# Harmonizing evidence-based practice, implementation context, and implementation strategies with user-centered design: a case example in young adult cancer care

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# Abstract

Background. Attempting to implement evidence-based practices in contexts for which they are not well-suited may compromise their fidelity and effectiveness or burden users (e.g., patients, providers, healthcare organizations) with elaborate strategies intended to force implementation. To improve the fit between evidence-based practices and contexts, implementation science experts have called for methods for adapting evidence-based practices and contexts, and tailoring implementation strategies; yet, methods for considering the dynamic interplay among evidence-based practices, contexts, and implementation strategies remain lacking. We argue that harmonizing the three can be accomplished with User-Centered Design, an iterative and highly stakeholder-engaged set of principles and methods.

Methods. This paper presents a case example in which we used User-Centered Design methods and a three-phase User-Centered Design process to design a care coordination intervention for young adults with cancer. Specifically, we used usability testing to redesign an existing evidence-based practice (i.e., patient-reported outcome measure that served as the basis for intervention) to optimize usability and usefulness, an ethnographic user and contextual inquiry to prepare the context (i.e., comprehensive cancer center) to promote receptivity to implementation, and iterative prototyping workshops with a multidisciplinary design team to design the care coordination intervention and anticipate implementation strategies needed to enhance contextual fit.

Results. Our User-Centered Design process resulted in the Young Adult Needs Assessment and Service Bridge (NA-SB), including a patient-reported outcome measure redesigned to promote usability and usefulness and a protocol for its implementation. By ensuring NA-SB directly responded to features of users and context, we designed NA-SB for implementation , potentially minimizing the strategies needed to address misalignment that may have otherwise existed. Furthermore, we designed NA-SB for scale-up ; by engaging users from other cancer programs across the country to identify points of contextual variation which would require flexibility in delivery, we created a tool not overly tailored to one unique context.

Conclusions. User-Centered Design can help maximize usability and usefulness when designing evidence-based practices, preparing contexts, and informing implementation strategies- in effect, harmonizing evidence-based practices, contexts, and implementation strategies to promote implementation and effectiveness.


# Contributions To The Literature

- Novel approaches are needed to harmonize *evidence-based practices*, the *contexts* in which they are implemented, and the *implementation strategies* intended to facilitate their implementation, thus minimizing burden on patients, providers, and healthcare organizations while optimizing implementation.

- User-Centered Design can be leveraged by implementation scientists to: (a) optimize *EBP* design to improve key determinants of implementation like usability and usefulness, (b) prepare *context* to promote receptivity toward EBPs (e.g., modifying workflows to accommodate EBP), and (c) select or design *implementation strategies* which increase the contextual appropriateness of an EBP.

# Background

Evidence-based practice (EBP) implementation is often challenged by poor fit between EBPs and their implementation contexts (i.e., the "set[s] of characteristics and circumstances that consist of active and unique factors, within which the implementation is embedded")[1, 2]. Use of an EBP (i.e., intervention with proven efficacy and effectiveness[3]) in a context for which it is not well-suited can compromise its effectiveness and burden users (e.g., patients, providers, healthcare organizations) with elaborate strategies intended to force implementation. However, EBPs are seldom designed to address the nuances of multiple, varying, complex, and changing practice contexts[1]. To accommodate nuanced contexts, EBP developers may produce increasingly complex EBPs[4], resulting in EBPs "that are ultimately too expensive, impractical, or even impossible to construct within real-world constraints"[5]. Despite consistent recognition that there is no implementation without some adaptation, few methods exist to inform systematic EBP adaptation[6].

Implementation scientists have identified various EBP characteristics that influence implementation[7]; such evidence may inform efforts to adapt EBPs to improve implementation. However, the relation between EBP characteristics and implementation outcomes varies across EBPs and contexts[7], and the same EBP may demonstrate varying degrees of effectiveness in achieving the desired patient outcomes across different contexts[8]. All of this suggests that an EBP's implementation and effectiveness are inextricably linked to context. Methods for considering the dynamic interplay between EBP and context have not been well articulated[6, 9].

To address discordance between EBPs and contexts, implementation scientists often turn to implementation strategies – i.e., "methods or techniques used to enhance the adoption, implementation, and sustainability" of EBPs[10, 11]. However, a "more is better" approach to deploying implementation strategies to compensate for poor EBP-context fit may burden EBP users. Moreover, implementation strategies have shown only modest effect sizes[12]. These findings may be in part due to an insufficient consideration of key determinants, such as contextual appropriateness, when selecting or designing implementation strategies[13]. To this end, implementation scientists have called for methods for tailoring implementation strategies to EBPs and contexts[13, 14].

