waste pickers to notify about their accumulated sorted recyclables. Using StoryboardThat, we presented this concept and scenario to some of the members of ASO San Francisco, obtaining a good response and interest in its development, which then led us to design and develop a prototype for basic testing.

The Information System Prototype

Considering that there is no platform to guide them with what type of waste is in demand at recycling plants or companies at each time of year and what price is offered, we built upon the well-received concept and started prototyping a system that could facilitate information management of collected recyclable waste, collection points of origin, waste pickers profiles, waste generators information, etc. Figure 3 presents the overall conceptual model of this prototype, with three main users: the waste picker, a system administrator, and the waste generator (who sorts waste at home or business).

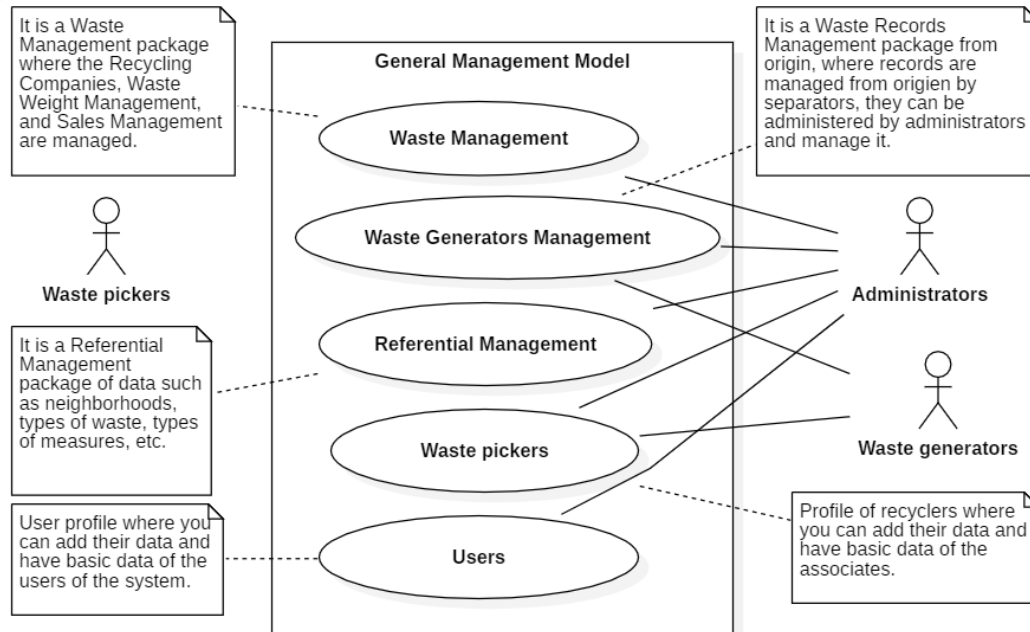


Figure 3: General Management model proposal.

- **Administrators** have full access to the system and will have the permissions to register, cancel and modify anything in it, and will be able to consult the system reports with all the permissions.
- **Waste generators** can only access the **collection points** module and some information about each **waste picker** available in the system.
- **Waste pickers** can access most parts of the system, including the management of referential data (e.g., data about intermediaries or recycling plants who buy their products) and the registry of recyclable waste collected day by day.

Using this basic conceptual model of the system, the key components of a prototype designed to test these ideas are presented in what follows.



a) Login design

b) Recycler profile



c) Design of waste weights

d) Waste sales design

Figure 4. Main screens of ASO San Francisco's Information System Prototype: (a) login screen, (b) waste picker's profiles, (c) recyclables weighing, (d) recyclables sales

The system login (a) is a typical authentication module, adapted to support three main types of users as described before, each with its related limitations and permissions. The waste pickers' profile module (b) is where the waste pickers registry is managed and viewed. All data about recyclable waste collected by the association is managed in the waste weighting management module (c). And finally, the sales module (d) is where every sale is introduced and viewed.

Validation through usability, technical and visual design tests

A "Thinking aloud" protocol was used for a first evaluation of the prototype, consisting of giving participants, in this case waste pickers from the association, access to the prototype and asking them to perform a couple of tasks while expressing aloud what they think about what they are doing, or what he or she understands they are doing (Lewis, 1982). We documented our observations in terms of errors and slips. Errors occur when the user perceives a functionality that was incorporated in the design in a different way than the original intent of its design. Slips are generally a signal of an ergonomic issue, for example, you wanted to press the X Button but it was very small and inadvertently touched another Z button. Errors point to mental model problems (designer and user have different understanding of a given practice), which help to rethink and improve the design in ways that make it more intuitive.

We carried out the tests with three types of users (i) candidates for the administrator role from ASO San Francisco, (ii) technicians with knowledge of recycling, (iii) a software designer, and (iv) visual audio professionals and graphic design. In the case of (ii), the test was more a technical functionality test, while with (iv), the focus was on visual testing and design. Due to the crisis that we are currently experiencing due to the pandemic, the test with potential administrators was carried out via google meet, presenting the prototype design and recording the evaluation by waste pickers. Test

sessions were organized between June 8, 2021, and July 12, 2021. Table 1 summarize the most significant results from this tests in terms of error and slips:

Table 1: Results of usability, technical functionality and graphic design.

Summary of usability error results	Summary of usability stumbling results
<ul style="list-style-type: none"> • Access by profiles between administrator and separator is not understood. • There is no list of waste weights by recyclers to generate a production report for each recycler from one date to another. • Vouchers missing for waste pickers when loading the weights waste solid. • Need to improve sales reports by bringing details of sales and suggestions by waste pickers. 	<ul style="list-style-type: none"> • The ADD NEW button was hard to find; I need help from the team. • The edit icon was hard to find; I need help from the team. • The delete icon was hard to find; I need help from the team.
Summary of error results in technical functionality	Summary of error results in technical functionality
<ul style="list-style-type: none"> • In the welcome sector put some Dashboards that help to know the situation of the Plant. • In the waste pickers profile, it is necessary to access the summary of the records of materials brought to the plant. • A description of the waste pickers is needed that indicates the type of materials that they usually recycle. • In the user group column, show the description of the group and not the encoding (1, 2,3). • To later have an option to define or differentiate if the materials you enter are the product of your daily departures or withdrawal requests to the ASO. • Generate a single record to discriminate in detail to load various types of waste at the moment of weight on the scale for each recycler. • Remove the solid waste already sold from the waste to sell list from the sales menu list. • Generate sales invoices or report. • Find a mechanism to evaluate for practical purposes how simple or complicated it can be to. 	<ul style="list-style-type: none"> • Rename Recyclers Companies to Recycling Companies. • In Recycling Companies, have a description of what types of materials are recycled and in what state they should be. • In the list of Recycling Companies, the title is better as List of recycling companies. • In Residual Weight Management it is better to name the Daily Materials Income Record or Residues directly. Adjust the names of the fields so that it is better understood what they refer to, eg: Types of Waste by waste category, management date by date or date of entry, Kilos Waste by Quantity (Kg).
Summary of visual and design stumbling results	Summary of visual and design error results
<ul style="list-style-type: none"> • More consistent and friendly colors like green on the sides. • Button colors more consistent with recycling. • Improve size and position of icons for edited, deleted and searched. • Improve column descriptions with a better size. 	<ul style="list-style-type: none"> • Add texts that identify the lists and impressions. • Add recycle-friendly colors to column headings for lists and reports. • Add title colors in the forms according to recycling with a better size. • Properly order column properties in better compression for users.

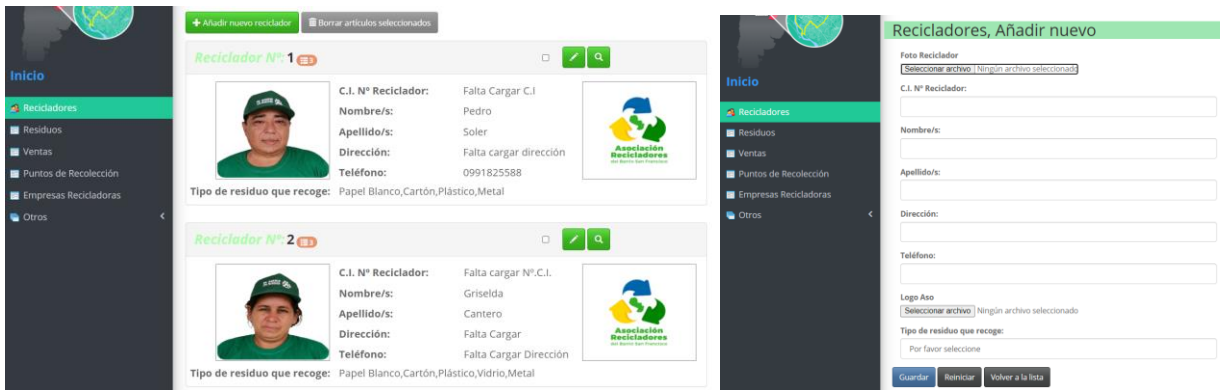
Prototype design improvements based on tests

Next, we present improvements introduced into the prototype after the thinking aloud results. In figure 5 we find a welcome page after signing in. The welcome page contains a description of what the platform, some graphics, and a new navigation pane on the left.



Figure 5: Menu and system start.

Figure 6 shows improvements on the waste pickers' profiles module. Two key changes are introduced here: (1) visual and graphics were refined, and (2) a summary of collected recyclables materials, in terms of weight and types, is now available in the detailed profile of each waste picker.



a) Waste Pickers Profile

b) Add new Waste Pickers



c) Waste Pickers collection history

Figure 6: Waste pickers Menu

The sales menu improved significantly after testing. Figure 7 shows these changes; in (a) we see the list of sales headers, the color change of the buttons, and adding sales to the description to differentiate ease of use for users, it was improved visually; in (b) we can see the form to add new sales to load the sales header and the details that in it a subtotal column was added that will be calculated

automatically. Considering the importance of promoting cooperative practice, the module now supports the option to **carry out joint sales**. In (c) we see a view of the sales, where the total to be charged for each sale is calculated; and in (d) we have sales reports to print and also export as this was one important feedback we obtained: the need to extract the data back for other analysis. Similar changes to the ones here were made to the collection points management module.

	Código	Fecha Venta	Venta Empresa Recicladora	Observacion
<input type="checkbox"/>	2	20/07/2021	BRASSUR S.A.	
<input type="checkbox"/>	3	20/08/2021	Cartón Jaguarete	Venta Conjunta

a) Sales header history

Fecha Venta: 20 Agosto 2021

Venta Empresa Recicladora: Cartón Jaguarete

Observacion: Venta Conjunta

Gestión Pesos Residuos	Cantidad en kilos, gramos	Precio Venta	Sub Total
3 Pedro Cartón 2021-07-07	30	2000	60000
2 Griselda Papel Blanco 2021-07-07	15.2	1000	15200
1 Pedro Papel Blanco 2021-07-06	10.5	1000	10500

b) Add new Sales

Código	Fecha Venta	Venta Empresa Recicladora	Observacion
3	20/08/2021	Cartón Jaguarete	Venta Conjunta

Gestión Pesos Residuos	Cantidad en kilos, gramos	Precio Venta	Sub Total
3 Pedro Cartón 2021-07-07	30,000	2,000	60,000
2 Griselda Papel Blanco 2021-07-07	15,200	1,000	15,200
1 Pedro Papel Blanco 2021-07-06	10,500	1,000	10,500
			Total 85,700

c) Sales Views



Informe Ventas

Página 1 / 1

Código	Fecha Venta	Venta Empresa Recicladora	Observacion
3	20/08/2021	Cartón Jaguarete	Venta Conjunta

Gestión Pesos Residuos	Cantidad en kilos, gramos	Precio Venta	Sub Total
3 Pedro Cartón 2021-07-07	30	2,000	60,000
2 Griselda Papel Blanco 2021-07-07	15	1,000	15,200
1 Pedro Papel Blanco 2021-07-06	11	1,000	10,500
Total:			85,700

d) Sales Report

Figure 7: Sales Menu

Collection point menu improved in stumbles and errors, in figure 8 we see in (a) how the improvements remain, they were the same as that of sales; in (b) we have how to add the point from the origin that is prepared to use a waste separator either from houses, institutions, factories, etc., sending the georeferenced points and photos of the waste; in (c) we see how we can see those points generated in a link in google maps and (d) we see a list report of the collection points that are sent from the separation origin points.

Código	Separador/a	Cantidad	Tip de medida	Tipo de Residuo	GPS en mapa google	Fotos de origen	Fecha/Hora Origen
1	Derlis Joel Domínguez Ramirez	2	Bolsa/s Mediana/s	Plástico	https://www.google.com/maps?q=-25.305760989972736,-57.48964167921542		25/07/2021 10:57:29
2	Juan Pérez	3	Bolsa/s Mediana/s	Papel Blanco	https://www.google.com/maps?q=-25.2822,-57.6351		29/07/2021 11:57:53
3	Derlis Joel Domínguez Ramirez	4	Bolsa/s Mediana/s	Papel Blanco	https://www.google.com/maps?q=-25.2822,-57.6351		22/08/2021 15:58:27

a) Collection point list

Gestion Registros Origen, Añadir nuevo

Tipo de Residuo *
Papel Blanco

Tip de medida *
Bolsa/s Mediana/s

Cantidad *
3

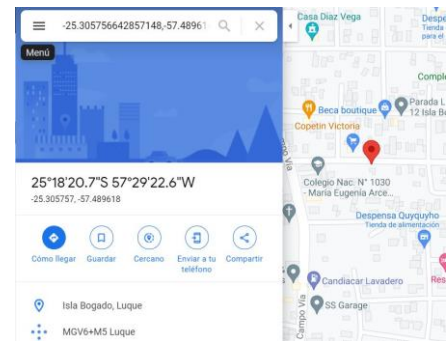
Fotos de origen
Seleccionar archivo Ningún archi... seleccionado

GPS en mapa google *
-25.2822,-57.6351

Los valores deben de ser de forma automática, favor activar su GPS si la posición no carga de forma automática, gracias.

Guardar Reiniciar Volver a la lista

b) Add new break point from origin



c) GPS in google maps generated from collecting points to be collected

Informe de Gestion de Puntos de Recolección

Código	Tipo de Residuo	Tip de medida	Separador/a	Cantidad	Fotos de origen	GPS en mapa google	Fecha/Hora Origen
1	Plástico	Bolsa/s Mediana/s	Derlis Joel Domínguez Ramirez	2		https://www.google.com/maps?q=-25.305760989972736,-57.48964167921542	25/07/2021 10:57:29
2	Papel Blanco	Bolsa/s Mediana/s	Juan Pérez	3		https://www.google.com/maps?q=-25.2822,-57.6351	29/07/2021 11:57:53
3	Papel Blanco	Bolsa/s Mediana/s	Derlis Joel Domínguez Ramirez	4		https://www.google.com/maps?q=-25.2822,-57.6351	22/08/2021 15:58:27

d) Report of the separations from the origin with the collection points

Figure 8: Collection points menu

In figure 9 we find the menu of Recycling Companies, which are the companies that are buyers of recyclable waste, and it was also improved in the same way as the previous ones already mentioned

(a), (b), and (c) are the same as the steps in the previous menus. It is worth mentioning that this menu is in the process of evolution and it is expected that just like the waste separators from the source, those who generate the collection points, the recycling companies will also connect with a user and upload their offers of the prices of the waste they buy. to try to solve some of the problems, that the waste pickers do not know about those prices, which is why they sell to intermediaries.

	Código	R.U.C.	Empresa	Dirección de la empresa	Teléfono de la empresa	Tipo de residuo que compra
<input type="checkbox"/>	1	80014691-3	BRASSUR S.A.	Avda. Ruta Acceso Sur Km 3.5 Ñemby - Paraguay	(021) 941 119/20	Cartón,Plástico,Metal
<input type="checkbox"/>	2	80001883-4	Cartón Jaguarate	Asunción: Avda. España N°303 c/ Sacramento.	0800 110 801	Papel Blanco,Cartón

a) Lists of recycling companies

b) Add new recycling company form

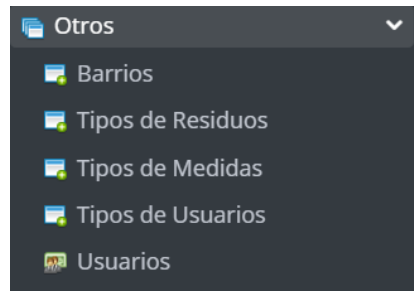


Informe lista de empresas recicladoras

Código	R.U.C.	Empresa	Dirección de la empresa	Teléfono de la empresa	Tipo de residuo que compra
1	80014691-3	BRASSUR S.A.	Avda. Ruta Acceso Sur Km 3.5 Ñemby - Paraguay	(021) 941 119/20	Cartón,Plástico,Metal
2	80001883-4	Cartón Jaguarate	Asunción: Avda. España N°303 c/ Sacramento.	0800 110 801	Papel Blanco,Cartón

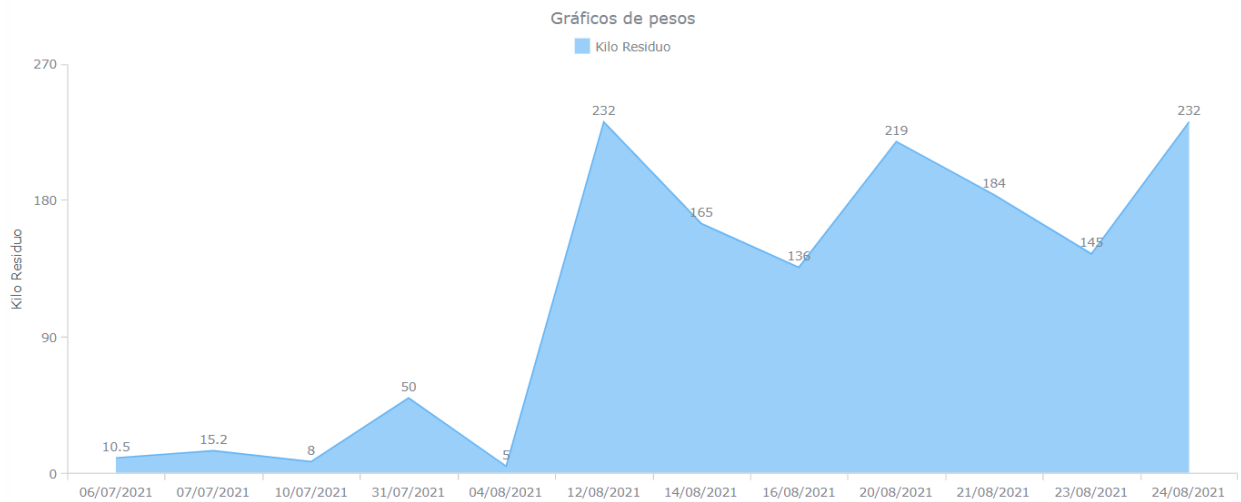
c) Recycling Companies List Report
Figure 9: Recycling Companies Menu

Finally, in this section in figure 10 we present two parts of improvements, first in (a) we find the list of referential data to register, cancel and modify, where to register users by roles to access the system. Second, we have two first statistical graphs in (b) the statistical history of kilos weighed by date on the scale to see the best days the waste is collected; and in (c) waste sales by date, the solid line shows how sales go up and down by date to see the days with the best sales.

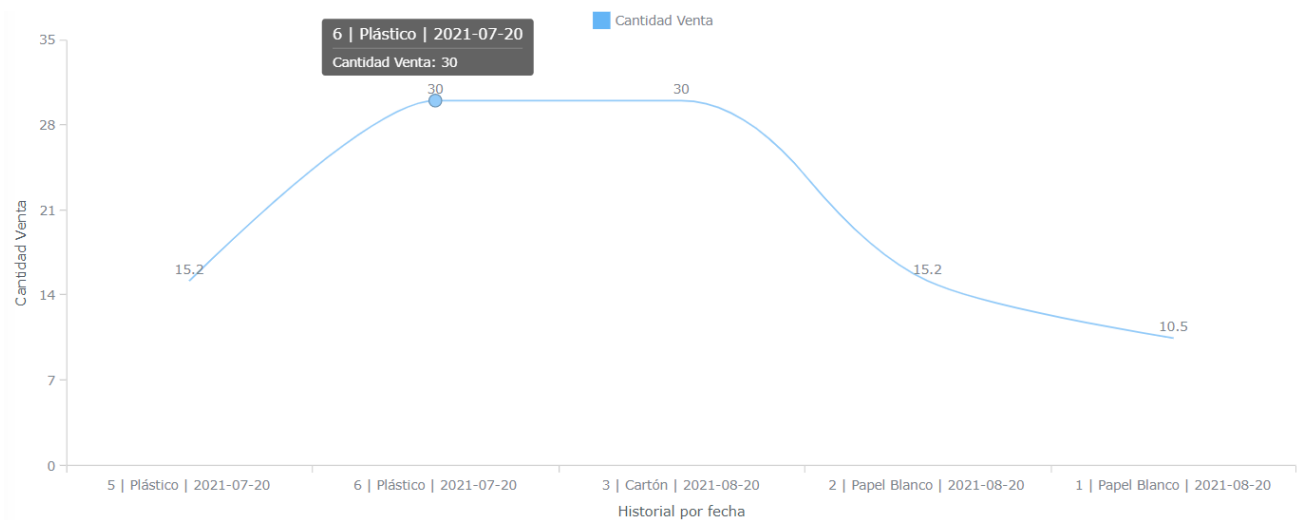


a) Other menu contents

Gráfico N° 1: Historial de pesos



b) History chart of recycled waste weights



c) Sales history charts

Figure 10: Weight and Sales Chart

Interpretation and discussion

An integrated waste management system, which dignifies and include informal waste pickers into the system, has been a hallmark of several national plans and strategies for sustainable MSW management (Lethbridge, 2017) and participatory waste management has been proposed as pathway

towards truly circular economies and more sustainable communities (Gutberlet, 2012). ¿How far is Asunción from achieving these goals of a more inclusive waste management system that recycles and reuses?. Our work with ASO San Francisco has provided us a unique opportunity to look into this question from the perspective of the city waste pickers: the network of informal workers that generate social value by addressing the needs of the system to recover recyclable materials from unsorted solid waste.

As a starting point, our field visits and interviews revealed a high level of vulnerability for this community: sanitary restrictions due to COVID-19 decreased their income to levels only enough for them to survive, in some cases, causing income to come to a halt. First stage quarantine in Paraguay began in March 2020, and with it, work by waste pickers came to a full stop. Some waste collection activities resumed around May 2020, once quarantine started to ease.

Although health protocols were respected in order to resume activities, sanitary measures continue to have an impact on the volume of recyclables collected, affecting also income from their sale. Fear of infection by waste pickers was very high while digging in garbage dumps, looking for recyclable waste. Not knowing where waste comes from and whether or not they represented a potential source of contagion of COVID-19, amplified these fears. In interviews and visits, sorting waste at origin was one of the responses to this issue, emerging as a practice that waste pickers hold in high esteem because they feel it helps to decrease the many health risks they face when waste is not sorted.

Emphasizing the importance of sorting at origin is a signal that recycling can be seen as a collective dilemma (Rompf, et al., 2017), involving relationships of trust between people and institutions, including those who generate waste in their homes, companies, communities, and the workers that collect, sort, dispose, and recycle the generated waste. Considering recycling as a form of collective action means that the ability of people and institutions to solve waste management problems depends upon the levels of trust they share (Ostrom, 1998). This led us to explore questions of participatory recycling and ICTs for connecting waste pickers to families. A few examples of ICT platforms for this purpose were found, but they provided little attention to the other challenge we identified: the need for an information system for waste picking activities.

Lack of knowledge about the companies that recycle, their current prices, the type of material they recycle, and the best price they can offer at different times of the year. These were some of the information needs we identified. After mapping their routes and experiences, making this information available and tangible through a cardboard map in the community, it also became clear for them that knowing themselves, viewing what their own daily work looked like, was an important information element they could use for improving their work, by facilitating better coordination and cooperation. Cooperative recycling as a poverty eradication strategy (Gutberlet, 2012) suddenly became an instance of an information management problem, one that was not addressed yet, neither in practice nor in academic literature.

Moreover, there is also a need to fill the gap about what to do with recyclable waste that recycling companies in Paraguay do not buy. ASO San Francisco's waste pickers believe that these materials can increase their income if they know what to make of them, which signals an intent on evolving from waste pickers only to waste pickers, who add value to the materials they recover.

After all this analysis, the role of ICTs that comes forward in this study, is therefore one of enabling relevant information and knowledge management and sharing as a way to increase cooperation and solve the specific challenges that this community is facing, and that others with similar characteristics will likely face. Productivity related data (e.g., amount and types of recyclables recovered on a daily or weekly basis) and geo-referenced information (e.g., daily routes, areas and neighborhoods attended by association members, location of high volume waste generators) came forward as the most important types of information for this new system. The limited connectivity and access to medium to high end mobile phones signified that the system was better situated in a place

with continuous connectivity, allowing for data collection practices to take place through offline or non-digital mechanisms, later uploaded into the system when waste pickers arrive at their common space (i.e., the recycling plant). This online/offline duality of our work makes it an interesting example of what others have referred to as “infrastructure hybrid community engagements” (Mosconi, et al., 2017).

Finally, this research links information systems, both digital and non-digital, to cooperative practices and increased productivity. This central hypothesis remains to be validated in the future of this community, and other similar ones, through a more experimental approach in which the systems are effectively used in everyday practice.

Concluding Remarks

In this study, we described and discussed a participatory design process, and its resulting artifact, focused on the daily experiences of a community of informal waste pickers in Asunción Paraguay. Through a process that included qualitative research activities, coupled with participatory mapping that was both quantitative and qualitative, we explored the many challenges that waste pickers face in a city that does not value the highly important social service they provide. We discussed lessons from this process and then presented a prototype we designed and developed together with the community, to respond to one of the many barriers we identified: the need of waste pickers for more and better information to enable more and better collaboration.

Testing and actively involving waste pickers in the process of developing this new system gives our research an dual disciplinary nature: while it retains its community problem solving aspects, with the community (the association of waste pickers) at the center of our design process, and the technological artifact as yet another element in the socio-technical system that is emerging (a characteristic of community informatics scholarship); it also actively engages in information systems development, the central activity on information systems as a discipline (Stillman & Linger, 2009).

Finally, although the Covid-19 pandemic limited the scope of our work and hindered many of our efforts, as we had to postpone activities once and again, we believe that the lessons we discuss in this paper may be of value for other groups of people exploring associativity, cooperation and the role of ICTs in their work, even beyond the waste management topic. There is value for them both in the lessons, but also in the methodology for enacting a participatory action research agenda with a mapping component.

In the future, we will continue with this work, facilitating other participatory processes and continuously supporting ASO San Francisco in their pathway toward a more and better every day work and quality of life. Some of the activities that follow include, (1) introducing and facilitating a set of training activities to strengthen the capacities of ASO San Francisco, (2) expanding the routes and experiences mapping process to incorporate all members of the association in the map, (3) experimenting with the information system in the context of real use, and (4) establish a participatory design process for both new tools and elements of use in the waste collection work and new cooperative practices and processes that could optimize the work of the association as a community.

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Community Action, Community Engagement ICTs to strengthen social capital: recommendations from case studies in vulnerable communities of Asunción during COVID19

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Abstract: The purpose of this research is to analyze and describe solidarity networks in vulnerable communities of Asunción (Paraguay), with emphasis on the role that ICTs played in the activation of these networks. The study focuses on two case studies of "ollas populares" (community soup kitchens), a type of local collective action response to the decline of food security during the pandemic, investigating how ICTs helped (or not) in organizing and sustaining these initiatives. Based on social capital theory, we use concepts of interpersonal and trust networks among individuals and groups to frame our analysis of collective action and resilience on the communities that are part of our case studies. Specifically, we analyze the patterns of use of ICTs as tools to develop and strengthen these social ties, within the studied communities in Asunción, with the goal of identifying use and design criteria that can guide future ICT-based strategies to enhance or complement community responses to similar crises.

Keywords: ICT, social capital, vulnerability, community networks.

Introduction

The global crisis generated by the COVID-19 pandemic has mainly affected the most vulnerable communities. While countries initially focused on mitigating the effects of strict health restrictions, over the weeks their attention shifted to one particularly serious threat: the economic and social crisis. In Paraguay, this crisis was particularly exacerbated in the *Bañados*, a set of peripheral vulnerable territories of its capital city, Asunción. As the crisis unfolded, initiatives emerged across sectors: government, religious, social and civil organizations, private institutions, and local communities themselves, organized collective action to respond to the challenges. In particular, the most common type of initiatives included sustaining production of and access to food for an increasingly vulnerable population that was losing their livelihoods due to the loss of economic activity caused by the much needed sanitary restrictions.

