Practitioners and ICTD: Communities of Practice Theory in Technology Interventionism

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ABSTRACT

ICTD is a field with a long history of interventionist research in a broad set of domains, including health, agriculture, education, and civics. A common thread between many of these interventions is that they addressed the knowledge and actions of practitioners who were engaged in development activities in their contexts. In this paper, I survey the past literature of ICTD interventions targeting practitioners to identify a common typology that spans domain and context. I use Lave and Wenger's Communities of Practice (CoP) theory as a way to understand the situated and social aspects of practice and describe how ICTD interventions have often engaged with such communities. I discuss how a CoP lens may intersect with other theoretical lenses in ICTD and related fields, specifically around concepts of agency, intrinsic motivation, amplification, and sustainability. I describe how such intersections may inform future interventionist research in the Global South.

CCS CONCEPTS

• **Applied computing** → **Sociology**; • **Social and professional topics** → **Socio-technical systems**; **User characteristics**.

KEYWORDS

ICTD, practitioners, communities of practice, theory

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1 INTRODUCTION

A core ambition of the Information and Communication Technology for Development (ICTD) field is to determine how technology can be used or designed to support the cause of poor and underserved populations in the Global South and beyond. Towards this goal, ICTD researchers have produced a rich body of work, spanning different technologies, problem domains, cultural contexts, and strategies to serve communities and affect change.

Much of this past work has focused on supporting practitioners [57]. A practitioner is a person engaged in a practice which requires some specialized skills and knowledge in order to achieve a specific goal. Examples of practitioners include health care professionals, farmers, students, and new mothers. In this paper, I survey this literature to illustrate how ICTD research is about practitioners and the different types of practitioners that researchers have attempted to serve spanning many different domains.

While I have made efforts to be thorough, this paper is not intended to be a comprehensive literature review. Instead, the goal is to make two broad contributions: The first is to show, through a synthesis of past work, how conceptualizing ICTD research as practitioner-focused provides a basis for understanding that work beyond the silos of context and domain. This is explored in section 3. The second contribution is a discussion of how a social theory of practice can provide an understanding of the mesostructural dynamics of practice relevant to theoretical concerns in ICTD and other development-related fields. This discussion and the related potential for future research is provided in section 5.

To help set the stage for the first contribution, section 2 describes the definition of practitioner in more detail and identifies practitioners in selected domains. While several authors have described ICTD research as practitioner-focused [39, 41, 57], the synthesis provided in section 3 supports this conceptualization by drawing parallels across domains based on the intentions and strategies of interventionists. These parallels result in a shared typology of ICTD interventions that shows how past research relates to the knowledge, motivation, and identity of practitioners. This typology demonstrates the ways that ICTD research is less domain- and context- bound and consists of five broad categories:

Interventions in the first category attempt to effect practitioners by structuring practice through processes programmed into the intervention or the technology deployed. Others attempt to improve practitioner skill using educational efforts, such as technology-supported training. And some interventions focus on informing practice with targeted information services. In contrast, other research views practitioners as knowledge resources and attempts to leverage knowledge in the community to support other members or improve the overall effectiveness of an intervention. Finally, some interventions attempt to motivate practitioners to fulfill their practice either more efficiently or effectively.

Though my typology describes different intervention strategies, it does not explain why a particular strategy with a group of practitioners was appropriate or provide guidelines for sustained and equitable impact. Instead, engaging with a social theory of practice can help researchers identify the social structures that are relevant

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to addressing salient challenges in impact-oriented work, such as questions of fairness, agency, amplification, and sustainability.

A social theory of practice recognizes that practitioners do not operate as individuals, but embedded in groups and relations that are focused on enabling and perpetuating practice [59, 118]. These could be work teams, clubs, or simply a loose network of contacts with whom a practitioner shares knowledge and advice about their practice. Furthermore, cohesive groups of practitioners may be maintainers of their own tacit knowledge and skills, centered around their shared practice [12, 121].

These concepts describe the idea of "communities of practice" (CoPs), which depicts the interactions of practitioners who share common goals of practice and knowledge about how to achieve their goals [12, 60, 117]. To provide necessary background for the second contribution, section 4 describes a brief history of CoP theory. This includes how communities maintain the knowledge and skills of practice, how practice influences the identities and motivations of practitioners, and how practitioners interact with outside agents such as researchers in the larger processes of global development. Communities of practice are present in ICTD research even when they are not explicitly framed as such.

Section 5 proposes directions for future ICTD research based on the intersection of CoP theory with existing theoretical perspectives in development studies, ICTD, and related fields. In particular, I consider the agency of intervention subjects and how thinking of practitioners as Gramscian "organic intellectuals" [40] can highlight their importance in defining futures for their CoPs. I describe how the process of identity formation through engaged practice can build intrinsic motivation and connect to cognitive theories of motivation. Finally, CoPs may provide a broader way of understanding community beyond co-location that can aid in designing interventions for sustainable impact and help identify new populations of practitioners where ICTD might produce consequential work.

Many researchers have examined the relationship between research and practice, which can be mutually beneficial [41, 57], but also fraught with challenges and unequal power relations [33, 39, 66]. This paper discusses how an approach focused on the social practitioner might engage with practice in more equitable and impactful ways. At the same time, such an approach may also create generative interactions with major theoretical concerns in development research and inspire new research and theory.

2 PRACTITIONERS IN ICTD

Working with practitioners and supporting their development-related efforts has been a common strategy for doing ICTD work while also benefiting from a deeper understanding of context and domain that practitioners have [39]. In this section, I elaborate the definition of practitioner and identify several different types that ICTD researchers have sought to support, grouped by domain.

2.1 Scoping the Practitioner

This paper involves literature from ICTD and adjacent fields that focuses on practitioners doing practice. Practice is a reoccurring activity with identifiable goals that requires specialized knowledge and skills [122]. Because not all relevant populations are described using those terms, I included research that discussed workers and formal education, as both are typically centered around repeating routines and specialized skills. I did not include research that involved a group of workers but was not concerned with their practice. For example, de Lepper et al.'s 2013 study provided an health education intervention to factory workers in Uganda [24]. While factory workers may constitute practitioners, this intervention was not related to the nature of their practice and thus excluded.