Rather than deploying cumbersome EBPs or implementation strategies to improve EBP-context fit, implementation scientists should seek to harmonize EBPs, contexts, and strategies (i.e., design each with respect to the other two). An analogy (Fig. 1) helps illustrate this harmonization: in embroidery, decisions about fabric, needle, or thread are interdependent. For example, a lightweight fabric and thin thread demand a smaller needle; using a large needle may damage lightweight fabric and thin thread. Likewise,

too-thin thread may break if used with a thick needle or heavy fabric. Depending on thread count, fabric may require stabilizer or alteration before embroidering. Similarly, an EBP (i.e., the thread), context (i.e., the fabric), and implementation strategies (i.e., the needle) should be harmonized to minimize user burden and optimize implementation.

There is a critical need for the development of “relational, and dynamic approaches to theorising the complex interplay between the characteristics of interventions, the activities of implementers, and the properties of variable broader contexts”[15]. Indeed, advancing methods for harmonizing EBPs, contexts, and implementation strategies has been articulated as a priority for implementation research[7, 16]. Here, we argue that such harmonizing can be accomplished with User-Centered Design (UCD), an iterative and highly stakeholder-engaged process for designing EBPs, preparing contexts, and informing implementation strategies. To demonstrate, we present a case example in young adult cancer care. Specifically, we describe a three-phase UCD process – (1) usability testing (optimizing the thread – i.e., EBP), (2) ethnographic contextual inquiry (understanding and preparing the fabric – i.e., context), (3) prototyping with a multidisciplinary design team (threading the needle – i.e., designing EBP and implementation strategies) - to design a care coordination intervention for implementation in a comprehensive cancer center. In this article, we focus on describing the methods used in our project; more detailed results will be presented in future publications.

# User-Centered Design

UCD is an iterative and highly stakeholder-engaged process for creating products which are directly responsive to their intended users and users’ contexts[17]. Primary goals of UCD are improving EBP usability (ease with which it can be successfully used[18]) and usefulness (extent to which it does what it is intended to do[19]). Usability and usefulness are proximal determinants of perceptual implementation outcomes (i.e., acceptability, feasibility, and appropriateness; e.g., usability promotes acceptability) through which they also influence distal behavioral implementation outcomes (e.g., penetration, reach, sustainment; e.g., acceptability promotes reach)[20].

Most UCD definitions and frameworks share a common set of principles that contribute to harmonizing EBPs, contexts, and implementation strategies: (1) refining EBPs based on user input to optimize usability and usefulness[21]; (2) engaging prospective users to achieve a nuanced understanding of context; and (3) a multidisciplinary design team collaborating to produce design and implementation prototypes. Together, these domains comprise an iterative cycle in which an EBP’s design and implementation strategies are refined until optimized for a given context[22]. Within each of these domains, UCD offers myriad methods[21] and strategies[23] for harmonizing EBPs, contexts, and implementation strategies (summarized in Table 1). Although some of UCD’s discrete methods and principles resemble those traditionally used in implementation science (e.g., stakeholder engagement), UCD is unique in its offering of an extensive suite of methods that may be leveraged to refine EBPs, contexts, and implementation strategies. We present UCD as one promising set of approaches implementation scientists may consider drawing upon.

Table 1

Applications of UCD in Implementation Science

| Construct | Definition | What UCD offers |
|---|---|---|
| Evidence-based practice (the thread) | Interventions with demonstrated efficacy and effectiveness including programs, actions, processes, policies, and guidelines[3] | • Selecting EBPs that are appropriate for users and their context (e.g., by leveraging UCD measures of usability such as the System Usability Scale[60])<br>• Redesigning EBPs to better fit users and their context (e.g., conducting usability test or heuristic evaluation to identify an EBP's design limitations) |
| Context (the fabric) | Set of characteristics and circumstances that consist of active and unique factors, within which the implementation is embedded including:<br>• Inner (i.e., intra-organizational) context[75]<br>• Outer (i.e., extra-organizational) context[75] | • Assessing context (e.g., conducting ethnography or developing user experience models)<br>• Preparing context to promote receptivity to EBP (e.g., using workflow mapping to modify workflow to accommodate EBP implementation) |
| Implementation strategies (the needle) | Methods or techniques used to enhance the adoption, implementation and sustainability of an EBP[10] | • Anticipating needed implementation strategies based on context assessment (e.g., conducting design workshops to identify areas where fit between EBP and context is low and problem-solve accordingly)<br>• Selecting strategies that are appropriate given EBP and context (e.g., using the Cognitive Walkthrough for Implementation Strategies[76] to assess strategy usability)<br>• Tailoring/designing strategies for EBP and context (e.g., by conducting iterative co-creation sessions with users) |

## Methods

Case example: implementation of a cancer needs assessment

# Background and project objectives

Each year, more than 20,000 young adults between the ages of 18 and 30 are diagnosed with cancer[25]; many of them do not receive services to meet the range of needs they experience during and after cancer treatment[26–30]. Young adults' unmet needs result in negative outcomes, including higher distress[27, 28], poorer health-related quality of life[31], and higher physical symptom burden[26]. Despite the complexity and scope of their needs, young adults often do not use potentially beneficial services/resources, even when access is not an issue[32–34]. This disconnect between young adult needs and their use of existing services/resources suggests the need for a care coordination model that (1) effectively assesses young adults' multifaceted, age-specific, individual, and dynamic needs, and (2) uses that information to efficiently connect them to services/resources.

