Learning Needs Assessment for Multi-Stakeholder Implementation Science Training in LMIC Settings: Findings and Recommendations

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Research

Keywords: Implementation science, low-and-middle income countries, capacity building, intelligent swarming

Posted Date: May 5th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-452722/v1

Abstract

Background

Despite significant progress in the field of implementation science (IS), current training programs are inadequate to meet the global need, especially in low-and middle-income countries (LMICs). Even when training opportunities exist, there is a “knowledge-practice gap,” where implementation research findings are not useful to practitioners in a field designed to bridge that gap. This is a critical challenge in LMICs where complex public health issues must be addressed. This paper describes results from a formal assessment of learning needs, priority topics, and delivery methods for LMIC stakeholders.

Methods

We first reviewed a sample of articles published recently in *Implementation Science* to identify IS stakeholders and assigned labels and definitions for groups with similar roles. We then employed a multi-step sampling approach and a random sampling strategy to recruit participants (n=39) for a semi-structured interview that lasted 30-60 minutes. Stakeholders with inputs critical to developing training curricula were prioritized and selected for interviews. We created memos from audio recorded interviews and used a deductively created codebook to conduct thematic analysis. We calculated kappa coefficients for each memo and used validation techniques to establish rigor including incorporating feedback from reviewers and member checking.

Results

Participants included program managers, researchers, and physicians working in over 20 countries, primarily LMICs. The majority had over ten years of implementation experience but fewer than five years of IS experience. Three main themes emerged from the data, pertaining to past experience with IS, future IS training needs, and contextual issues. Most respondents (even with formal training) described their IS knowledge as basic or minimal. Preferences for future training were heterogeneous, but findings suggest that curricula must encompass a broader set of competencies than just IS, include mentorship/apprenticeship, and center the LMIC context.

Conclusion

This work is the first to explicitly explore and highlight the need for fundamental, widespread, and context specific training in IS and capacity building in basic operational research for key stakeholders in LMICs. Therefore, we propose the novel approach of intelligent swarming as a solution to help build IS capacity in LMICs through the lens of sustainability and equity.

Contributions To The Literature

- This study fills an existing gap in the implementation science literature by systematically assessing implementation science learning needs of stakeholders in low- and middle-income countries (LMIC) and identifying the need for foundational, context-specific training opportunities.
- Study findings reinforce other studies in highlighting the need for training opportunities for implementation scientists that address a broad range of competencies in addition what is considered the standard body of knowledge.
- Based on the diverse set of learning needs expressed by different stakeholders in LMIC settings , this study proposes further research on an innovation called *intelligent swarming* which is a customized approach to capacity building used in the technology support sector.

Background

As the field of implementation science (IS) grows globally, interest in building researchers’, practitioners’, and policy makers’ capacity to engage in this work worldwide increases. Despite significant progress, current training programs are inadequate to meet the global need, especially in low-and middle-income countries (LMIC). Several authors have acknowledged that, even when training opportunities exist, there is a “knowledge-practice gap,” where implementation research findings are not useful to practitioners in a field designed to bridge that gap (1,2).

Addressing these two challenges is critical in LMIC settings, where many authors have acknowledged the urgent need for IS expertise to address complex, pressing public health issues (3–6). In response, various organizations have implemented training programs targeting LMIC participants in recent years. Examples are the University of North Carolina's (UNC) partnership with Wits University in South Africa (7), annual IS school at the annual conference of the Global Alliance for Communicable Diseases (GACD) (8), and various training programs sponsored by the World Health Organization's (WHO) Tropical Disease Research unit (9). Because the current body of knowledge on IS models, theories, and frameworks primarily stems from research in high income countries (HICs), training programs have mostly involved content and instructors from these settings. Differences in contexts and systems brings these programs' relevance into question (10). More broadly, stakeholders are raising questions about how imbalances in power and influence between rich and poor countries affect global health research (11). Furthermore, Eboreime and Banke-Thomas recently challenged capacity-building approaches in global health, stating that one-off training models are not useful and calling for approaches that emphasize "relationships, supportive supervision and coaching" (12). To develop appropriate and useful IS capacity building programs for LMIC settings, a formal assessment of learning needs, priority topics, and delivery methods for different stakeholders is necessary.

In this paper, we describe the results from such an assessment designed to answer the following research questions:

1. Who are the key stakeholders that need to learn/use IS methods in LMICs?
2. What kind of IS content would be most useful to each stakeholder group, and what is the optimal delivery of that content?
3. What are the implications for future research in IS capacity building in LMIC settings?

Our own impetus for this study was based on unpublished course evaluation data from various IS courses developed and taught by some of this paper's authors in 2018 and 2020. For example, in 2020, a joint team from UNC and Wits University led a two-day IS training course in Johannesburg for researchers and practitioners of HIV programs in South Africa. Formal course evaluations revealed significant heterogeneity in the perceptions of the material's utility and relevance. Researchers felt it was superficial; practitioners found it too theoretical and difficult to apply concepts to their contexts. Moreover, many participants thought the course covered specialized topics when more foundational research skills were needed. Others felt that additional coaching and support were needed to help adapt and translate models, theories, frameworks, and strategies (unpublished observations).

Based on these findings, we developed a conceptual "tiered" training model (Figure 1) for IS in LMICs, published elsewhere (13). This model is based on the premise that instructional systems must educate a large homogeneous population of learners on the basics of a field, with increasingly fewer specialists trained in progressively more complex problems. This model is commonly used in many contexts, such as education, where a general curriculum is offered to all students, with more intensive interventions targeting fewer students with specific needs and interests (14). Our goal of this research was to assess the suitability of this model to LMIC training in IS settings, develop more precise definitions of the occupants of each of these tiers, create learning objectives for each tier, and identify areas for further research.

Methods

Stakeholder Groups and Definitions

To identify stakeholders for each tier, we first reviewed a sample of articles published in *Implementation Science* in the past five years to identify IS stakeholders (MWT). We purposively sampled additional articles on dissemination, implementation, and knowledge translation frameworks based on one author's knowledge of the literature (RR). We included any person or entity the literature identified as having a role in any aspect of the implementation process. We aggregated stakeholders with similar roles and assigned a primary label and definition for each group, along with citations and examples (MWT). We sent the list to twelve individuals known to one author (RR)—each recognized as experts based on their publication record and visibility in IS conferences—and requested feedback. Seven experts supplied extensive inputs, which we incorporated into a final stakeholder table (Table 1) (MWT). Three authors (MWT, RR and CB) prioritized stakeholders from the list whose inputs would be most critical to develop learning curricula and training programs. These stakeholders (highlighted in Table 1) were those selected for interviews: senior government officials, organizational leaders, implementation researchers, clinical researchers, implementation specialists, staff managers, and implementers.

Interviewee Selection and Recruitment

We employed a multi-step sampling approach to recruit semi-structured interview participants, with the goal of approximating a random sample representing each IS stakeholder group. Our approach aimed to ensure the interviewees could demonstrate a connection to the field of IS, were based in or had extensive knowledge of LMIC settings and were geographically diverse. Two authors (RS and AHM) provided introductions to key members of three global networks: Adolescent HIV IS Alliance (AHISA), GACD, and National Institutes of Mental Health-funded Hubs for Scaling Up Mental Health Interventions in LMICs. We emailed these contacts, with seven- and fourteen-day reminders, explaining the project and requesting a list of potential interviewees (MWT). The contacts sent back a list of names, or in some cases forwarded the invitation directly to their contacts; one person allowed the research team to post the invitation to a forum of 235 individuals in an online research community.

After assembling the list of potential participants, we individually emailed and sent seven-day reminders explaining the project and linking to a Google form, which we asked stakeholders to complete to indicate their interest in participation (MWT). The form also asked participants to select the IS stakeholder category that best described them. Once respondents filled enough forms for a random sampling strategy to be viable, we emailed one to three randomly selected participants from each stakeholder group to schedule an interview; we sent a reminder in seven days. We conducted interviews simultaneously with ongoing recruitment using the same sampling process without replacement until reaching the target number of interviewees (five per stakeholder group) (MWT). During interviews, participants mentioned the dominance of English literature in the field. To explore whether there were significant differences in perceptions of learning needs of non-English speakers, we conducted preliminary interviews with one Spanish (MWT) and three French (MLE) speakers, aiming to recommend more detailed research in the future if necessary.