It is important to note that many interventions simultaneously targeted multiple sets of practitioners and that practitioners are not necessarily professionals who practice to fulfill their livelihoods. For example, maternal health care workers are practitioners, but so are the new mothers who are their clients. Like all practitioners, mothers must master specific knowledge and maintain routines - such as family planning, proper care around pregnancy, and needs of newborns - in order to achieve the goal of raising a healthy child. Thus an intervention that enables a nurse to help mothers provide better care for their children may in fact be targeting both sets of practitioners, to various degrees of directness and in different ways.

2.2 Types of Practitioners Considered

As the definition of practitioner is broad, this limited review cannot be considered complete or representative of all past work with practitioners in developing contexts. Instead, I focus on drawing literature from the domains of health, agriculture, formal education, and civics to support the arguments of this paper. And while practitioners exist on all levels, from ground-level workers to senior managers at an NGO, more literature exists on the former groups and thus are featured here. I briefly introduce some of the practitioners in these domains to underscore the diversity of areas in which a practitioner-centric approach has been valuable and set the stage for section 3 which draws comparisons between domains.

2.2.1 Global Health and Care Work. In healthcare, *community health workers (CHWs)* are workers from a village or community who are trained to provide health services in their locality. These services are often provided in clients' own homes and may include educational outreach, preventative care, and health advice [3]. CHWs can extend the reach and impact of under-resourced health care systems [63, 123] and may represent the only way for underserved communities to easily access care [3]. ICTD research has focused on creating tools for CHWs to track tasks [27], improve their training [38, 79], and enable community-led video education (CVE) for extension efforts [58, 96].

Many interventions in health education were targeted towards *new mothers*, another set of practitioners, by attempting to encourage best pre- and antenatal practices [58, 97]. Pregnancy and the care of a newborn introduce specialized informational needs around proper practices of feeding, sleeping, immunization, and other aspects of care [44, 107]. For new mothers in underserved populations, these needs might be supported by technology interventions [107], such as direct access to relevant CVE content [56].

Inside medical clinics, ICTD researchers have also aimed to support *traditional health care professionals*, such as doctors and nurses. To facilitate their work, such research has focused on creating tools that replace paper equivalents, such as electronic record systems [4], data collection systems [14, 45], digital patient summaries [5], and digitized medical protocols [28].

2.2.2 Agriculture and Food Production. Another domain which pioneered the CVE approach is agriculture, where projects like Digital Green taught sustainable agricultural practices to *smallholder farmers* [37]. Farming is a highly specialized practice with skills, knowledge, and routines that can vary by many factors such as crop, region, climate, and certification. Beyond CVE, ICTD researchers have created systems for farmers to access agricultural information and advice [88, 98] as well as updates on market prices [82, 108], weather [85], and their supply-chain [15].

As with new mothers and maternal care CHWs, interventions which targeted farmers were often also interventions which targeted *agricultural extension workers*. These workers visit farmers in their villages and fields to teach agricultural practices and were often involved in multiple aspects of digital extension interventions, such as helping to produce, distribute, and screen CVE content. In this way, projects like Digital Green were also interventions on the practices of the extension worker [37].

Like farmers, *small-boat fishermen* are a similar group of practitioners who typically use undecked vessels to engage in low-volume commercial or subsistence fishing. Past ICTD research addressing this group include tools for market price information [1, 50] and interventions designed to help track catch counts [92].

2.2.3 Formal Education. ICTD research has also been involved in education, typically in the interest of changing the learning practices of *students in formal education*. Beyond learning the material listed on class syllabi, students must also be familiar with how knowledge is reproduced in the pedagogy of the classroom and expectations of their role [9]. This familiarity is a form of social capital [21] and constitutes the practice of being a student. ICTD researchers have created interventions to affect this practice, by encouraging collaborative learning [61], online education [69, 70, 114], or changing study habits at home [94].

The practices of students are inextricably tied to those of their *school teachers*, another relevant set of practitioners. ICTD research has introduced a wide variety of technology to classroom environments, such as computers [91, 110], cell phones [16, 47], TVs, and game devices [47]. Other interventions had teachers working with intelligent tutoring systems [18], filming videos [74], and creating digital interactive content [36, 112]. All of these interventions affected the practices and pedagogy of school teaching.

2.2.4 Civics and Journalism. The final domain of practitioners addressed here is civics, including journalists and *broadcasters for community radio*. Community broadcasters run grassroots radio programs, which may require skills such as writing, managing content, and operating broadcasting equipment [75]. ICTD research has focused on creating ways for broadcasters to collect feedback and voices from listeners to enable more interactive and engaged community radio [55, 106].

Citizen journalists are individuals who take an active role in collecting, reporting, and publishing news about their communities outside of professional news media. Such journalism can play an influential role in facilitating activism by providing a grassroots process to build evidence on grievances and hold local government officials and companies accountable [71]. For these practitioners, ICTD interventions can provide better ways to gather, organize, discuss, and share information [71, 81].

3 TYPES OF ICTD INTERVENTIONS FOR PRACTITIONERS

Within their communities, practitioners orient their practice around common, tangible goals. Such goals could be getting a child vaccinated, growing a certain crop, or passing an exam. They share knowledge, skills, processes, and tactics for achieving those goals, whether that be challenging patients on misconceptions, knowing how to treat plant diseases, or engaging in regular group study sessions. Furthermore, practitioners represent action in the Global South because they exist on the front lines of doing the work of development. Thus, though their domains are exceedingly diverse, because all of these practitioners deal in the knowledge and action of development-related activities, ICTD interventions targeting them can have common typologies across domains.

This section describes one such typology based on the different intended goals of interventions when they were designed and deployed. To build this typology, I conducted a literature review of interventionist ICTD work in the past 15 years in the domains described in section 2. I wrote summaries of each work which described the intention, population, and outcome of each intervention. I used thematic analysis [11] to group and regroup work to create the categories described in this section. These categories were reviewed with three other researchers, each with at least a decade of experience working in ICTD or a development-related field.