A substantial step toward this care coordination model was the development of the first multidimensional measure of unmet needs designed specifically for adolescents and young adults: the Cancer Needs Questionnaire - Young People (CNQ-YP)[35, 36]. However, limitations to the usability and usefulness of patient-reported outcome measures like the CNQ-YP (e.g., length; wording ambiguity; redundancy or missing content; lack of connection between identified needs and follow-up actions) have frustrated their real-world implementation and effect on patient outcomes[37, 38]. In this project, we used UCD to redesign the CNQ-YP to optimize its usability and usefulness and prepare for its implementation in the University of North Carolina's Lineberger Comprehensive Cancer Center (hereafter, Lineberger). Our UCD process (Table 2, Fig. 2) produced the Needs Assessment and Service Bridge (NA-SB), a care coordination intervention for young adults with cancer. All procedures were approved by the University of North Carolina's Institutional Review Board.

Table 2
Data Collection Summary

| UCD Aim | Method | Deliverable |
|---|---|---|
| Review and refine EBP prototype (the thread) | Usability Testing<br>• Young adult Survey<br>• Cognitive interviews with young adults<br>• Concept mapping with providers/staff | Evidence of the usability and usefulness of the CNQ-YP |
| Identify user and contextual requirements (the fabric) | Ethnographic contextual inquiry<br>• Guided tours with young adults and providers/staff from Lineberger<br>• Semi-structured interviews with providers/staff from external organizations | User and contextual requirements for NA-SB's design and implementation |
| Design EBP and implementation strategy prototypes based on user and contextual requirements (thread + fabric + needle) | Design team Workshops<br>• Workshop #1<br>• Workshop #2 | NA-SB prototypes and anticipated implementation strategies needed |
| RESULT | | NA-SB + compilation of relevant implementation strategies |

# Multidisciplinary design team

In dissemination and implementation, stakeholder engagement is often limited or superficial[39–41]. In contrast, UCD demands an active and iterative approach to engagement, often with the same group of users reviewing prototypes at multiple time points[42]. Thus, at the beginning of the project, we convened an NA-SB design team comprised of key stakeholder groups. Throughout the project, the investigator team presented prototypes and other information to the design team and, based on their interactions with

prototypes and collaborative discussion, made iterative improvements to NA-SB design and implementation strategies.

Design team members included researchers in cancer care delivery, patient-reported outcomes, UCD, and implementation science (n = 4) and prospective NA-SB users, including Lineberger clinical partners (oncologist; social worker/director of Lineberger's young adult program [n = 2]), and young adult representatives (n = 5) nominated by clinical partners. Nominees were primarily individuals who had previously expressed interest in research or advocacy activities related to young adult cancer and thus, would be more likely to consider the extensive and ongoing participation that joining the design team would entail.

To recruit young adult representatives for the design team, clinical partners connected young adults via email to the project lead (EH). EH provided them with materials including a project summary, a breakdown of their expected role and time commitment, and a brief summary of UCD. EH then met with each young adult interested in participating to discuss the project and develop rapport, then met with them all together to build group rapport. Young adult representatives received a one-time $150 incentive for participation.

Young adult representatives included a racially and ethnically diverse group of 5 men and women. They represented different timepoints in their cancer trajectory, with one in active treatment, one in maintenance treatment, and the others in the survivorship phase. In addition to their lived experience with cancer, young adult representatives brought other areas of content expertise to the project, including instructional design and mental health service delivery.

(1) Review and refine prototypes (optimize the thread)

# Overview

We conducted three rounds of usability testing to examine user interactions with the CNQ-YP: (1) an online survey assessing young adults' needs and preferences for a needs assessment using the CNQ-YP as a prototype for them to react to; (2) cognitive interviews[43] with young adults to triangulate survey data with in-depth evidence of their perceptions of the CNQ-YP's usability and usefulness; and (3) concept mapping[44] exercises focused on usefulness, in which young adult program providers mapped CNQ-YP-identified needs onto services/resources to address the needs.

# Young adult survey

Objectives. To identify missing content, streamline redundant or low-priority content, and other usability and usefulness concerns.