Data Collection

The research team (MWT, RR) developed a semi-structured interview guide (Additional File 1) that we piloted and revised with two IS professionals and a doctoral student at UNC. The phone/video interviews lasted 30-60 minutes. We obtained verbal consent for and audio recorded each interview. We transcribed and translated French (NR) and Spanish interviews (MWT) verbatim so the analysis team could analyze interviews. For English interviews, the interviewer (MWT) took notes while interviewing, which two team members (MWT, SB) reviewed alongside the recording to clarify and add context to create “memos,” later used to elicit themes. Since most responses were in response to structured questions, this deductive approach to documentation captured the required level of detail while being efficient.

Data Preparation

We used a multi-step process to create a deductive codebook to analyze the memos. We created the initial codebook deductively from the interview guide (MWT). Three authors (MWT, SB, CB) used this version to code one randomly selected interview together to finalize the codebook. Next, to establish intercoder reliability (15), two authors (MWT, SB) coded a randomly selected 25% of the memos individually using NVivo 12 software. We calculated the Kappa coefficient for each memo, and the team met to refine the coding process before proceeding to the next memo if the coefficient was less than 0.6—indicating good agreement (16). Because the Kappa values of the first six memos were each greater than 0.8 (indicating excellent agreement), we terminated this step and randomly coded remaining memos independently (MWT, SB).

Data Validation

Validation techniques are recommended to establish trustworthiness of qualitative studies (15). Techniques include credibility (fit between respondent views and researcher interpretation), transferability (generalizability of results), dependability (research process is logical and clearly documented) and confirmability (conclusions clearly stem from the data) (17,18). Our systematic, rigorous approach to coding lent confidence to our dependability.

For confirmability, our data analysis must accurately capture the context of interviewee comments. Therefore, we conducted an internal reflection based on the concept of double loop learning (19). Double loop learning is intended to address dissonance between tacit assumptions based on mental models that individuals use to make decisions, and the theories individuals articulate as their basis for decision-making. To reduce the influence of our own assumptions and capture the interviewees’ context, two authors (EA, RR) created a rubric adapted from a reflective method called the Critical Moments Technique (20) (Additional File 2).

The main interviewer (MWT) used this rubric to identify critical moments from each interview that uniquely described interviewees' contexts, and to confirm these moments had been included in coding and interpretation.

For credibility and transferability, we sought to guard against implicit bias (21) in data interpretation that could arise from the study team's location in a HIC. We adapted our validation approach from member checking (22), which involves returning data or results to interviewees to ensure the interview's intent has been accurately captured. We purposively selected two interviewees and two other individuals who collectively brought a broad range of implementation research, practice, and policy experience from Africa and Asia. We requested they holistically review our results and the assumptions underlying our interpretation of the data to provide an independent assessment of the contextual credibility of our findings and their generalizability to LMICs. We incorporated feedback from these reviewers to refine our results.

Data Analysis

Concordance Analysis

For the first research question, we (MWT, RR, CB) performed a concordance analysis between the interviewees' self-classification of their roles and the interviewer's classification based on the definitions in Table 1. Table 2 shows a tabular representation of the concordance data.

Thematic Analysis

For the second research question, we used thematic analysis (23) to identify patterns from qualitative data. In further elaborations of the method, a distinction is made between "codebook" and "reflexive" approaches to thematic analysis. In the codebook approach, themes are pre-determined by codes derived from interview questions. Themes therefore are both inputs and outputs of the analysis process. In the reflexive approach, coding is open ended, and the themes reflect the analysis output (24). We primarily followed a codebook approach, though we refined our findings by our internal reflection and external reviewer feedback. This combination of methods assured rigor in the trustworthiness of the data while being sensitive to context. As Braun and Clarke state, "*overall, what is important is that researchers use the approach to TA [thematic analysis] that is most appropriate for their research, they use it in a "knowing" way, they aim to be thoughtful in their data collection and analytic processes and practices, and they produce an overall coherent piece of work"* (21, p. 7). Our analysis approach reflects this philosophy.

We followed the Standards for Reporting Qualitative Research checklist (25) (Additional File 3) to guide documentation of methods and results.

Results

Interviewee characteristics

Participants worked in over 20 countries spanning Africa, Asia, Latin America, and the Middle East, with most also living in their countries of work (Table 3). A few were currently associated with HICs (e.g., Canada, Japan), but their primary work experience had been in LMICs. Most of the participants who mentioned their prior professional experience had a medical degree or other post-graduate training. Many were responsible for program management or coordination, followed by researchers/academics, physicians, and health financing professionals. The majority had over ten years of implementation experience but fewer than five years of experience in IS.

Concordance analysis results

As the concordance analysis results show (Table 2), the self-reported stakeholder category and the interviewer assigned category differed among 28% of interviewees (11 of 28). This discordance was because interviewees played multiple roles within their organizations and throughout their careers. The greatest discordance was among interviewees who classified themselves as clinical researchers and implementers, who the interviewer classified as implementation researchers and staff managers, respectively. Our stakeholder definitions differentiated between those who managed implementation projects (staff managers) and those responsible for the implementation (implementers), but the interviewees did not always make this distinction. Similarly, we

distinguished between clinical researchers who primary focused on developing interventions, and implementation researchers who worked on creating and testing implementation strategies. However, these distinctions were blurred, and some clinical researchers also classified themselves as implementers because they provided services while simultaneously engaged in research.

Thematic analysis results

Themes are described in three major categories: experience with IS training, future training needs, and crosscutting contextual issues. The first two themes align directly with interview questions, consistent with the codebook approach to thematic analysis described above. These themes highlight majority perspectives. The third theme arose from our internal reflections and external validation inputs and emphasizes salient learning considerations beyond IS training.

Experience with IS training

Table 4 summarizes the perception of IS training that interviewees had received to date. About half the stakeholders had no formal IS training; others mostly participated in IS trainings as opportunities arose, for example through workshops or short courses. A few had pursued IS graduate training programs. Modalities through which the interviewees had acquired IS knowledge varied widely, including online resources, online courses, textbooks, self-study, collaborative learning or alliances, and conferences.

Most interviewees described their training experiences as positive, saying, for example, trainings helped them understand what IS is and learn new approaches to research or job duties. However, many struggled to define IS. Seventy-five percent of respondents defined IS as a) closing the research-to-practice gap in implementing programs or interventions or b) studying/applying scientific methods to design, implement, and scale programs. For example, one interviewee stated:

"Putting research into practice but doing it in an evidence-based manner. You don't just translate your findings into practice and ask people to just apply it, but you do it in a way that you make sure to monitor the process and evaluate each step, looking at what goes wrong or right and how to incorporate this in a way that can be scaled up."

-Clinical researcher

This definition is consistent with the responses to how IS is primarily applied. Two thirds of interviewees stated that they used IS for evaluation of implementation efforts or designing and adapting new programs. Fifteen percent indicated using IS to influence policy. Overall, even amongst researchers, the understanding of IS appeared more akin to operational research and process evaluation (e.g., to understand barriers to implementation within a specific program). Only five respondents described using IS to frame or guide implementation research activities, and five were unable to describe how IS applied to their work.

When asked about use of IS theories, models, and frameworks, almost 40% of interviewees were not using or were not able to identify any IS frameworks or tools. Fewer than ten stakeholders named any IS-specific models, theories, or frameworks. Eleven mentioned using evaluation frameworks, though with the exception of RE-AIM (26), those mentioned were generic, such as theory of change and logic models. This finding reinforces our prior result that there is confusion between IS and process evaluation. Four respondents described CFIR (Consolidated Framework for Implementation Research), one person mentioned EPIS (Exploration, Preparation, Implementation, Sustainment), and two generically described process frameworks.

Even respondents who had undergone formal training in IS mostly described their IS understanding of the field as basic or minimal. The stakeholders named several gaps in training, the most common (40%) being difficulty in applying IS principles to their work and not knowing how to convey IS to other stakeholders. In the words of one interviewee:

"I think there is a gap in understanding how IS can be integrated into each program to enhance the way it works. Very often, there is so much research out of which recommendations emanate, but there is not always guidance on how to implement those recommendations. There is a gap in knowledge of how do you translate those research outcomes into something meaningful on the ground."