Note that this approach based around researchers' intentions may leave out unintended impacts of interventions or the lack of impact. This typology is not an endorsement of a technologically deterministic perspective as similar typologies could be built around unintended, socially constructed, or co-opted uses, though such outcomes are less frequently reported. Also, many interventions have multiple stated goals and do not neatly fall into a single category. Rather than enumerating all possible combinations, I attempt to describe the most distinct and archetypal strategies.

Broadly, these intervention types can be grouped into interventions which attempt to influence or teach practitioner knowledge or processes, those which attempt capture or leverage existing practitioner knowledge, and those which attempt to motivate increased or improved practice. See Figure 1. The commonality in ICTD approaches towards practitioners despite varied application domains supports the idea that ICTD research is less about domains of practice, such as medicine or education, as it is about supporting and influencing development-oriented practitioners.

3.1 Structuring Practice via Programming

One of the most common ways that ICTD interventions worked was to structure the practice of practitioners via processes that were programmed into the intervention. An explicit example is e-IMCI, an application on a personal digital assistant (PDA) that implemented the Integrated Management of Childhood Illness (IMCI) algorithm developed by UNICEF. IMCI was a workflow for diagnosing and treating common symptoms in young children, traditionally described in paper flowcharts. Unlike paper, clinicians could easily carry and navigate e-IMCI during a client visit, which increased usage of and adherence to the protocol [28].

Similar work with CHWs includes Ramachandran et al.'s use of persuasive scripts to guide a CHW's consultation with a client.

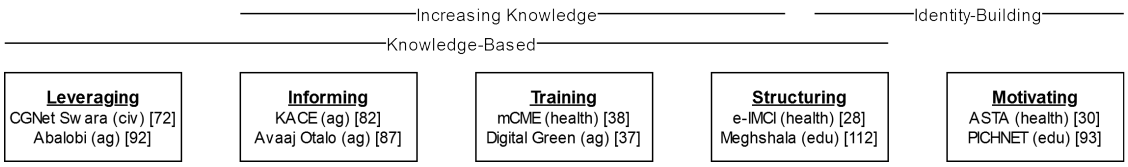

Figure 1: An overview of the different types of intervention strategies in this cross-domain typology with examples.

These scripts structured the consultation around different discoursive tactics, such as using a Socratic, dialogic approach. CHWs reported feeling more comfortable performing counseling with the aid of the scripts and were more likely to pause and offer explanations with dialogic strategies, resulting in longer sessions [97].

Many ICTD interventions included artifacts which impacted multiple aspects of practice. An example is Varanasi et al.'s case study on Meghshala, an Android app that structured content for creating and teaching lessons, and its use by schoolteachers around Bangalore, India. Meghshala's features centered around lesson-planning but also changed how teachers prepared for their classes, taught their lessons, and what administrative work needed to be done [112]. For example, teachers using Meghshala and similar systems spent more time looking for content from outside sources and including it in their lesson [36, 74, 112].

Changing the environment of practice also had effects on its structure. For example, students' roles and responsibilities changed centered around the tablet, as some teachers recruited students to assist with device management, making them "Meghshala leaders" [112]. Similarly, Koradia and Seth provide the example of an automated answering machine and how introducing it to community radio stations to save messages from listeners changed the practices of broadcasters towards engaging with their audience [55].

CVE-based projects were generally interventions on the process of extension work, as they included practices of script writing and video production that were new to CHWs, extension workers, and teachers [58, 74, 79, 96, 112]. Both the Digital Green and Projecting Health projects describe the effort involved in training existing extension workers to storyboard, feature in, film, and edit videos [37, 58]. Digital Green's intervention also introduced technologies and processes for the storage and dissemination of CVE content [37]. Finally, because workers mediated the screening of videos, CVE changed the structure of CHWs' existing interactions with their clients. This included CHWs who, uninvolved with video production, had to invent and learn new practices using video to teach, such as how and when to pause and explain key points, allow the video to play through, or replay important segments [58, 77, 96].

These process changes could be introduced for multiple reasons. In educational domains there may be pedagogical motivations, such as encouraging more collaborative learning [61, 91, 112] or better study habits [94]. Technology might be used to encourage adherence to existing canonical procedures, such as assuring medical protocols are observed [5, 28] or client consultations are carried out by CHWs [97]. Other interventions may propose entirely new processes to cover gaps caused by low resources, such as using mobile phones to distribute educational content [35, 47], mesh-network devices to collect community feedback [106], or enabling volunteer educators to hold remote office hours [114].

Altogether, the goal of interventions in this category is to create impact and support practitioners by introducing new routines, ways of doing, and the attendant changes in schedule, skills, and relations.

3.2 Training Skills and Knowledge

Introducing new practices often also means introducing new skills and knowledge. CVE interventions included at least some initial training on video production [37, 58]. ICTD interventions, as a whole, often involve some degree of training, even when only using existing technology, like basic cell phones [124].

However, interventions in this category are educational and place knowledge gain as a central goal with defined pedagogies. The most direct of these is using ICTs to deliver training materials, such as the mCME project, which sent questions for continuing medical education (CME) to CHWs via SMS [38]. Other interventions served the educational goals of traditional extension efforts. For example, Digital Green was interested in teaching smallholder farmers sustainable farming practices, such as composting and organic pest control [37]. Ramachandran et al.'s persuasive scripts tried to convince new mothers of the importance of anemia prevention by addressing widely held myths, barriers to adoption, and providing useful details for specific practices [97]. ICTD researchers have also provided educational videos directly to practitioners [22, 56].

Educational interventions targeted at students are not included this category by default, as most of those interventions are about learning course material rather than learning in the practice of being a student. One notable exception may be Maitland and Obeysekare's study on students taking MOOCs from multiple countries in the Global South. They found that students gained social capital from participating in online courses. Such capital may include experience with the pedagogical style of an American university course, practice using English, and exposure to different approaches to learning [70]. Though this was not the intent and subject matter of the MOOCs in that study, one could imagine an intervention designed explicitly to improve students' learning capital.