Instrument. The survey instrument (Additional File 1) included three sections: (1) study information, consent, and demographic items (i.e., age, gender, clinical characteristics, social support, educational/vocational status, health insurance status), (2) the CNQ-YP in its original form, and (3) items assessing respondents' perception of the CNQ-YP. To assess general attitudes towards the tool, we used

items from three Likert-type measures of feasibility, acceptability, and appropriateness[45]. We assessed usefulness through two Likert-type items asking (1) the extent to which respondents thought the CNQ-YP accurately captured their needs, and (2) the likelihood that they would use services or resources offered to them based on indicated needs. For each of these measures, we qualitatively probed respondents on usability and usefulness issues driving their concerns with the tool's feasibility, acceptability, or appropriateness.

Sample and Recruitment. To be included in the survey, we required participants (n = 100) to be age 18–30 and have been diagnosed with cancer prior to survey administration. To ensure young adult participant diversity (race, ethnicity, age, geographic region, setting of care, etc.), we recruited through key contacts (i.e., leaders of young adult programs and advocacy groups in the United States identified by our clinical partners), social media (i.e., a series of Twitter messages shared by tagging relevant groups and hashtags), and our design team.

Procedure. We administered the survey through a secure online platform, Qualtrics (Provo, UT). On average, the survey took 15 minutes to complete.

Analysis. We used descriptive statistics for respondents' demographics, needs reported on the CNQ-YP tool, and perceptions of the CNQ-YP. To identify emergent themes regarding the CNQ-YP's usability and usefulness in free-text responses, we used template analysis[46].

# Cognitive interviews

Objective. To triangulate survey data on CNQ-YP usability and usefulness through nuanced understanding of content, wording, or comprehension concerns.

Interview guide. With input from the design team, we developed the cognitive interview guide to encourage participants to "think aloud" as they read and reflected on the CNQ-YP itemset and probe them to comment on topics such as item content and wording, response options, format, length, comprehensiveness, repetitiveness, etc. (Additional File 2).

Sample and recruitment. To promote generalizability of cognitive interviews, we purposively sampled from among survey participants individuals who varied across select demographic characteristics (i.e., age, race, gender). We recruited young adults (n = 5) until we reached thematic saturation, i.e., when subsequent interviews did not generate new information regarding CNQ-YP's usability or usefulness.

Procedure. EH conducted one-hour cognitive interviews (n = 5) via Zoom, a video-conferencing platform. Interviews were audio-recorded. EH navigated the CNQ-YP through the Zoom screen-share function, soliciting participants' input on each item. At the end of each interview, EH summarized her takeaways with interviewees for the purposes of member checking[47].

Analysis. We inductively identified themes, noting concerns related to the CNQ-YP's usability and usefulness. We then created a table organizing participants' concerns within each of the identified

themes for presentation to the design team during our first workshop (described later).

# Concept mapping

Objective. To group needs assessed by the CNQ-YP by services/resources expected to address those needs.

Instrument. The design team approved changes to CNQ-YP content based on survey and cognitive interview results. We pre-loaded the resulting list of young adult needs into an online secure platform called Concept Systems Global Max © (CSGM). CSGM included two concept mapping exercises: (1) sorting an electronic deck of cards, each containing a young adult need, into like categories (i.e., “follow-up domains”) that could be addressed by the same service/resource, or other follow-up action (e.g., needs related to depression and anxiety might be grouped together as potentially addressable by referral to a mental health professional); and (2) rating needs on Likert-type response scales in terms of two key pragmatic properties: importance (i.e., severity of consequences if that need goes unmet) and actionability (i.e., likelihood that need can be met through a service or resource)[48].

Sample and recruitment. Concept mapping participants included cancer program providers (e.g., oncologists, nurses, and social workers) and staff (e.g., program managers and administrators) - i.e., the prospective NA-SB user group expected to have the most knowledge about service and resource delivery for this population. Recruitment through the key contacts established during survey recruitment was intended to achieve the minimum sample size of n = 15 needed for concept mapping analyses[49].

Procedure. Participants accessed the web-based concept mapping exercises through emailed links to the project in CSGM. The exercises took approximately 30 minutes to complete.

Analysis. CSGM used hierarchical cluster analysis to characterize how participants grouped needs, creating several potential cluster maps based on proximity among needs, where proximal needs were more frequently grouped together as triggering the same follow-up action than distal ones, and ‘go-zone graphs’, in which needs are displayed as points on a quadrant in terms of their relative importance and actionability. Young adult design team representatives vetted results.

(2) Identify user and contextual requirements (understand and prepare the fabric)

# Overview

To gather detailed information about prospective users and the context for NA-SB implementation, we used ethnography (i.e., guided tours and semi-structured interviews), a promising yet underused method for implementation research[50]. By documenting naturally-occurring user tasks and interactions among patients and providers through in-depth observation, ethnography provides rich data on implementation context[51, 52]. Ethnographic methods are relevant to UCD because they offer more nuanced understanding of users and context than traditional questionnaires or interviews, including novel insights on user tasks, attitudes, and interactions with their environment[17, 21, 53]. We used a novel UCD user and contextual factor framework[21] to guide data collection and analysis, combining ethnography and

contextual inquiry. Data from this phase informed context modifications and identification of minimally necessary implementation strategies. Additional File 4 includes the Standards for Reporting Qualitative Research (SRQR) checklist adhered to for these data collection activities.