-Organizational leader

Most of the other gaps mentioned involved foundational capacity not directly related to IS, such as proposal writing, research designs, or data visualization. Generic barriers to filling these training gaps such as language, time, training locations, training fees, and lack of access to experts were mentioned, but nothing was unique to IS training. In summary, most respondents appeared to view the IS training that they had received as part of general capacity building in program implementation and evaluation rather than as skills in a separate discipline. One interviewee stated:

"In the design of all projects, there is an inclusion of some sort of evaluation of how things are implemented. You include measures of how processes are going out, they use outcomes, outputs, and activities frameworks."

-Implementation specialist

Future IS training needs

Table 5 summarizes interviewees' stated requirements for an ideal IS training program. Reflecting the variation in individual training experience, there was significant heterogeneity in respondent opinions of who should be trained, who should train, how training should be conducted, and the topics that should be covered. However, amidst this variation, some common themes emerged.

A majority of respondents emphasized the need for IS topics to cover basic, practical topics. The top six topics that stakeholders felt should be covered were basic IS knowledge (14), practical application of IS (10), application to LMIC contexts (6), engaging stakeholders (6), integrating IS into program planning and evaluation (6), and IS research methods, grant writing, and dissemination (6).

A significant majority of respondents (70%) preferred a combination of online and in-person training. Many interviewees described the need for interactive training programs including elements such as workshops, training embedded in fieldwork, peer learning, and interactive online discussion. There was also a feeling that the training duration should be linked to the distribution of time spent online and face to face. As one interviewee suggested,

"If it's in person, then a shorter course. In person is much better. If online, then a bit longer. With online courses, not being able to engage that well is a gap."

-Clinical researcher

Twenty-three of 39 respondents expressed the need for an interdisciplinary team of trainers. An equal number mentioned the need for trainers to have practical experience, with a subset (17%) expressing a preference for trainers who were comfortable with both theory and practice. In addition, some stakeholders specifically stated that instructors should have experience working in LMICs rather than only having training from Western knowledge, and that IS training topics should include application of IS in specific contexts such as LMICs. As one interviewee mentioned,

"I recently went to an implementation science training…by someone from the UK. There was a bit of discussion after that there was some disconnect between the overly-theoretically driven approach by the lecturer and the actual needs in African contexts. So you need more than an implementation science researcher from North—you need someone working in the African context as well."

-Implementation researcher

Sixty-five percent of respondents emphasized the need for training programs to include or be supplemented by mentorship or apprenticeship either during or following training. Other ideas for ongoing support were also mentioned frequently, the most common being communities of practice or learning networks and monthly seminars or other structured events. There was an overall sentiment that training alone cannot build the skills needed to take IS principles from theory to practice. In the words of one respondent,

"Current programs place so much emphasis on the theories and frameworks, but little emphasis on mentorship. Beyond being a science, implementation is also an art. Transferring knowledge within the arts involves lots of learnings which are informal."

-Implementation researcher

Crosscutting contextual issues

Several interviewees did not distinguish between implementation research topics and basic research topics. When asked about gaps in their IS knowledge and desire for future training, many stakeholders listed skills and topics related more to general research than to implementation research. Some topics suggested were retrospective reflection to determine program impact, proposal writing, evaluating literature and evidence, designing research studies, data visualization, analysis, evaluation, project management, and use of statistical software.

Similarly, some interviewees stated that applying implementation research was difficult in their countries because basic research capacity was lacking. The ability to conduct implementation research assumes foundational research methods knowledge, and many interviewees described the need to build these skills first or in conjunction with implementation research capacity. In the words of one interviewee:

"Research capacity and output [in my country] is low...so we are just struggling to do basic research—to do operational research. We haven't been able to move from actually applying research to improving public health. So it is a difficult thing to do IS."

-Implementer

In addition, some interviewees found the emphasis on implementation research training premature when there is still a critical need to develop evidence appropriate to LMICs. Several stakeholders felt that much of the evidence is developed in HICs rather than LMICs, and that interventions are "imported." For example, many stakeholders worked on projects addressing HIV and/or tuberculosis (TB). The prevalence and impact of HIV and TB in Southern Africa is considerably different than in HICs. As one interviewee stated:

"The evidence is developed in HICs, but LMICs don't have the baseline data even of the current status and need. I think that first we must generate that evidence, and then we will need to use IS knowledge to scale up."

-Implementer

Interviewees also described how funding structures made conducting and applying IS research a challenge in their countries. In some cases, project funding that came from HICs placed constraints on implementers' local decision-making authority, optimal measurement, and sustainability of projects. One mentioned that the US-funded project she worked on was *"highly prescriptive and mandated by the US,"* and two others spoke to the pressure in their US-funded projects to *"do things fast,"* and measure indicators that impede implementation rather than advance it to targets set by the donor. Another described donors' impediment to project sustainability:

"So much of the work is donor-driven and therefore finite. At the end of the project cycle, the partner changes…The big development partners like [US funder] have capacity to absorb outputs [referring to IS research], but so much is done by community organizations. How can we involve those partners and capacitate there?"

-Organizational leader

Finally, five stakeholders mentioned language as a barrier to learning IS and/or spreading IS knowledge in their countries, pointing out that the vast majority of IS literature is written in English and that, *"even the very definition of 'implementation science' is purely in English."* A French-speaking interviewee mentioned the lack of IS training materials available in French:

"When I started my master's in English, I found it extremely challenging to access resources, to read and understand them to differentiate one approach from the other. For the French-speaking world, it's the fact that training materials and resources in implementation science are unavailable."

-Implementation researcher

Further, the French-speaking interviewees reported that IS is not widely known as a science itself and that some stakeholders involved in IS are not fully aware that they are doing IS work.

Discussion

Contribution to the field

To our knowledge, this is the first systematic assessment of IS learning needs of LMIC stakeholders. Our results reinforce findings from other researchers on both training needs and competencies. Many of the current IS training opportunities, such as the National Institutes for Health (NIH)-funded training institutes, are extremely competitive and not designed to train at scale. Conferences, such as the annual NIH conference on the Science of Dissemination and Implementation (D&I), Society for Implementation Research Collaboration, the Global Implementation Conference, or the Australian Implementation Conference provide additional training opportunities, but they have all been held in HICs. At a recent meeting convened by the NIH on training in D&I, participants acknowledged that a broader approach to training was needed than is currently available. Some salient recommendations by the attendees for improving D&I training were to increase training duration, review and update training content, employ train-the-trainer models, and build support networks for training program alumni (27). The need for support networks and mentors was universally mentioned by our study participants.

Our research has also reinforced the need for training curricula that encompass a broader set of competencies than just IS—a finding that has also been identified in other research (e.g., 25–27). For example, the WHO collaborated with a consortium of global universities to create a framework of competencies for implementation research in LMIC settings (31). The framework comprises 59 competencies in 11 domains, including stakeholder engagement, mobilizing resources, and team building in addition to more traditional skills in research question formulation and research designs. Our findings suggest that a training model in IS for LMICs should teach many topics from a broad set of competencies such as those from the WHO to a wide audience, rather than a specific set of topics taught in depth to a few. This is not currently the case with IS training programs offered to LMIC stakeholders.

The need for training on a wide range of topics and for intense learning support demonstrated the inadequacy of our tiered training model concept with an orderly hierarchy of training options into which discrete and mutually exclusive stakeholder groups could be conveniently slotted to meet the learning needs of IS stakeholders in LMICs. First, it became apparent that a “stakeholder group” is not a stable, homogenous entity. At various times in their careers, professionals can be researchers, practitioners, policy makers, or organizational leaders, sometimes simultaneously. As our concordance analysis showed, stakeholders may identify themselves as belonging to a particular group, even if their roles and activities make them more likely to be classified differently. Thus, the interview results indicated that there was as much variation in IS learning needs between interviewees belonging to a particular group as there was across groups. Therefore, the idea of stakeholder-specific learning needs is unsuitable for the LMIC context.