Overall, interventions following this strategy are attempting to increase practitioners' knowledge, skills, and cultural capital through direct and indirect training with defined pedagogies.

3.3 Informing Existing Practice

The interventions described in sections 3.1 and 3.2 tended to be program-driven, with the curriculum decided by an NGO or government agency. They also tended to be more intrusive, as they focused on teaching new knowledge or skills, introducing new practices, or changing existing ones. However, interventions in this category are information services intended to better inform practitioners' existing practices by providing targeted information.

The most direct examples are market information systems (MIS) [108], one of the earliest of which was the Kenya Agricultural Commodity Exchange (KACE) [82]. Providing price information on commodities that a farmer or fisherman is already trading in is unlikely to substantively change their practices, such as what crops a farmer grows [85]. Instead ICTs may allow farmers and fishermen to discover price information and sell in markets with higher demand [1, 50, 100]. Though the overall impact of MIS is contested [13, 105, 108] due to usability issues and costs of access [124] or loss of usefulness due to erasure of purchasing commitments [13], MIS in some contexts have led to higher profits [50].

Another example is on-demand weather forecast systems. In rural China, Burrell and Oreglia reported that receiving the weather forecast via SMS was the most successful information system relevant to farming, as farmers used it to alongside information from other sources and personal judgment to determine what the weather would be and how to respond [13, 85].

Beyond market and weather information, some researchers have built more general question and answer systems which allow practitioners seek the advice of experts. In ICTD, tools for this type of knowledge exchange were typically agricultural. The aAqua project was an early example using the Internet via web cafes and kiosks [98]. Avaaj Otalo used an interactive voice interface to allow even low-literate farmers with basic phones in rural India to listen to questions and answers from NGO experts, as well as record their own questions [87]. Query or question-answering applications could also exist on other platforms, such as smartphones [100].

Broadly speaking, these types of interventions are information services to address the existing information needs of practitioners and rely on practitioners understanding and pursuing those needs.

3.4 Leveraging Practitioner Knowledge

One commonality between the first three categories is that those projects were interested in increasing knowledge within a group of practitioners. A different type of ICTD intervention attempts to capture or expose knowledge already within a group so that it can shared with other members. One such adaptation is turning question and answer systems into systems for peer information exchange, like that described in Awaaz.De, where moderators could assign submitted questions to other knowledgeable farmers, thus providing a clearinghouse for accessing knowledge already in the community [88]. Social networks targeted at farmers can also potentially be used to share agricultural information [43].

Another reason that practitioner knowledge may be valuable to an ICTD intervention is because it can be mobilized to address needs in the practitioner's community. The clearest example is in citizen journalism. Soliciting information about local issues was often the central purpose of interventions targeting journalists, and that information can then be used to create mobilizing narratives. For example, the CGNet Swara platform to allowed journalists to source information about civic issues, which in turn enabled them to rally activism to address grievances, such as broken wells and other infrastructure [71, 72, 81]. Another example is the Abalobi project, which targeted fishermen and enabled them to report catch counts to build a community-sourced understanding of fish populations. In turn, this information was used to inform the national fisheries agency's decision-making in a way that reflects the realities of small-scale fishermen's experiences [92].

Empirical accounts have documented how groups of practitioners maintain knowledge about how to conduct their practice, such as cell phone repairmen's ability to fix a phone that won't charge [2]. There is also some research around the concept of "community-sourcing," in which targeting a specific group of practitioners using physical locality can leverage practitioner knowledge towards specialized tasks [46]. Both of these findings fit into the general thread of "asset-based" approaches to development which seek to mobilize social capital within communities as a starting point [73].

Finally, many interventions were made more credible and effective by incorporating the knowledge of local practitioners, a tactic exemplified by participatory techniques which use locally produced content. For example, the Projecting Health project incorporated local storytelling techniques and songs created by CHWs to enliven their health education videos and make them more engaging [58].

3.5 Motivating Practice

The final category of interventions is those intended to motivate practitioners. The best example of this is the SMS-based tool created by DeRenzi et al. to remind CHWs in Tanzania of pending client visits and escalated delayed visits to a supervisor. These messages were automatically sent both proactively, before and during the scheduled visit day, and retroactively to encourage CHWs to catch up on missed visits. This setup significantly reduced the average number of days that a client was overdue for a visit [26].

ASTA was a system that used visual and voice-based feedback to motivate CHWs working in child immunizations and maternal health in Uttar Pradesh, India [29]. CHWs were provided either individual or group feedback on their past performance, such as the monthly number of visits. Users receiving such feedback visited an average of 21.5% more clients per month than in the control group [30]. For high school students in Cameroon, the PICHNET system used a self-performance feedback strategy on SMS-based quizzes to motivate students to participate [93]. These quizzes also prompted students to study at regular intervals and review related material in preparation for their graduating exams [94].

Beyond encouraging more work, researchers have also explored how to motivate better quality work from practitioners. In Kenya, Okeke et al. created an application that enabled patients to submit feedback on their experiences with CHW visits. CHWs felt encouraged when they received positive messages and wanted more specific negative feedback on how to improve their practices. Administrators could also use these responses to address systematic problems for CHWs based out of certain facilities [84].

Researchers have also noted how motivation is often a side effect of well-funded and important-looking academics being involved in your practice [97]. Ramachandran et al. have tried to capture this effect by asking CHWs to solicit and film testimonials, particularly from villagers and other people with high social standing. They described how such testimonials made CHWs feel proud about the importance of their work and improved their self-efficacy, potentially leading to higher motivation [96].

One common factor between these motivating strategies is that they relied on social factors, whether peer pressure, surveillance,

fear of a supervisor, or the acknowledgement of an important personage. As such, they leveraged participants' role and identity as practitioners. Longer-term studies have not yet been done to see if motivating effects become internalized and intrinsic or can change practitioner identity. For example, DeRenzi et al. found that CHW performance decreased when the escalation to a supervisor was removed from the SMS reminder system [26].

4 COMMUNITIES OF PRACTICE IN THE GLOBAL SOUTH

The above typology shows how ICTD research has defined the work of development interventionism as practitioner interventionism, sharing tactics which span multiple domains. This illustrates the close connection between practice and impact-oriented research.