Interpersonal networks and trust relationships, both internal and external, of vulnerable communities were one of the elements that mediated collective action. Understanding them will shade light on what factors drive collective action that improves quality of life in local communities. We put our focus on understanding one of the many sides of this story: the role of ICTs as means of coordinating and articulating support for community soup kitchens ("*ollas populares*", in Spanish). Our main goal is to identify key lessons, in terms of design and use guidelines, that are relevant for the adoption, appropriation, and design of technologies or strategies that contribute to strengthening social capital in these communities.

Based on social capital theory, we use concepts of interpersonal and trust networks among individuals and groups to frame our analysis of ICT's role in expanding interpersonal networks of aid for vulnerable communities. Through this analysis, we seek to *characterize the solidarity networks of Bañado Sur and their relationship with the ICTs available in the community, with a focus on food security issues, specifically on the phenomenon of the community soup kitchens during the period of the COVID-19 pandemic*. We do this by analyzing the use of digital media for the articulation of aid in the soup kitchens of two selected case studies. In addition, we propose a set of hypotheses and recommendations about how to boost the benefits of ICT's use to improve social networks and collective actions

based on our findings. Our case studies include (1) the community soup kitchens organized by "Organización Coordinadora Lucha por la Tierra" (OCLT), and (2) those organized by "Organización Centro de Ayuda Mutua Salud para Todos" (CAMSAT). Both groups of community soup kitchens are organized in territories of southern wetlands of Asunción (Bañado Sur). In both cases, we first present a description of the solidarity networks that articulated aid during the COVID-19 pandemic. Secondly, we explore the relationships of bonding, bridging and linking social capital (Metaxa-Kakavouli, 2018), which were built at that time in these communities. Thirdly, we analyze the relationship between interpersonal trust and the environment; the uses of available technologies in the community; and the contribution of two technological platforms which emerged during the COVID-19 pandemic - Wenda¹ and AyudaPy²- to disseminate information about the activities that mobilized aid in Bañado Sur. Finally, we also interviewed members of a youth organization called "Jóvenes Voluntarios del Bañado Sur" (#JVBS), who were active in supporting the community soup kitchens of OCLT.

Our study is built upon 27 qualitative interviews with the beneficiaries, supporters and leaders who articulated the selected community soup kitchens. In addition, some ICT experts; and other people who were part of the solidarity aid networks were also interviewed. From our analysis, four key conclusions emerged and we classify them in four design challenges: (1) how to design and develop community solutions to expand and improve community connectivity; (2) how to design and develop community solutions to improve the logistics and local coordination of mutual aid; (3) how to design and develop solutions to expand the scope of dissemination of the community soup kitchens and their needs in a more sustainable way; and finally, (4) how to design and develop solutions to make better use of the existing resources and collective assets in the community.

The remainder of this paper is as follows. First, we start by a brief literature review on related work. Secondly, we describe the context and details of our two case studies, including a description of materials and methods of our study, followed by the analysis and discussion of our main results. Finally, we conclude by discussing our findings and guidelines for future ICT-based strategies to enhance community responses.

2. Background and Related work

a. The Concept of Social Capital

Research has identified the particularly important role of social capital in disaster response and recovery (Aldrich, 2012; Aldrich, 2015; Pfefferbaum, 2017; Reininger, 2013). Following this evidence, the conceptual framework of our work builds upon the concept of social capital frame our analysis.

The concept of social capital we use refers to the nature of group life and sociability for cooperation, trust, and social cohesion. Political scientists and sociologists define it as the characteristics of social organization, such as interpersonal networks and norms of reciprocity and trust, which facilitate coordination and cooperation for mutual benefit (Putnam, 2000). Our conceptualization of social capital focuses on three types of social capital, as defined by the type of ties that make up people's interpersonal networks: *bonding* social capital refers to the interpersonal networks connecting us to others who are quite similar; *bridging* social capital comes from weaker or thin ties to people with whom we spend less time and have less in common; and *linking* social capital refers to interpersonal networks that connect a regular person to people in power or authority.

¹ www.wenda.org

² www.ayudapy.org

b. Related Studies in ICT

We hereby provide a short review on how ICTs are connected to dynamics and concepts of social capital and resilience. As interactive and mobile ICT infrastructures become increasingly accessible, they transform the way in which social capital is generated and allocated. This has enormous implications for society and the economy.

ICTs can play an increasingly important role in social learning and in the sharing of knowledge and knowledge-based resources within communities of practice, especially now that network infrastructures and access to networks are becoming more widespread. But all this will not happen automatically. It is necessary to go further and design a paradigm focused on functionality and external appearance. The use of ICTs in social practice and their challenges to traditional conceptions of time and space present new challenges to social organisation, reorganising those structures and processes that create social capital (van Bavel et al., 2004). Focusing on the role of ICT in the health crisis, systems and technologies were adopted to alleviate the shortcomings and weaknesses that occurred in different areas of health performance. As problems were detected, technology was seen as the only solution (Sampedro, 2020).

There are several studies on community organizations and social networks supported by ICTs, in relation to the process of social appropriation of ICTs as instruments of communication and social organization for local development (Finquelievich, Kisilevsky, 2005). Some studies place the Internet as an efficient way in terms of cost and time to generate or maintain social capital through connective or bridging type of relationships, regardless of the degree of isolation in which people live. However, the type of resources that can be accessed through these networks continue to be conditioned by geographical distance (Pino, 2013).

The literature consulted indicates that there are close relationships between social capital and the impact of ICTs. Both contribute to the development, increase and enhancement of aid to vulnerable communities, especially in times of crisis. The first lesson learned from the literature is the importance of group association in any collective action. If people are associated, they can achieve a common good for the members belonging to the group. It is important to expand networking and trust in any society by using technology to help each other and leave no one behind.³

3. Context, materials and methods

In this section, we present the context of our research, the methodology we followed and the materials we used to reach the results we discuss in this paper.

The research presented in this article arises from the Social Capital learning cycle organized by the UNDP Accelerator's Lab in Asunción⁴, with a focus on the communities of the Bañados de Asunción and people who actively participated in the coordinating, supporting or managing *ollas populares*, also known as community soup kitchens, during the COVID-19 pandemic. Initial interactions began in July 2020 and continues at the time of writing, documenting the collective action of the community soup kitchens and how ICTs have mediated or facilitated requests for help from residents of the selected neighborhoods in *Bañado Sur*.

³<https://www.un.org/sustainabledevelopment/es/sustainable-development-goals/>

⁴<https://acceleratorlabs.undp.org/content/acceleratorlabs/en/home/>



Figure 1. Photos from Bañado Sur, the San Cayetano and Tacumbú neighborhoods

The communities we studied, which represent the main unit of analysis of this paper are: the “Coordinadora lucha por la tierra”, “Jóvenes Voluntarios del Bañado Sur” belonging to Barrio San Cayetano, including some areas of San Miguel, Caacupemi and San Ignacio (three smaller and locally defined neighborhoods that are part of San Cayetano); and the “Centro de Ayuda Mutua Salud para Todos” (CAMSAT) of Barrio Tacumbú. The soup kitchens organized by these communities reached 880 people in the neighborhoods San Cayetano, Sector Caacupemí, San Miguel and San Ignacio, and over 350 people in Tacumbú.



Figure 2. Communities studied. Own source and photo provided by Héctor Silva of Jóvenes Voluntarios del Bañado Sur

The objective of the study is analytical and we want to contrast the hypothesis: “In times of crisis, technology enhances solidarity aid in the neighborhoods of Bañado Sur”. In addition, we seek to derive hypotheses to answer the question "How are ICTs used? The time of the study is retrospective since the phenomenon to be studied has already taken place at the beginning of the research.

Methodology

Based on the evidence that connects social capital to resilience, we start from the premise that social capital, social relationships, and interactions, are key factors to enhance collective aid in the communities we are working with. As social informatics researchers, we were interested, first, in understanding how ICTs available in the community were used in people's social interactions and relationships and, second, in designing ICTs for this purpose.

We used an ethnographic design research approach, immersing ourselves in context to perform participant observations and using qualitative methods such as interviews and qualitative surveys. We combine face-to-face and remote interviews (via audio or text messages, and phone calls) to key actors of selected community soup kitchens that were active during the pandemic. Interviews and observations focused on how community soup kitchens organizers and volunteers articulated and coordinated their activities, and how they used ICTs (e.g., WhatsApp, social media networks and other more traditional ICTs) to meet their food security needs. From these research activities, key lessons emerged, which will be the basic input for a series of future participatory design workshops, where scenario based

design will be used to explore a day in the life of community soup kitchens volunteers, in scenarios that explore the possible solutions that emerged.

Data collection includes the systematization of text messages, photos, audios, observational field visits, images, audio/video recordings, notes, records of use of the tool we designed; interviews, questionnaires on the use of ICTs within the social environments in which the people from Bañado Sur articulate their community actions.

All in all, our design research approach uses human-centered design principles and tools, including the use of scenarios on a scenario based design process. The final result of this study will be presented through "Design Scenarios", mainly focused on typical analysis and design stages of the framework proposed by Rosson & Carrol (2002) that helps to generate design recommendations for future processes of prototyping and evaluation of ICT for vulnerable communities.

Design research activities

First, we selected the cases of studies by mapping the community soup kitchens of the vulnerable communities from the Bañado Sur and Tacumbú. This mapping was carried out through preliminary interviews, field visits, analysis of existing data such as digital maps created during the pandemic, and documents related to the specific cases of community soup kitchens on which we deepen the questions of our study. We also leveraged prior mapping efforts that had already surveyed and documented the phenomenal rise of community soup kitchens⁵.

Second, once the cases were selected, we conducted semi-structured interviews with key stakeholders using qualitative interviews and questionnaires.

Third, we map the actors and networks in each selected case through field or virtual visits, document review and participatory stakeholder mapping workshops. In addition, we conducted interviews and in-depth focus groups on ICTs use with members of the community soup kitchens selected for the studies.

From the data and analysis generated in the previous activities, we generated abstract scenarios that describe the activities, information, and interactions observed through the in-depth activities. This is done by using the Scenario-Based Design (SBD). The proposed activities represent the application of a scenario-based participatory design methodology, from which hypotheses and design recommendations or specifications can be derived. As a result, this study aims to produce "design scenarios" and final recommendations following the scenario-based participatory design framework of Rosson & Carrol (2002).

⁵ See mapa.wenda.org.py for an extended map of COVID-19 related initiatives

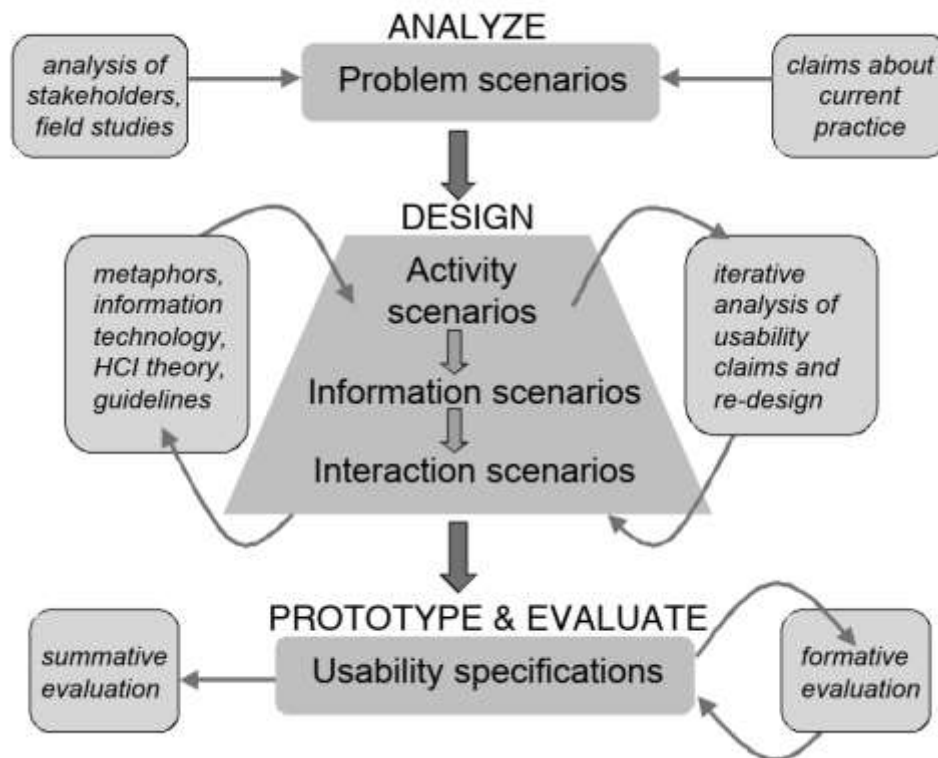


Figure 4. An overview of the scenario-based design (SBD) framework. Scenarios serve as a central representation throughout the development cycle, first describing the goals and concerns of current use, and then being successively transformed and refined through an iterative design and evaluation process (from Rosson & Carroll, 2001b)

4. Results

This section presents our main results, organized in the following themes and categories that emerge from the analysis we carried out.

4.1 Needs exposed by the Coronavirus Pandemic in Bañado Sur

The general problems detected in communities of San Cayetano, Caacupemí, San Miguel and San Ignacio are:

- 1) Lack of good nutrition and poor water supply
- 2) Lack of decent work and fair remuneration
- 3) Lack of technology, digital divide
- 4) Poor infrastructure (flooding, no sewage drainage, etc.), deficient and hard-to-access health system and services
- 5) Shortage of public transport
- 6) Environmental problems, which start with scarce vegetation, intense heat, odours, etc.
- 7) Very poor education
- 8) Social insecurity prevails: robberies, crimes, etc.
- 9) Mistrust between the members of the community.

In the immersion and observation in the Bañado Tacumbú, within the organization *Centro de Ayuda Salud para Todos (CAMSAT)*, the problems mentioned by the actors are:

- 1) The abundance of informal jobs
- 2) Lack of funds or money to keep the soup kitchens going
- 3) The social exclusion of these groups by society
- 4) There is no fiber optic service
- 5) There is an Internet connectivity point, but it does not work well, because the signal is very bad
- 6) The internet connection does not reach 80% of children and adolescents of school age that need to access virtual classes
- 7) Low levels of economic or social aid from the government.

4.2 Community organizations and initiatives

In the mapping of 6 soup kitchens, data was collected from the San Cayetano neighbourhood in the Caacupemí, San Miguel and San Ignacio sectors. From the interviews carried out with the people in charge of the soup kitchens, some data related to the social capital dynamics emerged, particularly, on the composition of the sub-organizations and their functions. From the *Coordinadora Lucha por la Tierra* (in existence for twelve years), 80 people worked as volunteers, of whom 60 are women and 20 are men. This organization is supported by the Sisters of the Sacred Hearts of Jesus and Mary, at the beginning of the pandemic, an example of bridging ties between these communities. During the pandemic, they distributed food for approximately 3,000 people, including lunch and/or snacks. Other local community organizations are part of this coordination community, including local community radios, organized civil society, and religious groups.

One key organization in this network is “*Jóvenes Voluntarios del Bañado Sur*”, composed by over 30 young people working since 2014 in community collective action, including soup kitchens, but expanding to activities to mitigate the impact of floods, fires, the pandemic, cold weather, etc.

In the second neighborhood, Tacumbu, the organization that leads community soup kitchens is CAMSAT. A more formal and institutionalized organization, CAMSAT has annual planning cycles, which start at the beginning of each year. To achieve their mission, they divide into eight different areas of work, and place special emphasis on working with adolescents and children. Their bridging social capital includes help from international organizations, including the Spanish Agency for International Cooperation for Development (AECID) and Adveniat, a German organization focused on providing help to the poor in Latin America and the Caribbean. Together, they contribute approximately 40% of the help to CAMSAT, with the provision of food, the construction of homes, streets, etc.

From all of this mapping and analysis, an abstraction of the social capital networks that come into play in Bañado Sur is shown in Figure 5. This diagram shows two case studies: "San Cayetano" and "Tacumbú", represented by the large circles. From left to right, using the figure of the rounded rectangle, we represent private entities, institutions, educational or religious groups. The hexagons represent NGO entities that articulated aid. Shaded squares represent public entities, local governments, or political parties that helped during the pandemic. Smaller ovals represent the actors in each case study. The green dotted arrows represent aid coming from outside. The arrows on either side represent the type of relationship between actors. In such diagram the relationship types are shown: Bonding (union, social bond, horizontal form, similar groups); Bridging (bridging, social link, horizontal form, different groups); Linking (Linking, social integration, vertical form). The revision and refinement of this map was carried out in the deepening stages of this work, expanding the mapping in the selected case studies, generating learnings and the hypothesis: the networks of relationships and links of Bañado Sur were strengthened using ICTs.

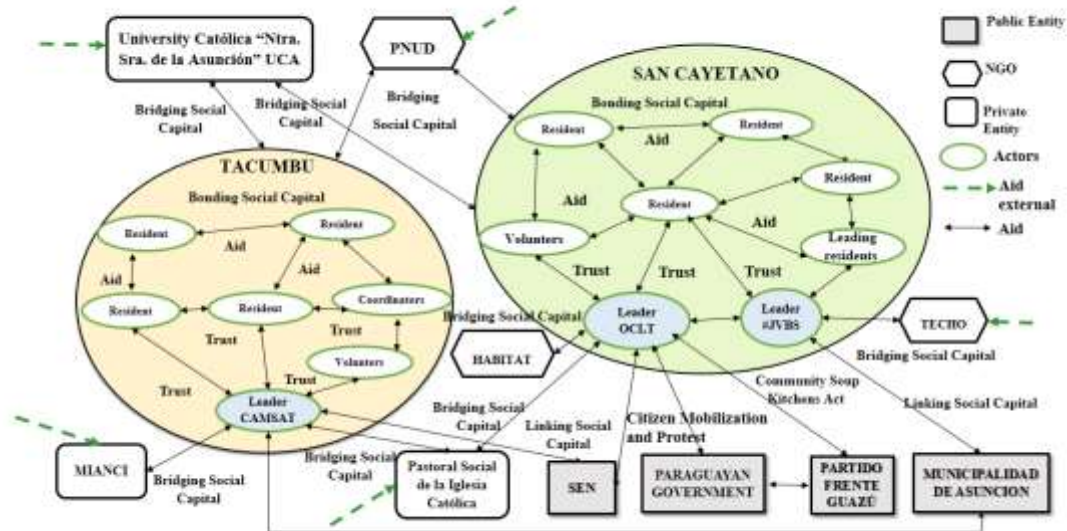


Figure 5. Type of relationship: Bonding, Bridging and Linking of social capital. Own elaboration based on the model of Nakagawa & Shaw, 2004.

4.3 Help Requests

Given the lack of resources to cover basic needs, the people of Bañado Sur made their requests for help in the form of donations of food supplies, such as milk, fruits, vegetables, dry goods, and tools for the cooking pots. These requests were made to friends, fellow students, citizens in general, Catholic and Evangelical churches, social organizations, Non-Governmental Organizations (NGOs), groups of volunteers, the State, schools, universities and the Municipality of Asuncion, among others. By means of a demonstration and diffusion through the ICTs, they asked the Government for the recognition of the “Ley de ollas populares”, which was enacted by the Legislative Power under the Law N° 6603 “De Apoyo y Asistencia a las ollas populares organizadas en todo el territorio de la República del Paraguay durante la pandemia declarada por la Organización mundial de la Salud a causa del COVID-19” (Support and Assistance to the popular pots organized in the whole territory of the Republic of Paraguay during the pandemic declared by the World Health Organization due to the COVID-19). The movement of the *Jóvenes Voluntarios del Bañado Sur*, when faced with any situation of vulnerability, assesses the needs by looking for party candidates, sponsors and organizations that can help. To do so, they use computers, phone calls, social media networks, etc. They prepare a list of beneficiaries, with personal data and follow them up via WhatsApp and Facebook.

In the case of the organization Centro de Ayuda Mutua Salud para Todos (CAMSAT) of Barrio Tacumbú, the help received was mainly from the Social Pastoral and the Catholic Group MIANCI, individuals, groups of anonymous entrepreneurs, etc.

4.4 The role of ICTs

ICTs were the essential tools for communication and mobilisation of the aid coordination implemented by the organization Coordinadora Lucha por la Tierra, the Jóvenes Voluntarios del Bañado Sur, and the organisation Centro de Ayuda Mutua Salud para Todos (CAMSAT). For the diffusion of the requests for help, they call the press, communicating first by cell phone in order to forward their requests and claims. They make flyers, videos or audio messages and disseminate them by the technological tools described below:

WhatsApp: The *Coordinadora Lucha por la Tierra*, Jóvenes Voluntarios del Bañado Sur and the CAMSAT organizations, frequently use WhatsApp. They obtained positive responses in the first place with the use of WhatsApp, to organize the procedures, ask for help, make calls for meetings, to channel communication with solidarity networks and/or the press, to monitor their activities, and to account for what was received and distributed.

Instagram: Although some young actors of the organization *Coordinadora Lucha por la Tierra*, initially made their requests through WhatsApp, asking for help from their friends and colleagues, then turned to the social network Instagram, where despite having fewer followers and contacts, they got more response to their requests for help.

Facebook: The organizations made flyers and posted them on Facebook. It is important to mention that in the case of a sub-organization of the *Coordinadora Lucha por la Tierra* (i.e. *Juvenusur*), although they have many followers on this network, the response to the posts was low. Facebook was used to follow up on beneficiaries, as a channel of accountability to their solidarity networks or sponsors who provided them with aid, but the most important for them is the live broadcast via Facebook Live made by the *Jóvenes Voluntarios del Bañado Sur*.

Radio stations: The organizations communicate, according to their needs, with the community radios available in the Bañados and with the radios with the largest audience in Asunción and the Metropolitan Area. The community mainly relies on the community radio (RPB), which reaches the entire neighborhood. In addition, other radios such as Radio La Unión and Radio Cáritas, also present the requests and/or complaints of the community. CAMSAT used the radio a little more than the community in San Cayetano that, in turn, own their community radio, Radio Tape Pyahu 87.9 FM, the voice of *La Ribera*.

Television Channels: In San Cayetano, another medium used to disseminate the community's requests for help were television channels, such as Canal 9, Canal 13, Canal de Televisión Gen, Bañado Sur TV, Telefuturo, Unicanal, ABC TV, ASA TV and all their digital media. In general, the leaders and referents call on the press to make their requests for help or complaints. The use of traditional media such as TV, at the time of the study, is supported by volunteers, students of the faculty, parents, or friends of the young people of Juvenusur. The Jóvenes Voluntarios del Bañado Sur are interviewed on several occasions each time they carry out a campaign to raise money, or each time they support the work of the Social Pastoral.

On the other hand, CAMSAT volunteers contact the television press by telephone. They made notes and live links that have allowed them the diffusion and the reach of the community soup kitchens and the activities that they carry out. The impact of greater reach of diffusion of the community soup kitchens is by means of the television, nevertheless, the aid is ephemeral and lasts little. In the interviews they comment on how they maintain the community soup kitchens and how important they are to certain people in the community. This potentially points to the need for "solutions to expand the reach of the community soup kitchens and their needs in a more sustainable way".

Specific platforms: as a response to the COVID19 pandemic has emerged some specific platforms, such as Wenda⁶ and AyudaPY⁷, to promote articulation between various sectors of the country. However, the organizations of the neighborhoods under study have not used them yet.

⁶ www.wenda.org

⁷ www.ayudapy.org

In both territories studied, regardless of the means by which they learned about the experiences of the popular soup kitchen and the work done, different persons contacted the organizers to offer their donations, in cash, or through bank transfers, account deposits, and money transfers through e-wallets Internet connectivity. However, it is worth noting in San Cayetano and Tacumbú, internet connectivity is scarce making it difficult to receive the help.

4.5 Solutions provided by community action

During the quarantine, the *Coordinadora Lucha por la Tierra* and its sub-organizations were able to feed 3,000 families and increased the number of soup kitchens to 21.

The "Jóvenes Voluntarios del Bañado Sur" distributed 1700 plates per day for 195 people and co-helped 4 soup kitchens.

The CAMSAT organization began distributing 750 plates of food per day at the beginning of the pandemic in three community kitchens, then distributed 350 plates. They follow the rules of access to the soup kitchens. At the entrance there is a volunteer in charge of controlling the access of people who come to get food, who want to make consultations at the health center, or who come to the radio; making sure that everyone has a mask and to wash their hands.

c. 4.6. Stakeholder perceptions

The perceptions of the actors on the use of specific platforms, such as Wendá and AyudaPY, and on the use of communications technologies and social networks that they have used were as follows:

In San Cayetano, the perception was: "It is necessary to facilitate so that the majority of people have access to the Internet. The platforms exist and I think they are very efficient and effective, the attention is personalized, the messages arrive en masse, but with the difficulty that is the means by which it is transmitted, the Internet, the lack of accessibility to the Internet because of the cost and the low signal that exists in the sectors of the Bañados". *Interviewee from Juvensur.*

"The good use of technology opens doors", is the conclusion reached by the social and political youth advisor". Interviewee from Jóvenes Voluntarios del Bañado Sur.

In CAMSAT, a very interesting conclusion is reached in the interview with the leader of the organization. "The virtual environment is essential today, I believe it is a human right. Just as today a government has to guarantee that people have water, that people have electricity, I believe that today, the government has to guarantee that all citizens have access to the technical means of communication, because we are only talking about this natural problem, many things today are solved and done through these means. That is my perspective". *Leader of the CAMSAT Organization.*

As we have seen, the perception of the actors is that the internet and social networks offer a great opportunity and therefore they demand access to these resources.

Regarding the exploration of the Wendá and AyudaPY platforms, the social communicator, marketing and advertising responsible of CAMSAT said: "I found it quite interesting and that we can take advantage of, we had no knowledge about this tool, I could see that it is a map where you can search by people's needs, see the area, see the water, and we could use that for example with our project of the coastal strip..."

Thus, we can think that there is room to explore the use of specific platforms such as those mentioned and analyze their possible impact on enhancing social capital and obtaining more sustained help over time.

5. Discussion and Conclusions

The different activities and interventions that we developed through this research help us shape four possible design challenges based on the insights we find:

1. Solutions to expand and improve community connectivity

The use of WhatsApp as the main tool for coordinating the activities of each of the cases indicates that these communities have a need for constant connectivity. However, San Cayetano does not have a connectivity point nearby and although CAMSAT has one at the organization's premises, the internet connection is very poor. To solve this problem, the actors resort to internet packages that cost approximately US\$ 1,5 per day, a very high cost considering the degree of vulnerability we find in these communities. In this context, designing interventions that help to expand and improve community connectivity could have a positive impact on increasing the food security of these families, given the importance of ICTs for building social capital and thus to generate collective action to mitigate vulnerability.

2. Solutions to improve local logistics and coordination of mutual assistance

Regarding the local logistics of the organizations we study, we found two different realities. On the one hand, although *Coordinadora Lucha por la Tierra* organization has been operating for 12 years, the logistics is mainly emergent, as the meals are prepared in some canteens or precarious homes of those who coordinate the actions. On the other hand, CAMSAT has a long history of 32 years of operation and is organized according to a horizontal leadership, where the actors and partners of the organization are volunteers that avoid clientelism. The organization has its own infrastructure that helps to coordinate the activities in a more centralized way.

Despite these differences, we observed that the strategies they use to coordinate mutual assistance are similar. In both cases, ICTs serve as a communication channel to organize efforts. In particular, they adopt WhatsApp as a tool to disseminate information about the needs of the soup kitchens and how to articulate the donations. In addition, the community radio is used to communicate the places where the soup kitchens are concentrated each day, and Microsoft Excel to organize the stock of donations. They also use Facebook to inform about the status of donations, and in particular, CAMSAT also uses e-mails to communicate with their actors.

These observations suggest the key role of both, a physical infrastructure and an integrated system that could address all the interaction needs that the initiatives have with all the beneficiaries, donors and the community. Thus, interventions with a focus on building collective assets, such as community dining rooms, or a community platform that systematize the donations and needs of each soup kitchen could significantly improve the efficiency and scope of the collective actions articulated in the Baños.

3. Solutions for extending the reach of the soup kitchens and cover their needs in a more sustainable way

The press, and specifically TV, is the most effective tool to let known the initiatives of popular soup kitchens and therefore generate the interest of the citizens in donating more resources. However, as mentioned by some interviewed: "the aid lasts a short time... only 3 days", indicates that this massive diffusion and the solidarity that it generates in the citizens

are ephemeral. Therefore, a design opportunity is to explore how the popular soup kitchens initiatives can have more reach, and how to keep the same level of aid and support over time.

Despite that both agree that the solidarity response generated by the press audience is ephemeral, it is interesting to note the difference between San Cayetano and CAMSAT. In San Cayetano, the community "goes in search of the press", while at CAMSAT, the press comes looking for them. This difference is mainly explained by the connective social capital that the leaders of CAMSAT have developed in the last 32 years.