Our findings suggest the need for a learning approach that builds upon individual participants’ existing strengths and knowledge, facilitates generation of context specific IS knowledge, and is taught in an interactive format, with mentoring as an integral component. Situational learning theory (32) may serve as a useful frame for developing a learning model. Situational theory states that learners progress from novice to expert through engagement in communities of practice where learning opportunities arise through social interactions with others involved in the same pursuit. Rather than primarily investing in classroom training, where an external expert delivers a body of content that may not be relevant or useful, a promising approach might be to create learning networks focused on implementation research, practice, or policy. Facilitator teams with IS knowledge and understanding of the local context would mentor participants in systematic approaches to test, adapt, or create locally relevant implementation frameworks, tools, and strategies. These networks would be different from the global networks such as GACD or AHISA in that they would intentionally focus on a local region or geography, explicitly recruit an interdisciplinary team of advisors who combine technical IS knowledge with a deep understanding of context and promote learning through a variety of relationships (e.g., apprentice/expert, peer-to-peer, mentored groups) that emphasize practice. To our knowledge, these types of networks do not exist today in LMICs.

Wenger defines three necessary characteristics for a community of practice: 1) the *domain*—the shared area of competence that the learners seek to advance; 2) the *community*—the intentional group of learners committed to relationships to further learning; and 3) the *practice*—the collection of activities, processes, and interactions through which learning occurs (33). Learning networks

based on these characteristics may be attractive models when there is agreement about the domain. But our interview results revealed significant variation in background and knowledge even within the domain of IS, and also wide differences in learning priorities. As mentioned earlier, the WHO core competency framework for implementation research in LMICs (31) identifies 11 domains ranging from engaging stakeholders, to conducting ethical research, to research designs—each an area around which a learning network can form. A single model to facilitate learning of IS seems unlikely to meet the diversity of need. Our findings suggest that dynamic models that bring situational learning to the individual level by providing customized, adaptive, and agile learning environments still rooted in mentoring, relationships, and practice are necessary. Rather than establishing a predefined body of knowledge and a rigid instructional structure, the learning process and the learning support would emerge from the scope and complexity of the need.

Drawing from the service sector: Directions for future research

An idea for a dynamic support model, called Intelligent Swarming℠ (34), has been proposed in the technology industry as a way to provide more responsive, timely, and customized technical support. Drawing from the principles of agile software development, Intelligent Swarming replaces the traditional process of referring customers from generalist to experts with handoffs at each level, with a collaborative “swarm” of support personnel who best match the customer’s unique needs and are motivated and capable of providing the necessary assistance. For simple problems, the swarm could be a single person; for more complex problems, the customer is at the center of an interdisciplinary network of helpers that could include technical support staff, sales teams, strategic partners, or other customers. The approach is based on the principles listed in Figure 2. It is instructive to speculate how such a model might work to meet the diverse learning needs of LMIC stakeholders. Figure 3 shows a network of support resources who could constitute a swarm.

One of the critical features of the swarm that makes it dynamic and adaptive is the matching process. This could be manual or automated, but the success of the swarm model will depend on the matchmaker’s ability to quickly assess, identify, and assemble the particular support team that meets the learning need. Depending on the need, this could be as simple as referral to relevant literature or instructional modules. For more complicated requests, such as the need to understand the use of a particular framework, the swarm may include networks of peers who have experience with the framework in various settings or consultation with local experts. For assistance with an implementation research proposal, the swarm might include implementation scientists, researchers, and program implementers with contextual knowledge about the setting. The learners themselves may be both customers of the swarm and suppliers, and willingness to contribute to the swarm might be imposed as a necessary precondition for access to resources. The swarm model may not always be a replacement for traditional training but may be a translational supplement to facilitate knowledge use. Initially, when local capacity in a particular setting is scarce, the networks from which swarms can be assembled might need to be global, and swarms must be carefully assembled to balance external expertise with local experience.

Intelligent swarming is still theoretical and would need the infrastructure, incentives, and local capacity to make these models a reality. But we strongly believe that an emergent, adaptive approach is the only way to accommodate the enormous heterogeneity in background and skills amongst those involved in implementation-related activities in LMICs and to meet the enormous demand for capacity building in the field. We advocate for increased research efforts to develop and test swarming models for learning. As increasing numbers of local researchers and practitioners gain competency in key IS domains, learning networks with deeply rooted context-specific expertise can be developed, resulting in the availability of an equitable and appropriate body of implementation research knowledge closest to where it is most needed.

Limitations

Although we employed a strategy meant to approximate a representative sample of each stakeholder group, misrepresentation could have skewed the results. Additionally, our positionality as researchers based in a HIC researching the learning needs of stakeholders in LMICs may have biased our methods and findings. However, we made several attempts to limit bias (e.g., member checking, critical moments rubric).

Conclusions

This work is the first to explicitly explore and highlight the need for fundamental, widespread, and context specific IS training and capacity building in conducting basic operational research for key stakeholders in LMICs. These learning needs differ from those in HICs, and the previously proposed conceptual “tiered” training model will not adequately address these stakeholders’ specific needs. We propose the novel approach of intelligent swarming as a solution to build IS capacity in LMICs through the lens of sustainability and equity.

Abbreviations

AHISA—Adolescent HIV Implementation Science Alliance

D&I—dissemination and implementation

GACD—Global Alliance for Communicable Diseases

HIC—high-income countries

HIV—human immunodeficiency virus

IS—implementation science

LMIC—low- and middle-income countries

NIH—National Institutes of Health

TB—Tuberculosis

Declarations

Ethics approval and consent to participate.

The University of North Carolina Institutional Review Board deemed this research exempt.

Consent for publication

No identifiable individual data is presented in this manuscript.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was funded by NIH Fogarty International Center Grant D43TW009774 University of North Carolina/University of the Wits Waters Rand AIDS Implementation Research and Cohort Analyses Training Grant. AP and RR are co-PIs, KS is the program manager and MWT was funded as a graduate research assistant to conduct the study.

Authors' contributions

RR, AHM, RS, AP and KS conceived of the study. MWT, RR, and CB designed the study protocol and wrote the interview guide. MWT acquired IRB approval; conducted the literature review and concordance analysis; defined stakeholder groups; recruited participants with assistance from RR, AHM, RS; interviewed English- and Spanish-speaking participants; and transcribed and translated Spanish interview materials. MLE recruited and interviewed French-speaking participants and transcribed French interview results. NR completed French translations of recruitment materials, the interview guide, and transcripts. MWT and SB wrote and coded memos

of English interviews. MWT, SB, EA, CB, and RR analyzed results and wrote the manuscript. EA and RR developed the data validation protocol. All authors read and approved the final manuscript.

Acknowledgements

The authors sincerely thank the 39 interviewees who volunteered their time and insights to this study, and to two of the interviewees for member-checking the results. We appreciate Drs. Latifat Ibisomi and Malabika Sarker for their external review of the results. Finally, thanks to Andrea Mendoza for assistance translating English materials to Spanish.

Authors' information (optional)

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Tables

Table 1. Master List of Stakeholders Involved in Implementation of Interventions, Programs, and Policies

Stakeholder	Definition	Alternative names	Example
Stakeholders providing funding for implementation of programs or interventions			
Donor	Provides financial support for research, translation, and/or implementation of programs.	Funder	"The **donors'** main role is funding research, KT [knowledge translation] activities, and implementation of research findings [3,21]. However, Young pointed out that the role of **donors** in KT can be both supportive and disruptive [27]. Failure to address local research priorities and taking control of the research and policy agendas are among the criticisms leveled against **donors** [28,29]" (35).
Insurer	Pays for services delivered and influences what interventions are allowed and paid for.	Payer, government insurance	"Economic evaluations of interventions usually take a variety of perspectives, including those of the social planner (societal perspective) as well of the entity making the decision whether or not to adopt the intervention being evaluated (i.e., the **payer**). The latter perspective is important because the payer is making the decision of whether or not to adopt the intervention; the reason the societal perspective is also important is because the payer may vary by intervention and disease… Currently, third-party **payers** do not as yet explicitly resource the costs of implementation in their rate-setting decisions, basing reimbursement either on the intervention or, additionally, on the type of provider delivering the intervention" (36).
Stakeholders responsible for making decisions about implementation priorities			
Elected official	Has political power and can enact policies to support the implementation of EBPs and/or influence research agendas.	Politician, political leaders	"The roles of **politicians** have been identified as mobilization of communities, dissemination of evidence, and advocacy. However, politicians may face several challenges, including the pressure to respond to their constituencies and political ideological agendas that may influence how they deal with the available evidence [3,10]" (35).
Policy maker/senior government official	Responsible for formulating policy to support implementation of EBPs but do not have political power.	Civil service employees, regulatory agency staff	"**Policy makers** influence the degree to which research informs policy development, shape the research prioritization process, and impact the actual generation of knowledge [7,21]. In addition, policy makers play a key role in establishing the required platforms for engagement in KT and in building partnerships between researchers and other stakeholders [23]." (35).
Licensing organizations	Responsible for influencing priorities for EBPs/program implementation.	Accrediting agency staff	"Finally, strategies that attend to the policy context (n = 3) can encourage the promotion of clinical innovations through accrediting bodies, licensing boards, and legal systems" (37).
Stakeholders responsible for allocating organizational resources for implementation support or service delivery			
Organizational executive/leader	Holds a position of organizational authority to make decisions about organizational priorities related to resources and approach to implement EBPs or programs.	Chief executive officer, senior leadership team member, health systems leader	"When management communicates the importance of the implementation of a new practice through its policies, procedures, and reward systems, employees are able to clearly understand that the **leaders** in the organization care about the implementation and use of the innovation, therefore enabling employees to better focus their energy and motivation for that goal. As a result, the overall implementation is more likely to succeed" (38).
Manager	Manages frontline workers in implementation and is supervised by top managers in an organization.	Project managers, nurse managers, team managers	"Studies of middle managers' role were conducted in sev- eral countries and healthcare settings, across multiple implementation phases, and were related to a range of EBPs; this suggests the breadth of contexts in which middle managers may play an important role in implementing innovations and practice changes" (39)
Stakeholders contributing to generating implementation related knowledge or evidence			