ICTD and related fields have long been concerned with the research and practice duality. Gitau and Marsden argue that building strong and fair relationships with local practitioners and NGOs is crucial to doing impact-oriented research [39]. Ebyen warns that evidence- and results-oriented approaches driven by research can stifle development practitioners and be used as coercive tools to sustain power inequalities [33]. In contrast, Kumar and Dell have explored how NGOs view research and highlight research's potential to create more effective and informed practice [57]. Gray et al. describe a model for the different mechanisms by which practice and research can inform each other [41].

In this section and section 5, I build upon this past work by examining the interactions with practitioners in closer detail using a social theory of practice. ICTD researchers are not likely to work with practitioners in isolation but instead among a cohesive group. Many practitioners are embedded within a "community of practice," a structure of social relations between people with common skills, knowledge, and goals of practice, and who use these relations to build and share the social and cultural capital necessary to achieve those goals. This section discusses this concept in more detail and how the social and contextual aspects of practice are evident in ICTD research.

4.1 Intellectual Tradition of CoPs

The concept of communities of practice was first introduced by Lave and Wenger as part of a social and situated theory of learning. They describe the process of peripheral participation that enables a newcomer to learn the skills and knowledge of a practice through apprenticeship with old-timers. Apprenticeship is a way of life that shapes the identity as well as knowledge of its participants [60].

The concept has been adopted and extended in various ways. Based on an ethnography of copy-machine repairmen [86], Brown and Duguid show how CoPs not only train apprentices but can also enable the creation of new knowledge. Through a process of dialogic storytelling, repairmen built a new and more sophisticated understanding of their domain of practice. The knowledge created by CoPs can bridge the gap between the actual practices which influence community outcomes and canonical, or official, sources of knowledge which can be more prescriptive than explanatory [12]. Later research has used the terms explicit and tacit knowledge to make the same distinction [32].

CoP theory has been influential in understanding the management of knowledge in organizations [20]. Lesser and Prusak argue that CoPs build organizational knowledge by providing a network for practitioners to find other community members with relevant information, a space to create and foster interpersonal relationships, and the generation of stories, artifacts, and terminology that shape the practice of newcomers and the community as a whole [62]. However, more work is needed to establish what characteristics of a CoP relate negatively to organizational effectiveness [54].

Wenger expands on the concept of CoPs as spaces with an ongoing negotiations of meanings. These meanings relate to the shared practices, knowledge, and artifacts which define the community, but also to the identities of its participants. For the former, members project the history of the community or interpretation of knowledge into shared artifacts which become foci of further discourse [121]. These artifacts, or "reifications," are touchpoints which shape future practice and relationships with outsiders [116, 120]. For the latter, the identity of members are constantly being negotiated through the lived experiences of participation or marginality, learning trajectories, and social interactions within the community [119]. Thus, CoPs are spaces where its members are transformed through participation in a process of identity creation.

One persistent critique of CoP theory centers around the relatively flat portrayal of social relationships within a CoP and the structuralist treatment of power. This viewpoint may underestimate the potential for differences in identities and power between and within communities to cause conflict [48]. CoPs can also mobilize to be resistant to changing practices [80]. However, not all relationships of power are repressive. Episodic power clashes between members of a CoP can help to generatively steer practice and build knowledge in the group [19]. In any CoP, newcomers learn from old-timers, who have more powerful and central positions in the community [60]. Engaging with theories of power may provide an enriched understanding of how power influences the creation of knowledge and learning in an CoP [34].

The intersection of CoPs with technology interventionism has existing since the beginning. One of the earliest online technology tools designed explicitly to support communities of practice was Eureka, based on Brown and Duguid's original analysis of copy-machine repairmen's non-canonical processes for repair. Eureka was designed by Xerox France as a knowledge-sharing portal to capture tacit knowledge about copy-machine servicing and share it with other practitioners [10]. Information sharing portals have since been built to try to record and leverage the knowledge of practitioners in a variety of domains [111].

Recent work has explored fostering CoPs in many application domains [83, 90], including communities that exist mostly online, known as "virtual" or "digital" CoPs. Some have argued that CoPs are an outdated analytical lens for online spaces [42], noting that digital communities have more fluid and vague boundaries [104], and questioning whether situated learning still occurs with computer mediation [68]. Kimble et al. argue that shared artifacts can serve as boundary objects to help navigate distances between members of trans-national CoPs [53], but it is questionable whether such communities are perceived as singular, coherent entities [42].

4.2 Identifying CoPs in ICTD Contexts

Besides digital spaces, practitioners in the Global South represent another relatively recent context for CoP research. One of the earliest works explicitly using the lens of communities of practice was Ramachandran et al.'s research with persuasive community video for maternal health CHWs, where she proposed that an online portal could be used to share CHW-generated content [96].

A more in-depth treatment was given by Oreglia in her ethnography of information sharing practices among smallholder farmers in China, where she described newcomers as learning farming by participating in peripheral and low-skill activities, observing more experienced farmers, and being observed and corrected by old-timers. To discover market prices for crops, Oreglia described the central role of CoPs in sharing and corroborating price information[85].

Zegura et al. framed the Liberian iLab project, a teaching technology hub, as a maturing community of practice. They described efforts to emphasize the production of shared artifacts, such as course projects shown during a "Demo Night," and how to progress students beyond peripheral participation into advanced roles where they can demonstrate and continue to grow their expertise. Such advanced roles included assistant instructors, librarians, and other administrators filled by former students [125].

Finally, Ismail and Kumar used an intersectional approach to examine the impact of inexpensive mobile data services on the experiences and roles of CHWs in India. They describe how considering the different identities and community memberships of CHWs illuminate the power differences within a CoP. These variations can explain how members can be differently affected by CoPs, leading to outcomes of empowerment or marginalization [49].