# Guided tours

Objective. To capture contextual elements beyond just those which users can verbalize, including details and motivations that have become habitual or implicit to the tasks they perform[54].

Instrument. To promote the flexibility required for guided tours[55, 56], we identified potential questions based on four domains of Maguire et al.'s typology of user and contextual factors to consider in UCD from which we could choose: (1) user characteristics, (2) user tasks, (3) physical and technical environment, and (4) organizational environment[21] (Additional File 3).

Sample and recruitment. To capture the perspective of potential NA-SB implementers, we conducted guided tours with our clinical partners at Lineberger (n = 2). To capture the patient perspective, we conducted guided tours with young adults ages 18–30 receiving inpatient or outpatient care at Lineberger (n = 10). Our clinical partners at Lineberger facilitated the recruitment of young adults for guided tours by distributing a recruitment flyer and connecting EH via email to those interested.

Procedure. EH conducted four-hour guided tours with clinical partners as they completed clinical, administrative and other duties, asking questions about their tasks and thoughts. EH followed young adults and accompanying family members from the moment they entered the hospital for their outpatient appointments until the moment they exited, asking them questions as they interacted with their environment and healthcare professionals, while attempting to minimize participant disruptions. For inpatient guided tours, EH spent two hours with young adults receiving inpatient care. EH took extensive field notes and audio-recorded portions of the guided tours for which only consenting parties were present. We offered young adult participants a $50 participation incentive.

Analysis. We used template analysis, identifying a priori themes based on Maguire's constructs and allowing for identification of additional themes[46]. Two study authors independently coded excerpts from guided tour field notes and interview transcriptions per Maguire constructs. For each domain, they collaboratively synthesized user and contextual factors and created a "translation table"[57], which translated factors into their implications for NA-SB design and implementation. For example, providers reported the importance of integrating new tools into the electronic medical record; we translated this into the requirement that NA-SB interface with Lineberger's electronic medical record. All requirements were vetted and prioritized by the design team during the second workshop (see description below).

# Semi-structured interviews

Objective. To review findings from guided tours with external users and identify any areas of divergence or additional needs or contextual features, thus promoting generalizability of findings.

Interview guide. With input from the design team, we developed a semi-structured interview guide based on Maguire's typology[21] and guided tour findings.

Sample. We conducted semi-structured interviews with the leaders of young adult programs and advocacy groups who had previously facilitated survey and concept mapping recruitment: program managers (n = 2), nurse navigators (n = 2), and patient navigators (n = 2) serving primarily young adults.

Procedure. EH conducted one-hour semi-structured telephone interviews. At the end of each interview, EH summarized major takeaways for member checking[47]. We audio-recorded and transcribed interviews verbatim.

Analysis. We analyzed interview data using template analysis[46].

(3) Design prototypes based on user and contextual requirements (thread the needle)

# Overview

Through two three-hour workshops, the design team collaboratively redesigned the CNQ-YP (i.e., the EBP) with usability and usefulness in mind and redesigned Lineberger care processes (i.e., the context) to facilitate the tool's implementation and usefulness in routine care. This prototyping process – which relied on visual cues to digest user data with multiple user groups – represents a novel method for coproduction in implementation science. It resulted in NA-SB and a compilation of implementation strategies, each informed by context and designed to account for the other's characteristics.

# Design Team Workshop #1

After the survey, cognitive interviews, and concept mapping, we convened the NA-SB design team for a workshop in which we selected the most interpretable concept mapping cluster map (i.e., the cluster map with the highest face validity) and considered eliminating from the CNQ-YP needs that were relatively unimportant and not actionable. For example, the design team eliminated items assessing whether patients perceived their treatment staff as "approachable" or "friendly" based on concept mapping participants' low ratings of these items' actionability in terms of service or resource provision. The refinement of CNQ-YP items was further informed by usability and usefulness data from the survey and cognitive interviews. For example, the original CNQ-YP features similar items with different lookback periods (e.g., "since my diagnosis", "in the last month"); survey and cognitive interview participants felt these multiple reference periods were confusing and redundant given the tool's goal of addressing current needs through service provision. Thus, the design team anchored all items to needs present at the time of CNQ-YP completion and eliminated redundant content. In other cases, items were added based on user feedback on missing content (e.g., sexual health). Usability data also informed changes to the tool's display, instructions, and sequencing.

After grouping high-priority needs by follow-up domains, the design team identified services/resources at Lineberger which corresponded to each follow-up domain. We also anticipated implementation strategies needed to facilitate this kind of multidisciplinary service provision. The meeting resulted in a redesigned

patient-reported outcome measure for use in NA-SB in which priority needs were grouped based on services/resources available at Lineberger to address those needs.