Stakeholder	Definition	Alternative names	Example
Clinical/public health researcher	Generates evidence for innovative interventions, programs, or policies and can be involved in researching methods for the translation of these innovations into practice.	Investigator, evaluator	"**Researchers** have a key role to play in the synthesis and translation of innovations. Often, the developers of a particular innovation play a major role in its translation. However, it is important to consult or work collaboratively with the intended audience, so that the product developed is more useful to the end user" (40).
Implementation researcher	Generates evidence on factors affecting successful implementation of innovations and researches strategies for addressing these factors.	Investigator, evaluator	"**Implementation researchers** have identified constructs, variables, and strategies that support the sustainable use of evidence to improve outcomes. These constructs and strategies have been synthesized into frameworks and conceptual models that provide a basis for the science of implementation and are used by implementation specialists to support communities to implement, scale, and sustain evidence-informed practices for impact" (41).
Stakeholders involved in translation and dissemination of implementation related knowledge			
Knowledge broker	Bridge stakeholders by synthesizing and disseminating research in packages that are contextually appropriate and user centered, to close the knowledge/utilization gap.		"Brokering: Enable knowledge exchange and sharing among stakeholders to increase understanding of diverse perspectives and increase the application of implementation science to improve outcomes" (41).
Stakeholders involved in supporting implementation of interventions, policies or programs			
Implementation support professional	Uses models, frameworks and strategies from implementation research to aid implementers in implementation, scaling, and sustainability of interventions, policies, or programs.	Purveyor, support provider, intermediary, implementation scientist, implementation specialist, facilitator, coach, consultant, technical assistance provider, quality improvement leader	"Implementation researchers have identified constructs, variables, and strategies that support the sustainable use of evidence to improve outcomes. These constructs and strategies have been synthesized into frameworks and conceptual models that provide a basis for the science of implementation and are used by **implementation specialists** to support communities to implement, scale, and sustain evidence-informed practices for impact" (41).
Stakeholders involved in implementing interventions, policies, or programs			
Implementer	Carries out innovations and can contribute to developing local innovations and strategies for effective implementation.	Practitioner, provider, healthcare professional, clinician, staff, implementation team member	"…**practitioners**, who are responsible for program implementation, management, or evaluation, described by Kirchner et al. as the agents who promote evidence-based interventions by using implementation tools and through collaboration with implementation experts in order to employ evidence-based strategies [12]. **Implementers** must systematically and rigorously employ the theory informed frameworks and strategies proposed by the researchers in routine practice in particular settings" (42).
Stakeholders involved in providing training and education in implementation-related knowledge			

Stakeholder	Definition	Alternative names	Example
Implementation science capacity building professionals	Provide implementation science training in academic and non-academic settings.		"Various institutions have begun offering stand-alone implementation science courses to various student audiences [35–37]. For example, the **University of Michigan** Medical School's Health Infrastructures and Learning Systems program offers, to master's and doctoral students, a two-semester sequence in 'Implementation Science in Health' [35]" (42). "The intensive workshops offered by the Implementation Research Institute (IRI) and the Training Institute on Dissemination and Implementation Research in Health (TIDIRH) are prime examples in this category [researcher training programs not leading to a university degree, diploma, or certificate]" (42).
Stakeholders whose outcomes are influenced by the quality of implementation			
Patients	Influence implementation research and practice by making decisions about adherence and adoption of interventions, policies, and programs.	Consumers, clients, families, community members	"Considering D&I as a process with multiple phases has implications for how the various topographic levels (i.e., country, system, organization, provider, **patient**) may impact or be impacted by the D&I of evidence-based practices into routine care. Such bidirectional effects are key to conceptual models that recognize recipients of new technologies as not passive but as highly likely to react in various ways depending on characteristics of the context, the innovation to be implemented, and individual differences in health care providers and **patients**" (38).

Table 2. Stakeholder Concordance/Discordance

		Researcher's classifications						
		Senior gov. official	Org. leader	Imp. researcher	Clinical researcher	Imp. specialist	Staff manager	Implementer
Stakeholders' self-classifications	Senior gov. official	4						1
	Org. leader		5	1				
	Imp. researcher			5	1			
	Clinical researcher			1	2		2	
	Imp. specialist					6	1	
	Staff manager						6	
	Implementer				2		2	1

Table 3. Demographics of Interview Participants

	Response	N
Countries of Work	South Africa	8
	Nigeria[a]	5
	India	3
	West Africa	3
	Ghana	2
	Kenya	2
	Nepal	2
	Uganda	2
	Burkina Faso	2
	Benin	1
	Colombia	1
	Brazil	1
	Germany[b]	1
	Japan	1
	Latin America and Caribbean Region	1
	Lesotho	1
	Malawi	1
	Mozambique	1
	Canada[a]	1
	Tanzania	1
Past Professional Experience	Graduate training[c] (Master's degree and/or PhD)	3
	Medical doctor (with a specific mention of a public health specialization)	6
	Monitoring & evaluation[c]	4
	Nurse	2
	Project management	2
	Medical doctor (general, no mention of specialization)	2
	Trainer	1
Profession/Role	Program director, manager, or coordinator	18
	Researcher	4
	Medical doctor (with a specific focus on public health)	4
	Professor/Researcher	3
	Medical doctor and researcher	4
	PhD Candidate[d]	2
	Other medical provider[e]	2

	NGO Executive Director	1
	Health lead specialist at bank	1
Years of Implementation Experience	1-5 Years	1
	6-10 Years	3
	11-15 Years	6
	>15 Years	6
	Did not specify	2
Years of IS Experience	<1 Year	3
	1-5 Years	11
	6-10 Years	5
	11-15 Years	1
	>15 Years	3
	Did not specify	4
	No IS training	2

[a] One person mentioned working in two countries; respondent is on leave from Nigeria and currently working in Canada. They have been counted in both countries.

[b] Respondent mentioned that they work in Germany, but they have connections to other countries through the project (Tanzania, Uganda, India, Israel, UK).

[c] One person mentioned past professional experience in monitoring and evaluation, as well as specifically noted a master's degree; respondent is counted in both categories.

[d] One PhD candidate is also a "health financing expert for the country."

[e] Includes a general "medical practitioner" response and a midwife.