The results show that the building of social capital is a very important issue to be addressed by interventions or public policies that aim to ensure food security in these communities. In other words, although the initiatives could rely on the press to reach homes, a more sustainable network of aid and donations would be available if these communities work on strengthening their social ties. This could be done first among the members of the community (bonding social capital), second with other actors of the society (bridging social capital), and third with those who have the power to make decisions that affect the whole society (linking social capital).

4. Solutions to make better use of existing community resources and collective assets

One of the most striking findings is that around the neighborhoods where the community soup kitchens take place, there is an internet connection point offered by the Ministry of ICT, but it did not come out as a relevant resource used by the interviewees. This opens a door to analyze the reasons why this resource is not being used effectively while one of the most mentioned needs by the organizers of soup kitchens was the lack of internet access. Therefore, exploring what other resources such as public spaces, community radios, parks, among others, are nearby but are not known or could be better used could be a venue to propose interventions in these communities. This is particularly important since the access and management of community commons could improve the level of trust within the communities, which in turn, increase the probabilities of articulate collective actions. Furthermore, as the production and maintenance of community commons may be a vehicle to decrease the territorial vulnerability (Montanía *et al.*, 2021), addressing this issue could be a very interesting strategy to improve the levels of food security in these communities.

Future Work

In next steps of this research, we aim to expand the preliminary findings that describes the social capital of Bañado Sur, to other similar or dissimilar groups, civil organizations, non-governmental organizations (NGOs), universities, citizens, etc., and the link between social capital and the Paraguayan government. This way, we will be able to make a deep analysis of the networks that exist in the communities of Bañado Sur and Tacumbú, and how they generate collective initiatives to overcome adversities, and how they articulate the aid using ICTs. Part of this future research will also include the analysis of the data collected at the country level in the Sustainable Development Goals investment map of Paraguay (Wendá platform) and AyudaPY.

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Outlining a Design Justice-based Social Media Website for University Students in the Age of COVID-19

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Abstract: The University of Illinois Urbana-Champaign (UIUC) discontinued in-person classes in favor of online instruction in March 2020 due to the COVID-19 pandemic. The sudden shift to online courses was challenging for university students who have experienced the logistical and emotional upheaval of the abrupt disruption. In such a scenario, this project aims to design a social media website that serves the UIUC student community to be updated with campus information and stay connected during and after the COVID-19 pandemic. Together with six undergraduate students, the researchers brainstormed their information needs for the website. Meanwhile, the researchers had deep and ongoing reflections on how their racial and cultural backgrounds can impact the design process. Based on these reflections and to design a more inclusive and privacy-focused website, this project focuses on users with color blindness while prioritizing FERPA compliance. To do this, the researchers conducted a preliminary literature review, including a comprehensive survey of the works published relating to FERPA-compliant website design and optimization of a website for users who are color blind. The review provides the foundation of an effective user interface, highlighting how future research and participatory design are needed to further this study.

Keywords: design justice, website design, FERPA, color blind, COVID-19

1. Introduction

In March 2020, the COVID-19 pandemic worsened in the United States, and its impact was felt nationwide. One of the universities impacted by the pandemic was the University of Illinois Urbana-Champaign (UIUC). It is the flagship school of the three University of Illinois campuses. UIUC is a residential campus where students live close to campus in residential housing, private certified housing, Greek housing, or off-campus residencies. In 2020, the total enrollment within the school was 52,331 students (Illinois News Bureau, 2020). However, due to the pandemic, UIUC discontinued in-person classes in favor of online instruction for Spring 2020, Summer 2020, Fall 2020, and Spring 2021. After March 2020, some students were displaced from their dormitories and peer groups, required to leave campus, and expected to continue their studies as usual, remotely. The university expected roughly 2,500 fewer students to live on campus in Fall 2020, compared to 8,800 in 2019 (Spaulding, 2020).

As the pandemic affected the myriad of people living on campus, it also impacted student mental health. Loneliness presents significant challenges for college students and can frequently lead to mental health issues like anxiety and depression (Bhagchandani, 2017; Moeller & Seehuus, 2019). For students, a sudden shift to online courses was challenging. Current studies have found that young people's mental health has been significantly impacted by the COVID-19 pandemic (Loades et al., 2020). According to the Centers for Disease Control and Prevention (2020), three out of four Americans (18 - 24 years old) note that they have poor mental health due to the pandemic (Czeisler et al., 2020). One study demonstrated that nearly

one-fourth (24.9%) of college students were found to be experiencing anxiety due to the COVID-19 outbreak (Cao et al., 2020). Another study reached a similar conclusion that within the first five weeks of the lockdown, students' mental well-being had decreased (Savage et al., 2020). In a Public Broadcasting Service (PBS) (2021) report, students were interviewed to describe their feelings during the pandemic, and some of the words they used to describe how they felt included "worried," "regret," "alone," "feeling pretty bad," "heightened isolation," and "depression."

The first and second authors of this article were attendees of the Community Informatics (CI) Studio class in the 2021 Spring Semester at the School of Information Sciences at UIUC. Taught by Professor Martin Wolske, this course aimed to examine Library and Information Sciences-led (LIS) community engagement by modeling actual learning environments where future LIS professionals can develop meaningful CI projects (Wolske et al., 2014). During the class, the authors, who consist of doctoral students at the School of Information Sciences and a software engineer (recent graduate of UIUC), together with six undergraduate students, had a self-reflection on how their mental well-being was impacted by the COVID-19 pandemic and how much they expected to be connected with other classmates and friends when studying remotely at home.

Therefore, this study examines how the COVID-19 pandemic affected the UIUC student community, focusing on issues related to connectivity and mental health among students. To meet pandemic-related student needs, it highlights the necessity for a more inclusive and all-encompassing online platform that also considers student privacy. This study aims to design a website that addresses student loneliness, encourages friendships, and incorporates campus information. Based on the self-reflection the researchers had undertaken with the undergraduate students, prioritizing student needs, making sure privacy regulations are followed, and improving accessibility for students that are color blind (as one of the undergraduate students expressed how color blindness impacts their technology usage) became the main goals of this research. Inspired by design justice principles from Costanza-Chock (2020), this study aims to highlight inclusivity and accessibility in the design process. In light of these goals, the paper presents a preliminary overview of relevant literature, initial findings, discussions, and future directions for the work.

According to Costanza-Chock (2020), design justice underscores ethical and inclusive outcomes when designing technologies and systems. It spotlights the need to rethink the design process and focus on communities of people who are often underrepresented in design. By prioritizing the voices of marginalized communities, design justice aims to challenge systemic and structural biases, power imbalances, and inequality via participatory practices. As both a community of practice and a framework, design justice advocates for designing in a way that facilitates fairness and accessibility (Costanza-Chock, 2020).

1.1 School-Related Websites and Social Media

The authors learned that although there is a plethora of different school-related platforms for UIUC students, none of them facilitate complete connectivity among students. Currently, UIUC students utilize a handful of learning management platforms such as Compass 2g, Moodle, and Learning Online Network with Computer-Assisted Personalized Approach (LON-CAPA) for accessing classes, submitting homework assignments, engaging with their peers, reviewing class material, and potentially taking quizzes and exams (Center for Innovation in Teaching & Learning, 2021). While these websites are helpful for students to engage with class materials, reach out to professors, and take exams, they are mainly targeted toward classwork. It would be unusual for students to discuss material unrelated to their classes on these websites. Additionally, the university created Rokwire, a platform created by the Smart, Healthy Communities Initiative at UIUC that can be used for different purposes, including helping students find transportation, maintaining advising relationships, and assisting them with finding housing (Rokwire, 2021). However,

this platform is not just for students, and it does not specifically focus on allowing students to connect with one another online via shared interests, needs, and classes.

According to current statistics from 2021, the most popular social media sites include Facebook, YouTube, WhatsApp, Instagram, WeChat, and TikTok (Tankovska, 2021). These platforms serve unique purposes: Instagram for students to express themselves and show the activities they engage in; Facebook to talk about academic achievements and information they care about; and WhatsApp to maintain their current, already-formed relationships (Kircaburun et al., 2020). Regarding platforms specifically made for university students to connect, the following social media sites are still active in 2021: Socioteria (<https://socioteria.com/>), Campus Karma (<https://www.campuskarma.in/>), and Campus Media (<https://campusmedia.mailchimpsites.com/>). Socioteria focuses on helping university students find jobs, internships, and alumni connections. Campus Karma is for university students in India. Meanwhile, Campus Media has a mobile app where students can interact with each other.

Students can also use university subreddits (e.g., /r/UIUC, /r/UTAustin, and /r/uwaterloo), university-specific Facebook groups (e.g., University of Illinois Housing, Sublets, and Roommates, University of Illinois Class of 2019, Free & For Sale at UIUC, and University of Illinois Urbana-Champaign Rideshare Group!), and university Discord servers (e.g., Illini Scape, Cham_pain, and Illini Esports) to engage with each other online. These platforms have diverse purposes and functionalities, which may lead to students maintaining multiple social media accounts.

1.2 Self-Reflections

The self-reflection among the researchers and six undergraduate students, along with an examination of existing platforms, led to two main conclusions: (1) there is a necessity among UIUC students for a website that integrates campus information and creates connections during the COVID-19 pandemic; and (2) current social media sites and learning management platforms do not fully meet students' needs. Additionally, the self-reflection process revealed that many of the current websites are not inclusive, especially when it comes to people who experience color blindness, as noted by one student during the discussion who has color blindness. Making a website specifically for students also brings up significant privacy issues with student information, which all six undergraduate students noted in the reflection. Therefore, the designed website should focus on user inclusivity and privacy protection while also integrating campus information and facilitating student interactions and relationships. This strategy emphasized the value of designing with various user experiences in mind to adhere to design justice principles (Costanza-Chock, 2020).

By the end of the 2021 spring semester, the researchers decided to design a website that helps UIUC students keep updated with campus information, connect, and combat loneliness. The researchers and the six undergraduate students organized one focus group and brainstormed their information needs. They designed seven components of the website, namely, the students' profile page and forums for finding friends, exchanging items, searching for apartments, learning about student events, talking about classes, and engaging in general student activities. The students and researchers brainstormed the details of each component, as described in Section 3.3 of the paper.

Further, during the discussion, the first author of this article, who is an international student from China, reflected that students in the brainstorming session tended to imagine the future users of this website as domestic students who are now living in the United States. Instead, during the COVID-19 pandemic, she observed many Chinese students returning to China and having online classes or connecting with teaching assistants and friends late at night because of the time differences between the United States and China. Based on this reflection, the researchers added time zone information to the user profile page and allowed

participants and users to search for a friend by time zone. The focus group further reflected and recognized that they tend to imagine the default participants and users of this website as students who are U.S. citizens residing in the United States, who do not have disabilities and have strong access to the Internet and digital devices, speaking proficient English. Therefore, numerous students can be excluded from the design process in this project.

1.3 Overview

Based on the self-reflections, the researchers decided they should focus on understanding how to prioritize students' requirements who are at risk of marginalization in the design process. As noted previously, one of the undergraduate students shared the challenges that they experienced as a person with color blindness while visiting some websites that were not made for users who are color blind. Further, all undergraduate students shared how they were deeply concerned with data privacy when visiting a website. From the self-reflection among students, the researchers decided they should focus on understanding how to prioritize students' requirements who are at risk of being underrepresented in the design process. More specifically, at this stage, this study focuses on addressing the website requirements of students with color blindness and compliance with the Family Educational Rights and Privacy Act of 1974 (FERPA).

2. Methodological Overview

To fulfill the objectives of this paper, a preliminary narrative literature review approach is adopted. This approach has two specific purposes in this study. (1) It produces a comprehensive survey of published works relating to FERPA-compliant website design and optimizing a website for users with color blindness. This step should provide researchers with some solutions in terms of building a FERPA-compliant and color-blind-friendly website, which should serve as the basis for the prototype of the website. (2) It evaluates the main methods adopted in current studies and assesses if the participatory design approach is adequately used in current design justice studies. If not, this study plans to fix the gap by using a participatory design approach to optimize the website further in the future.

The researchers decided to include two types of resources while doing a preliminary literature review on FERPA-related information: official website information and scholarly publications. The current analysis includes two official websites about the FERPA, namely, the official FERPA introduction page from the U.S. Department of Education (<https://www2.ed.gov/policy/gen/guid/fpco/ferpa/index.html>) and the official FERPA introduction page from the Office of Registrar at the University of Illinois Urbana-Champaign (<https://registrar.illinois.edu/faculty-staff/ferpa-fs/what-is-ferpa/>).

To collect scholarly publications highly relevant to FERPA, the researchers searched within the Engineering Village database using the keywords "FERPA" or "Family Educational Rights and Privacy Act" in the Subject/Title/Abstract field. The researchers obtained 45 results, which they further screened. After removing the duplicates, only those that discussed how to design FERPA-compliant technologies were kept. As a result, 24 papers were kept and reviewed.

To conduct a preliminary literature review to learn more about designing websites for people with color blindness, the researchers utilized the Scopus database to find relevant literature to review. To do so, the following search strategy is used: (TITLE-ABS-KEY ("color blind*" OR "colorblind*")) AND TITLE-ABS-KEY ("design") AND TITLE-ABS-KEY ("web" OR "website"). After searching, the researchers received 29 results. From these results, only those that specifically discuss how color blindness can affect website or technology design were chosen. After narrowing down the results, the researchers were left with 14 articles and conference papers to be kept and reviewed. The papers were examined to help get a better

understanding of the different types of color blindness that affect people and how web design can assist people with color blindness.

3. Findings from the Preliminary Study

In this section, the researchers discuss the preliminary findings for designing a social media website for UIUC students. To highlight inclusivity and privacy within the website, FERPA compliance and ways to make the website more accommodating for users with color blindness are addressed. Further, key features of the proposed user interface are outlined, highlighting ways for students to connect, share resources, and socialize.

3.1 What is FERPA and Why it Matters

FERPA is a federal law governing the privacy of education records. According to FERPA, education records are defined as records that are “directly related to a student and maintained by an educational agency or institution or by a party acting for the agency or institutions” and include “any information recorded in any way, including, but not limited to, handwriting, print, computer media, video or audio tape, film, microfilm, and microfiche” (U.S. Department of Education, 2021). The FERPA applies to all public K-12 educational institutions and most postsecondary institutions that receive federal funds from the U.S. Department of Education (Ramirez & McMillan, 2010). Even though this study’s proposed website design does not belong to the UIUC, researchers want to focus on this ethical perspective to protect users’ privacy. Thus, one of the goals of this project is to build a FERPA-compliant website.

The researchers examined the online tutorial that the Office of the Registrar at UIUC offers to faculty and staff in terms of FERPA and how to protect the confidentiality of students’ education records. The tutorial is open access (available at <https://registrar.illinois.edu/faculty-staff/ferpa-fs/tutorial/>), which was designed with the goals to (1) build knowledge of laws and policies governing acceptable use and release of student records; (2) facilitate faculty and staff understanding of their responsibilities in complying with the laws and policies; and (3) instruct faculty and staff how to protect a student’s right to privacy (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d.). As shown in Figure 1, researchers examined the tutorial from three levels: information level, students’ action level, and institutional policy level.

Information Level: What Can be Disclosed and What Cannot? According to FERPA, faculty and staff may disclose directory information without the student’s written consent. Specifically, at UIUC, directory information for current students includes names, addresses (including email), telephone numbers, University Identification Number (UIN), date of admission, date of birth, previous institutions attended, attendance site (campus or location), dates of attendance, full or part-time status, college, curriculum, major field of study, class level, expected graduation date, degrees, honors, and certificates received or anticipated, eligibility for membership in registered University honorary, participation in officially recognized activities and sports, weight, and height of an athletic team member (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d.). In addition, for students appointed as fellows, assistants, graduate, or undergraduate hourly employees, their directory information also includes title, appointing department, appointment dates, duties, and percent time of the appointment (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d.).

However, if a student requests not to disclose certain information in the directory, faculty and staff are prohibited from sharing this information with anyone. Meanwhile, the non-directory information is not supposed to be shared with anyone. It is also essential to recognize that even though FERPA allows for the

release of directory information, faculty and staff are not allowed to release lists of information (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d.). The definition of “list of information” is vague and is not explained in the tutorial. This rule may have been proposed because the combination of some information risks leaking personally identifiable information.

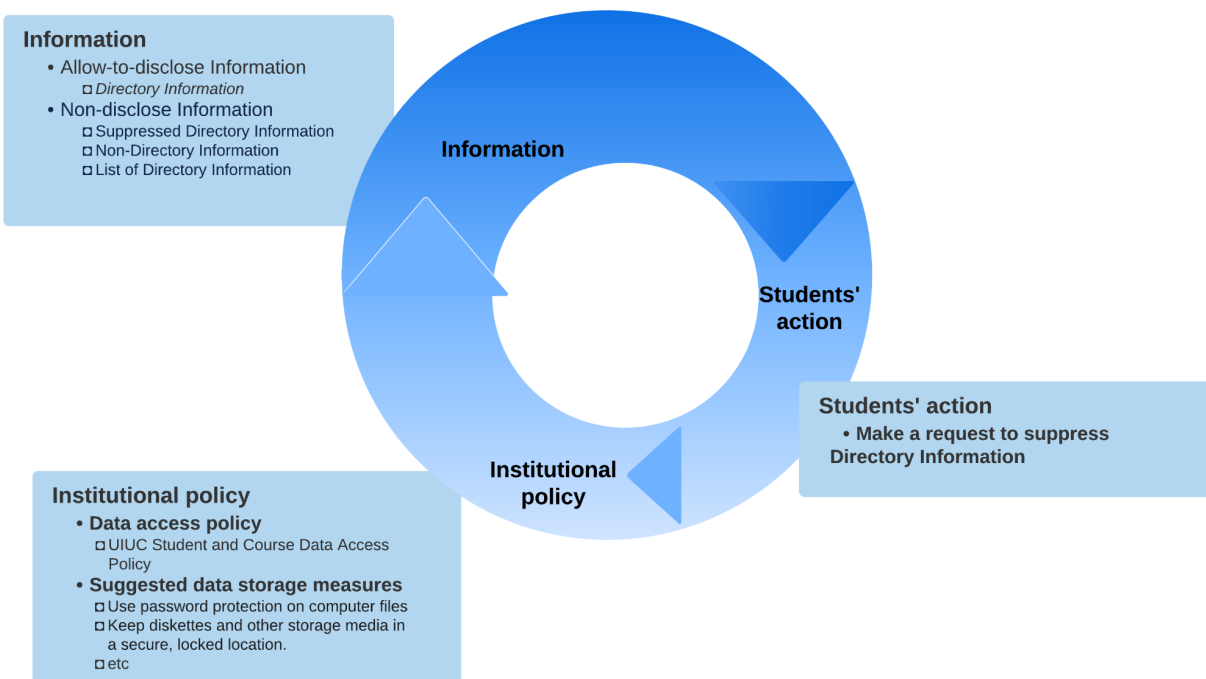


Figure 1: UIUC Tutorial on FERPA

Action Level: Students have the Right to Suppress the Directory Information About Them. Students have the right to suppress directory information themselves. If that is the case, the faculty and staff are not allowed to reveal the information to anyone who does not need it to complete official university duties directly related to the student’s educational need and should respond to inquiries as “there is no information available for any student by that name” (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d., Suppressed Directory Information section).

Privacy Policy Level: Policies in Terms of Accessing and Storing Students’ Educational Records. In order to strictly manage access to students’ education records, the university has issued the UIUC Student and Course Data Access Policy (<https://cam.illinois.edu/policies/apr-25/>). According to the policy, only some faculty and staff who are using data for “fulfilling officially assigned University responsibilities” (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d., Access to Student Records section) may use the student data; however, faculty and staff should not use email for data sharing unless it is encrypted. Any release of the student data to a third party, including students’ parents, is not allowed. To protect the stored students’ educational records, the university also has some suggestions for faculty and staff, such as using password protection on computer files and restricting access to one’s computer (Office of the Registrar at the University of Illinois Urbana-Champaign, n.d.).

Information Level: What User Information is Disclosable and What is Not? In this section, the researchers will discuss in what context they might need to disclose users' education record information while designing and maintaining the website and how they know if the information is disclosable. Researchers have identified three scenarios in which there might be a need to disclose users' education records:

- Scenario 1: A disclosure request from another user: If user A views user B's post or profile picture and requests to have more information about user B for further communication;
- Scenario 2: A disclosure of users' education record information among the website design team to carry out the project responsibilities;
- Scenario 3: A disclosure of users' education record information to third parties outside the researcher team to carry out the project responsibilities.

There are two sources from the website that might include information on users' education records: a user profile page and a forum post. The website requires all users to register with their UIUC email account. After registration, a user will need to fill out a student profile page. Specifically, the information that a user needs to provide includes their name, profile image, school, major, department, other social media accounts (e.g., Facebook, Instagram, and Twitter), the classes they are currently taking and have taken at specific semesters, their interests, and their time zone, and country and state information they are currently located at. Among all the profile information, only name information is required, and users do not have to fill in their real names. Users might include information on their education records in their posts, such as a student's name, previous institutions attended, and more.

Comparing the users' profile information with the definition of Directory Information in FERPA, the researchers identified all the collected user data that can be categorized as directory information and thus can be legally shared. However, this is under the premise that the user does not request to suppress the related information. As shown in Table 1, the researchers cross-listed the above-mentioned three scenarios and different types of information collected from the website.

To build a FERPA-compliant website, the website will not share any non-directory information or suppressed information with any user, other website design team members, or any third party. However, the preliminary literature review indicates there can be challenges if the website strictly follows the FERPA requirements; Coombs (2004) notes the inherent tension between users' privacy and the desire to improve services to users when discussing how to follow FERPA in a university library environment. The tension is echoed in Ramirez and McMillan's article, where they find the broad FERPA definition of "education records" ostensibly encompassed all student work, which is against the library's mission to provide open access to students' research outcomes (Ramirez & McMillan, 2010). The tension also exists while designing and running a commercial website. To strictly follow the FERPA, non-directory information and suppressed information are prohibited from being shared or used by the website design team, including third parties. This might make the website slow to improve its services to users. The preliminary literature review finds that few articles have addressed the strategies to solve the tension between privacy protection and service provision when designing technologies.

Table 1: Disclosure of Users' Education Record Information

	Scenario 1 (Share with a Requested User)	Scenario 2 (Share Among Website Design Team)	Scenario 3 (Share with a Third Party to Improve the Website Design)
Users' Profile Information (Directory Information)	No	Yes	Yes
Directory Information Mentioned in Users' Posts	No	Yes	Yes
Non-directory Information Mentioned in Users' Posts	No	No	No
Suppressed Information Requested by Users	No	No	No
List of Directory Information	No	No	No

Privacy information is often established by context (Earp & Payton, 2001). At this stage, while designing the website, researchers are unlikely to make a list of educational record information, the combination of which can lead to the leak of personally identifiable information. This should be addressed in future participatory research. Even though the website can share or use the directory information, for example, the information collected on users' profile pages, according to FERPA, the data should be de-identified (Angiuli et al., 2015) before sharing. De-identification is the process of removing the association between a set of identifying data and the data subject (International Organization for Standardization, 2008). Angiuli et al. (2015) indicate that "de-identification is hard," and the human subject needs to decide the level of de-identification based on which different anonymity techniques will be used. Future studies should address the issues of the level of anonymity and the de-identification technique so that the designed website will strictly follow the requirements addressed in FERPA. Meanwhile, if a user requests to have another user's information, even though it is directory information, the website is not supposed to disclose it. This is because privacy information is often established depending on the need to know. The information requesters can combine the requested data with some datasets they have had to re-identify a person.

User-Action Level. The designed website will allow users to send requests to suppress certain profiles or posts that include information about their education records. This is a common FERPA-compliant practice, as illustrated in the preliminary literature review. For example, Ramirez and McMillan (2010)

discussed in the dissertation management system that users can set FERPA privacy restrictions once they are logged into the portal. By default, the system allows access to student directory information, while a student can change the settings to limit the information shared with other campus stakeholders. Parks and Mead (2014), in their examination of the utilization of biometric technology, address that many users lack awareness about the privacy issues involved with using devices. The education of the users becomes an essential step to empower them to protect their privacy information and balance their need to have higher-level services. On this study's designed website, researchers plan to provide a FERPA page, which provides detailed educational information to users about what FERPA is and how users can protect their privacy information by actions. However, current studies do not address how the website interface should be designed to keep users informed of their rights and make it easy for them if they want to send a request to suppress certain private information. Future participatory design studies will need to address this issue.

Policy-Level Practices. Earp and Payton (2001) find that academic professionals who have daily exposure to student information are largely concerned about improper access to these data. This is also a concern for researchers who want to design a FERPA-compliant website. Future studies should address how to make policies at the organizational level to ensure proper access to the privacy data that the website collects. The policy should cover the "security management process, assigned security responsibility, workforce security, information access management" (Katsuno et al., 2016, p. 361).

In summary, the preliminary literature review on FERPA reached two conclusions: (1) The majority of current studies address applying FERPA in a university environment, and FERPA has rarely been addressed for commercial website design in current studies; and (2) Current studies mainly focus on document and policy analysis while participatory design approach is rarely used.

3.2 How to Optimize Website Design for People with Color Blindness

Color blindness is a common condition affecting more than 300 million people worldwide (Pendhari et al., 2020). People who have red-green color blindness are roughly 8.5% of the total global population (Chai & Cao, 2017). One out of every 12 men has some type of color deficiency issue (Rigden, 1999), and 0.8 percent of women suffer from some type of color blindness (Liu et al., 2009). Jefferson and Harvey (2007) assert that color blindness and color vision deficiency are significant barriers to using computers. Similarly, color is a large part of website design, and it is important that this study recognizes how people with color blindness view the website. To make the designed website inclusive, researchers should consider the needs of everyone, including students with color blindness, especially since the use of color can greatly affect users with color blindness and how easily they can use the website.

There are different kinds of color blindness that people can have. Specifically, hereditary color vision deficiency (also known as congenital color vision deficiency) has three distinct types: achromatism, dichromatism, and anomalous trichromatic (Bailey, 2010; de Araújo et al., 2020). Achromatism is rare (people who have achromatism only see black and white tones), dichromatism occurs when one of the pigments is missing, typically either red, blue, or green, and people with anomalous trichromatic have trouble distinguishing pigmentations of the different types of retinal cones (de Araújo et al., 2020; Rigden, 1999). Deuteranopia is a type of dichromatism, and people who have this type of color blindness confuse red and green, while tritanopia is another form of dichromatism where all colors are matched by mixtures of only red and green (de Araújo et al., 2020).

Regarding tools for websites that can help with color blindness, Tigwell et al. (2017) proposed the Accessible Colour Evaluator; this tool helps web developers and designers with accessibility constraints for those who have trouble seeing different types of colors. Barrera-Leon et al. (2016) described Tukuchiy

as a dynamic user interface generator that helps to improve usability based on specified rules, and this interface can be adapted for people with color blindness. Sagata et al. (2007) created VoiceBlog, which is a browser that focuses on universal design and has an audio user interface rule to help people who have weak eyes (such as those with color blindness) more easily access blogs. Moreover, Takamoto and Tosaka (2005) cover Fujitsu Accessibility Assistance, a tool group that helps web page designers create presentation materials, and one of the tools within Fujitsu Accessibility Assistance, namely Weblnspector 4.0, diagnoses if web pages can be understood and read by people who experience color blindness.

When designing websites for people with color blindness, additional considerations need to be made. Color is a significant part of most websites, and it is important that people with color blindness are able to distinguish colors within the website, as both text and links may be unreadable depending on the colors used (de Araújo et al., 2016). Rigden (1999) proposed color palettes that help people with color blindness view web pages more efficiently. As seen in the study by Soegoto et al. (2019), instead of using color combinations between red and green, combining light and dark colors can help people who experience color blindness see and distinguish information presented on a website. It is crucial to use colors that are easily recognizable for people with color blindness or who have weak eyes (Sagata et al., 2007). Also, people who experience color blindness may prefer websites that use black and white for the critical elements (de Araújo et al., 2020).

In addition to website color combinations, as mentioned in the article by Strantz (2021), it is critical when designing a website for people with color blindness to create contrast, use whitespace efficiently, include clear graphics and readable text, and label visuals clearly. Icons used within the website should be easily recognizable for people who are color blind or have weak eyes (Sagata et al., 2007). Furthermore, having additional visual elements and cues helps people with color blindness view websites more effortlessly (van der Geest, 2005).

From this preliminary literature review, the researchers recognize (1) color blindness is a significant problem that can affect how people view websites; (2) researchers have developed different tools for those with color blindness outside of typical web design; and (3) there are multiple ways to design websites for people with color blindness and most of the designs are simple ones.

3.3 Prototype: Website Interface

The final product will be a social media website serving UIUC students. The researchers want this to be a place for students to connect, find opportunities, and exchange information and tangible items (e.g., textbooks and lab manuals) with each other. To ensure that only UIUC students are engaging with the social media website, students will need to add their university email to register an account on the platform. However, based on the self-reflections the researchers had with six other students, the following key components of the platform are proposed.