# Design Team Workshop #2

After soliciting user and contextual data through guided tours and interviews, we convened the design team for workshop #2 during which we presented the ethnography translation table (developed from the guided tours and semi-structured interviews) alongside the NA-SB measure produced during design team workshop #1. This allowed the design team to anticipate context modifications and necessary implementation strategies with respect to the redesigned tool. For example, the content of the tool might necessitate its administration by certain providers (e.g., social workers); staffing and workflow patterns may need modification to facilitate administration by social workers. Through popular UCD methods, 'personas' (i.e., generic representations of key user groups to convey users' needs to the design team,) and 'scenarios of use' (i.e., specific examples of how users, context, and NA-SB might interact)[21], we collaboratively determined the most salient requirements for NA-SB delivery, resolved discrepant requirements, and specified who will deliver the needs assessment, when, how often, and the materials and procedure that will be used to do so. Additionally, we used this workshop to co-design the bridge between identified needs and care delivery—i.e., making explicit the follow-up actions needed for each patient-reported need. Finally, we walked through Maguire's four domains to discuss potential remaining barriers to NA-SB-context fit and identify appropriate implementation strategies to address them. For example, some important user and contextual requirements could not be addressed through specification of NA-SB delivery (e.g., leadership buy-in); these were areas in which the application of strategies was deemed important for future implementation.

# Results

To allow for more detailed focus on our methods, we have limited our reporting of results to key takeaways on how UCD may enable EBP-context-implementation strategy harmonization. More detailed results will be presented in future publications. Briefly, though, the methods described above culminated in an NA-SB prototype, including a redesigned patient-reported outcome measure and a protocol for its implementation. By ensuring NA-SB directly responded to features of users and context, we designed NA-SB for implementation, potentially minimizing the strategies needed to address misalignment that may have otherwise existed. Furthermore, we designed NA-SB for scale-up; by engaging users from other cancer programs across the country to identify points of contextual variation which would require flexibility in delivery, we created a tool not overly tailored to one unique context.

# Discussion

To date, efforts to improve healthcare quality have focused on implementing EBPs as originally designed[58]. A potential consequence of this emphasis on EBPs has been resistance to considering the implications of their design for implementation into practice and an overemphasis on rigid conceptualizations of fidelity. Faced with EBPs that have been carefully tailored to unique contexts, implementation scientists often must facilitate their implementation with features ill-suited to the diverse

scale-up contexts. In response, implementation scientists turn to implementation strategies that may further burden users. In fact, the NIH defines implementation science as “the scientific study of the use of strategies to adopt and integrate evidence-based health interventions into clinical and community settings”[59], a definition that we think overly narrows the scope of practice for implementation. In this paper, we assert that the pitfalls associated with cumbersome EBPs and implementation strategies may be avoided by attending equally to EBPs, contexts, and implementation strategies, through the application of UCD.

Just as embroidering requires compatible thread, fabric, and needle, implementation may be optimized by harmonizing EBP, context, and implementation strategies. We acknowledge that this analogy is imperfect; for example, some might regard embroidery as decoration or embellishment; on the contrary, our intention with this analogy is to convey the integration of the thread such that it becomes a part of the fabric itself. Despite its imperfection, the analogy is useful as it urges implementation scientists to attend equally to features of EBPs, context, and implementation strategies. Doing so has the potential to limit the challenges associated with complex EBPs and implementation strategies that burden stakeholders.

In this case example, usability testing elicited user concerns about the CNQ-YP that may have limited its uptake in practice, allowing our design team to redesign the CNQ-YP to maximize usability and usefulness. For example, through concept mapping, providers identified needs assessed by the CNQ-YP which, as originally written, could not be addressed with available services/resources (e.g., “I feel frustrated”); assessing such unactionable needs would have produced additional burden for users, without improving care. Through the survey and cognitive interviews, young adults identified important missing content (e.g., sexual health), and other areas in which the CNQ-YP’s content, length, wording, and response format were unacceptable. By addressing these usability and usefulness concerns upfront, we designed a tool to be more feasible, acceptable, and appropriate to users.

Considering EBP characteristics like usability and usefulness in a vacuum may compromise implementation and burden stakeholders. To avoid these concerns, we leveraged UCD contextual inquiry methods to describe both NA-SB’s specific implementation context (i.e., Lineberger) as well as its broader future scale-up context (i.e., other young adult cancer programs in the United States). To explore context, UCD offers frameworks such (e.g., Maguire’s framework), as well as questionnaires (e.g., System Usability Scale[60]), and a menu of methods (e.g., diary keeping, user surveys, etc.[21]) compatible with others used by implementation scientists in the assessment of implementation determinants. Despite some overlap in UCD and implementation science methods, UCD goes further than traditional barriers/facilitators assessment by embedding users more deeply in the process. In this case example, we used ethnographic contextual inquiry to obtain a detailed understanding of users and context. Additionally, we went further than traditional barriers/facilitators assessments by engaging users in analysis to promote shared understanding of context: our design team reviewed ethnography findings to ensure that the user interpretation of context remained central, as opposed to relying solely on the researcher’s interpretation of contextual data.