Table 4. Past IS training

Code	Response	N
Definition of IS	Putting program/ intervention into action by closing research-to-practice gap	19
	Study and application of scientific methods to design, implement, and scale programs	10
	Understanding implementation of programs and how they effect change for the purpose of replication/improvement	4
	Translation of research into policy change	3
	Improving impact of an intervention	2
Application of IS in work	To frame/guide evaluation of implementation efforts	16
	To design/adapt new programs or strategies	9
	To influence policy	6
	To frame/guide implementation research activities	5
	To train others to implement	3
	To guide scaling up	3
	To help report implementation efforts	2
	To engage stakeholders	2
	To guide dissemination efforts	1
	Ongoing quality improvement/learning	1
	Unable to describe how IS applies to work	5
IS topics and tools used	Monitoring and Evaluation frameworks	11
	Other theories of change	6
	Quality improvement methods	5
	Determinants frameworks	5
	Process framework	2
	EPIS	1
	Not applying IS specific framework/tools or unable to identify	15
Past IS learning experience	In-person workshop/short course	14
	No formal training	16
	Online resources	7
	Online courses	6
	Graduate program	5
	Textbook/journal	4
	Self-study	6
	Alliance/learning collaborative	3
	Conferences	2

	Practical experience/application	4
	Fellowship	1
	Podcast	1
Usefulness of past IS training	Helped understand what IS is and how it's applied	5
	Learned new approaches to research	4
	Provided new ways of framing existing work	3
	Learned new approaches to job duties	3
	Basic knowledge	2
	Usefulness limited by lack of opportunity to apply	2
	Improved quality of work	2
	Adequate knowledge	1
	Non-IS training did not meet IS-specific needs	1
	Useful to receive training related to project and program management	1
	Preparation before training and access to materials	1
Gaps in training	How to apply IS (e.g., theories and frameworks) in practice	15
	How to convey IS to other stakeholders	4
	Mentorship	2
	Planning for sustainability	1
	Importance of exposure to multiple perspectives within IS	1
	Need for retrospective reflection to determine program impact	1
	Proposal writing	1
	Difficulty working with people in other roles	1
	How to use learnings to influence policy change	1
	How to display findings (data visualization)	1
	Evaluating literature and evidence	1
	How to design research study	1
Methods of addressing training gaps	Consult others	5
	Self-study	3
	Mentorship	1
	Tutoring session at conference	1
Barriers to addressing training gaps	Language	5
	Time	3
	Location of training	1
	Training fees	1
	Experts are in other countries and busy	
Ongoing IS learning approach	Conferences/Workshops	5

	Online courses	4
	Through practice	4
	Self-study	4
	Reading journal articles	4
	Meeting with knowledgeable colleagues	3
	Continuous medical education	1
	WhatsApp group	1
	Online databases/resources	1
Ongoing learning needs identification	Through conversations with colleagues in the field	1
	Through conferences/trainings	1
	Through reviewing literature	1
	Through practice	1

Table 5. Future IS training

Question	Themes	Sub-themes	N	Illustrative quotes
Optimal IS training topics	Basics of IS	· What IS is · How IS relates to other disciplines · When to use IS · Models, theories, frameworks · Implementation outcomes, inputs, and strategies · Generic presentation so applies to multiple disciplines	14	
	Practical application of IS	· In implementation · Research · Policymaking · Translating research to practice · Scaling community models	10	"So if one could focus on how to implement, rather than how do you develop a policy or strategy or monitor a policy…For instance, if they need to make a shoe, there is a lot of concentration on how to make the shoe, but little concentration on actually making the shoe. They need to concentrate on making the shoe rather than just the plans and the monitoring and evaluation. There is all this focus on the shoe must have a lace, a sole, leather on top, black color, but no concentration on actually making the shoe. How do we implement all these wonderful policies and get from point a to b to c and really do the thing rather than just knowing how to measure it or develop a strategy for it?"
	IS research methods, grant writing, reporting, and dissemination	· Disseminate to people on the ground · Experimental design · Practical	10	
	Application of IS in specific contexts (e.g., LMICs)	· Through case studies	6	
	Engaging stakeholders		6	
	Integrating IS into programs/research (rather than add-on)	· On the ground · Into overall research programs	6	"Because implementation research is not its own topic, we can integrate it into any research we are doing – any kind of epidemiological research."
	Optimal data use	· Using data for implementation · How to measure if implementing optimally · Making data-informed decisions	4	"A key issue here is to show results—of how an IS study really provides useful information for you to make decisions."
	Leadership, behavior change, organizational culture		4	
	How to introduce IS to junior scientists		1	

	Political analysis, stakeholder assessments, cost-effectiveness, economic analysis, other theory		1	"I find it difficult to see how IS can in reality be effective without knowledge of health systems. So there is a lot of knowledge in health policy and systems research in the last 20 years which IS can leverage."
	How to be involved in the world of IS	· At the table in WHO discussions	1	
	Ensuring continuity between funding/partner cycles		1	
	How to access IS information		1	
	Other topics	· Evaluation · Data visualization · Data analysis · Data management · SPSS · Project management Complexity theory	9	
Optimal IS training duration	1-3 days		3	
	5-7 days		5	
	1-2 weeks	· Broken up or together If in person	4	
	6-8 weeks	· 2-3 weeks online, 4 weeks in person, another 1-2 weeks online	2	
	1-3 months	· Full-time · 3-4 days a week	4	
	3-6 months		1	
	6 months – over a year	· Minimum 1 year if online, or 3-6 months if in person	2	
	Several days over several months	· 6-8 weeks spread out · 2 hours each week over 3-6 months · Short modules with practice in-between · 3-5 day intro with follow up period after applying	15	"…process where people have an opportunity to come back after developing a concept and raising the questions in their own organizations, applying it, and seeing what is achieved through it and how practices change as a result."

		· 4-5 short courses, each 5 days · With 5-day intro (2) · With 1-day intro If online 3-5 days every 6 months		
	21 sessions		1	“It’s proven that if you do something more than 20 times, you’re most likely to stick with it.”
	As long as the implementation process		1	“Since it is actually about the implementation of the thing, it needs to be coupled to practical things that people do in their workplace, so it needs to be very minimal lecture time—rather, more practical time on the job. Taking the person through the process, where the person can learn throughout the process of doing the thing. Going back to the shoe, take them through the process of here is the sole, how do you stitch this up, and it must be for as long as it takes to make the shoe.”
	Academic multi-year PhD program		1	
Optimal IS training format	Hybrid	· Online first to familiarize participants with content, then face to face (3) · Face to face first, then online (with experts or mentors) (3) · Online primarily for convenience · Synchronous lectures preferred but video lectures acceptable · Some instructor contact face to face or online for answering questions · In person once in beginning, middle, and end · Small cohorts in particular region · Online, in person, then online	25	“COVID will change the way we work. Globally there has been so much virtual linkage, and within [my country], it has propelled us into an online learning environment. A lot of IS input could be online—it’s cheaper, could reach more people, and is as effective with the tools we have. If this is offered globally or within one nation, you can still have small groups of people that come together face to face as needed where there is geographical proximity...they could get together to present projects to each other.”
	Face-to-face	· At the worksite	5	“If I had the opportunity, she would have an in-class training. Face-to-face training would be slightly shorter...At the MOH, most people would prefer an online course if will be a year. But if it were 3-6 months, if I could get an opportunity, I would like it to be face-to-face, if I had resources to support me to go for that training...Because it would be more interactive, you would be able to ask questions and have discussion groups. [A previous training] We had an interactive online platform where people would

				discuss, but people were busy, so not many people did that."
	Online	· With real-time support/interaction · Post courses online	6	
Optimal IS training mode	Combination of self-study, lecture, workshops, discussion, case studies	· Bring project from own work	12	"Lectures are useful, but in these training contexts, lectures usually end up being people presenting their research, and that isn't helpful because you can just read about that in their publications."
	Workshop		12	
	Lecture	· Videos with lecturer on half of screen with PPT slides on other half · For introductory material	5	
	Embedded in fieldwork	· With online/telephone mentorship	4	
	Assessment of knowledge		4	"Capacity assessments—assess where people are before so you can tailor the strategy to where people are at. Because how do you know what my needs are and what level I am at…Then you need to evaluate if it works—that's part of implementation science. There must be some kind of evaluation tool."
	Self-paced/self-study	· Readings	4	
	Case studies	· Through videos	2	"You need to have a variety of case studies that are context specific, that allow participants to relate to them to understand better. Especially if you're trying to present a conceptual framework to a case study, then the case study must relate to something that I've worked on. If you're entering into the long-term process of building capacity in people in IS, you better write a book of case studies."
	Peer learning	· While in-person	1	
	Interactive online discussion		1	
Optimal IS training participant composition	Diverse roles	· Including policymakers · So can learn from each other · People from different sectors · Everyone who is part of implementation process · Diversifies thinking	25	"Having different stakeholders will make it easier for us to explain our knowledge to other people." "You would need to include a wide range of people, including policy makers, in the training, and implementers, so that we could really bring a culture of implementation science to the work."
	Diverse and similar roles		4	
	Similar roles		4	