Beyond these explicit mentions of CoPs in the ICTD literature, I use Wenger's definition to identify and highlight some work that addresses practitioners as a CoP. Wenger defines communities of practice as having three central attributes: The first is mutual engagement, the fact that members participate in the community and recognize the legitimacy of each other's participation to allow collaborative relationships, social ties, and norms to form. Second, CoPs are centered around a joint enterprise, a shared understanding of common goals or domain of practice which is negotiated among its members. Third, members of a CoP share a common repertoire of knowledge, skills, and social and cultural resources that enable members to pursue their joint enterprise [118].

One demonstration of an active community of practice can be seen in Molapo and Marsden's research with CHWs in Lesotho. This work started with a PC application designed to enable regional trainers to edit, produce, and share videos that could serve as training aids. CHWs received an intervention in the form of the videos that started showing up in their monthly training sessions at the regional health center and being shared to any CHWs with multimedia-capable phones to take back to their field sites [79]. This eventually became a multi-year CVE project known as Bophelo Haeso (BH) [76–78].

Following Wenger's definition, these CHWs attending the same regional training center constituted a CoP for three reasons. They had a site, the training center, where they met and interacted regularly and saw themselves as a distinct group relative to the nurses and researchers that they worked with. Secondly, they shared a common motivation and domain described in the name of "Bophelo Haeso," given during consultation with CHWs, meaning "Good Health for My Home Village." And finally, CHWs saw themselves as experts in understanding health practices in their own villages and maintained a common repertoire for how they would serve their communities. Molapo et al. revealed some of this repertoire by asking CHWs to write and enact skits on how they would do common activities, such as playing videos back to clients [78].

The following quote is provided by Molapo et al.'s paper in 2016 [78]. It comes from a CHW participating in a co-design session with nurses and researchers and illustrates the speaker's identification of being part of a like-minded group of practitioners with their own domain of expertise:

> *"Among us, we have different types of knowledge. Others are experts of technology, others are experts of health, but we (CHWs) are also important because we are the direct servants of the people, and experts of what happens in the villages."* [78]

Many other interventions have likely engaged with CoPs, such as the extension workers who helped create videos for Digital Green [37] or the farmers who answered questions on Awaze.De [88].

4.3 CoPs Can Support ICTD Interventions

Communities of practice strongly influence the success of ICTD interventions through situated knowledge and structures of social support. For example, in the Bophelo Haeso project, researchers treated CHWs as experts on the health and healthcare needs of the villages that they represented. CHWs feedback was instrumental in creating educational materials relevant to their villages, such as videos on first aid [79]. CHWs were also active in negotiating emergent practices surrounding the usage of the BH app and how the intervention would fit into their existing practices. For example, CHWs commented on how pausing a video midway to take questions from clients would be disruptive and would not help answer the detailed questions that clients were likely to ask [78]. These practices continued to be refined over the course of continued usage of the app and by comparing notes with other CHWs [77].

In general, a large number of interventions have benefited from resources drawn from an underlying CoP. The Projecting Health project relied on the network of ties in the partner community of CHWs to find workers who had the knowledge to produce video content. This expertise, such as storyboarding, scripting, or filmmaking from experience in prior jobs, was social capital or organizational knowledge that jump-started the success and effectiveness of the intervention. The researchers also noted that with practice, these skills in filmmaking and giving presentations with video aids became absorbed into CHWs' broader expertise [58].

CoPs can help the adoption of new technology succeed by providing networks of support where more tech-savvy practitioners can help others understand how to use intervention artifacts [74, 78]. Interventions which relied on peer effects also may have depended on the network of a CoP. For example, motivational interventions which employed collaborative feedback used the social pressure of one's peers to affect the user [29]. Peer social pressure can also be useful in driving adoption of an intervention, as can be seen in

participatory video, where featured practitioners became strong proponents of the intervention [37].

Many interventions previously identified as capturing and leveraging practitioner knowledge in section 3.4 may have benefited from a CoP purposed around maintaining that knowledge. For example, projects such as Awaze.De enhanced information flows between peers. Questions answered by peers were more valued than answers provided by experts perhaps because participants judged peer-provided knowledge to be more likely relevant and practical to their own needs [89]. In CVE interventions, researchers have noted that viewers were sensitive to the cultural and sociotechnical environment of people shown in the videos to help them determine if practices shown were useful to adopt [37].

5 INTERSECTIONS FOR ICTD RESEARCH

While CoPs can impact the success of interventions in the field, using the theoretical lens of communities of practice can provide additional opportunities for framing future ICTD work. I argue that CoP theory has generative intersections with other perspectives in development studies, ICTD, and human-computer interaction for development (HCI4D). In this section, I discuss some of these intersections and the resulting potential directions for further research along a social theory of practice.

5.1 Empower Agency of Organic Intellectuals

International development projects often involve an intrinsic power gap between the interventionists and populations being targeted due to the economic and class differences between the two parties. One common way to address this power difference is to use participatory action research (PAR) approaches to ground action in the culture and social relations of the local context. Through ongoing self-reflective practice, PAR seeks to empower local populations and increase their agency in the development process [8, 17, 52]. The Bophelo Haeso project explicitly used this approach to incorporate the feedback, practices, and needs of CHWs into a design of an application for video playback [78]. All projects which relied on local content creation were participatory to some degree due to their focus on involving community members.

However, PAR does not necessarily dissolve the power imbalance caused by expertise. Even when materials are produced via participatory means, experts may remain the authoritative voice on proper knowledge and practice, as with farmers versus extension workers in Digital Green videos [37]. As described in section 3.4, there is a difference between interventions focused on providing expert knowledge to a community and those attempting to mobilize indigenous knowledge. In the former case, a tension remains on who is treated as the authoritative source.

Such experts exist outside of the target CoP and may be researchers and extension workers, nurses and doctors at the nearby clinic, or standards setters at an educational ministry. Participatory methods are intended to empower the most marginalized groups. However, as long as the source of expertise is not addressed, interventions risk placing authority in an external expert figure. As an unintended effect, this can depoliticize social action and depower local community members by devaluing local knowledge and needs in favor of the expert. This produces work that, despite the best efforts of a PAR approach, removes the agency of local actors in deciding for themselves their future course of "development."