UCD also provides methods for translating user and contextual factors into user and contextual requirements—i.e., usability and usefulness determinants[21]. Translating contextual factors into contextual requirements using UCD requirements engineering approaches (e.g., translation tables, 'personas', and 'scenarios-of-use') could help implementation scientists prioritize implementation determinants by focusing attention on the critical subset of contextual factors that influence EBP usability and usefulness[13]. In this case example, the ethnography provided valuable source data for workshop materials, helping us to leverage design team expertise to identify these usability determinants and prioritize contextual features to target with EBP redesign, context preparation, or implementation strategies. During design team workshop #2, we presented several alternative scenarios-of-use, or simple descriptions of plausible user interactions with NA-SB, to inform the specification of NA-SB delivery. These scenarios provide user- and task-oriented information about the context in which an EBP has to operate[61], and also offer concrete examples for design team members to react to. For example, scenarios helped our design team walk through different patient visit types (e.g., just infusion versus infusion + clinical visit) to ensure that design decisions about staffing and timing for needs assessment administration suited the range of potential appointments.

We used UCD to enhance the usability and usefulness of NA-SB and reduce the number of implementation strategies needed to embed the tool in routine care. However, where EBP and context diverge, UCD can help tailor strategies which make EBP and context more compatible. In this case example, we anticipated areas where NA-SB provision may clash with user or contextual requirements, some of which could not be addressed by EBP redesign or context preparation. For example, NA-SB – a tool that spans across multiple domains of care – will require the cooperation of multiple departments and disciplines; although users are more likely to buy into a usable and useful tool[62, 63] and engaging users in its development likely generated some buy-in, additional implementation strategies targeting cross-department buy-in may be required. These remaining gaps in EBP-context fit inform the selection of strategies to promote NA-SB implementation. Leveraging UCD to identify user and contextual requirements and tailor implementation strategies addresses an articulated need in the field[14, 64] and complements approaches for selecting and tailoring strategies that have recently been proposed in the implementation science literature[13]. Future work will assess the extent to which UCD minimizes the need for complex implementation strategies or, when needed, aids in the tailoring of strategies that are contextually appropriate and minimally burdensome.

As demonstrated by this case example, UCD can help implementation scientists to operationalize the field's commitment to stakeholder engagement. For example, establishing a design team upfront ensured that users remained central throughout NA-SB development and implementation planning. Design team members offered key insights to inform data collection (e.g., review of instruments), data analysis (e.g., selection of concept mapping cluster map; prioritization of user and contextual requirements), and, ultimately, NA-SB and implementation strategy design. Further, design team members proved critical to the recruitment of users for usability testing and ethnographic data collection. UCD also offers methods for translating user feedback into design decisions. For example, the use 'scenarios-of-use', allowed our design team to translate ethnographic data into NA-SB design features, in a way that group discussion

without such engagement methods may not have. Finally, UCD demands an iterative approach to user engagement, often with the same group of users reviewing prototypes at multiple time points; this type of iteration may be a key moderator in the relationship between stakeholder engagement and improved EBP design[42]. The extent which this holds true for implementation is a topic that warrants further exploration.

Applying UCD to implementation science has notable challenges. Embedding the extensive engagement UCD requires can sometimes be costly and time intensive. Additionally, this level of engagement places issues of sampling and recruitment at the forefront. For example, the UCD process hinges on complex decisions about who counts as a user and which individuals accurately represent users more broadly. Prioritizing divergent feedback from multiple user groups[65], or weighing the relative importance of user feedback with the feasibility of design solutions, may not always be straightforward. Inexpert application of UCD methods may lead to 'feature creep,' in which new ideas are incorporated into the EBP without careful consideration and evaluation of the effects of the added features. UCD's emphasis on iterative design thinking and local insights may also raise concerns about diminishing fidelity as EBPs are recurrently revised to better align with context outside of the controlled environment where the EBP was originally designed and tested. Finally, implementation scientists may struggle to shoulder the challenges associated with incorporating new disciplines into already multidisciplinary teams and projects (e.g., reconciling terminology and frameworks). In addition to such practical differences, there may be fundamental philosophical differences between the two fields. In general, implementation science focuses more-so on the EBP and UCD on the users; where there is divergence between what is best for the EBP and what is best for the user, reconciling these competing viewpoints may be difficult. However, if implementation scientists are to leverage key insights from other disciplines, they must continue to surmount such roadblocks to knowledge integration.