	Diverse roles but common career level	· Multisectoral	3	"The hierarchical society in [my country] means junior people won't speak openly around senior people." "If you're running a training for implementers, you need to target the mid-level staff like program managers. The senior staff either have gone through the ranks and have the knowledge and are leading other people, or they don't have time to implement it… For the most senior staff, it would be beneficial to have a strategy workshop, or input on how to incorporate and effectively utilize IS at a programmatic/policy/strategic direction level. In other words, how to enable/optimize IS as part of a program. Then for the next level we initially spoke about, to have more of the nuts and bolts of the how-to."
	Diverse fields but common implementation issues/responsibilities		3	"Managers speak the same language. They all complain about people. Policy makers might just be complaining about stakeholders and who didn't come to a meeting. They won't relate. It needs to be people facing similar problems in different contexts."
	Policy makers (implementers stated)		2	
	Diverse roles but same field		1	
	People with research background		1	
	Diverse roles but common level of IS experience		1	
Optimal IS training instructor characteristics/ background	Interdisciplinary team/multiple instructors	· Experience with research/grant writing (2) · Experience applying IS to policy/practice (3) · Experience using data (1) At least two areas of expertise (e.g., policymaking and research	23	
	Experience in the field	· Implementing · Guiding policy makers · Working with many stakeholders · High-level implementers or policymakers	16	
	Combination of strong theoretical and practical experience		7	"I would want someone who is academically strong because I would want a strong theoretical base. I want to be able to draw on their knowledge of the evidence base of IS as a practice rather than just a 101 how-to. And experience as an implementer in whatever the discipline and someone who has applied this knowledge, because I would want them

				to be able to share lessons from the ground—what worked, what didn't."
	Non-specialist in a particular health area		4	
	Understanding of/experience in context	· LMIC context	4	"I recently went to an implementation science training…by someone from the UK. There was a bit of discussion after that there was some disconnect between the overly-theoretically driven approach by the lecturer and the actual needs in African contexts. So you need more than an implementation science researcher from North—you need someone working in the African context as well."
	Theoretical knowledge/ expertise		4	
	Single coordinator/coach		2	
	Background in IS research		2	
	Good teacher	· Lively/fun personality Good communicators	2	
	Speak/understand English well		1	
	Mix of HIC/LMIC instructors		1	
Optimal IS post-training support	Mentorship	· Months or years duration · Monthly or less frequent calls · Face to face or Zoom options · Leading to certification/ability for trainee to coach/mentor (3) · On-demand (2) · Spreading knowledge to others in office · Feedback on application · Proposal writing	25	"One key aspect that I have talked with colleagues about which is lacking in many IS programs is mentorship and apprenticeship. It's one thing to sit in a class and get theoretical knowledge about what IS is, but often, given that IS is supposed to be practical, in the real world, you can't just pick up theories and tools. It's an unfortunate emphasis in the current programs. So much emphasis on the theories and frameworks, but little emphasis on mentorship. Beyond being a science, implementation is also an art. Transferring knowledge within the arts involves lots of learnings which are informal."
	Network of peers, instructors, and experts/community of practice	· Opportunities to collaborate	10	
	Continuous capacity building	· Monthly seminars where trainees present · CME for implementation · Group activity	5	

		· Webinar · Booster session		
	Small grant		3	“Depending on the provider of the IS training, ideally there would be a small grant attached to that training…That’s when the educational input really becomes useful. Even if that is just offered to a few select participants who have shown promise, that is a quick and easy way to build the practice at the implementation frontline because those people are involved in organizations and are going to engage their colleagues around it.”
	Developing a plan after training that is monitored	· Homework to apply models in delivery setting	2	“Maybe during the training, you develop a project that you would go back to implement. Then working with someone—follow up with the trainer to talk about your stage of implementation. It should be the kind of project you know you’ll get approval for in your place of work.”
Optimal ongoing learning opportunities	Online library/resource list		4	
	Mailing list of trainees		1	
	Newsletter or website for updates/comments		1	
Other/ Miscellaneous	Need to develop culture of IS	· Everyone should learn IS so can make population impact	2	
	Pressure	· Global paradigm shift toward IS necessitates capacity and skills in IS · Under pressure regarding implementation, and time is constrained, so training must be considerate of that	2	
	Resource requirements for doing IS well		1	“It's really expensive to do this stuff well. [RA asks if he is referring to the training or the work itself] The work itself. Training too, but IS itself is a big undertaking.”
	Measurements		1	
	Umbrella organization for IS		1	
	Professional training points should be part of any training		1	
	Language barrier of IS materials	· English – French	4	
	Funding mechanism for training?		1	
	Strong desire to help those in interviewee's country		1	
	Donors affect		1	“Sometimes something that worried me a lot is about

	implementation		monitoring and evaluating implementation science programs. This is so important, mainly for donor funded programs like PEPFAR and Global Fund things. All of them are worried and concerned about indicators. So they put in place lots of means and resources to ensure they can get indicators. But they aren't realizing that the presence of these people trying to get information from them about indicators is affecting implementation. So finding a way to monitor and evaluate implementation science program without interrupting the implementation is important."
	Little IS expertise in Africa, but very needed	1	