Students' Profile Page. Each user has their profile page, including her/his/their name, profile image, school, major, department, other social media accounts, their current or previous classes taken, and their interests. Additionally, the user can set their preferred time zone and update it whenever they want. Sharing location would solely be the user's country, time zone, and city. Each user can select if and how they want to publish this information, and they can choose to make the information (1) private; (2) open to students who have taken the same class; (3) open to students who are in the same department; (4) open to students who are in the same school; (5) open to students with specific email accounts; (6) open to all the users on this platform; or (7) open to everyone (to be entirely publicly accessible).

Find a Friend. The platform allows users to search for friends in specific time zones who have opted for this feature. It also helps users search for people in specific classes, majors, departments, and dorms. In addition, users can search for friends or potential roommates based on their interests (e.g., people who like to go to the gym, people who enjoy running, and people who like to play video games). Furthermore, users can search for students to be their study partners, lab partners, and research partners based on the class sections they are in and their research interests. In summary, this function can be used to help students find friends with the same interests, study partners, research partners, lab partners, and roommates.

Item Exchange Forum. This will be a place where students can easily exchange items with each other, such as textbooks, lab equipment, clothes, and lab manuals. Therefore, students will have a place to buy and sell, give away, or exchange items.

Apartment Forum. This is where students can find apartments available to rent or buy. Students can also post whenever they want to sublease their apartments, which is especially useful during the summer when classes are no longer in session and when students typically have internships elsewhere.

Student Event Forum. Here, students can find different events happening at the university. Students can search for events based on their interests, majors, departments, or the time the events are happening.

Class Forum. This is where students can talk about their experiences taking different classes and give class recommendations to other students.

General Student Forum. In this section of the website, students can discuss anything related to their school or life in general. For instance, students can discuss a basketball game that happened last weekend.

Building a website for the modern age can be an interesting challenge. The world has become mobile, and accessing technology has become easier for many. Introducing low-cost technology, such as Chromebooks and smartphones, has made them accessible to many groups. Designing a website that can be versatile for both mobile and browser is essential to reaching a wider audience. This is illustrated in Figures 2, 3, and 4, which respectively show the browser view of the website's homepage, the browser view of a user's profile page, and a view from an iPad (tablet). Based on the self-reflection with the undergraduate students, the researchers learned that students often opt to use tablets for note-taking, and this is factored into consideration when designing for a mobile experience.

In addition, having an appealing website with a simple user interface (UI) allows for a lower barrier to entry to adopting a website. For this UI, it uses a straightforward card-based design with modular components for each card. Figure 2 shows a few items on the homepage, such as a welcome bar telling the user where they are, a secondary banner with more information, and promotional videos from the UIUC YouTube channel. To the left of the screen, there are tabs such as "FERPA" to get privacy-related information, "Profile" to access the user's student profile page, "Community" to engage with the item exchange, apartment, student event, class, and general student forums, "Connect" to interact with the "find a friend" function, and "Accessibility" to learn about options to make the website more accessible (such as options for alternative text, color contrasting, and descriptive links).

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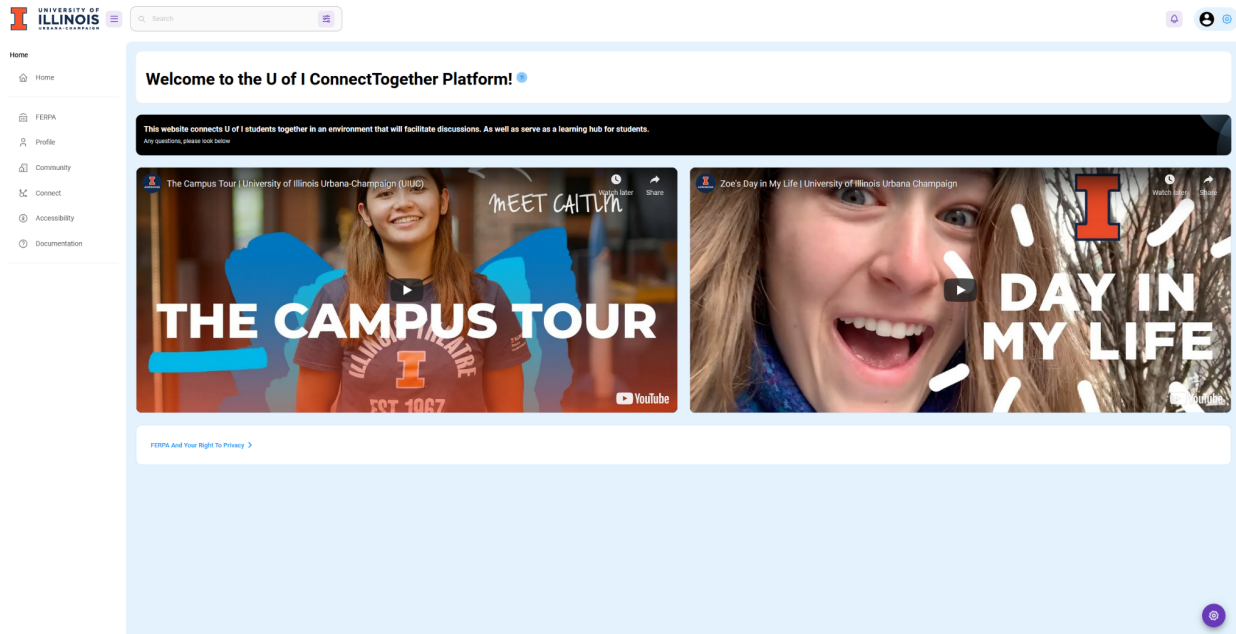


Figure 2: Browser View of Homepage

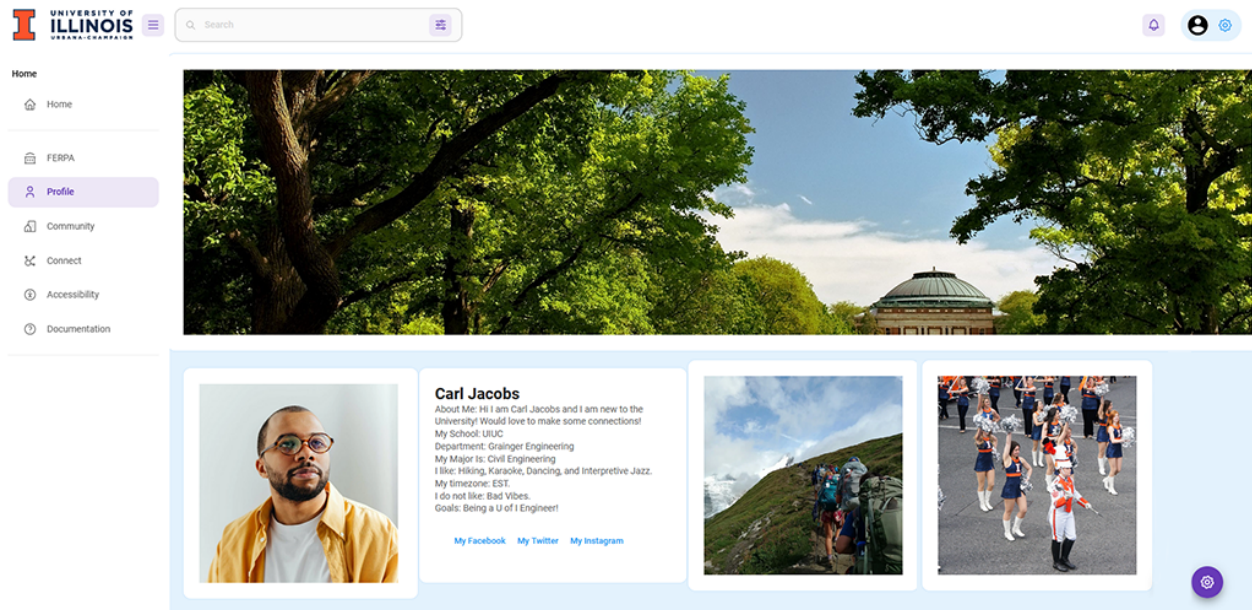


Figure 3: Browser View of Profile Page

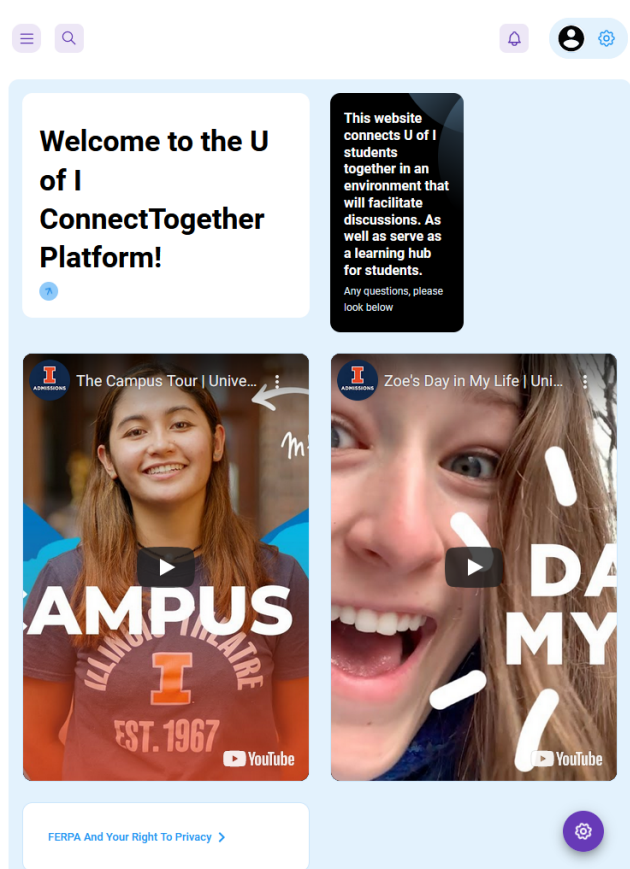


Figure 4: Tablet View (iPad) of Homepage

Within a user's profile page (Figure 3), the researchers want students to be able to share their interests, hobbies, and majors and build their own profiles on this platform. Users can also post images on their profiles with links to social media if they desire. In keeping with FERPA, if a user does not have their directory information displayed, they would not have a profile that can be viewed.

Regarding FERPA, the decision to include a card with a link to FERPA on the homepage is necessary for informing students of their rights to their information. Students have the right to exclude certain information from the rest of the UIUC population, which is essential and should be respected. Figure 5 is a prototype example that allows users to learn more about FERPA.

Considering UIUC's diverse student community, it is an additional challenge to design a website that is as accessible as humanly possible. The researchers are paying attention to students who have color blindness. The text is opted for white, gray, and black backgrounds, allowing for ease of reading. The colors that are used are the UIUC colors and light shades of blue and purple. Any user inputs are in black and white text to allow for an easier readability experience. The choice of colors was limited in consideration of all types of visual impairment.

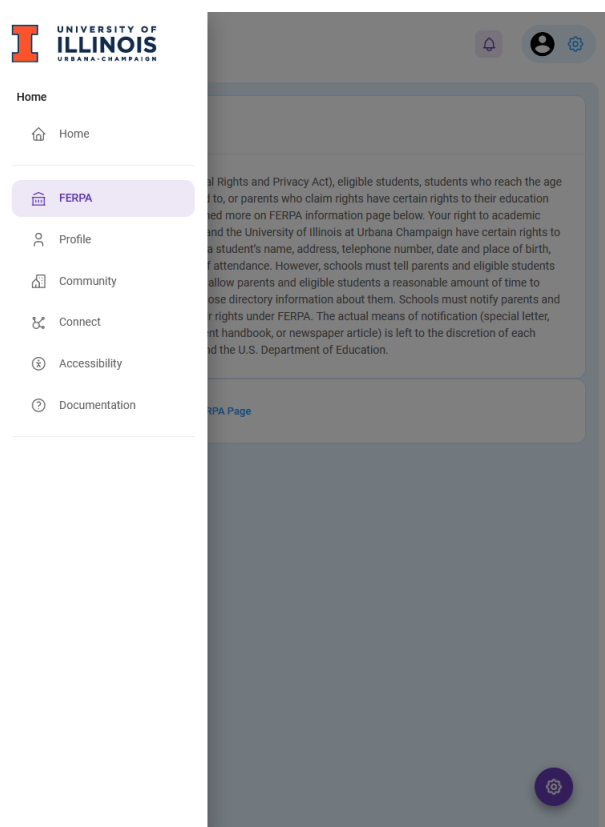


Figure 5: FERPA Introduction Page on the Website

4. Discussion, Limitations, and Future Work

As shown in Figure 6, Milner (2007) proposes a framework to guide researchers in working through seen, unseen, and unforeseen dangers in the practice of inquiry. To start with, researchers need to critique current situations and introspect about their cultural and racial backgrounds. Next, researchers are supposed to reflect on themselves in relation to communities and people involved in their research studies. The third feature of this framework is engaged reflection and representation, which means researchers and participants engage in reflection together to think through what is happening in a particular community. In this process, both the researchers and undergraduate students can include counter-narratives. Lastly, the framework requires the researchers to consider historical, political, social, economic, racial, and cultural realities on a broad scale.

In this article, the researchers argue that this framework also works for design justice projects, and the four components of this framework do not have to be in a linear order, as proposed by Milner (2007). Since this project started as an assignment for the CI Studio class, the researchers and participants (six undergraduate attendees of the class) began with an “engaged reflection and representation.” In this process, the researchers and undergraduate students shared their counter-stories on how the pandemic brought extra pressure to their lives and made connecting with school friends more challenging. Then, the researchers moved to the “shifting from self to system” stage. “System,” in this context, means the “technological system” instead of the “social/political system,” as initially proposed by Milner (2007). The researchers decided to build a website to help students keep updated with campus information and connect with friends. Next, the researchers and undergraduate students shifted to the “research the self” and “research the self in

relation to others” stages simultaneously. For example, the first author of this article reflected on her identity as an international student and how international students’ unique experiences during the COVID-19 pandemic can shape the website design.

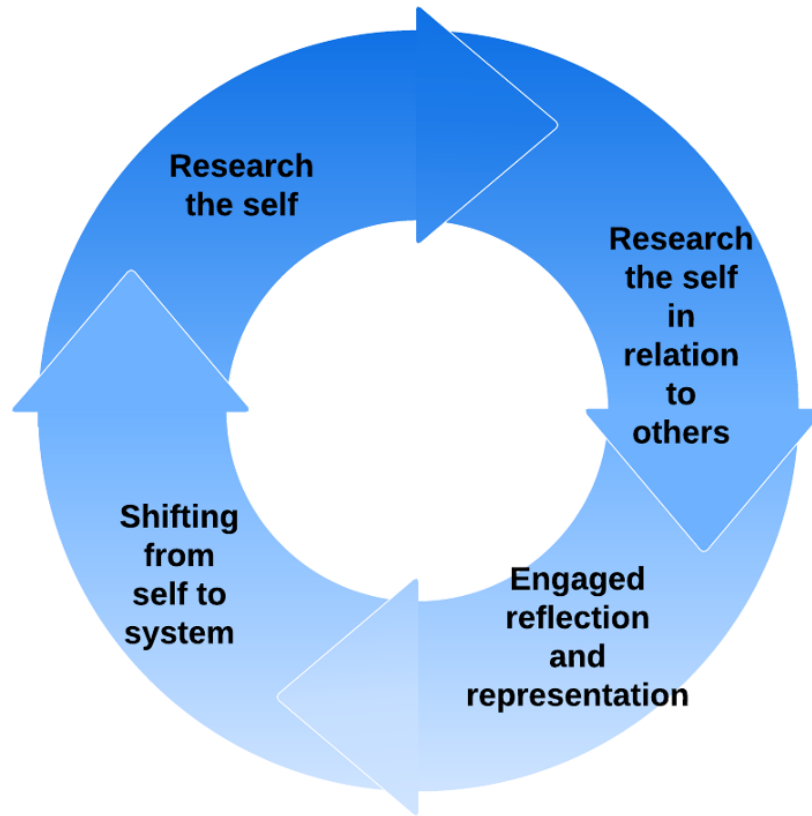


Figure 6: A Framework of Researcher Racial and Cultural Positionality Proposed by Milner (2007)

The preliminary literature review on FERPA-related articles finds that the current discussion mainly focuses on designing FERPA-compliant systems in an educational context, for example, at a university. None of the articles discuss if a commercial website should also comply with FERPA and how it should be done. Applying FERPA to a commercial website is more complex than applying it in a university environment. On the information level, the website has less control over when and what education record information will be posted by users. This requires the researchers to keep engaging with users in the future to understand the potential privacy issues in the collected website data. On the users’ action level, in addition to helping users make the best decisions on what information they want to suppress or give consent for sharing, educating users about their right to privacy is also crucial. The designed website has a page for FERPA education; however, future work should invite more participants and address how the website interface design should be adjusted based on the participants’ needs.

4.1 Limitations and Future Work Toward Design Justice

The reflection, whether among researchers or participants, should always be an ongoing process. In this project, only six undergraduate student participants were involved in the reflection process with the researchers. COVID-19 also shaped the design process because the researchers did not have the opportunity to meet in person with the other participants. The limited size of participants in this project points to one of the limitations of this study: The researchers and students can be potentially influenced by what Costanza-Chock (2020) calls the “matrix of domination.” The matrix of domination refers to race, class, and gender as interlocking systems of oppression. For example, the researchers and six students have at least one smartphone and one study computer. Thus, they tend to imagine that future participants and users will also be equipped with similar types and numbers of digital devices. In this case, students of lower socioeconomic status can be excluded from the design process. As Costanza-Chock (2020) asserts, the process of selecting whom to include is a political process that prioritizes some marginalized communities’ needs while excluding others. The future study will include semi-structured interviews with Disabilities Resources and Educational Services (<https://dres.illinois.edu/>) staff at UIUC to further understand the needs of the marginalized student communities on campus. When doing so, the researchers will be dissecting more variables (other than FERPA and color blindness).

Future work related to FERPA also includes the following questions: (1) What are participants’ privacy concerns when visiting the website? (2) How can the website optimally offer more privacy and information about participants’ privacy rights? (3) In what contexts might researchers disclose participants’ education record information with others? (4) What is the level of de-identification expected by participants? Meanwhile, it is also important to recognize that even though students at risk of marginalization participate in the design process, participation is political and shaped by the dynamics of power. In certain contexts, some users will feel they have more power than others regarding participation and sharing ideas. For example, in a room with professional designers, general users may not feel confident sharing their design ideas in front of the “experts.” Therefore, in future work, while inviting more participants, the researchers should address the power dynamic issues among them.

Additionally, while writing the article, the researchers discovered that the use of the term “colorblind people” itself was a continuation of the objectification of people. The researchers realized this was an inappropriate term to use throughout this article. Instead, the researchers recognized that “people with color blindness” and “people who experience color blindness” are more inclusive terms than “colorblind people.”

5. Conclusion

This project aims to build an inclusive website to help UIUC students access updated campus information, connect with classmates, make friends, and combat loneliness during and after the COVID-19 pandemic. At the study’s current stage, it focuses on building a FERPA-compliant and color-blindness-accessible website. The researchers adopted a preliminary literature review approach and conducted a comprehensive survey of the literature relating to FERPA-compliant website design and optimizing a website for users with color blindness. The review provides the foundation for the prototype of the website interface. Finally, the researchers demonstrate how the current study is limited and how future studies are planned to address the limitations.

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The Impact of Digital Equity on Education: A Systematic Review

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Abstract

Digital equity is defined as a condition in which all members of a community or communities have access to the technology needed to properly engage in society, and in education, it has been a long-term dilemma. This systematic review addresses digital equity in education by focusing on three research questions: (1) What is the impact of digital equity on education? (2) What are the main factors that affect digital equity? and (3) What are ways to improve the impact of digital equity on education? Based on the PRISMA review framework, we performed three rounds of systematic selection, beginning on May 31, 2021. First, we searched predetermined keywords in 3 databases: JSTOR, IEEE Xplore, and Web of Science. A total of 45 non-duplicate results remained for round two screening. Second, we screened the titles and abstracts using predetermined inclusion/exclusion criteria; 33 remained for round three screening. Finally, we screened the full texts of the 33 selected articles and excluded 8 articles. We then analyzed the 25 remaining articles in the final sample. These articles were published between 2005 and 2021. The year 2019 had the most publications of all years (9), suggesting an increasing interest in this topic. The majority of these studies used qualitative methods including case studies and surveys. Despite the fairly reasonable amount of information that we found regarding this topic, there is still much more to learn in order to truly find the right solutions to this worldwide dilemma.

Keywords: digital equity, education, learning, digital divide

Introduction

In Willems (2019), digital equity is defined as “equal access and opportunity to digital tools, resources, and services to increase digital knowledge, awareness, and skills (Davis, Fuller, Jackson, Pittman, & Sweet, 2007).” Students who are influenced by the issue of digital equity lack adequate internet connection and/or technology, causing many challenges when they attempt to participate in online activities. But this problem is not limited to students; teachers also face similar digital inequities. Among the factors influencing digital equity are household income, education level, race or ethnicity, geography, and gender, to name a few. Furthermore, the issue of digital equity has been exacerbated during the pandemic due to the increasing demand for technology in online learning. In order to ensure that students continue to receive an education, schools, governments, and other individuals have provided various forms of assistance, including free devices as well as internet access.

The purpose of this systematic review is to study the impact of digital equity on education in order to not only bring awareness to the matter but also provide individuals with an adequate understanding of it. Educating individuals on this dilemma is the first step to solving it, for people cannot take action to fix a problem without first recognizing the problem. As technology usage increases and becomes a necessary aspect of our lives, it is vital to solve the issue of digital equity as soon as possible in order to ensure that no one is left out of society.

This systematic review aims to address digital equity in education by focusing on three research questions (RQs):

RQ1: What is the impact of digital equity on education?

RQ2: What are the main factors that affect digital equity?

RQ3: What are ways to improve the impact of digital equity on education?

Methods

Based on the PRISMA review framework, we performed three rounds of systematic selection, beginning on May 31, 2021. First, we searched predetermined keywords in 3 databases: JSTOR, IEEE Xplore, and Web of Science. A total of 45 non-duplicate results remained for round two screening. Second, we screened the titles and abstracts using predetermined inclusion/exclusion criteria; 12 articles were excluded and 33 remained for round three screening. Finally, we screened the full texts of the 33 selected articles to ensure that they were within the same inclusion/exclusion criteria; another 8 articles were excluded. We then analyzed the 25 remaining articles in the final sample.

Round 1: Keyword Search

On May 31, 2021, we searched the Title/Abstract in the JSTOR database for articles using the following two sets of keywords ("education") AND ("digital equity"). This process produced a total of 3 results. In addition to JSTOR, we searched in the All Metadata of IEEE Xplore and the Topic in Web of Science. Using the same sets of keywords that we used for JSTOR, we received 41 results from IEEE Xplore and 1 result from Web of Science. In the end, a total of 45 non-duplicate results remained for round two screening.

Round 2: Screening the Titles and Abstracts

Second, we screened the titles and abstracts using predetermined inclusion/exclusion criteria. The two authors each independently screened approximately 1/2 of the titles and abstracts of the 45 articles. This screening resulted in the removal of 12 articles.

This round of screening was based on the rationale that the focus of our systematic literature review is the impact of digital equity on education. Other topics are outside of the scope of this review. Specifically, we removed an article if it met at least one of the following exclusion criteria:

- Full text not in English;
- Primary focus is not the impact of digital equity on *education*;
- The article is a review article, editorial, or book.

After removing 12 articles, a total of 33 articles remained for round three screening (full-text screening).

Round 3: Screening the Full-Text

Third, we screened the full texts of the 33 selected articles to ensure that they were within the same inclusion/exclusion criteria. During this round, we eliminated 8 more articles from our sample because they met at least one of the aforementioned exclusion criteria:

- Full text not in English;
- Primary focus is not the impact of digital equity on *education*;
- The article is a review article, editorial, or book.

A total of 25 articles remained in the final sample. Figure 1 shows the search and screening process.

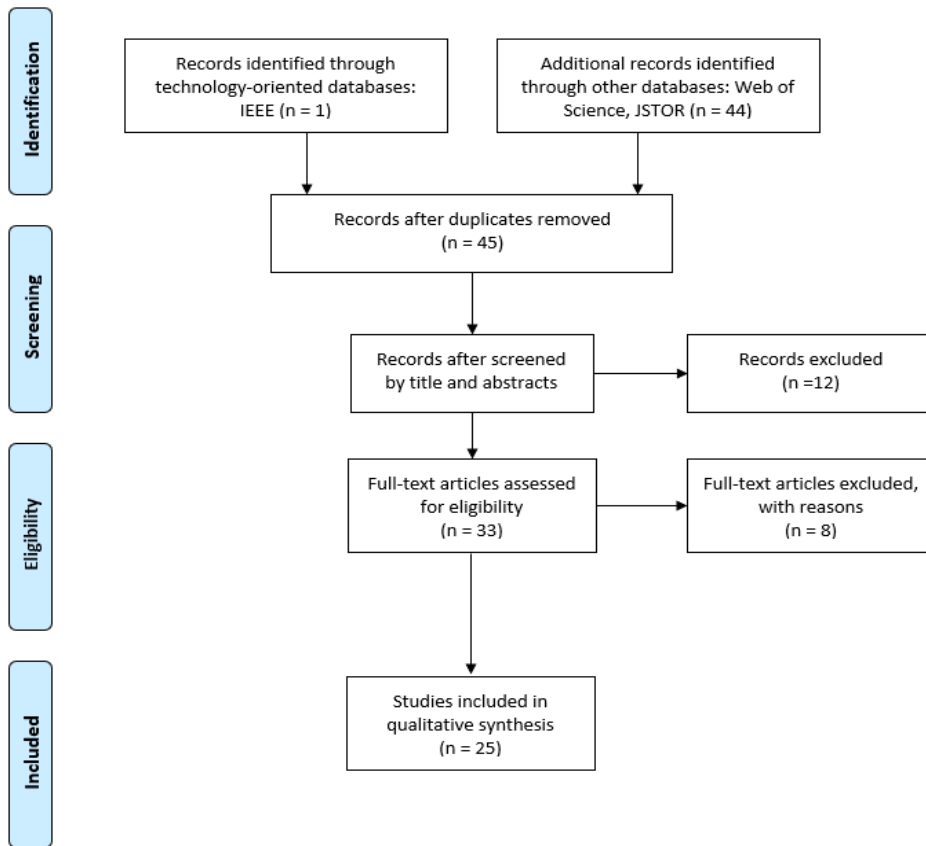


Figure 1. Search and Screening Process.

Round 4: coding the full-text

Finally, we coded the 25 articles in our final sample using a coding framework, where we summarized key information from each article.

Results

Table 1 lists several factors affecting digital equity.