This critique is raised by Li who characterizes development projects as driven by a "will to improve," a desire for betterment that invokes the imagination of trustees who attempt to work on behalf of target populations. Trustees drive a continual process of problematizing and technicalizing the complex social issues that populations face so that these issues can be targeted by packaged interventions to achieve some definition of improvement. However, trustees are constrained by the structure of their relationship with local governments and elites, which can result in conflicting policies and potentially unintended effects. Further, trustees' definitions of improvement may not match those of everyone that the trustee purports to serve. Through the process of rendering problems technical, trustees attempt to remove development from politics and place it in the purview of experts and intellectuals [64, 65].

Li argues that this process ignores the reality that development is inherently political. Removing development from politics can serve to make both trustees and communities complicit in advancing the interests of local elites [67]. Li proposes that a more representative way to pursue development projects that respects the realities of local social issues is to enable populations to develop Gramscian "organic intellectuals [40]." The role of such intellectuals would be to help their community recognize and mobilize against the mistreatment of trustee-driven development. They can do this because they are both embedded in local social relations and able to converse with experts in the processes of development and offer alternative technical realities [65, 66].

An open question remains for how to best identify and "activate" organic intellectuals to represent target populations. Understanding practitioners in a community of practice as a specific type of organic expert may provide a framework towards this end. In CoPs, trustee versus organic knowledge parallels the tension between canonical knowledge, thought to be published by the organizations which encompass CoPs, and non-canonical or tacit knowledge, which is created and maintained by CoPs [12, 32]. One way to see organic intellectuals is as practitioners who are specially versed in their non-canonical knowledge and able to mobilize it to present different imaginaries in interaction with outside interventionism.

Alongside the typology from section 3, this suggests ways for ICTD interventions to be designed for the needs of organic intellectuals understood as practitioners. For example, interventions could enable these intellectuals to be more connected to other community members and more easily share their expertise and mobilize the community. Participatory approaches of content creation and co-design, instead of reproducing expert knowledge, should be geared towards giving organic intellectuals more tools to express non-canonical knowledge, and thus allow other community members to become more versed and expert. Providing ways for practitioners to reflect on practice and share those reflections may induce the creation of new indigenous knowledge. See Figure 2.

There are still open questions to this approach. For example, how authentic is the engagement and empowerment of organic intellectuals née practitioners, insofar as that engagement occurs on platforms that are constructed and sponsored by trustees? For example, there may be an inherent "gradient of agency" in the strategies described in Figure 1. What are appropriate times and

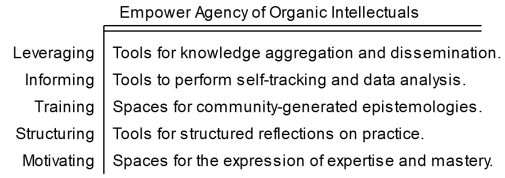

Figure 2: An example of potential future research intending to address the agency and empowerment of practitioners.

places for discourse to occur between practitioners and trustees on the values implicit in their design? What are the ethics of enabling the non-canonical knowledge of practitioners in domains such as medicine, where there are high-stakes consequences? Finally, what are the limits to understanding practitioners as organic intellectuals and the differences between them? Notably, empowering a practitioner to become master at their practice, as is envisioned in CoP theory, is different than activating and mobilizing an organic intellectual for the cause of their community, as envisioned by Gramsci and Li [40, 66].

Perhaps future research could help define guidelines for a type of "Gramscian communities of practice" praxis to address questions of agency, power, and empowerment. By building interventions which support the indigenous knowledge of CoPs, ICTD researchers can potentially empower practitioners to enter into effective conversations to represent the desired futures of their communities in the process of global development.

5.2 Build Identity and Intrinsic Motivation

Another area where a CoP lens can suggest future work is for ICTD interventions which attempt to motivate practitioners, particularly intrinsic motivation. Past motivational work has focused on using social pressures, as described in section 3.5. However, such pressures are typically only effective insofar as they are constantly applied. As many interventions are transient, providing external motivators is often not enough. It would be ideal to increase practitioners' intrinsic motivations, the inherent drive in a person to satisfy internal desires and rewards [101]. In fact, some research has shown that tangible extrinsic rewards and pressures may result in detrimental effects to intrinsic motivation [25].

Cognitive evaluation theorists (CET) place the roots of intrinsic motivation in social and environmental factors that influence a person's self-efficacy or perceived competence [7, 102]. In the context of a CoP, as a practitioner more strongly identifies with the practice, they may place more of their self-esteem in the outcomes of the practice and in the acknowledgement of their peer practitioners [113]. Practitioner identities are continually shaped and reinforced through the situated learning that occurs in a CoP [119]. Thus, designing interventions which change the environment of practice to encourage learning may shape the identity and self-efficacy of its practitioners and thus influence their intrinsic motivations.

Such interventions may focus on facilitating the process of mastery in an apprenticeship. For example, intelligent tutoring systems could be built from community sources of knowledge to aid in the teaching of new practitioners. ICTD interventions could structure apprenticeship by providing ways to visualize the learning process, explicate the progress of a newcomer, and map the knowledge that exists within a CoP. Specialized social networks, newsletters, or community networks could be created as platforms for practitioners to display their knowledge and make mastery visible to peers. Interventions which highlight membership and esprit de corps may encourage members to more strongly identify as practitioners.

CoP theory may also point to valuable places to apply extrinsic incentives. In particular, participation in a CoP is required for eventual mastery [60] and collaborative activities, such as thinking together on problems, build expertise and identity [95]. On the other hand, learning trajectories which push a practitioner towards the boundaries of the community result in marginality and divestment of practitioner identity [119]. Thus continued participation and interaction with community members is a prerequisite for continued learning, strong identity, and intrinsic motivation.

This suggests that interventions which focus on using extrinsic motivators may also build intrinsic motivation by encouraging increased participation in the CoP. For example, a intervention could use rewards and incentives in a computer-mediated social network to increase interaction between practitioners, particularly focusing on engaging newcomers. Reminders and nudges might be used to encourage practitioners to interact, such as prompting a more-established practitioner to follow up with a newcomer on a regular basis. Collaborative feedback systems [29] may be more effective if team members could send messages to each other.