Figures

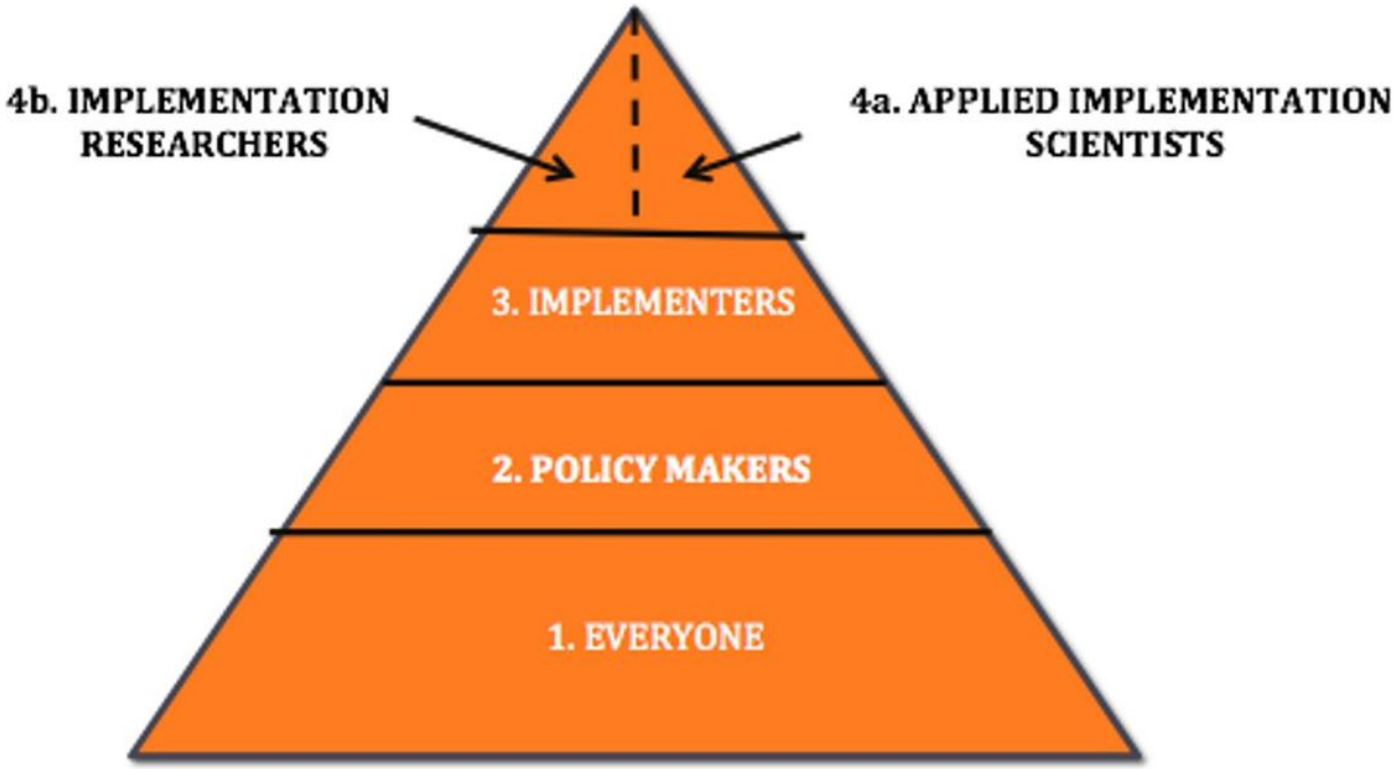

Figure 1

Conceptual "tiered" training model

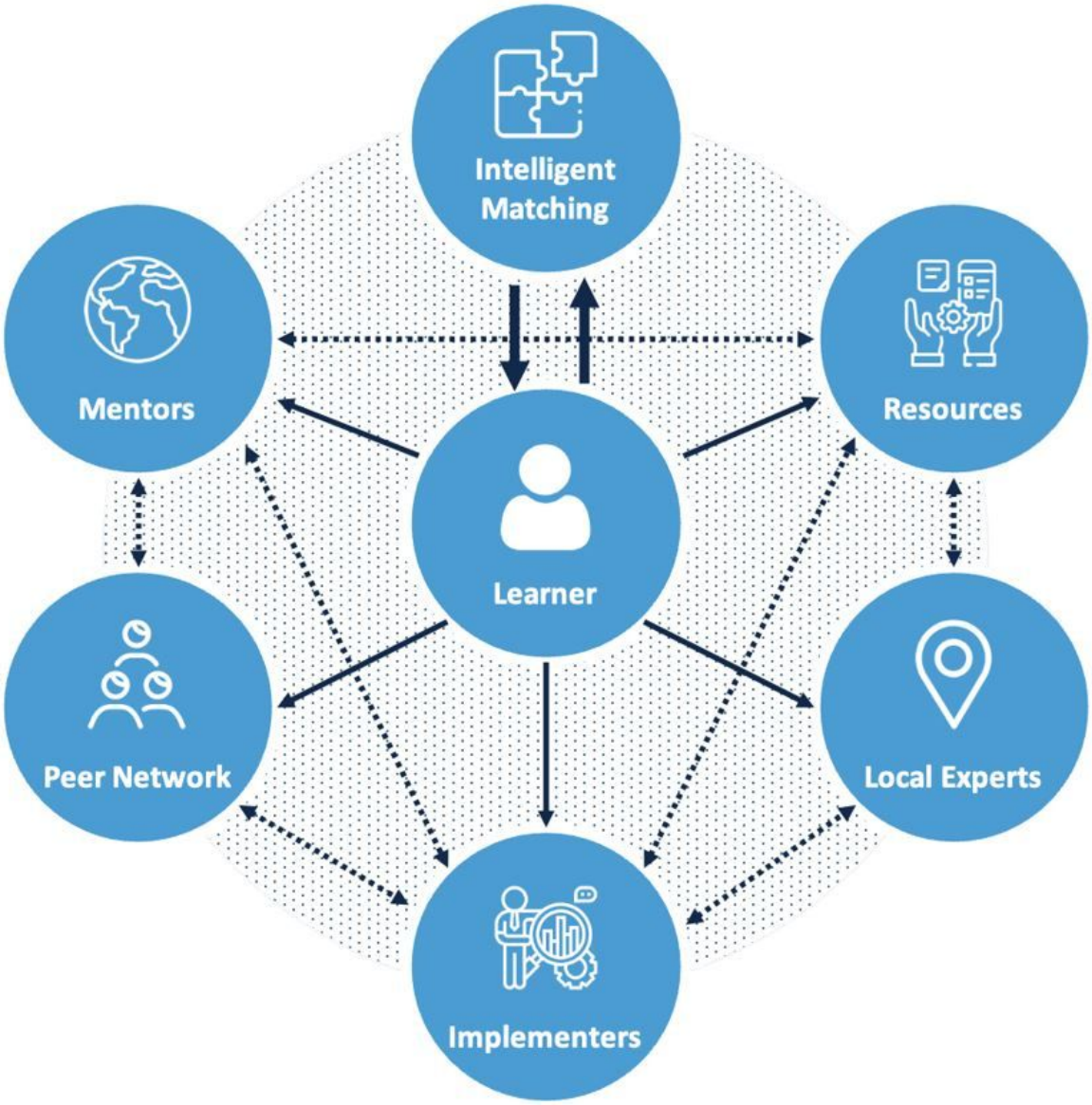

Figure 2

Illustration of an “Intelligent Swarm” network of support resources

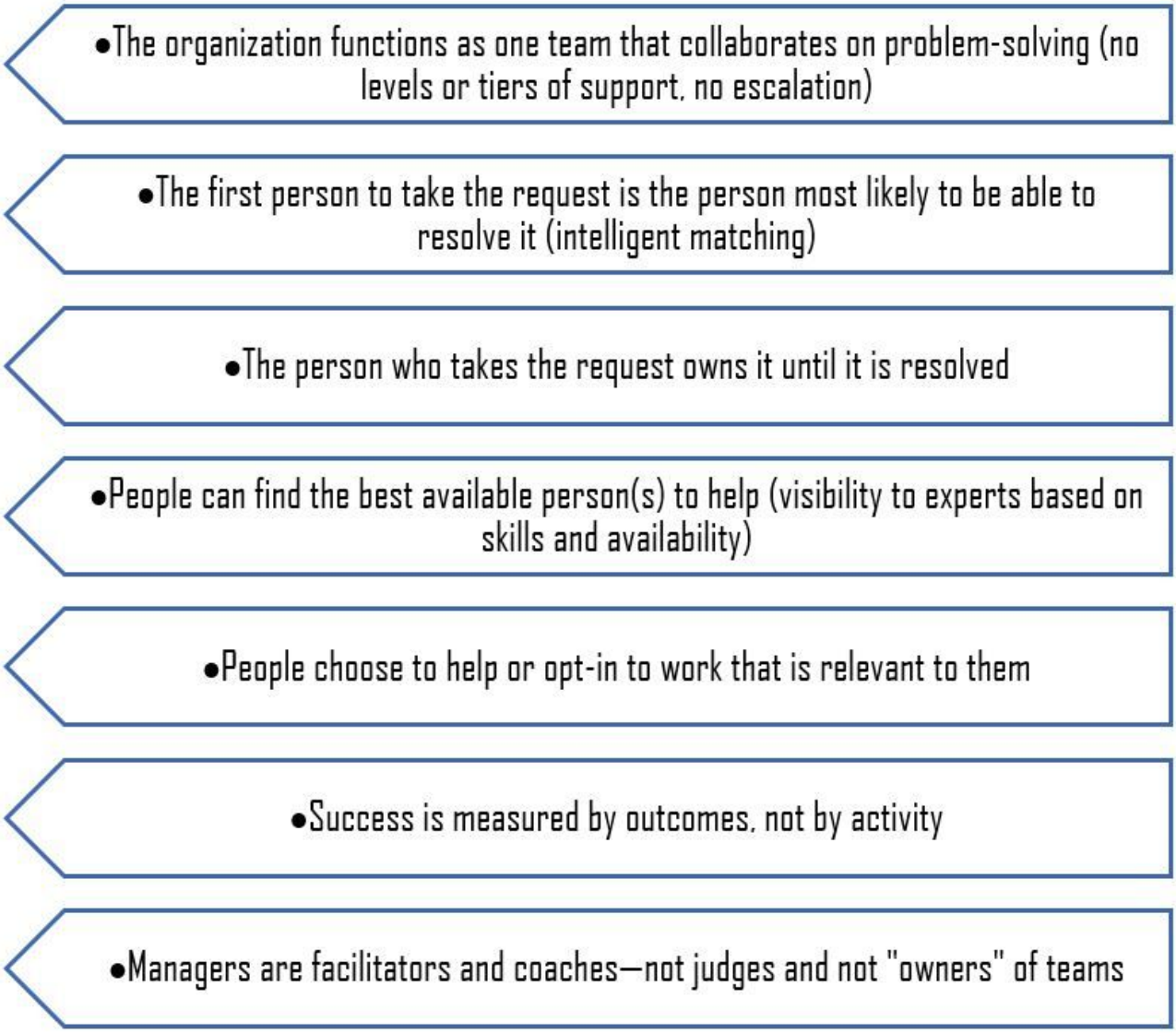

Figure 3

Principles of Intelligent Swarming

Supplementary Files

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- AdditionalFiles.docx