Table 1: Factors Affecting Digital Equity

Factors	Evidence	Citations
Household Income	“In fact, only 57% of families earning under \$25,000 a year have a computer at home (Tate and Warschauer, 2017).”	Aguilar, 2020

	<p>“Further-more, Rideout and Katz (2016) report that one-third of lower-income parents with school-age children feel they have insufficient time online because they share devices with too many family members.”</p> <p>“Policymakers and educators are increasingly concerned that unequal access to technology exacerbates inequities in educational opportunities between low- and high-income students.”</p> <p>“The range of online activities individuals report also varies across socioeconomic groups; the range is generally narrower for people with lower incomes and educational attainment (Wei, 2012; van Deursen & Helsper, 2017).”</p> <p>“Gonzales (2016) shows how low-income Americans experience cycles of ‘dependable instability’ by routinely exceeding their data plans or having service disconnected because of unpaid bills, as well as their difficulties maintaining the functionality of their internet-connecting devices (Gonzales, 2014).”</p> <p>“These analyses revealed that race/ethnic origin, parent education, and household income modified associations between family connection type and parents’ internet confidence, internet frequency, and internet activity scope.”</p>	<p>Katz, Moran, and Ognyanova, 2019</p>
	<p>“Constrained access to the Internet and new communication technologies is commonly associated with social disparities related to income, education, immigration status, age, and geography.”</p>	<p>Katz and Gonzalez, 2016</p>
	<p>“Early research on digital divides found there were ‘gaps in access to computers and the Internet among individuals and groups based on race, gender, socioeconomic status, first language, disability, and other social or cultural identities (Gorski, 2003, p. 458).’ ”</p>	<p>Lambert, 2019</p>
<p>Education Level</p>	<p>“For example, Pew reported in 2016 that 34% of adults without a high school diploma were not online (compared with 3% with a college degree)...”</p> <p>“The range of online activities individuals report also varies across socioeconomic groups; the range is generally narrower for people with lower incomes and educational attainment (Wei, 2012; van Deursen & Helsper, 2017).”</p> <p>“These analyses revealed that race/ethnic origin, parent education, and household income modified associations between family connection type and parents’ internet confidence, internet frequency, and internet activity scope.”</p>	<p>Katz, Moran, and Ognyanova, 2019</p>

Race/ Ethnicity	<p>“White adults are more likely than ethnic/racial minorities to be online [13% of Whites are not online, compared with 16% of Black and Hispanic adults (Anderson & Perrin, 2016)]. Studies that dis-tinguish among Hispanics indicate that Spanish-dominant and foreign-born Hispanics are significantly less likely to be online than are English-dominant or US-born Hispanics (Lopez et al., 2013; Rideout & Katz, 2016).”</p> <p>“These analyses revealed that race/ethnic origin, parent education, and household income modified associations between family connection type and parents’ internet confidence, internet frequency, and internet activity scope.”</p>	Katz, Moran, and Ognyanova, 2019
	<p>“Not surprisingly, then, even after controlling for factors such as education and income, Mossberger, Tolbert, and Stansbury (2003) found that African American and Latino people are less likely than their White counterparts to report having the skills necessary to use computers and the Internet.”</p>	Gorski, 2009
	<p>“Early research on digital divides found there were ‘gaps in access to computers and the Internet among individuals and groups based on race, gender, socioeconomic status, first language, disability, and other social or cultural identities (Gorski, 2003, p. 458).’ ”</p>	Lambert, 2019
Age	<p>“Constrained access to the Internet and new communication technologies is commonly associated with social disparities related to income, education, immigration status, age, and geography.”</p>	Katz and Gonzalez, 2016
Geography	<p>“The issue of digital divide prevails, at least to some extent from very large to very small scale. It may contribute to the differences in rich and poor countries, rural and urban areas, men and women, competent and incompetent populations, and micro and macro organizations (Hameed, 2007).”</p>	Soomro, Kale, Curtis, Akcaoglu, and Bernstein, 2020
	<p>“There are many reasons for the digital divide. Factors of gender, urban-rural gap, economic conditions, education, ethnicity, and cultural differences are some of the possible causes.”</p>	Chen, Liu, Hui, and Chung, 2020
	<p>“Constrained access to the Internet and new communication technologies is commonly associated with social disparities related to income, education, immigration status, age, and geography.”</p>	Katz and Gonzalez, 2016
Gender	<p>“The issue of digital divide prevails, at least to some extent from very large to very small scale. It may contribute to the differences in rich and poor countries, rural and urban areas, men and women, competent and incompetent populations, and micro and macro organizations (Hameed, 2007).”</p>	Soomro, Kale, Curtis, Akcaoglu, and Bernstein, 2020

	“There are many reasons for the digital divide. Factors of gender, urban-rural gap, economic conditions, education, ethnicity, and cultural differences are some of the possible causes.”	Chen, Liu, Hui, and Chung, 2020
	“Early research on digital divides found there were ‘gaps in access to computers and the Internet among individuals and groups based on race, gender, socioeconomic status, first language, disability, and other social or cultural identities (Gorski, 2003, p. 458).’ ”	Lambert, 2019
First Language	“Early research on digital divides found there were ‘gaps in access to computers and the Internet among individuals and groups based on race, gender, socioeconomic status, first language, disability, and other social or cultural identities (Gorski, 2003, p. 458).’ ”	Lambert, 2019
Disability	“Early research on digital divides found there were ‘gaps in access to computers and the Internet among individuals and groups based on race, gender, socioeconomic status, first language, disability, and other social or cultural identities (Gorski, 2003, p. 458).’ ”	Lambert, 2019

Our initial searches found 45 articles. Through multiple rounds of screening, we removed 20 of them for our final sample. The reasons for excluding these 20 articles are summarized in Table 2.

Table 2. Summary of the Reasons for Excluded Articles

Reason for exclusion	<i>N</i>
Full text not in English	1
Primary focus is not the digital equity in <i>education</i>	1
The article is a review article, editorial, or book	18
TOTAL	20

Our final sample included 25 articles. These articles were published between 2005 and 2021. Between the years 2005 and 2015, there were very few publications, but from 2016 to 2021, the number of publications each year drastically escalated. The year 2019 had the most publications of all years (9), suggesting an increasing interest in this topic.

The study aims of these articles fall into one of four major themes: (1) the factors affecting the issue of digital equity; (2) the digital inequalities among students as well as teachers; (3) the impact of digital equity on education; and (4) the methods in which communities, governments, etc. can help to improve digital equity in education.

The majority of these studies used qualitative methods including case studies and surveys. There are 16 papers involving participants. The sample size of all the studies in our final sample ranged from 9 participants to 449,403.

In most of these studies (11 out of the 16), the setting was not explicitly reported. However, the other 5 studies mentioned the following settings: Pakistan Universities, an Australian University, Chavis Elementary, secondary schools in Hong Kong, and an urban renewal community of a Southwestern metroplex.

Of the 25 studies, 36% were from the United States, 16% were from Australia, 8% were from China, and another 8% were from the United Kingdom. In addition, Pakistan, Taiwan, Canada, Colombia,

Mongolia, Ireland, India, and the Netherlands each had 1 study, taking up 32% of the overall number of studies.

Of the 25 papers that we analyzed, 6 of them mentioned ways to improve digital equity, the most common solutions being policies implemented by the government addressing digital inequities as well as multi-stakeholder partnerships.

Discussion

This PRISMA systematic review, which aims to help researchers find a solution to digital equity and to bring awareness to the issue, examines the impact of digital equity on education, the factors that influence digital equity, and the ways to improve digital equity. The issue of digital equity has impacted billions and will continue to have harmful effects if certain measures are not taken. As technology continues to be integrated into our lives, we will one day find ourselves fully dependent on the internet and our devices--if we are not already. But if digital equity remains a problem, those impacted by it will find themselves completely excluded from the rest of society. To avoid this, knowledge must be spread regarding the issue of digital equity and steps must be taken to solve it.

As mentioned previously in Table 1, some factors affecting digital equity are household income, education level, race or ethnicity, age, geography, gender, first language, and disability. Families with low incomes often do not have adequate Internet connection and/or enough devices to share. According to Aguilar (2020), "In fact, only 57% of families earning under \$25,000 a year have a computer at home (Tate and Warschauer, 2017)." This deficiency is mainly due to the inability of households with low incomes to pay for the internet services and data plans as well as to properly maintain their devices. Education level also plays a role in digital equity, as adults without a high school diploma are more likely than individuals with a college degree to lack not only technology but also the necessary digital literacy to utilize computers. In addition, according to Katz, Moran, and Ognyanova (2019), "white adults are more likely than ethnic/racial minorities to be online [13% of Whites are not online, compared with 16% of Black and Hispanic adults (Anderson & Perrin, 2016)]." Depending on race, individuals experience different levels of the digital divide. Another factor that impacts digital equity is age. Studies have shown that students from young households (where the guardians' age is between 18 and 35) are more likely to lack broadband and technology than students from older households (where the adults are between 46 and 55 years old). Additionally, geography, meaning from rural, suburban, or urban areas, is proven to have an impact on digital equity among individuals, as students from rural areas are most likely to have trouble accessing online learning, while students from urban areas are least likely. Finally, women are more likely to experience the digital divide than men, people whose first language is not the language that is primarily spoken in the area are more likely to have trouble accessing technology than native speakers, and individuals with disabilities also find it very challenging to obtain the necessary tools for online activities.

Despite all of the challenges and obstacles presented by digital equity in education, there are ways to solve this issue. According to the paper by Nieves, Moya, and Soldado (2019), "the great potential of educational technology to improve teaching and learning will only be realised if our educational technology efforts go hand in hand with a commitment to digital equity." Of the many methods that can be used to improve digital equity, two are most worthy of mention: policies implemented by the government addressing digital inequities and multi-stakeholder partnerships. Some of these ideas have already been executed. For instance, according to the paper by Yuen, Lau, Park, Lau, and Chan, (2016), "between 2008 and 2011 the UK government introduced the Home Access Programme (HAP), to provide a computer and one year's Internet connectivity to low-income households with children aged 5–19. Findings from the evaluation of the initiative showed that the pilot HAP had a material effect, narrowing the digital divide and delivering educational benefits for students and households, through offering support and opportunities for students to engage in informal learning at home (Jewitt and Parashar, 2011)." By implementing initiatives to assist households that lack devices and broadband, the UK government, within a fairly short period of time, saw great improvement in the issue of digital equity. In

addition, multi-stakeholder partnerships, which are collaborations between various parties to address challenges and/or explore solutions, have seen great success. For example, Tata Trusts, a philanthropic company in India that is part of a multi-stakeholder partnership, has successfully decreased the digital divide in education (Charania and Davis, 2016). Through multi-stakeholder partnerships, new policies addressing digital equity, and other methods, the issue of digital equity can be solved.

This systematic review has its limitations. First, we only selected articles with English full texts. It is quite likely that we missed several cutting-edge papers published in other languages. Second, the selection of our initial search terms was also not exhaustive. We only used “digital equity” and “education” as our search terms, so we may have missed some studies or reports that used other similar terms, such as “digital divide.” Last, the removal of books, editorials, and review articles may have led to the exclusion of some relevant findings. Despite these limitations, our systematic review is valuable as it has identified existing information regarding the impact of digital equity on education.

Conclusion

This PRISMA review suggests that digital equity has a significant impact on education. In a remote learning setting, technology as well as sufficient internet access is vital for students to access their online classes as well as assignments. But even when school is not being run in a virtual environment, technology is constantly being implemented into education. Utilizing technologies in education certainly has its benefits, but it also has its consequences, for students and teachers who suffer from digital inequities find it close to impossible to participate in online school and end up being excluded. As our communities become more and more reliant on technology, this issue of digital equity, if left alone, will not only cause challenges in accessing education but will also give rise to other dilemmas, such as difficulty in participating in democracy and the economy. This review raises awareness to the impact of digital equity on education and, through the explanations of the factors influencing digital equity as well as the solutions for the issue, will hopefully provide future researchers with the necessary information to take steps towards fixing this problem.

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COVID-19 Vaccine Comments on Twitter: Analysis of Shared User-Generated Contents

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Abstract: User-generated content refers to media contents created by users to share information and/or opinions with other users (Tang, Fang, & Wang, 2014). We analyzed the COVID-19 comments about vaccines on Twitter in order to find out which kind of user-generated contents (UGC) were shared and identify the patterns of the comments. Three text datasets were collected. A sentiment analysis was conducted to determine the valence of each comment. Results indicate that neutral comments account for a high proportion in each of three datasets. However, users' attentions on neutral UGCs about three vaccines are different.

Keywords: Sentiment analysis, COVID-19, Vaccine, User-generated content (UGC)

Introduction

In the field of public health, people often apply User-generated contents (UGCs) in social media to survey demographics, estimate population-wide sentiment about public health issues (Salathé M, and Khandelwal S, 2011), forecast influenza outbreaks (Collier N, Son N, and Nguyen N, 2011), and produce spatial indicators of language, behavior, and mood (Mocanu D, Baronchelli A, Perra N, Gonçalves B, Zhang Q, and Vespignani A., 2013).

User-generated content refers to media content created by users to share information and/or opinions with other users (Tang, Fang, & Wang, 2014). Due to the development of social media and explosion of online review websites, UGC represents a highly dynamic media form: on average, there are 500 million items shared by Twitter users each day in 2020 (Oberlo, 2020). The power of UGC lies in its ability to influence users' attitudes and the corresponding behaviors; UGC is created, shared and consumed by users and therefore is usually perceived as credible and trustworthy (Mudambi and Schuff, 2010). Most studies examined the effect of positive or negative comments on people's behavior. Although neutral comments account for a substantial part in social media, prior studies have not examined the effects of neutral UGC systematically.

This paper analyzed the COVID-19 comments about vaccines on Twitter in order to find which kind of user-generated contents (UGC) were shared. In the following, background of the work, method, results discussions, and conclusion are presented sequentially.

Mixed- and Indifferent-Neutral UGC

Traditional bipolar attitude model (Figure 1) uses a one-dimensional line to code people's attitude, with positive evaluations at one extreme and negative evaluation at the other, and with neutral evaluations in the middle (Kaplan 1972). From the perspective of one-dimensional view, positive and negative evaluations were treated as equivalent, and thus they were reciprocally activated and could be interchangeable with each other (Yoo 2010). With the increase of positive attitudes, the negative evaluations should decrease. However, since the neutral attitudes, with score at the point of zero in the unidimensional line, could be generated from two different ways: either through a balance of positive and

negative claims or with neither positive nor negative ones, these two different subgroups of neutral attitudes could not be differentiated using bipolar attitude model.

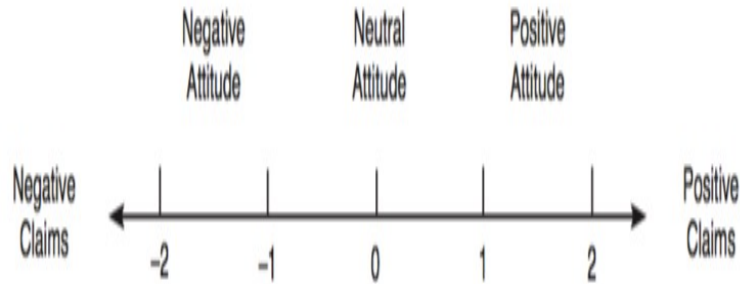


Figure 1. Bipolar Attitude Model

Recently, many researchers have been challenging against the one-dimensional view of attitudes and proposed a two-dimensional measure of attitude (e.g., Alvarez and Brehm 1995; Basinger and Lavine 2005). These scholars have claimed that attitudes have both positive and negative components simultaneously and independently (Crowley and Hoyer, 1994; Thornton, 2011). Figure 2 illustrates the two-dimensional view of attitude, with mixed-neutral attitude that locates along the diagonal, which contains equal amounts of positive and negative claims leading to balanced evaluations, attitudes, and/or emotions, and indifferent-neutral attitude that places in the origin, which contains neither positive nor negative claims lacking any dominant attitudes and subjective preferences (Thornton, 2011; Yoo, 2010).

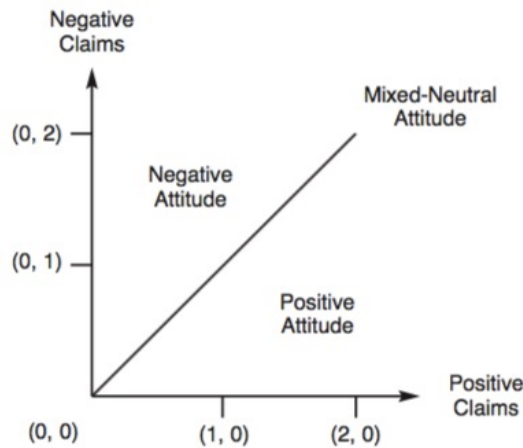


Figure 2. Two-Dimension View of Attitude

Research Method

In this research, web scraping technique was applied to collect data, that is users' comments concerning COVID-19 and vaccine. More specifically, user comments from Twitter were scraped through

Application Programming Interface (Twitter API), a tool that allows authorized application developers to download, listen to, analyze relevant internal data about users and comments.

Twitter API store historical UGC information about each comment: what it is, who posted it, when it was posted, other user's responses (reply, retweet, and liking). Some tweets may contain the post's recipient or certain hashtag information. The language of all comments is restricted to English, which is labeled by Twitter. The data collected from Twitter API would be stored in a csv file containing seven fields including user name (a string), user ID (a string), post time (a string), tweet (a string), reply (a number), retweet (a number), liking (a number).

A word cloud, which is a tool to analyze users' attitude, was shown in the next section. A word cloud is an image that is composed of words used in a particular text document, in which the size of each word indicates its frequency or importance. The more often a specific word appears in the document, the bigger and bolder it will be appeared in the word cloud image. The word cloud image provides a hint to learn about what terms users always use in the comment concerning COVID-19 vaccine so that the researcher could analyze users' attitude based on this hint.

Data Collection

In this study, three datasets of tweet comments were collected on May 11, 2021, using “#COVID-19 #Vaccine #Pfizer”, “#COVID-19 #Vaccine #Moderna”, and “#COVID-19 #Vaccine #Johnson&Johnson” as key word respectively. A total of 415 twitter comments was collected for Pfizer dataset. The latest 10 tweets in Pfizer dataset were illustrated in Table 1.

Table 1. Latest 10 Tweets in Pfizer Dataset

0	RT @SABCNews: Brazil's Health Ministry announc...
1	Brazil's Health Ministry announced it had sign...
2	#News #COVID19News #Brazil buys 100 #million m...
3	RT @askdrfitz: This week I'll interview Dr. Le...
4	RT @thesixthnewkid: Have you gotten your covid...
5	@Aly_Meek @andrewbostom Since they cancelled #...
6	RT @EpochTimes: US regulators expanded the use...
7	#Pfizer spokeswoman comments on the report of ...
8	This week I'll interview Dr. Lee Beers, Presid...
9	RT @Aroguden: Parents, schools and clinics qui...

Then the text data are cleaned, removing @mentions symbols, RT symbols, punctuations, and hyperlinks. After data cleaning, all non-text information has been removed from the text data. The latest 10 tweets, after data cleaning, are illustrated in Table 2.

Table 2. Latest 10 Tweets after Data Cleaning

0	Brazil's Health Ministry announced it had si...
1	Brazil's Health Ministry announced it had sign...
2	News COVID19News Brazil buys 100 million more ...
3	This week Ill interview Dr Lee Beers Preside...
4	Have you gotten your covid19 vaccine CovidVa...
5	Since they cancelled PRISM the only active v...
6	US regulators expanded the use of Pfizer's V...
7	Pfizer spokeswoman comments on the report of S...
8	This week Ill interview Dr Lee Beers President...

Data Analysis and Discussions

Sentiment Analysis

A sentiment analysis was conducted to determine the valence of each comment. Sentiment analysis is “to systematically identify, extract, quantify, and study affective states and subjective information about a given topic using natural language processing techniques” (Natsukawa and Yi, 2003). Typically, the sentiment analysis system would assign a positive or negative value for document (in this research context, the document refers to as text comments). If the sentiment is neutral, then the polarity score would be zero. Therefore, the overall sentiment is often inferred as positive neutral, or negative based on the sign of the polarity score of the document.

A lexical approach compares words included in a comment with a labeled word list, in which each word has been scored for valence. In this research, we adopted the dictionary of affective word list from SentiStrength 2 (Thelwall, Buckley, and Paltoglou, 2012). This word list comprises 575 positive words and 1791 negative words. We adopt SentiStrength 2 because the word list results from training on social media websites, and the it is superior to other dictionaries because of its high accuracy. Moreover, it uses non-lexical information to identify sentiment strength, which suits the research context of this paper.

In the sentiment analysis, a positive comment obtains a polarity score from 0 to 1, while a negative comment has a score from 0 to -1. Score of a neutral comment would be 0. According to the unique feature of social buzz on social media, lexicon-based sentiment analysis was employed, which could process informal and no lexical information, such as emotions (e.g., ☺), punctuation (e.g., !!!!!!!), and repeated letters (e.g., “soooooo haaaaaapy,” which is much more positive than “happy”).

Of the text comments in Pfizer dataset, 195 (46.99%) were positive tweet comments, 45(10.84%) were negative ones, and 175 (42.17%) were neutral ones. With key word “#COVID-19 #Vaccine #moderna”, a total of 146 tweets were collected, of which 60.27% tweets were positive, 2.74% tweets were negative, and 36.99% tweets were neutral. With key word “#COVID-19 #Vaccine #Johnson&Johnson”, 174 tweets were collected, which included 54.6% positive and 45.4% neutral comments with no negative information.

WordCloud

In order to plot a wordcloud, stopwords were removed from the cleaned text. Stopwords refer to function words filled in various documents with little text information. The most popular stopwords—“the,” “a,” “an,” “that”, and “those” — are determiners. Preposition, such as “over,” “under,” “above,” and “below”, is another main source of stopwords. In this study, we imported python STOPWORDS library in addition to default stopwords in wordcloud.

In this study, we remained 12 most frequently appeared words in each valence tweet comments. Wordcloud figures of each comment datasets are shown below, see Figure 1a, Figure 1b, Figure 1c for Pfizer comments, and Figure 2a, Figure 2b and Figure 2c for Moderna comments, and Figure 3a, and Figure 3b for Johnson comments (No Johnson&Johnson negative comments available).

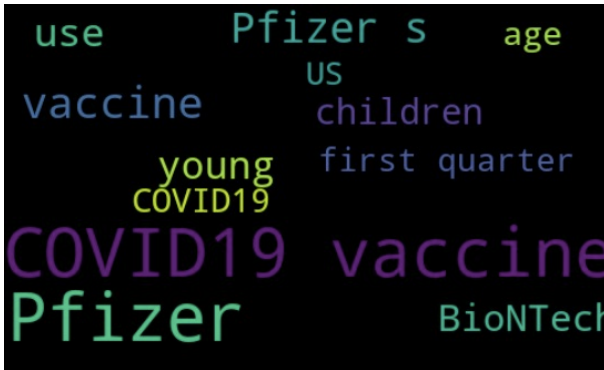


Figure 1a. Wordcloud from Positive Pfizer Comments

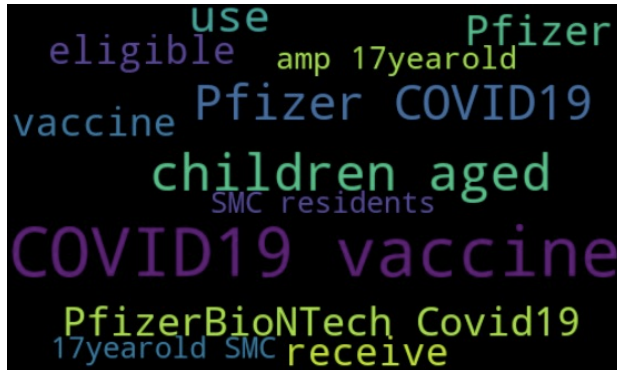


Figure 1b. Wordcloud from Negative Pfizer Comments

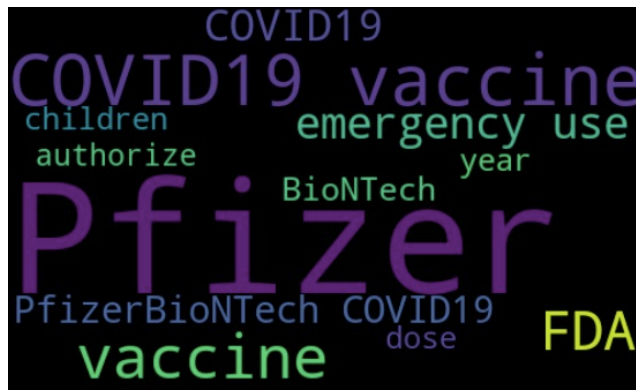


Figure 1c. Wordcloud from Neutral Pfizer Comments

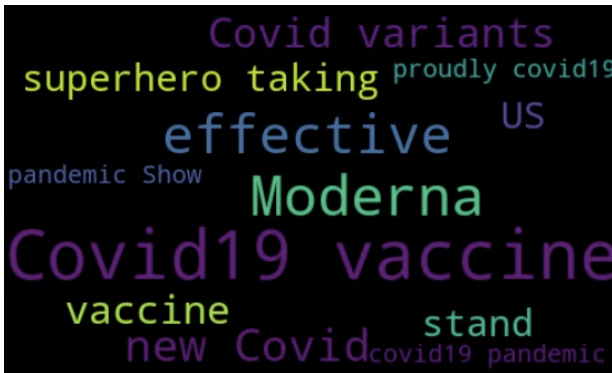


Figure 2a. Wordcloud from Positive Moderna Comments

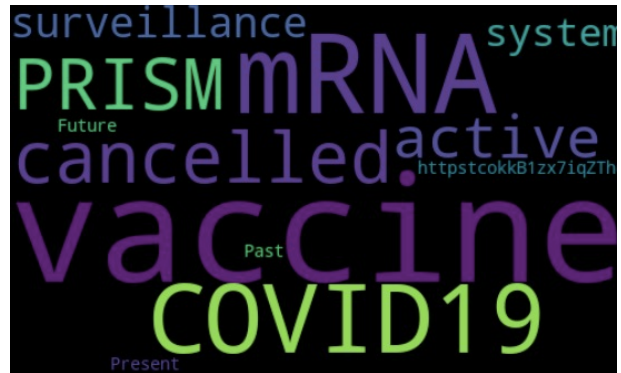


Figure 2b. Wordcloud from Negative Moderna Comments

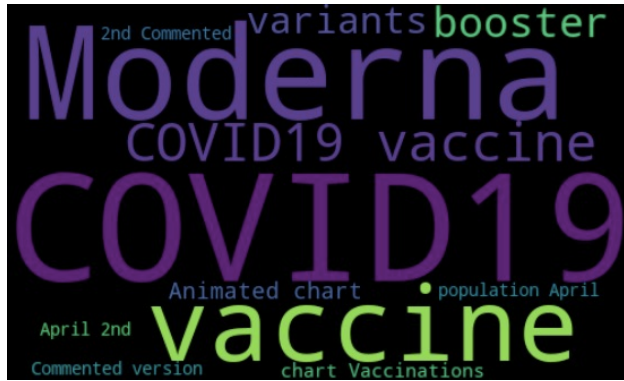


Figure 2c. Wordcloud from Neutral Moderna Comments

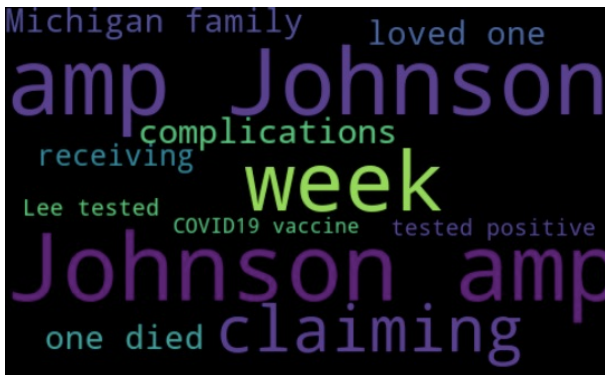


Figure 3a. Wordcloud from Positive Johnson Comments

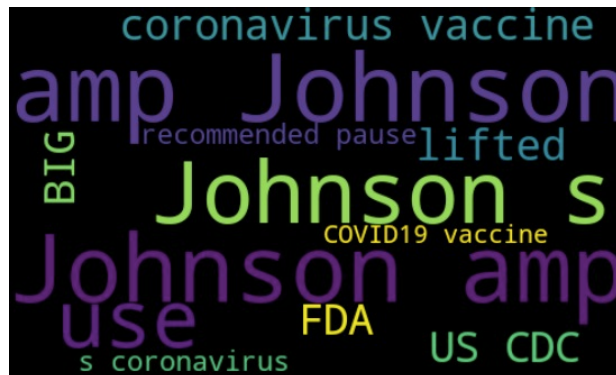


Figure 3b. Wordcloud from Neutral Johnson Comments

Word clouds indicate that users' attention on neutral UGC in three vaccines is different. In the positive and negative comments of Pfizer, users care more about young and children, while users talk more about emergency use in the neutral portion. In the neutral part comments of Moderna, users pay more attention to the booster, while users in positive and negative comments care more about the effectiveness and mechanism of the vaccine. With regard to the comments on Johnson&Johnson, both positive and neutral comments associated with amp. (Note: In our scrawled data, there is no any negative comment associated with Johnson&Johnson.)

Conclusion

This paper analyzed the COVID-19 comments about vaccines on Twitter in order to find which kind of user-generated contents (UGC) were shared. Three datasets of tweet comments were collected using “#COVID-19 #Vaccine #Pfizer”, “#COVID-19 #Vaccine #Moderna”, and “#COVID-19 #Vaccine #Johnson&Johnson” as key word respectively. Neutral comments account for a high proportion in these three datasets. However, word clouds indicate that users' attentions on neutral UGC in three vaccines are different. In the neutral comments associated with Pfizer, people pay more attention to the emergency use. Users talk more about booster in the Moderna neutral comments. While the neutral comments on Johnson&Johnson are associated with amp.

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News and climate change: Opinions, degree of information and awareness of Italian university students

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Abstract: The main purpose of the present study was better understanding opinions, beliefs and awareness of a group of Italian university students about (1) climate change; (2) trust about news and media and (3) their self-perception of the quality, accuracy and completeness of the information they have on the topic. A questionnaire was administered to 585 students of University of Udine, in order to understand (1) their relationship with the media/media consumption; (2) the main sources of information; (3) their degree of trust and their awareness regarding the different media; (4) their habits regarding the verification of sources and (5) how much they are really interested in, and informed on, the issues of climate change.

Students declare (1) media consumption focused on new media (they declare themselves influenced about climate above all by the content of social media or by info available on the Internet); (2) a (theoretical) high attention to the issue of climate change but also (3) a scarce frequency of active search for information on this issue. The students' responses also indicate a (4) general distrust of the various media, in particular about the media that they effectively use, both in general and in relation to the topic dealt with and, (5) although they declare that they often carry out source checks and are able to list numerous signs of recognition of a false or biased news, (6) their self-perception about the quality, accuracy and completeness of the information they have on the topic is quite low.