Further research could also focus on the process of identity formation itself, how it occurs in CoPs, and how it relates to the motivation of practitioners. Are there qualitative differences in the forms of participation which contribute to stronger or weaker practitioner identity? For example, an intersectional approach may uncover how heterogeneity within a CoP can influence engagement or marginality. Furthermore, if self-esteem is the critical variable for both intrinsic motivation and identity, how can it be meaningfully measured to understand how interventions impact it?

Many questions still remain for the intersection of communities of practice with CET, but these two theoretical lenses provide interesting potential to bridge the gap between extrinsic and social forces and intrinsic and individual motivations.

5.3 Amplify Relationships of Mentorship

A criticism of technology interventions focused on motivating individuals is offered by Toyama's amplification theory. In this perspective, ICTs are amplifiers of pre-existing human intent and capacity, and technology alone cannot make students better if they are already unmotivated or CHWs more effective if they were already unskilled. Furthermore, technology can be harmful if introduced into contexts with dysfunctional human institutions and pre-existing inequality by accelerating the harm the such institutions can do or the inequality in the context. Instead, Toyama argues that interventionists should focus on building human capital, what he describes as intention, discernment, and self-control, through education and mentorship [109].

Communities of practice theory provides an relevant intersection with amplification theory because it describes mentorship processes by which practitioners gain mastery. Such descriptions can provide insight on where to apply the amplifying forces of technology to

improve processes which build human capital. CoPs contain both old-timers and newcomers, who exist in relationships of unequal power, but this relationship is structured to reduce inequality by resulting in the eventual mastery of the newcomer. Technological interventions applied to healthy mentorships may accelerate the processes of learning rather than exacerbate the inequality in the community of practice.

Potential interventions may include tools to allow newcomers to better learn from the work of old-timers. Some interventions, such as Awaze.De [88], have done similar work in connecting practitioners to each other to share knowledge. However, CoP researchers have observed that newcomers primarily learn by observing old-timers performing practice [60, 85]. One possible intervention might be giving video cameras to newcomers to allow them to record and review observations of old-timers' practice. Researchers have begun to examine online video platforms as sites for experts to publish and demonstrate their knowledge [103]. Further work could extended these platforms to be spaces for personalized mentorship.

As practitioners in the Global South often work in distributed settings, providing ways for practitioners to remain in contact can help foster and maintain relationships of mentorship. For example, creating a contact list or phone book catered to low-literate practitioners [51] may be able to help maintain mentorships over physical distances. Using social media, email, and other forms of computer-mediated communication may also have the same effect [6, 43]. Because remote interactions result in a lack of social awareness, tools could be built to identify and make visible who needs mentorship and facilitate connections to enable it.

Some open questions exist relating to gaps in both amplification and CoP theory in regards how power is structured in the community of practice. Beyond the difference between old-timers and newcomers, what structural sources of power and inequality can exist in CoPs and are potential pitfalls for harmful amplification? How can differences in class, race, caste, and so on, change the relations of mentorship? CoPs may also have unhealthy apprenticeship relations [2], and understanding how to identify and address them may reduce unintended impacts.

5.4 Vest CoP Ownership for Sustainability

ICTD researchers have long concerned themselves with the sustainability of technological interventions [23]. Without sustainability, the potential impact of interventions is minimized, as benefits may not exist beyond the initial investment period. This not only applies to motivational and educational efforts but general technology interventions due to the costs and efforts of maintaining ICT resources. Designing interventions to encourage community ownership is one way to encourage sustainability, as it engages an enduring group of people who feel a sense of commitment to the continued maintenance of the intervention [99, 115].

CoPs represent another potential definition of community beyond the traditional sense of co-location. Practitioners often see the value of ICT tools but lack the expertise to utilize and maintain them [75]. Structuring interventions so that the day-to-day use of such tools is managed by practitioners may be one way to encourage the development of expertise and build a sense of ownership. Connecting smaller CoPs with each other may also allow communities to pool technical expertise by creating a second, overlapping community of more technically-inclined practitioners.

This area requires further research to understand how communities of practice can contribute to sustainable development. What influences the ability of CoPs to maintain technology without being a drain on local resources and the willingness of CoPs to adopt ownership? Because communities of practice vary widely in their different characteristics [31], what factors make a "strong" and sustaining CoP in the contexts of the Global South? To improve sustainability, more work can be done to better understand both how to design technology that CoPs can maintain, and how to design technology to maintain and support CoPs.

5.5 Exploring the Limits of a CoP Perspective

Finally, as described earlier in section 2.2, this paper is necessarily limited in scope to practitioners in selected domains. And, as mentioned in sections 4.1 and 4.2, certain areas of CoP theory are still relatively unexplored, such as communities in virtual spaces and developing contexts as well as issues of power. The unique contexts of the Global South can build upon our understanding of CoPs in these areas and the limits of a CoP perspective.

For example, many practitioners in developing contexts already work in distributed teams where they do not come in contact with other members of their CoP on a daily basis. Examples include CHWs and citizen journalists, and for such practitioners, online environments can be particularly central. Researchers could also use the definition of practitioner to identify and serve CoPs in domains not addressed here but salient to developing contexts, for example informal merchants, food sellers, repairmen, and NGO staff. Finally, issues of intersectionality and power are especially visible in the Global South, and thus these contexts may be uniquely valuable to expand on the conception of power in CoPs.

6 CONCLUSION

Interventionism in ICTD consists of research in a broad swath of domains, many of which target practitioners. Because practitioners represent development-oriented knowledge and action across all domains, interventions focused on practitioners resolve to common patterns. In this paper, I have built an typology for conceptualizing ICTD interventionism as practitioner interventionism based on the various intents and strategies of researchers.

Communities of practice theory provides a framework for understanding how the social relations and cultural capital of practitioners is structured. Interventions in developing contexts can benefit from leveraging the situated nature of practice and knowledge. By intersecting the CoP perspective with existing theoretical lenses, along with a typology of practitioner-centric interventions, I suggest new avenues of inquiry which can motivate future interventionist research to address concerns of agency, intrinsic motivation, amplification and mentorship, and sustainability.

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