Keywords: Climate Change, News, Media, Students, Awareness

Introduction

Reflections on climate change accompany human history in various ways. The topic became relevant to scientific debate as early as the 1700s and grew in interest in the 1800s (Boykoff, Roberts 2007:4-5). However, it is with the twentieth century and the development of modern media that the topic comes to the forefront of public debate. Attention to this issue initially developed in the 1930s (Boykoff, Smith 2010:212) particularly with the New York Times which devoted important articles to the climate change and its consequences which have founded the cornerstone of the following debate internationally. After a pause in the years characterized by the Second World War, the debate was rekindled at the international level in the 1950s and then became a topic of fundamental importance from the 1980s. The media attention on climate change since the '80s has always been growing (for the years up to 2000 see Weingart, Engels, Pansegrau 2000: 265; updated data to 2006 can be found in Boykoff, Roberts 2007: 36; for an extension of these analyses to 2019, see Pianta and Sisco 2020: 4), making this issue one of the most debated, politicized and controversial topics of contemporary public debate internationally.

The importance of the media in influencing opinions about climate change has been analysed by Boykoff and Rajan (2007: 207-208); Boykoff (2008: 11); Billett (2010: 2); Boykoff and Yulsman (2013). These studies emphasize how the climate change debate is organized around a core of key variables: the scientific sphere, the political sphere and the sphere of public opinion, with the media acting as a central and connecting point (Anderson 2009: 179).

However, this guiding and connecting role is not neutral. It has been observed that, in addition to the inherent difficulty of narrating in the media issues related to "risk" and "uncertainty" (Smith 2005; Painter 2013) the media follow different logics from those of scientific debate and politics, logics based on the principles of "novelty, personalization and

dramatization" and are influenced by the problem of "balance" and "authority order" in the presentation of their content (Boykoff, Roberts 2007: 43; Boykoff, Boykoff 2007: 1193). This would produce a distortion in public discourse, a distortion that is important since public opinion on this issue depends a lot on the media, politics, and social movements and very little on scientific research (Carmichael, Brulle 2017: 232). So much so that, according to Weingart, Engels and Pansegrau, one should no longer speak only of a risk related to climate change but also of a "risk inherent in communication" (2000:261).

In this context, talking about climate change and media, for some years now we have also had to deal with new media and their specificities, also because the university students we interviewed, as we will see, inform themselves mainly using social networks and content on the web. Obviously, this is not the place to describe the communicative specifics of these new media. We limit ourselves to recalling (1) their growing importance in orienting public opinion with respect to climate change (O'Neill, Boykoff 2012) and (2) that the literature emphasizes the fact that new media can, given their characteristics of being "integrated" and "interactive" (van Dijk 2006) play a highly positive or highly negative role with respect to the issue of climate change. Anderson (2017) points out as positive effects of social media their ability to increase knowledge on the issue, to create mobilization and debate, and to increase the effectiveness of communication; however, the other side of the coin is represented by the fact that social media are also able to communicate false or inaccurate information, to mobilize skeptics and to convey denialist or critical forms of communication.

The combination of all the variables that we have quickly mentioned (importance of the topic, increasing attention by the media, influence of media on opinions and beliefs and the growing importance of the information about climate change conveyed within the new media with their specificities) produces what has been called an "information jungle" (Loy, Hamann, Reese 2020), in which it is very difficult to move and find a synthesis. The ability to search for information within the complexity of the media landscape, and particularly on the web (on the topic of "digital literacy" and its relationship to climate change, see Damico, Baildon, Panos 2018) influences opinions and the ability to understand climate change issues (Arlt, Hoppe, Wolling 2011; Boykoff 2011).

And this is where we reach our topic, focused on young people, in this case students at the University of Udine (Italy). Previous studies involving samples of students of various levels and countries agree that there is a generally high level of student concern about climate change. Lieske, Wade and Roness (2014), focusing on the Canadian case, indicate that 81% of participants in their focus groups believe that the problem of climate change is "considerable" or "severe". Cordero et al (2008: 866) in research focusing on US college students indicate that "student concern about global warming is relatively high, with 80% indicating that global warming is a pressing environmental issue". Also in the US college Wachholz, Artz and Chene (2014: 134) report similar results, indicating that two-thirds of the students surveyed "were either very worried (17%) or somewhat worried (48%)" about the climate change".

Di Giusto, Lavalley and Tai-Yi Yu (2018) working on a questionnaire submitted to a sample of university students in Taiwan, report that 65% of their students declared themselves to be "somewhat concerned" and 28% "very concerned," about climate change problems.

A high level of concern is also found by Özdem, Dal, Öztürk, Sönmez and Alper (2014) on a sample of seventh grade students in Turkey.

Acquadro Maran and Begotti (2021) in the case of students from the University of Turin (Italy) note that "most participants stated they paid either some or a lot of attention to information about climate change (89%), while only 11% stated they paid little or no attention".

This high level of attention and concern does not, however, seem to be reflected in a real awareness of the students analysed of the real assets of the topic. In fact, the literature identifies a large number of misconceptions about the basic causes and consequences of climate change on the part of the students analysed (Chang, Pascua, 2016, on students of secondary school in Taiwan; Wachholz, Artz and Chene, 2014, on college students, USA; Cordero, 2000, on Australian university students; Liarakou, Athanasiadis, Gavrilakis, 2011 on

Greek secondary school students; Punter, Ochando-Pardo, Garcia, 2011, on Spanish secondary school students; Shepardson, Niyogi, Choi and Charusombat, 2011, on US secondary students).

It seems that "they lacked a rich conceptualization of the issue" (Shepardson, Niyogi, Choi and Charusombat, 2009, with reference to seventh level students of three different schools in the Midwest, USA) and that they often reproduce some typical mistakes: Gowda, Fox and Magelky (1997) assess the range of "mistakes" that are made by US high school students on this issue (inflated estimates of temperature change, confusion between ozone depletion and global warming above all).

Huxster, Uribe-Zarain and Kempton (2015) describe how U.S. undergraduate students frequently confuse climate change with other environmental issues and they do not have an understanding of climate change that matches the scientific model.

Cordero, Todd and Abellera (2008) found the same misconceptions when they interviewed 400 college students attending San Jose State University who participated in a study that focused on climate change science (i.e. students who should, thanks to this specific educational activity, be more and better informed).

Shepardson et al. (2009) suggest that the origin of these errors lies in low levels of information, in the fact that most of the information comes from television and in the confusion between the messages young people receive on this issue.

In fact, in all the studies mentioned above, prior to around 2010/2012, the main source of information for young people on climate change was unquestionably television (see, for example, Gowda, Fox and Magelky, 1997; Liarakou, Athanasiadis, Gavrilakis, 2011). After the advent of the internet and social media, however, studies began to indicate the new media as the main source (along with television, however, which resists as a reference media: Acquadro Maran, Begotti, 2021) with the consequent emerging issue of reliability and different trust to be given to different sources and different messages that, from 2016 onwards, begins to translate into the issue of how to manage the so-called "fake news" on climate change. The recent work of Cheng and Gonzalez-Ramirez (2020), for example, analysed a group of American college students and observed how these students 1) inform themselves mainly using new media and the net; 2) how they simultaneously give a higher level of trust to the media they use less, i.e. the traditional and "institutional" ones; 3) and that they do not seem so skilled and active with respect to digital literacy. Our research began with these observations in mind.

Hypothesis, research method and general description of interviewees

Student opinions were collected in a pilot study via questionnaires disseminated across all students enrolled at University of Udine in the autumn of 2019, just before the pandemic emergency and the consequent alteration in consumption and agenda setting proposed by the media. A total of 585 students participated in the research (39% men and 61% women). This means that about 3.7% of the 15600 students enrolled at the university at that time decided to answer the questionnaire. Their ages ranged from 18 to 28 years, with a median age of 23. Participants took part in the research on a voluntary basis, and no compensation (or extra credit) for their participation was provided.

31.9% of the questionnaire respondents are enrolled at the University of Udine in humanistic or linguistic degree courses; 10.6% in medical degree courses; 16.7% in degree courses related to law or economics and finally the remaining 40.8% in degree courses characterized as "hard sciences".

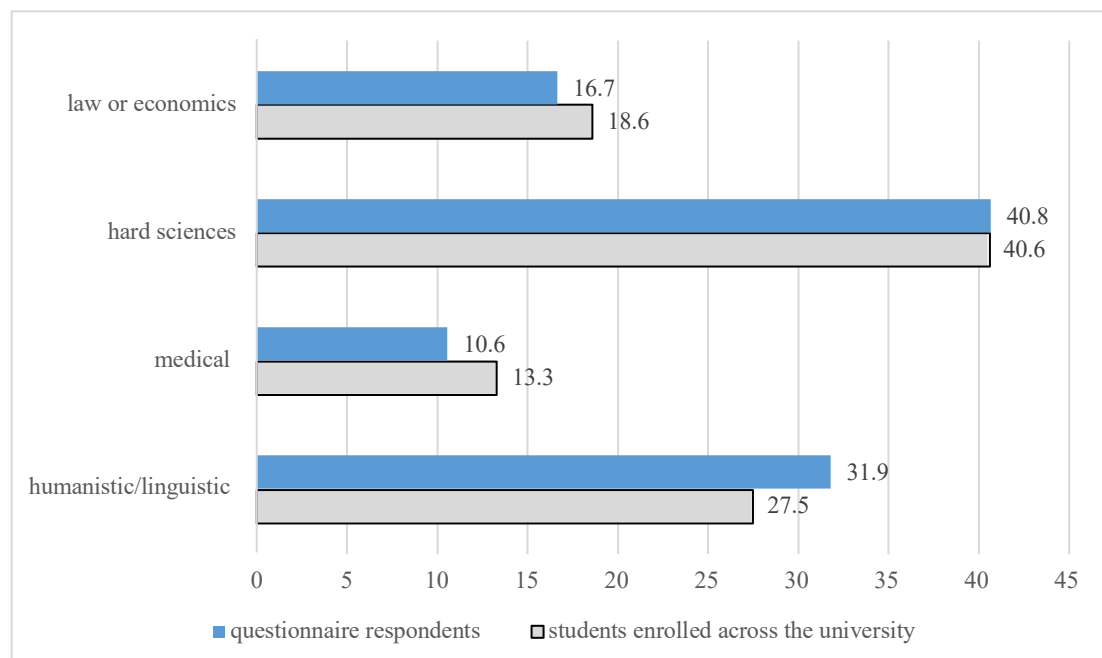
This distribution of responses is generally in line with the overall distribution of students in the various degree courses at the university, with a slight underestimation of students on medical, legal and economic courses and an overestimation of students on humanities and language courses (Graph 1). Both gender, age and type of degree course, as we shall see, are significantly correlated with different styles of media consumption, different opinions and different perceptions regarding the issue of climate change.

The questionnaire was structured around 17 questions, two of which were open-ended, in order to understand 1) students' opinions and their degree of concern about the topic of climate change; 2) students' media consumption; 3) the trust they place in the various media; 4) their perception with respect to the quality of news on the topic; 5) their perception about the specific influence of the so-called fake news on their opinions on climate change.

In other words, we first tried to reconstruct the main ways in which students inform themselves about climate change and the trust they place in the various media they use. Then, in order to verify their actual level of knowledge and awareness on the issue, instead of questioning them on the scientific evidence related to climate change as done by several researches reported in the previous paragraph, we tried to estimate 1) how actively they seek information on the topic and 2) their self-perception regarding how complete and credible they believe the information they have is; 3) how much they think fake news influences opinions on the topic; and 4) what their effective digital literacy and ability to define and recognise fake news on climate change seems to be.

Our main hypotheses are:

- 1) that students declare a high level of interest and concern on the topic of climate change;
- 2) but at the same time do not frequently engage in active practices to directly seek information on the issue;
- 3) that their main source of information on the topic is the new media;
- 4) that they demonstrate a certain degree of awareness towards the specific risks of the information that is conveyed in these media (specifically, about "fake news");
- 5) that their level of trust in the media is rather low (in agreement with the findings on similar issues made by other surveys, e.g. see the 2019 Edelman Trust Barometer) and consequently
- 5) that their self-perception of the completeness, accuracy and credibility of information available to them on climate change is not very high.

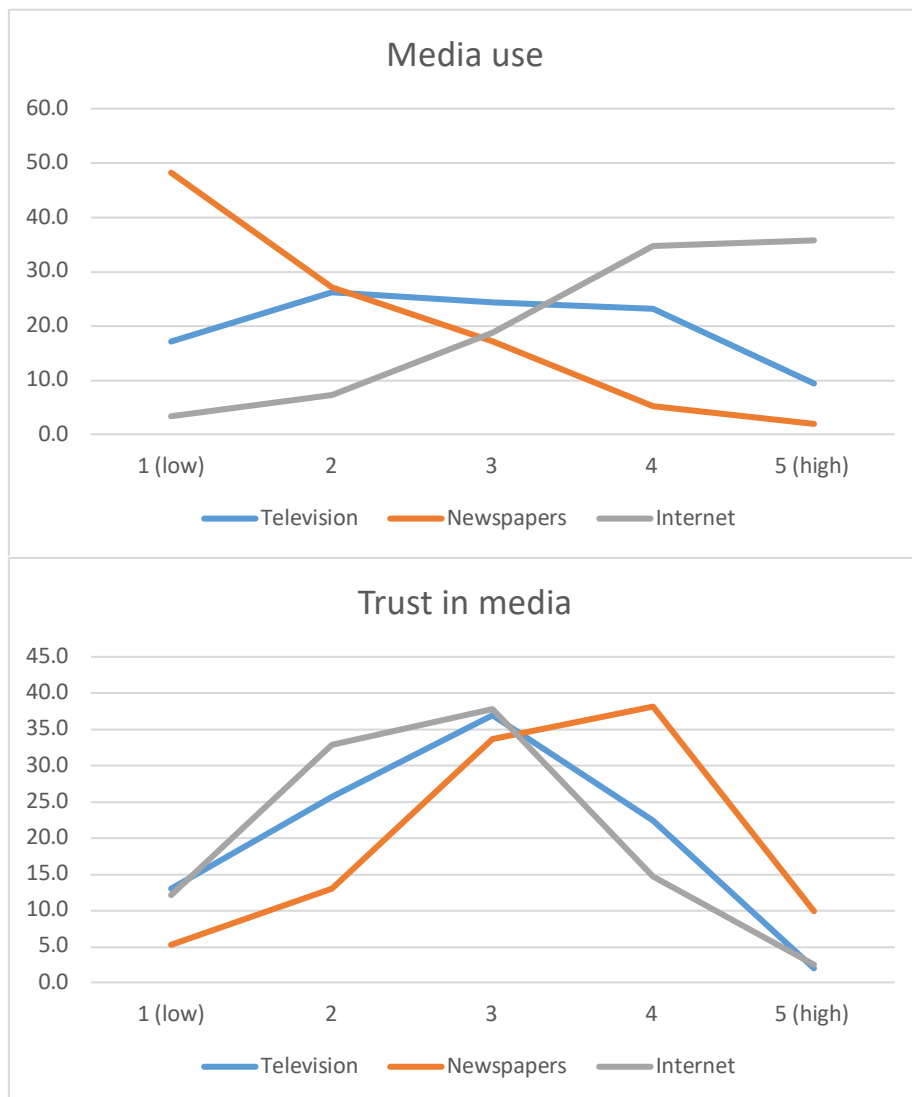


Graph 1. Distribution of completed questionnaires by type of degree course compared to the total number of students enrolled in the same courses at the university of Udine (%)¹.

¹ Source: Planning and Management Control Area - University of Udine Data Warehouse.

Media consumption and trust in different types of media

When asked what media they use to get informed, our students predominantly use the Internet, with a specific focus on "online articles" as opposed to more generic *social* content. Next, they use television and in particular the news and are not very familiar with printed newspapers. These data, basically taken for granted, are interesting if compared to the answers we obtained regarding the trust they place in the various types of media. Trust in media types is inversely proportional to their use. The trust they express in the media is generally low, and in any case tends to increase in the case of the least used media and to be lower in the case of the media they actually use (Graph 2).



Graph 2. Consumption and trust in media. Scale 1(low)-5(high).

Larger surveys conducted on the Italian population in the same period, for example the Edelman Trust Barometer (2019) provide low average data regarding trust in the media, with trust percentages that seem in line (or slightly higher) with those expressed by our students

(although a direct comparison, due to the different form of data collection is obviously not possible). Our students, therefore, in general seem to be characterized as rather distrustful of the informative contents they use.

The frequency with which they inform themselves seems to be quite high, with two thirds of the sample stating that they inform themselves "at least once a day" (67,2%) and almost all the rest "several times a week" (28,4%).

The gender variable is significantly correlated with media use. Females use television and news to inform themselves more, while reading print newspapers is more masculine. The degree of trust placed in various media also varies by gender. Women trust the news coming from the web less than men, and on the contrary they trust television, news programmes and above all newspapers (which, however, as we have seen, they tend not to read) more than men. Also in this case the observation that we made earlier, according to which more trust is placed in media that are not used, returns.

Also the age variable is significant with respect to the fruition of information from the media, even if the age range realized by our research is rather limited. Dividing the youngest (18-23 years old) and the least young of our sample (over 24 years old) we notice that the least young tend to get information more often, they have counter-intuitively a greater use of Internet as an information medium compared to the youngest, they use less television and above all they denote a significantly lower degree of trust towards news coming mainly from television and newspapers, but also towards news retrieved on the net (also here, the greater use of Internet to get information is correlated to a lower trust towards this media).

We have divided the approximately 40 different types of degree courses attended by our interviewees into four macro areas, in order to check whether there are significant correlations with the type of studies chosen. We have identified (1) a humanities and languages area; (2) an economics and law area; (3) a medical area and finally (4) the area of the so-called "hard sciences".

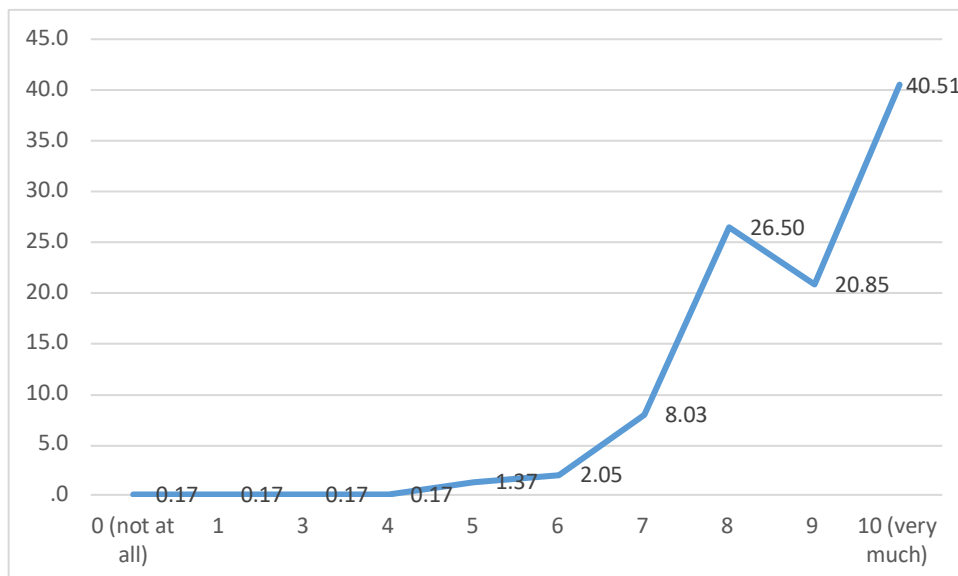
The frequentation of paper newspapers seems to be limited to the students of economics and law, where we also find a greater use of television compared to the other subgroups. The medical area is instead the one that uses less the Internet to get information than the others. With regard to the trust placed in the various media, trust is significantly higher in students of economics and law (especially with regard to television and newspapers). The medical area is the one that shows the least trust in news and television, while the students of the humanities and sciences are the ones who declare the least trust in news from the Internet. The students of the hard sciences are instead those who inform themselves less actively and less often (even if, as we will see, they are the ones who believe they are better informed on the issue of climate change).

As for a focus on information content from social media, we asked our students how often they check these news stories against other sources (not about climate change, but in general). Our respondents state that they check this news very often. 32.1% of them say they do it "almost always", to which we must add 37.4% who say they do it "often". It is obvious that this is a self-declaration and that the perception of what it means to verify a news item is a very individual fact. We will deepen this aspect of verification and fact checking in the next paragraphs. For now, we just observe that 1) males and 2) students in medical areas are the subgroups that show a greater propensity to verify general news coming from social networks.

The importance of environmental protection and views on climate change

We asked our interviewees to express, on a scale of 1 to 10, how important environmental protection is to them. The answers to this question are a plebiscite in favour of the importance of the topic: 87.1% of students answer between 8 and 10 on the scale. Among them, 40.5% of the interviewees declare the utmost importance, expressed with the number "10". Those who declare a rating equal to 5 or less are approx. 2.1% of the overall sample (Graph 3).

This very high level of attention to the topic appears to be in line with the aforementioned research by Cheng and Gonzalez-Ramirez on American colleges (2020). However, it should be noted in our case that the questionnaire was distributed to students with a title that immediately stated the environmental and climate change issue as the *focus* of the interview. This probably caused an auto-selection: it can be assumed that people not very interested in the topic were also not very interested in answering the questionnaire. Conversely, a person who is very interested in the topic may have greater motivations in filling it out. More interesting is the internal articulation of this data and the differences that can be found in our database. Given the crushing of the answers towards one of the poles of the scale, in the following interpretation we will privilege only the most clear-cut answers, that is to say the interviewees who expressed their interest in the subject with the highest mark on the scale, that is to say “10”.

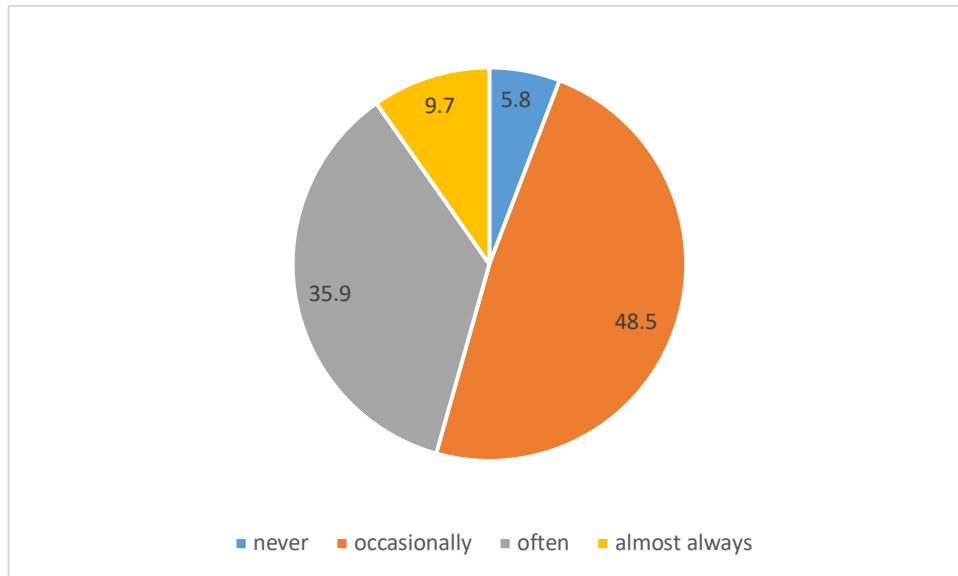


Graph 3. “How important it is for you to protect the environment”. Scale 1-10 (%).

Isolating the students with a relatively higher age, starting from 24 years old, it can be seen that this age group is significantly more attentive to the topic than the younger ones in the 18-23 range. The youngest students give the highest rating on the importance of the theme of the environment for 36.2%. This percentage rises to over 50% in the "older" age group. The same applies to gender: females consider environmental protection more important than males (highest interest: 42.3% against 37.7%). The variable linked to the average trust index of the interviewees also appears to be positively correlated with the importance of the topic of the environment: in other words, interviewees characterized by greater trust in the media in general tend to express themselves more clearly on the importance of the topic than those who have less trust in the media.

Less easy to interpret, but absolutely clear in the trends of the data, are the differences related to the type of studies: students of the humanistic area are the most clearly aligned with respect to the importance of the topic (46.3% of these students declare the highest degree of importance scale). About 5 percentage points below (41%) we find the students of the scientific area. Students in the medical area express themselves in this way "only" in 36.1% of cases, and students in the area of law and economics fall to 30.9%.

However, this theoretical great attention to the environment is not reflected in an active search for information. Almost half of the interviewees (48,5%), declares to look for information on this issue only "every now and then" and 5,8% expresses itself even more clearly saying that they never do it (Graph 4).



Graph 4. "How actively you seek information on the phenomenon of climate change".

The over 24 years old age group declares a slightly greater propensity than the younger ones to actively search for information on the topic. The attitude to this research is obviously positively correlated also to the frequency with which people declare to get information through the media: those who declare to expose themselves more to the various media describe themselves as more active also with regard to the search for information. Students enrolled in medical or scientific areas are those who have most searched for information on the phenomenon of climate change.

The fact that our interviewees in general do not appear to be particularly active in seeking information on the subject is reflected in the fact that they seem to be aware that they are not very well informed about it.

Only 28.9% of the interviewees declare themselves to be "well informed about climate change". 65.3% say they are well informed, but "not in depth", to which we have to add the remaining 5.8% who clearly expresses that they are not well informed at all.

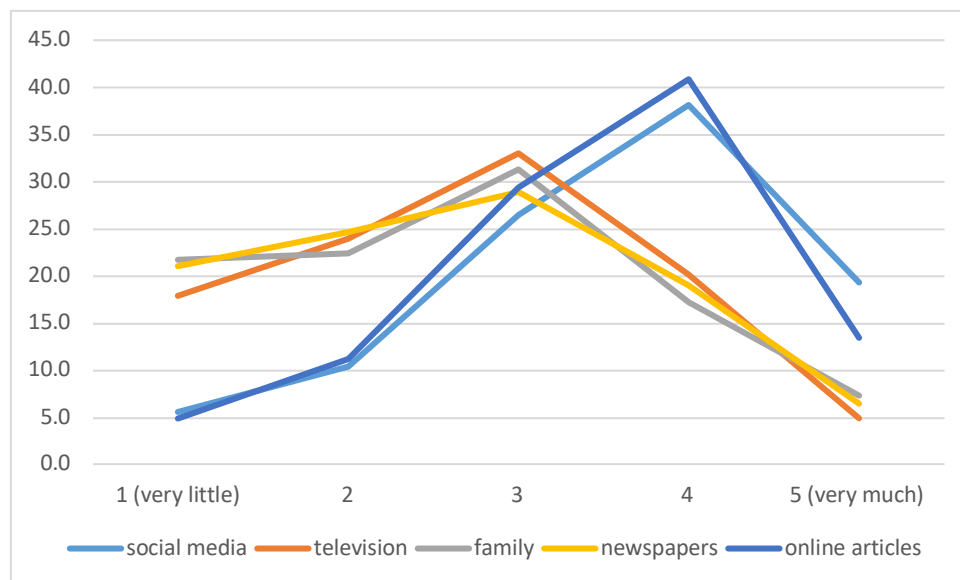
It is males who consider themselves the most informed on the subject of climate change (who, as we shall see, are also the most pessimistic about the quality of information on the subject). The respondents who consider themselves best informed on the issue of climate change are the students of science courses, followed by those of economics-law, and also the sub-group of respondents who were most confident about the quality of media information in general.

Opinions on climate change and the media

But what is the opinion of our interviewees on the issue of climate change? The questionnaire offered the possibility to answer in three ways: 1. "the climate is not changing"; 2. "the climate is changing and human kind is responsible for it"; 3. "the climate is changing but human kind is not responsible for it". To say that the responses obtained are polarized on one answer would be reductive. Three interviewees, equal to 0.5% of the sample, tell us that in their opinion the climate is not changing. Twenty-two respondents, or 3.8%, tell us that the climate is changing but independently of human activities. The remaining 560 respondents (95.7%) all polarize on the remaining option. In this regard, it is useful to note that a content analysis parallel to this research we are conducting (on the topic of climate change and Italian

newspapers) tells us that the problem of "false balance" (Boykoff 2011; Brüggemann, Engesser 2017; Petersen et al. 2019) in the Italian media does not exist: our content analysis shows how the representation of contrarian or denialist views are essentially absent from the mainstream media debate. In this sense, it is difficult to understand whether this absolute plebiscite of our students on the answer "the climate is changing and human kind is responsible for it" is due to a clear awareness towards the topic or to the lack in the Italian media of a debate open to multiple positions.

When asked about the media or social contexts that most influence opinions on the issue of climate change, our interviewees tell us that they gathered most of their information on this issue from the Internet (social networks and online articles) while declaring little influence from television, the printed press and even less from the family environment (Graph 5). However, the absolutely majority opinion presented by the Italian media is also absolutely majority in the data collected on the opinions of these students, who are perhaps more influenced than they think with respect to the opinions on this topic.



Graph 5. Influence on opinions about climate change (scale 1-5).

In any case, our students declare themselves aware that the media do not deal with the subject in an adequate way. 71,1% of those interviewed say that the media deal with the subject in a way that is "not very" (65,3%) or "not at all" adequate (5,8%). Less than a third of respondents think they are well informed about climate change (28.9%).

The impact of the Internet and social media on communication

Having the opportunity to interview a large number of students on the topic of climate change, we did not miss the chance to ask them some broader questions on the issue of so-called "fake news" and more generally on the impact that they believe the advent of the Internet and social networks has had on the overall information landscape. We therefore formulated two specific questions, leaving the students free to answer them in an open form.

The number, articulation and completeness of the argumentation of the answers obtained was very high, with few students who evaded the questions, went off topic or did not clearly express their opinions: overall these "non-answers" reached only 15.6% of the questionnaires collected. We know the difficulty of making the interviewees answer to the open questions and moreover the questionnaire allowed the possibility of evading some part of it: this makes

us assume that these topics are of real interest for these young university students, who did not miss the opportunity to express their opinions about them.

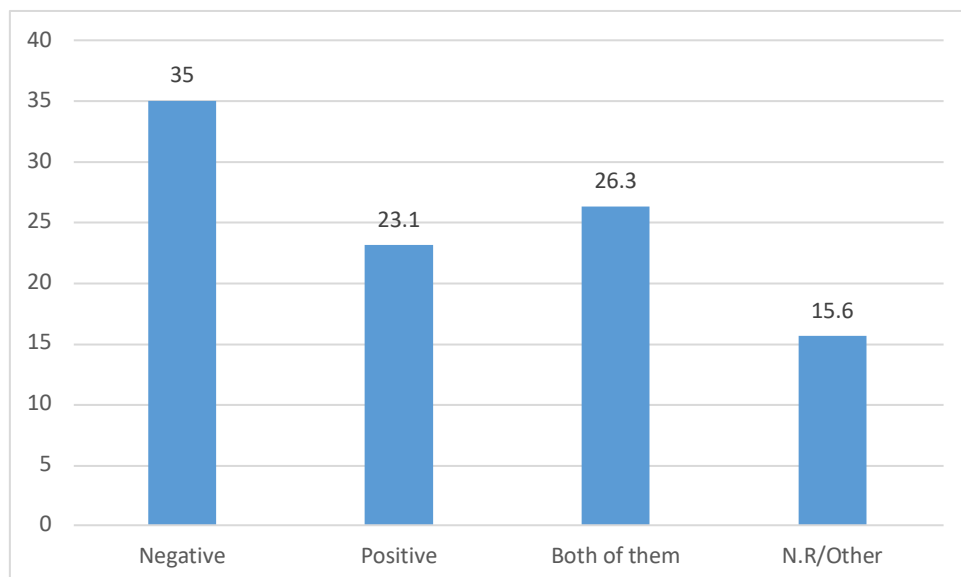
The first question was about the impact of social on the information landscape. We asked "In your opinion, has the advent of social media affected the way we get informed? If yes, in what ways?"

Obviously it is difficult to summarize the results of an open question and in the case of this question in particular the use of summary indices, such as word frequency, did not seem appropriate or particularly informative. We therefore tried to categorize the overall tone of the response, dividing the field between (1) those who told us that basically the advent of the Internet of social networks has had a positive effect on the quality and quantity of information and on the overall information landscape; (2) those who said the opposite, emphasizing the negative aspects of these innovations; (3) and those who, finally, a rather large group of responses, made explicit both these aspects, emphasizing positive and negative sides of the same phenomenon (Graph 6).

Negative responses are clearly in the majority and cover 35% of respondents, thus over a third of our sample. The main argument is related to the increased difficulty of really understanding the facts when faced with too much information and the consequent difficulty of discerning true information from false ones. Other types of answers, less frequent, emphasize the social changes that the advent of the Internet and social networks would have had in terms of what they say results in a "greater superficiality" on the part of people or the advent of a less careful, less critical and more conformist behavior in front of the news (some respondents go so far as to use the expression "flock of sheep" to summarize this last aspect). Even fewer, but nonetheless significant, were the answers given by students who evidently have a greater specific competence in this world and who underlined the negative effects of echo chamber's, filter bubble phenomena, and so on, without anyone, and this seems to us very significant, specifically highlighting the information distortions linked to targeting, profiling and the impact of algorithms on the information landscape.

This group of pessimistic answers is contrasted by 23,1% of the interviewees who expressed themselves in clearly positive terms with respect to the impact that Internet and social networks would have on the information landscape. These students emphasize the positive aspect of the possibility to access much more information than in the past: this is the most frequent type of answer. Then, there are the answers that emphasize the increased speed of finding and circulation of news and information and someone expresses explicitly underlining that the greater amount of information, combined with the speed and ease of reference, makes possible a greater activity of fact-checking and verification of the information itself. Finally, the number of students who stressed the positive aspect of "without charge" access to information is also significant.

More numerous than those who expressed themselves in clearly positive terms, are the respondents who have balanced, in their response, both positive and negative sides of the advent of the Internet and social networks. We categorized 26.3% of the responses in this way. There is not much to add with respect to the themes dealt with by these respondents, as they are the same as those we found in the field of "positive" and "negative", simply juxtaposed to each other. To give an example of a typical type of response of this kind, we could quote: "it brought more information but also more difficulty in understanding and discerning information". And so on.



Graph 6. "In your opinion, has the advent of social media affected the way we get informed? If yes, in what ways?" (positive/negative synthesis)

So-called "fake news" and the ability to recognize them

The second open-ended question aimed to investigate the awareness and opinions of the interviewees on the topic of so-called "fake news" and in particular on how it is possible to recognize it and thus distinguish "false" from "true" information. The question was formulated as follows: "In your opinion, how can you recognize fake news?".

Also in this case we obtained a relevant number of answers and a rather complex and overlapping articulation of themes. For this reason, it does not seem appropriate to us to search for a synthetic quantification. We will therefore limit ourselves to proposing, from a qualitative point of view, a list of the main themes and their internal logical articulation.

The most recurrent concept in the answers is certainly that of "source". In order to recognize fake news, according to many answers, it is necessary to take into consideration the so-called "authoritative", or even "reliable" sources, in the idea that false news can only be found in "unofficial" sources. The concept of source is also mentioned by the interviewees who underline the importance of actively searching for more information to be able to unmask false news: the basic idea is that on the same piece of news it is necessary to look for more sources and compare them, or go and look for the same piece of news on sources that are known, or simply go back to the source of the news to verify its validity.

The same kind of reasoning is made by those who don't use the word "source" but more generally say how important "active research" is to unmask fake news. Here the key word is "search": looking for the news on more newspapers or searching for more data about it on the Internet is a similar opinion to the concept seen before of referring to more sources, or to more authoritative or credible or reliable sources or even to "more neutral" sources on the subject.

In the same logic are those who tell us that, in order to unmask a fake news, it can be useful to look for information directly on sites that deal with debunking or, carrying out the logical opposite of what we have described so far, but basically it is the same mechanism, to search the network for evidence that would support the fake news: in this case it would be the failure to find the evidence that supports the fake news to decree its falsity. These students are accompanied by a large number of responses that emphasize in a broader and more abstract way the same concept: these students tell us that you can fight fake news by "informing", "verifying", "studying", "deepening" or doing "fact checking". Similar but even broader are

the reflections of those who tell us that in order to combat fake news a form of "critical reasoning" is necessary, or it is important to "doubt" as a basic attitude, or it is simply necessary to "use common sense".

Of a different tenor are the answers of those who do not reason in terms of the structure of the information panorama (the sources, etc.) nor in terms of the activity, attitude or competence of those who read the news, but rather trace the possibility of understanding that a piece of news is false to the formal characteristics and content of the news itself.

In other words, according to these answers the proof that a news item is false is found in the news item itself in the form of various clues such as: the paradoxes and incoherence that characterize it; the fact that only that news story says a certain thing and that's not reflected in other media; the exaggeration or partisanship of the argument; the completeness/correctness of the data cited; the lack of links and references; the type of rhetoric used; the "it sounds too good to be true"; the presence of "clickbait" headlines or "call to action" like "pass it around"; the signature or lack thereof; the graphics or other exaggerated or connoted formal elements; the presence of writing errors; the emphasis on the emotional-scandalism aspect.

With regard to the list we have just compiled, we would like to underline that the students who had expressed themselves in positive or negative terms in the previous question, seem more confident about the possibility of being able to distinguish fake news by its content or its formal elements or with an active research activity. Vice versa, students who had provided an articulated answer in both positive and negative terms in the previous question, and therefore had already expressed a more articulated and complex reasoning, seem less confident about the possibility of tracing the distinction between what is true and what is false. It is in this group of students that we receive the most "pessimistic" answers, those who emphasize that fake news "are difficult to recognize", or that "you can't always recognize them" up to the most radical "it is not possible to recognize them". The whole thing goes on to even broader, and somehow "philosophical", reasoning, such as the response of the student who wrote to us: "the real question is: are we able to recognize fake news from reality? Or is our reality fake news?".

Conclusions

Students, as we expected, are very interested and concerned about climate change. When asked to give their opinion on the subject, almost all of them tell us that "the climate is changing and that human activity is the cause".

At the same time, however, when asked about their real rather than abstract behaviour, they confess that they do not frequently seek practical information on this issue.

Their main source of information is the content carried on the web. The second media is television (but very detached) and practically do not use paper information (even if in any case we find the echo of the news coming from paper sources, to the extent that they live on the network in the form of shares, posts of informative pages, etc.).

They do not seem, as expected, to trust the media, but it is interesting to note that this trust is higher for media they do not use and lower for media they do use. Gender has a clear influence on these opinions, with women being more distrustful, particularly of news coming from the Internet, but also more passive than men in actively seeking information and verification.

In general, they seem to have a good level of awareness of the risks of communication mechanisms, especially those transmitted through the network. In most cases they emphasise the negative aspects of online information, although positive considerations are not lacking. And they seem, at least in theory, to be quite aware of the possibility of encountering false news.

They also declare themselves rather confident with the possibility of verifying the news and on their ability to unmask the so-called "fake news": a part of the sample, in particular the younger ones, expressing themselves in more naive forms (those who tell us that they find the evidence of fake news within the news itself in the form of obvious features) and another part

instead emphasizing awareness, critical attitude, attention to the quality of sources, practical activity of research, data comparison and so on.

In general, however, the high level of theoretical interest in climate change drops sharply when we move from ideal statements to statements about actual information research practices. And even if their answers are comforting with respect to their theoretical awareness of the problem, their low level of trust in the media combined with their infrequent activity of actually searching for information on the subject ultimately translates into their awareness of not having particularly complete, credible and accurate information on the subject of climate change.

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The role of ICTs in introducing good recycling practices at home

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Abstract: Municipal solid waste (MSW) is ever growing in volume, and in Paraguay, the lack of adequate infrastructure aggravates the problem of its management, generating various environmental problems. Sorting and classifying waste at its point of origin (households and workplaces) is one of the many good practices that improve the quality of life in the communities. The COVID-19 pandemic deepened the need for well-designed and affordable ICTs in most of the communities and for most of the everyday activities. Enabling communication and training around the various issues related to MSW has been no exception. In this research, we used human centered design to create and experiment solutions that facilitate waste sorting at origin in ways that better respond to needs and capacities of the communities. The main goal is to analyze the design and use of ICTs that promote waste sorting at origin and help community members engage in these practices. This paper reflects on the lessons we learned about the role of ICTs to allow a more sustainable waste management system in the city.

Keywords: social informatics, waste sorting at origin, participatory design, human centered design

Introduction

Environmental degradation is one of the most relevant problems that humanity is currently facing. Although the causes of this phenomenon are varied, one of the main concerns is the management of urban waste.

The generation of waste in Latin America and the Caribbean is constantly increasing. Each inhabitant generates an average of 1 kg of waste per day, and in total, approximately 541,000 tons of urban waste are generated, which will increase by at least 25% by the year 2050 (UN 2008).

The Ministry of the Environment and Sustainable Development (MADES) states that, in Paraguay, less than 10% of the waste produced in the country was recovered in 2018, while in developed countries the recovery rate of said waste is 30% (MADES 2020). On the other hand, only 5.5% of the municipalities have controlled and authorized disposal sites (3 sanitary landfills and 11 controlled landfills).

In addition, data from the "Continuous Permanent Household Survey" of the National Institute of Statistics, Surveys, and Census, indicate 48.5% of the households have access to public collection service, while 4% of the households have a private collection service. However, nearly 37.6% of the households burn their garbage, and in particular, approximately 4,240 households in Asunción carry out this practice.

Within this context, sorting waste at its source is a sustainable activity with myriad benefits: it prevents water, soil, and air contamination by promoting waste's correct disposal and leveraging on waste's lifecycle, it collaborates with energy and costs savings; it dignifies the work of waste pickers, who play a fundamental role in the management and transport of recyclable waste to different recycling centers, especially in areas without recyclable waste management, as it is the case in Asunción and its metropolitan area.

Currently, due to the pandemic, waste it's also a source of risk. In the absence of protocols or workshops for communicating the correct ways in which waste should be disposed,

particularly, of the correct disposal of sanitary waste related to COVID-19, the work and health of waste pickers and other actors involved in the recycling process have been at risk (WHO 2020).

As a first response to the pandemic, most governments restricted or stopped the majority of the daily activities and imposed a quarantine to mitigate the spread of the virus. To face this situation, the use of ICTs has been encouraged and promoted for several activities such as working, learning, and getting informed without leaving our homes. Although waste sorting and recycling activities cannot be done remotely, technologies can play a key role to raise awareness, train, and communicate detailed information about good waste sorting and treatment practices, particularly where waste is generated.

In this study, we analyze the different realities that affect recyclable waste sorting and other good practices that could help to develop a better and sustainable recycling management system in Asunción, Paraguay. Our analysis focuses on the design and impact of ICTs in the adoption of good practices that contribute to increasing recycling as a collective action dilemma.

Related works

In order to better understand the scenarios of citizen participation in the process of sorting waste at source, we have carried out bibliographic searches analyzing the most current solutions that exist in the scientific literature, the so-called gray literature (web pages, blogs, etc.) and the market.

Within the existing literature, waste management is an issue that has been approached with several strategies. Rojas *et al.* (2006) conclude that it is necessary to have the support of the entire community to improve recycling practices, and that individual's engagement could be achieved through strong awareness campaigns. Another important point is the impact of the minimization of waste generation by the inhabitants, since this activity avoids the saturation of sanitary landfills, and as consequence, improves the sanitary conditions, collaborating in an indirect way in improving the quality of life of waste pickers.

Perez -Belis (2013) analyzes the way in which sustainable habits and behaviors can be promoted through the use of ICT. The focus of this study is the management of electric and electronic toys. The results show that the use of ICT is a viable means of achieving the traceability of the waste and influencing the withdrawal habits of electric and electronic toys, promoting their correct management and ensuring better environmental behaviors.

Chaur (2019) concludes that there is awareness about the importance of recycling for the protection of the environment. However, it is necessary to provide more information for this practice to be effective and have a real contribution to reducing waste. Even though waste sourcing is carried out in most households, the previous treatment of recyclables is not taken into account.

Reams and Ray (1992) present a comparison of the effects of three stimulation methods on the rates of participation in recycling. As the main result, they find that direct and personal contact with the researchers could have had an impact on a higher level of awareness about recycling, greater pressure from colleagues to recycle, and better delivery of information without being related to the signing of the commitment.

On the other hand, the Santiago Recycles Program, an initiative in Santiago de Chile that creates a series of strategies for the minimization of waste in municipal regions from the metropolitan area, offers several interesting insights. Firstly, they find that the main actions that helped to increase the volume of waste sorted at source were the design of environmental education strategies and the planning of house-to-house selective removals. Another of the relevant points of these experiences are the incentives used to keep the motivation and promote the habit of separating waste at source, such as the delivery of recycling kits to facilitate the separation of waste at home (Santiago Recycles Program 2018).

In summary, these articles emphasize the importance of creating strong awareness and training campaigns that help to understand the scope and impact of waste sourcing, as well as good practices to benefit the communities. At the same time, all of them point out the key role played by ICTs in the monitoring and dissemination of educational information.

Regarding the applications that are oriented to the management of urban waste, we find four relevant solutions for the management of urban waste generated at source.

ReciclApp-Chile¹: application that focuses on the removal of waste separated at source, organizing the collection by zones and days. This app allows the registration of waste pickers that accumulate points, which can be redeemable for incentives within the same app. This app is available for Android and IOS systems.

Cataki - Brazil / Colombia²: application that seeks to make the recyclers visible and guarantee greater efficiency to waste generators, such as households and workplaces, as they can easily find a trustworthy recycler, connect with him in order to deliver usable waste free of charge and improve conditions of environmental sustainability. The main advantage of this app is that it encourages socialization with waste pickers. Although the application is free, it specifies that the work of waste pickers is not. Therefore, the application leaves the pricing of this job to waste pickers and waste generators. This app is available for Android and IOS systems.

Reciclatelo - México³: This Mexican recycling program with social inclusion, has a free application available for Android and IOS systems. Users separate and register packages on the platform, then deliver the packages to authorized centers or waste pickers who must subsequently validate those records. Once validated, users will receive Biyuyos. Biyuyos are virtual currencies exchangeable for products of the companies associated with the project. This app can only be downloaded within Mexican territory.

Where I Recycle - Uruguay⁴: It is a collaborative project between CEMPRE (Business Commitment for Recycling), DATA URUGUAY and ReAcción. This project is based on unifying all the information about places, containers, and national programs that are responsible for receiving waste according to its value chain that can be recycled or reused. The project is a free software solution, it is a web tool and also has versions available for mobile devices either Android or IOS with the following functions: map, files, tips, news, surveys, among others.

All these platforms are focused on citizen participation in the processes of waste sorting, as well as in the correct disposal of waste for its use. Regarding the strategies observed, all the platforms rely on a strong campaign to reinforce the knowledge of the benefits that recycling could have in the life of the users. Another interesting point is the integration of waste pickers within the applications, validating their participation and importance in the recycling processes.

Research activities

As a design research project, design is both a method to generate knowledge, but also a result of other research activities. Our design activities are probes into the reality of waste sorting in origin, allowing us to better understand how they play out in a city where recycling is not formalized. And they are also our objective, seeking to create new experiences that can contribute to increasing waste sorting and other good practices. We use human-centered design (HCD) methods to derive design challenges from observation and create solutions that motivate and promote the waste sorting at its source. We have conducted initial activities of discovery and exploration, with the HCD approach, designed and organized by UNDP's Accelerator Lab⁵, contributing to the overall goals of the "Asunción Green City of the Americas - Ways to Sustainability" UNDP project⁶.

¹ Reciclapp - <http://reciclapp.cl/>

² Cataki - <https://www.cataki.org/es>

³ Recycle it - <https://www.reciclatelo.org/>

⁴ Where I Recycle - <https://dondereciclo.com.uy/>

⁵ <http://acceleratorlabs.undp.org/>

⁶ <https://www.py.undp.org/content/paraguay/es/home/projects/proyecto--asuncion--ciudad-verde-de-las-americanas--vias-a-la-sust.html>

The bases of the HCD establish to face a problem through 3 stages: Listen, Create, Deliver and later go iterating until finding a solution that meets the characteristics of desirability, feasibility and viability (IDEO 2015), we have carried out the following activities iterating and analyzing the different situations surveyed

A. Waste Diary

In their study, Gaver et al. (1999) observed how when using cultural probes, they favored and encouraged people to describe their emotions and appreciations about a topic in different ways and simple language. Even completing notes with phrases about why the request was complicated or specifying that it was not understandable to them. They have proposed simple activities specifically designed for the project, reaching high levels of people's participation . Our waste diary is a cultural probe inspired by this work.

Thus, we have firstly carried out the "Waste Diary" to learn about the waste management activities at homes, from the point of view of the participants who document their activities on a daily basis. A group of 8 participants documented their day-to-day experiences with urban solid waste (MSW) management in their homes, during one week of August 2020. Once a day, participants had to answer to the following prompts, sent to them through WhatsApp:

- What did you do today in relation to the garbage in your home? How would you describe your interactions with the artifacts involved and the environment?
- Was this experience satisfying or frustrating? Why?
- What waste did you interact with? (check all that apply, write in detail if not listed: Plastics, Bottles, Cardboards, Food scraps, Other organic waste, Sheets of paper, Glass bottles, Batteries, Textiles, Toys, OTHERS)
- ¿ Did you keep in mind the importance of separating recyclables from non-recyclables in this experience? (But because?)
- Where did this experience take place? What objects or artifacts were used? (check all that apply)
- Did you take out the trash today? In what quantity? (freely express your estimate)
- Was the garbage collection satisfactory today? (But because? Who has done the collection? (Formal: collection service / Informal: collector, other)
- Did you take out the trash today? In what quantity? (freely express your estimate)
- Any other comments about your experience?

Due to the COVID-19 pandemic, it was carried out virtually, through Google forms and WhatsApp instant messaging.

B. Wastebaskets 2.0

As a second activity, we carried out an urban design and information intervention called "Wastebaskets 2.0". This intervention was realized along the whole extension of a residential street in a traditional neighborhood of Asunción , with the goal of promoting waste sorting in the homes of this neighborhood, facilitating the collection of recyclables by waste pickers, and providing information about recycling to the community. The design of the new urban wastebaskets take advantage of existing wastebaskets, which are typical in Paraguay and are available in front of most houses, adapting them with low effort,, using a removable grid to create multiple colored spaces that allow residents to distinguish between recyclables and non-recyclables, incorporating information materials in the form of posters that provide guidance on waste sorting . In total, 12 baskets have been modified.

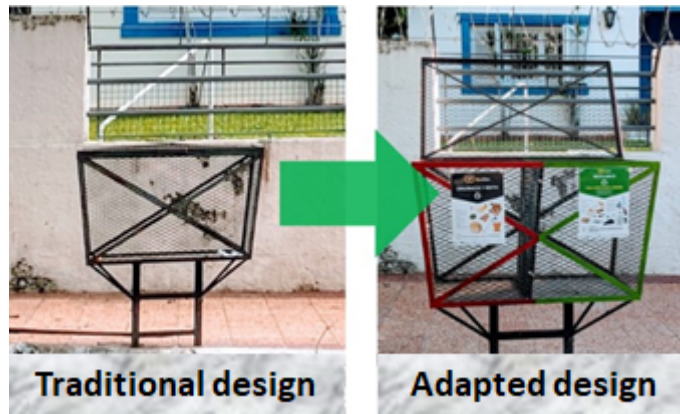


Figure 1: Adaptation of a traditional basket to a WasteBasket 2.0

To assess the impact of this intervention, 28 surveys were collected, asking questions in relation to recycling practices, perceptions about waste collection services, and trust levels in the community. Approximately one month after the adaptation of the baskets, 4 interviews were also carried out to deepen our understanding of the experience with qualitative data⁷⁸.

C. Low fidelity prototype

The third activity of our design research process consisted of designing a low fidelity prototype, integrating lessons we learned in the first two activities, introducing possible solutions to the problems we detected.

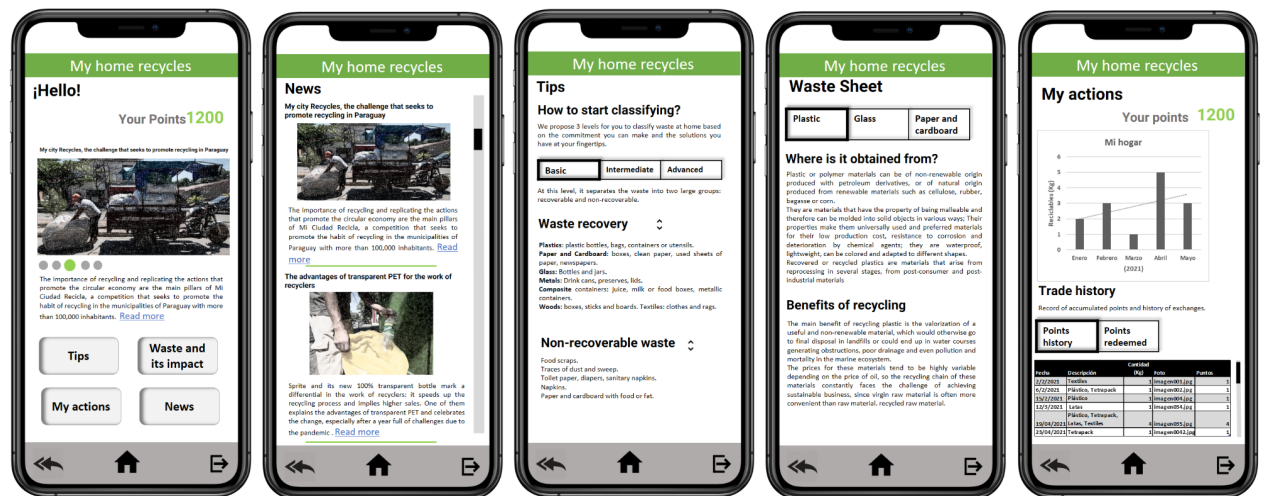


Figure 2. Screens of the prototyped solution, showing its four main features: (1) news and updates about recycling and good waste management practices, (2) advices about how to sort waste at home, (3) detailed information about different types of recyclable waste, and (3) personal space where user’s actions and practices are registered and displayed.

Usability testing of this prototype was carried out with a group of 13 people, including 4 participants from “Wastebaskets 2.0”. JotForm was used⁹ to collect data in these sessions, showing the different screens of the prototype to highlight its functions.

⁷ A first account of lessons learned through the wastebaskets light urban intervention is available at: <https://www.py.undp.org/content/paraguay/es/home/blog/2021/prototyping-a-new-generation-of-eco-friendly-wastebaskets.html>

⁸ Surveys were collected using KoboToolbox (www.kobotoolbox.org).

⁹ Jotform is a tool for creating responsive web forms. <https://www.jotform.com/>

This activity was carried out virtually, the form test first describes the instructions and later, they were presented with a screen at the same time related to a specific function, after each observing each screen, the participants were asked to describe in a leaf what they understand by observing them and what sensations they transmit to them. They were then asked to attach a photograph of their annotations and, finally, 8 questions were asked about the prototype and the methodology used.

Key Results

A. Waste Diary

- This activity allowed us to observe that there is a tendency to accumulate waste in bags. Since all the participants indicated this option, 3 have selected that in addition to bags they use metal, plastic or wooden containers, 1 mentioned that they do so in cardboard boxes and 1 person who accumulates them in a sector for compost.
- Only 3 of the 8 participants separate their waste, and they pointed out that the main cause that prevents sorting is the lack of time, space and garbage cans.
- There are cases in which burning waste is a choice, which happens mostly due to irregularities in the collection service.
- Accumulation of waste inside the house was one of the sources of distress, as some participants mentioned cases in which their frustration or their action was triggered essentially by realizing how overflowed their garbage cans were.
- **Lessons about the methodology:** documenting every day was an effort intensive and tiring activity.

B. Wastebaskets 2.0

- It allowed us to observe a simple change in the urban landscape, it generates new dynamics of participation and collective action. Although there is awareness of the importance of sorting, it is not always practiced.
- Incentives such as informational materials, differentiated garbage bags help to maintain interest and motivation.
- There is awareness, but not so much knowledge, especially about the usefulness of each material to be recycled.
- In general, there are no links between waste pickers and families, which represents an opportunity for the use of communication media and information systems that facilitate or promote interactions.
- In addition, some informal recyclers do not know the meaning of the colors of the dividers and ended up lowering the bags and looking for the recyclable products with which they work on the ground.
- After we installed the first 5 modifications, several neighbors contacted us, asking to be part of the intervention, so much that we had to expand it to 12 wastebaskets. One of the residents of the street defined the impact of the intervention as inspirational, changing the urban landscape in a way that motivates others to act.
- Finally, we have observed through this experience how recycling continues to be a fundamentally structural problem, where there is still a need to optimize, codify, coordinate, and integrate the different waste picking and management services and infrastructures, both formal and informal, with practices at the household level.
- **About the methodology:** prototyping a new infrastructure by slightly intervening the urban landscape at a low cost allowed us to identify more precisely the need for participation and involvement of community members to promote recycling as a collective action. A toolkit for replicating this activity was produced by UNDP's Accelerator Lab through this intervention¹⁰.

¹⁰ DIY Toolkit to implement the intervention of the Wastebaskets 2.0 in a local community:
<https://cutt.ly/diy-urban-wastebaskets>

C. Low fidelity prototype

- The participants emphasize the understanding that the proposal seeks to train people on the different materials and how they are recycled, in addition 6 of the 13 people used a paper, 3 did it by digital means (Block notes, excel, notes application of a smartphone) and 4 have not attached any image.
- What most caught the attention of the participants is the possibility of having a record and accumulating points.
- The participants in general mentioned that it is viewed as a simple application, which offers a source of information about recycling at home, in addition to raising awareness and motivating the sorting of waste. However, they have mentioned the need to interact with the product and not just look at images of the prototype. In addition, they have commented that on some screens there is a lot of text, small letters, absence of colors and graphics.
- Of the total number of participants, 10 have said that they would use the application, 2 have said no, and 1 that they do not know.
- **About the methodology:** Regarding the methodology to evaluate the ideas, 3 people did not respond, 4 people were dissatisfied and 6 people were satisfied commenting that this helped them to get into the idea.

Discussion and Future Work

We have carried out three design research activities, with the goal of understanding the different scenarios and situations that emerge when managing waste in home settings.

The pandemic and proposals to cope with the situation have prevented activities from being developed within a normal context. Commonly the strong point of people-centered design relies on the pillar of socialization to build confidence and get everyone participants can express themselves and give their opinion on the problem of waste management. Due to the restrictions, we have adopted ICTs support to mitigate this scenario seeking to be continuously in contact with people.

The main results show that people have a desire to carry out sustainable activities in relation to waste and how it is treated, however, there is also evidence that there is no sufficient knowledge to perform this process correctly. On the other hand, they are also aware of the opportunities offered by technologies to train and educate themselves towards correct management, indicating that the incentive or reward systems (e.g scoring strategies) are particularly palatable for potential users, combined with logging functions that allow for users to keep track of their sorting activities.

Moreover, recycling can be seen as a problem of collective action, involving relationships of trust between people and institutions, including those who generate waste in their homes, companies, communities, and the workers that collect, sort, dispose, and recycle the generated waste. Considering recycling as a form of collective action means that the ability of people and institutions to solve waste management problems depends upon the levels of trust they share (Ostrom 1998). For example, people will be willing to adopt recycling behaviors if they know that others in their community will do the same. We have seen this at work in our wastebaskets intervention, where we were able to observe an increase on the willingness to participate of the intervention after observing neighbors with newly installed and adapted wastebaskets. The information elements of the redesigned urban baskets, as well, were informative and inspirational for residents.

Alternatively, an external institution could provide services, infrastructure, and coordination to stimulate or facilitate individual behaviors (Mansbridge 2014). We have seen how the limitations on the access to the collection service leads to unsustainable practices, like waste burning, as part of the experiences documented in the Waste Diary. The waste diary also showed us how sorting at the point of origin involves the internal waste management system of each home, so that recyclable material has room to accumulate up to a certain point where it makes sense for someone to come pick it up.

Based on these concepts and observations, we can see how recycling practices represent a collective action dilemma (Rompf, Kronberg & Schlosser 2017), especially in contexts of

minimal or weak institutional coordination, which is the context we are working in. In a city where formal recycling practices, like sorted collection, are not part of the formal collection service, these activities are carried out mostly, if not only, by informal waste pickers. In order to scale up these practices, we may need to mind (and bridge) the gap there is between the desire to carry out sustainable practices (which we observed and documented) to the actual daily activities performed by waste pickers to sort and recover recyclables so that they reach recycling companies. Waste pickers themselves can become the teachers and trainers, as they are currently the best guardians of the local knowledge related to what is recyclable locally, and what it is not in practice (even if in theory it represents a recyclable waste).

ICTs, including the redesigned wastebaskets, as an informational intervention, and the training app we designed and tested, have shown a potential to address the learning aspects of this gap. Gamification strategies like scoring systems have also shown some appeal in the usability tests, along with the sole aspect of keeping some track on what we sort, when and in what quantity. On the other hand, the small samples (8, 12, and 13 participants) in each of the activities make it necessary to replicate these experimental activities in order to validate the findings. Currently, with the experiences acquired and following the iterative and incremental process of human-centered design, we are designing a fourth activity oriented to carry out tests with prototypes that allow interaction with the end user and in addition. For this, we are refining the proposal by creating the sharing and interaction flows using the FIGMA¹¹ platform, whose main characteristic is to allow data to be obtained through interactive usability tests.

Moreover, we may not fully bridge the gap without addressing the structural issues of disconnect among the parts of the broken municipal waste management system. The interventions we explored in this paper will build upon the lessons we have learned, to expand further and focus on supporting trusting interactions and relationships between waste pickers and families, eventually connecting and coordinating sorting and collection of recyclables also with the formal collection system.

¹¹ FIGMA is a web-based graphics editing and user interface design app.

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Sequential Mixed Methods and Feminist Data Science as a Methodology in Community Informatics Research

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Abstract

Online communities have emerged around ideas, beliefs, and needs that are intrinsic to one's sense of self. Some communities have emerged to help members find a place of support and safety when they possess stigmas that do not have any visual evidence unless disclosed, also called concealable stigmas. This paper explores sequential mixed methods can enhance community informatics methodology for data collection and analysis. This is accomplished by using online global communities centered around the safety afforded by membership to evaluate local community perspectives about issues. By focusing on the intersection of information and communications technologies (ICTs) and social capital, community informatics, sequential mixed methods, and feminist data allows for a more thorough understanding communities. It may also be possible to indirectly improve the well-being of members by respecting social context and shared values to modify or use existing social and technical systems.

1 Introduction

The case study for this methodological approach uses data gathered from global communities situated online to design localized studies. The case study consisted of a preliminary study conducted in 2018 in two parts. Part One conducted interviews of voluntarily childless women in a closed Facebook group, and Part Two surveyed university students for perceptions about voluntarily childless women. Based on the results of the preliminary study, a three-part examination of voluntarily childless women took place in 2019. Phase One was an analysis of pre-existing data on social networking sites, Phase Two included local interviews and focus groups, and Phase Three surveyed two local communities.

The needs and sentiments expressed in the voluntarily childless community were used to evaluate existing perceptions, bias, and social norms around family and family planning. The social media platforms Facebook, Twitter, and Reddit were scoured for the keywords and hashtags “childless woman” and “childless women.” After valence and lexicon analysis, qualitative and quantitative instruments were developed to evaluate perceptions about childlessness in two diverse local communities in Hawai'i. These communities were selected because of their diverse population demographics. However, these communities are external from the global Facebook community with no overlap. This methodological approach was data rich, and over 30 findings about perceptions and social norms relating to family, family planning, and childless women were identified. These findings can be evaluated in future research about climate change, family planning, social media, and ethical AI.

2 Background

This case study explores how feminist data science, community informatics, and sequential mixed methods work together to develop research questions, instruments, and variables. Feminist data science is used to identify the marginalized populations across all stages of the study, define the constructs, and craft the research questions [11], [7]. Community informatics is used to gather the needs and issues of a community [19]. Sequential mixed methods are employed because each stage builds on the previous stage's findings [24]. This unique approach to evaluating community needs and perceptions about the community align with the community informatics and feminist data science sentiments of expressing pluralistic voices and interdependence. This methodology is versatile and can incorporate

existing data and new data from social media and from study participants. It also allows for broad and complex statistical analysis and qualitative methods like thematic analysis, and open and axial coding, allowing for a wide range of application depending on the needs of the study. Employing this approach highlights many experiences and responses using easy to understand methods across all stages research.

2.1 Feminist Data Science

Feminist data science applies intersectional practices and principles as a framework for evaluating how social and political identities impact data science and data ethics. Primarily acting as critical analysis, feminist data science applies a feminist lens to the process of data collection and analysis [8], [7]. This includes the roles of researchers and participants, processes of designing the study, from whom data is collected, what perspectives are gathered and presented, ethics throughout the process, considerations about power, and what constitutes data [6]. These points are to try to make research more inclusive and relevant.

Researchers have long studied populations that are easily accessible, and both researchers and populations studied were often men. Campbell and Wasco articulate, “research projects in the social sciences have often ignored women and issues of concern to women, or have created differences between men and women, girls and boys that are not ‘natural, essential, or biological’ (West & Zimmerman, 1991, p. 24)” [3]. These dynamics have negatively impacted girls and women in many ways, including being properly diagnosed on the autism spectrum [2], heart attack warning signs [9], and encouragement throughout the STEM pipeline [17], [27]. Researchers are still struggling for an intersectional integration into the sciences, especially in informatics.

Studies in computer sciences, informatics, and information sciences maintain divides along power dynamics of race, gender, and socioeconomic class, which still present persistent problems today. In 2011, Bardzell and Bardzell [1] examined the integration of feminist theory into HCI practice. The authors acknowledge the tension between viewing science as socially and politically engaged and the traditional view of science as separate and distinct. Leurs [16] makes that case that as we delve deeper into data-driven research, the focus on ethical considerations of feminist principles like explorations of power, responsibility, and subjectivity of participants and data throughout all phases of the data collection and analysis process should increase as well. In a CSCW 2020 panel about critical refusal, or the process of talking back focusing conversations on what can and should be acceptable, as a data practice, Garcia and others discuss harmful practices in data science that serve to perpetuate structural inequalities [10]. *Coded Bias* is a documentary that highlights inequalities embedded into computer vision algorithms and image libraries. One computer vision program had issues recognizing the facial features of real, brown people but could easily identify features on a plain white mask [14]. All of these cases show deficits still present in research today.

D’Ignazio and Klein outline seven principles that should guide research. They are:

- Principle 1- Examine power
- Principle 2- Challenge power
- Principle 3- Elevate emotion and embodiment
- Principle 4- Rethink binaries and hierarchies
- Principle 5- Embrace pluralism
- Principle 6- Consider context
- Principle 7- Make labor visible [6]

These principles guided the exploration of voluntarily childless women in a detailed manner. Each principle was instrumental in developing a design that respected the marginalized voices of voluntarily childless women both by gathering perspectives from the community itself and gathering reactions to disclosures of childlessness from interview and survey respondents. These principles also guided the development of research questions, caused a discussion about what information constitutes data, and examined study participants’ responses holistically. Each principle and its role in the study will be examined further in Section 4.

2.2 Community Informatics

Community Informatics (CI) focuses on the intersection of information and communications technologies (ICTs) to improve the well-being of communities. This is done through respecting social context and shared values to modify or use existing social and technical systems [21], [26]. In the paper “Feminist Visions of the Network Society,” Gurumurthy [11] examines what feminist perspectives can bring to the colonized landscape of technology. She explains, “The seamless arena of dominant information society ecologies creates a techno-social architecture where there is, it appears, ‘voice without agency, participation without politics, and collaboration without appropriation’ (Singh and Gurumurthy, 2011). Feminists need to bring their understanding of political economy to the fore of the debate” ([22], p. 466). The notion that online microcosms of niche communities create safe spaces, or digital inclusion of marginalized individuals [11], that reverberate out into broader community is one expected benefit to feminizing ICTs and online spaces. The inclusion of marginalized individuals can be slower to transfer into their real world societal counterparts.

Several papers in CI have examined the role of CI in online groups and how feminist perspectives can enhance CI in theory and analysis. Still, O’Neil’s exploration of methodological approaches to CI evaluate criteria for future studies.

Based on case studies of CI, O’Neil broke down five areas that research projects can fall into. They are:

1. “Strong democracy: Includes theories of increasing democratic participation with a meaningful association of citizens within a civic community.
2. Social capital: Includes features of social organization such as social networks, norms, and trust that facilitate co-ordination and co-operation for mutual benefit.
3. Individual empowerment: Includes discussions of information literacy and ICT access for disadvantaged communities so that all people have opportunities for meaningful participation in an increasingly digitized society.
4. Sense of community: Includes discussions of increasing community involvement and commitment to geographic communities.
5. Economic development opportunities. Includes theories about the use of ICTs to encourage economic activity.” p.78-79 [19]

The preliminary study examines the issues expressed by voluntarily childless women in real world interactions as discussed in a closed Facebook group setting. The preliminary questions were developed to evaluate how ICTs contributed to individual empowerment and a sense of community. These concepts were explored further using focus group and individual interviews and the survey instrument. This research in community-based approach led to the development of the population selection and focus group questions. Next, examining how new media impacts family planning must be explored.

2.3 Sequential Mixed Methods

This research study is a sequential mixed methods, multi-stage design as outlined by Tashakkori and Teddlie [24] for a study in an academic setting. Tashakkori and Teddlie propose using qualitative methods to develop quantitative tools, as shown in the top-left illustration of the Figure 1 sequential mixed method design. For the purposes of this case study, an evaluation of social media data and a study at two contrasting universities in the same university system was selected in order to develop a deeper understanding of the global data gathered. This design was selected because “...the phases are clearly distinct, [allowing] the investigator ‘to present thoroughly the paradigm assumptions behind each phase’” ([4], p. 177). An exploration of paradigmatic assumptions in the study allows for depth of exploration of data as well as shifting methodology when necessary. This flexibility was useful for analyzing selected Top Posts across social media sites in Phase 1 and in the two-site approach for qualitative and quantitative data collection in Phases 2 and 3.

This study also evaluates the persistence of stigmas about childless individuals by younger generations (Millennials and Centennials in particular) against previous generations’ prevailing opinions of childless individuals. Participants in this study included faculty, staff and students affiliated with

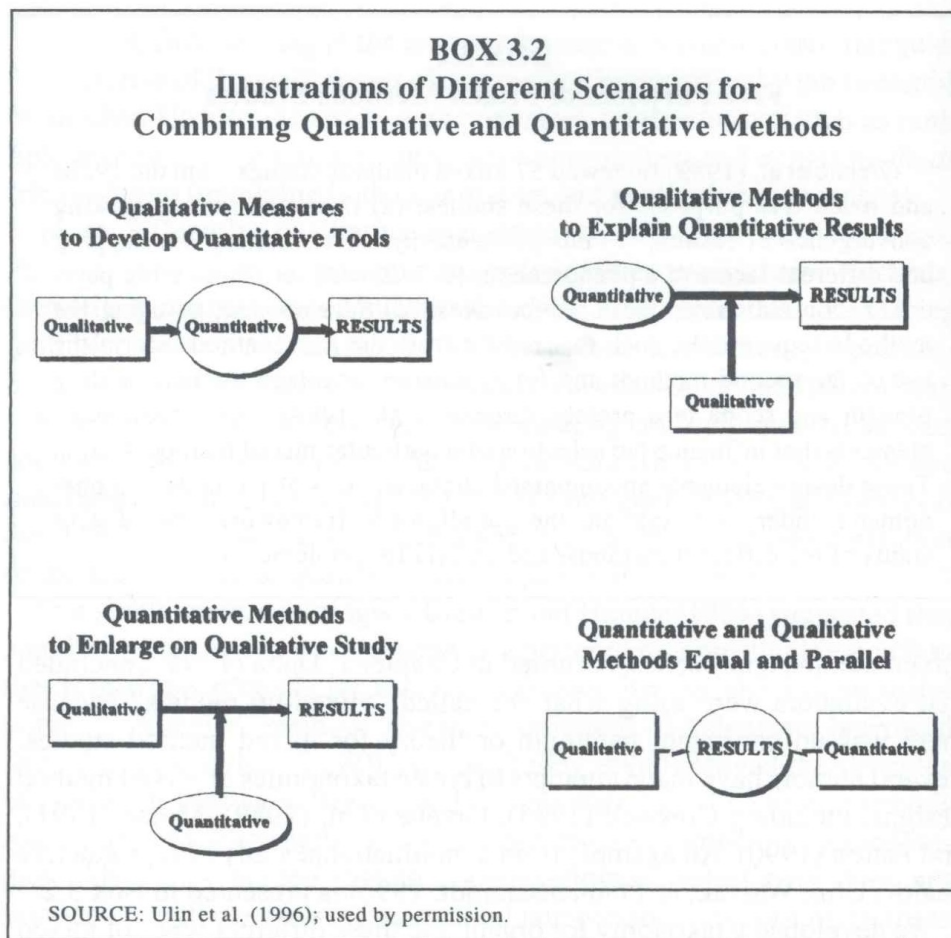


Figure 1: Tashakkori and Teddlie's Scenarios for Combining Methods, pg. 44

the contributing universities. Given the political and cultural ideologies of Hawai'i, a study about changing opinions about stigmatized individuals should be conducted here to evaluate if opinions and perceptions about voluntarily childless women differ from those in previous studies. Again, hānai is an often referred to social construct on Hawai'i island, also known as the Big Island.

3 Methodological Overview

This study consists of many parts that built on each other. The preliminary study consisted of interviews of voluntarily childless women in a closed Facebook group and adapting a survey for university freshmen to compare against this population in studies over time. Phase One is exploratory in nature and examines perceptions and opinions about childless women across several social media sites. This stage identifies aspects of voluntary childless women that require deeper evaluation in the later stages of the study. Phase Two addresses the factors influencing voluntarily childless women. Focus group and individual interviews were conducted to collect information about stigmas and general notions about family planning across generations. Phase Three focuses on quantitative data collection to determine significant factors influencing perceptions about voluntarily childless women. During analysis, Stage Three further validates the findings of Stage Two by giving statistical evidence to support the qualitative findings. Stage Three also draws conclusions about childless women and family planning.

3.1 Preliminary Study

In a preliminary study, two sets of data were collected. Part One asked voluntarily childless women to share their stories of disclosure to evaluate whether or not it resulted in a failed account. The results indicated that 88% of respondents noted poor reception upon disclosure. These results suggest that negative perceptions about childless women still exist, especially upon self-disclosure. This phase evaluates perceptions of voluntarily childless women from the experiences of voluntarily childless women in the context of family planning and support. In addition, opinions about information shared in the family and information sought out online about family planning were gathered. This data set was collected from surveys and evaluated perceptions about voluntarily childless individuals. Results revealed that religion of choice and age were correlated with perceptions about childless individuals, particularly with regard to choosing negative descriptors for childless women.

The responses to the Facebook survey highlighted the persistence of stigmatization of voluntarily childless women. Eighty-eight percent of respondents indicated that they received negative responses in self-disclosure, indicating a failed account with a subset of 24% of respondents indicating a threat to safety, preventing them from disclosure, even to family and friends. The stigmatization illustrated in the Facebook group supports the need to research the perceptions of voluntary childless women in various individuals. Therefore, the similarities and differences in perceptions in those of varying ages, socioeconomic status, race, religion, and other factors could improve our understanding of this concealable stigma. The two universities targeted for this study were among the top 10 most diverse college campuses in the US. The University of Hawai'i at Hilo was deemed the most diverse university in the United States in 2018 with The University of Hawai'i at Mānoa ranking 6th. One is in a rural setting, where the concept of hānai, or an informal and open adoption, is still practiced (e.g. [20]), and the other is in an urban city. A mixed methods approach was employed to evaluate the perceptions of childless individuals across generations to determine if attitudes are becoming more tolerant of this growing population of women.

Building on Halford's [12] evaluating perceptions about voluntarily childless women according to respondents' religiosity, or the importance that religion plays in one's life, and gender, a preliminary study was conducted in 2018. This phase gathered university students' opinions about voluntarily childless individuals. The results of this survey found that childless men were viewed more favorably than childless women irrespective of the gender and religious background of the respondents.

The preliminary study illustrated initial perceptions of voluntary childless women and how they shared information on a closed Facebook group. This demonstrated a baseline of information which influenced the methods used in this study. A sequential mixed methods approach allowed the researcher to ground the methods with the findings from each of the previous research questions. This ensured that the methods employed were based on a logical approach given the findings at each stage.

3.2 Case Study Design

Phase One was exploratory in which data were gathered through social media analysis to determine the volume of content that is created about childless women. This stage evaluated the pervasiveness of information about voluntarily childless women in social networks. Phase Two used a qualitative exploratory approach to identify possible factors influencing perceptions of voluntarily childless women. This stage focused on two universities in a university system. This stage employed focus groups and individual interviews to evaluate how people get their information about family planning, where they seek support, and their perceptions about voluntarily childless individuals. Triangulation across data sets was used to verify the findings, and interrater reliability was employed to show the agreement of those emerging themes.

3.3 Phase One

The Top Posts in Phase 1 were collected by scraping publicly available posts in social media sites. All participants in Phases 2 and 3 were recruited from two campuses in the University of Hawai'i system. The University of Hawai'i at Hilo (UH Hilo) was the most culturally and ethnically diverse university in the US in 2018, and The University of Hawai'i at Mānoa (UH Mānoa), a large university in an urban city setting with a diverse population, was the sixth most diverse university in the nation [23]. The student diversity at both campuses is partially due to the state's complicated history with

post-colonialism. The purpose of this study was to gather data about family planning, particularly the decision to remain childless, across generations to determine if respondents view voluntary childlessness as a viable family planning choice among women.

3.4 Phase Two

The University of Hawai'i at Hilo (UH Hilo) and The University of Hawai'i at Mānoa were selected for different features of their environment. While scholars often define O'ahu as local in contrast to the mainland [15], [28], business and other values are closely aligned with a mainland approach [29]. Unique Hawai'i concepts like *hānai*, *pidgin* (a creole language that emerged from a mixture of languages of plantation workers [13]), and *hapa* (to denote racial composition, meaning part or less than whole [5]) still exist in use and practice, but O'ahu's business style, economy, and more are influenced by mainland culture and ideals [25]. Another aspect that distinguishes UH Hilo from UH Mānoa are the population demographics of the two parts of Hawai'i with different populations. Universities were selected because they are a place where a lot of people across many demographics gather. Nationally, the typical student is 18-21. According to the Institutional Research Office of the University of Hawai'i system, however, the average age of students at both campuses is 25 years old. Forty-two point five percent of UH Mānoa's, and 41.4% UH Hilo's students are between 18-21. Both campuses are well below the national average of 60%, but UH Hilo has a smaller population, more students under 18, and less graduate programs than UH Mānoa [18]. These factors are expected to contribute to the ways in which people view childlessness as a viable family planning choice.

3.5 Phase Three

Phase Three strengthened the results from Phase Two using a quantitative approach. In this stage, factors discovered in Phase Two were paired with Halford's factors and the inclusion of childless men to further validate findings and determine if previously discovered factors about voluntarily childless women are still statistically significant. This Phase was a survey disseminated to students, faculty, and staff at two parts of Hawai'i with different populations to gather a diverse range of opinions from different generations and socio-economic classes. The survey evaluated current perceptions about the decision to remain childless, identified traits in childless men and childless women, and discussed differences (if any) between involuntary and voluntary childlessness. A further exploration about adoption and *hānai* (informal inclusion into a family) children was also included. Survey respondents also answered a series of questions about how they see the world and the possible impact of beliefs on perceptions of childless individuals.

4 Global to Local

This study examines perceptions of voluntarily childless women because disclosure, as discovered in the closed Facebook group, is still met with rebukes, criticism, and dismissal. Once the data is gathered from the global community, sequential mixed methods and feminist data science are employed to evaluate the local community. The experiences about safety, support, and reactions to disclosure of voluntary childlessness provide the framework for the case study and is inherent in the research questions, instruments, population, and variables. Adapting from the global community to a local study requires examining pluralism in practice.

The design of the case study, therefore, includes a range of voices such as university faculty, staff, and students. The diversity in age, ethnic background, and socio-economic status in this convenience sample allows the study to gather a breadth of insights in a short period of time. This research examines the perceived, self-reported reactions to voluntarily childless women, family planning information, and idea formation to determine whether access to the internet, including social media as an information hub, has changed stigmas about voluntary childlessness.

4.1 Developing Research Questions

This study was largely shaped by Halford's research; however, community informatics has a large role in developing the research questions. The preliminary study was not designed to meet a need, but

designed to explore disclosure and how the closed Facebook group builds a sense of community or aids individual empowerment. The perceptions of the women in the closed Facebook group must be taken into account throughout the case study because their experiences and needs are the force driving the study. The Facebook group presents a safe space in which voluntarily childless women can seek support that may not be available in their offline lives. Research questions are developed to evaluate offline spaces, explore sentiments expressed by the Facebook group, and evaluate possible reasons for those similarities and differences in community perceptions.

The primary principles of feminist data science that guide the development of research questions are examining power, challenging power, and considering context. On challenging and examining power, D'Ignacio and Klein state that research has to begin with understanding that power exists and that research should challenge unequal power dynamics [6]. In developing research questions that allow data to be emergent, existing power structures should become apparent. In this case, the institution most attributed to maintaining negative perceptions about voluntarily childless women was religion. Power structures help to situate perceptions in context.

To get context for perceptions about voluntarily childless women, social media sites must be one source of data. Social media data helps to establish context for the most ethical evaluation of data since data is not neutral or unbiased [6]. Still, conversations about sentiment and perception are also needed to help shape the context about voluntarily childless women locally. Designing research questions that allow gathering information from multiple data sources and viewpoints is possible from a feminist data science perspective because each question can emphasise gaining information from one source of data.

4.2 Developing Instruments

The multi-stage approach to data collection outlined in sequential mixed methods enables collecting data suggested by global communities in a local context. Sequential mixed methods also facilitates tailoring instruments in each stage based on previous findings. After each stage of data collection, data has to be analyzed. While sequential mixed methods hinders parallel studies, it does adhere to the feminist data science principles about pluralism and hierarchies. D'Ignacio and Klein urge researchers to challenge counting and classification that continue oppression with particular attention to the gender binary. Designing instruments based on previous findings enables deeper exploration of topics, research participants, biases, stereotypes, and variables in the next stage's instrument.

In addition to questioning classification and gender equity, pluralism is employed in instruments designed with sequential mixed methods. D'Ignacio and Klein state "...that the most complete knowledge comes from synthesizing multiple perspectives, with priority given to local, Indigenous, and experiential ways of knowing" (p. 3). Designing instruments based on findings allows researchers to include indigenous concepts, local knowledge, or other relevant information into subsequent stages of research so gaps can be mitigated. For example, Phase Two identified the expression of hānai adoption, so questions evaluating this style of adoption were included in the survey instrument in Phase Three.

4.3 Identifying Variables

Sequential mixed methods paired with feminist data science can employ the evaluation of traditional classification variables like education and income along with more flexibility in race, gender, sexual orientation, gender identity, and age. Allowing participants to write in their self-identification provides a richer evaluation of demographic data. Additionally, asking for experiences in surveys elevates emotion and embodiment. D'Ignacio and Klein argue that, "value multiple forms of knowledge, including the knowledge that comes from people as living, feeling bodies in the world" (p.3). By gathering the experiences of study participants through focus group and one-on one interviews, respondents' experiences and emotions are treated as variables for analysis. In this study, Phase Two was qualitative. Thematic analysis was employed on transcripts, and interraters were recruited to verify the findings. Emotions, concepts, and experiences were collected and evaluated to identify emergent themes and sub-themes. This technique allowed for an ethical review of data addressing broad ideas like family. The local respondents came up with their own definitions that were used to construct the findings.

Indigenous knowledge is also highly valued. By excluding traditional categorical variables, more space is given to localized concepts which may not be present in data collected from the global community. Hānai is a concept that would not have been evaluated if the only population of the study was the

global community. Conversely, introducing hānai allows for potential change in the global conversation about family structure and adoption. Sequential mixed methods and feminist data science can help construct variables that are unique and can be adapted to a larger community.

4.4 Interpreting Findings

Keeping all seven principles in mind, the lens for interpreting findings is one that critically examines the data collected. Because conversations happen at the local and global level, a pathway for information-sharing occurs in two directions instead of just one. Both communities have the opportunity to inform and shape each other. Two sets of social norms and values will present themselves.

Revisit the initial conversations with the global community, and update that community on the progress of the project and findings. Be sure to situate your findings in context of those initial conversations. The needs of the global community must be addressed in the research. Include interraters to validate findings and themes. Explore the ramifications for social change, if relevant.

Reporting back to the global community. Share the findings with them, and conduct a debriefing session if necessary. In this case, the marginalized community felt seen and respected for their experiences and validated for their life choices as expressed in the case study findings.

5 Discussion

The process of conducting community informatics research using sequential mixed methods and feminist data science is a long process. There are some hindrances to conducting research and presenting findings to the public. After each phase, instruments may have to go through additional institutional review. The entire study with additional reviews of instruments took 18 months to complete. This timeline was from preliminary study to data analysis and write up of Phase Three. While it may be easier to conduct separate studies instead of one contiguous study, the data gathered at each stage will help create a more complete picture of local communities' values, norms, similarities, and differences when compared to the global community.

The global community can be included in all phases of the sequential mixed methods design. Integrating the global community will add more dimension to results, giving the web-based, co-located global community an opportunity to reflect and respond. However, the methodology proposed is designed to explore how norms and experiences in a global community can be used to evaluate a local community.

6 Conclusion

Community Informatics studies can be enhanced by applying sequential mixed methods and feminist data science. The ability to adapt and evaluate global experiences and perceptions in a local context can produce novel information about changing social norms, institutions that maintain social norms, power dynamics, and new forms of data.

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