# Conclusions

Implementing change in dynamic healthcare settings is complex; understanding the nuances of implementation requires a multimodal, multidisciplinary purview. To this end, implementation scientists have borrowed knowledge and approaches from systems science[66, 67], organizational studies[68], cultural adaptation[69], community-based participatory research[70], behavioral psychology[71], and quality improvement[72], just to name a few. We argue that UCD methods like usability testing, ethnographic contextual inquiry, and design team prototyping can join the list of approaches available to implementation scientists. This may first require investigation of where UCD and implementation science converge and diverge. Fortunately, efforts to this effect are currently underway[73]. While points of divergence may represent barriers to integration of the two fields, they may also represent important new insights and approaches for implementation scientists to consider.

Just as embroidery requires the alignment of thread, fabric, and needle, EBP implementation and sustainment requires harmonizing EBP, context, and implementation strategies. The importance of each of these has been acknowledged; however, methods for understanding the dynamic interplay among

them and optimizing each with respect to the other two are lacking. UCD offers methods and approaches for achieving this. Future research should explore the utility of collaborating with UCD experts or embedding UCD approaches in implementation research[73]. In particular, we argue that UCD's potential for promoting harmonization among EBP, context, and implementation should be tested empirically, work that is currently underway[74]. To the extent that UCD helps facilitate this harmonization, it will advance us towards the field's goal of bridging the gap between research and practice.

# Abbreviations

EBP
Evidence-based practice
UCD
User-Centered Design
NA-SB
Needs Assessment & Service Bridge
CNQ-YP
Cancer Needs Questionnaire- Young People
CSGM
Concept Systems GlobalMax©

# Declarations

### *Ethics approval and consent to participate*

This study was approved by the University of North Carolina's Institutional Review Board (19-0255).

### *Consent for publication*

Not applicable

### *Availability of data and materials*

Data collection instruments are available as additional files.

### *Competing interests*

The authors declare that they have no competing interests.

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### *Authors' contributions*

All authors (ERH, AD, AL, HW, MB, GV, DH, SB) were involved in manuscript conceptualization, drafting, and editing. All authors read and approved the final manuscript.

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# Additional Files

### Additional File 1:

This file contains the survey instrument used for the online survey of AYAs, including demographic questions, questions from the Cancer Needs Questionnaire-Young People tool, and questions surrounding the tool's usability and usefulness. (DOCX 50 kb)

### Additional File 2:

This file contains the cognitive interview guide, including the original Cancer Needs Questionnaire-Young People. (DOCX 50 kb)

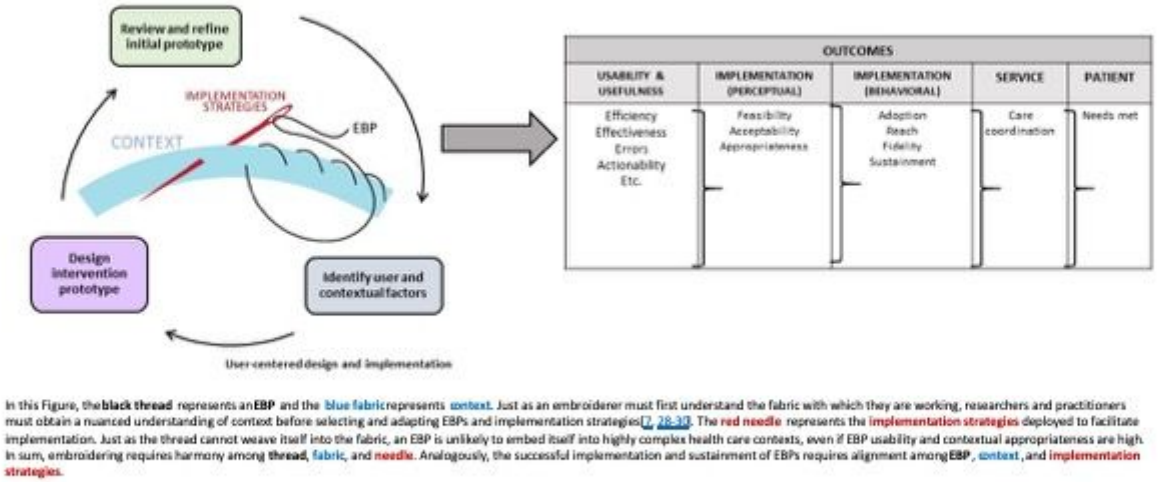
### Additional File 3:

This file contains Maguire et al.'s framework of user and contextual factors to consider in User-Centered Design. The file also includes example questions within each domain of Maguire et al.'s framework used during ethnographic contextual inquiry (i.e., guided tours and semi-structured interviews). (DOCX 21 kb)

**Additional File 4:**

This file contains the Standards for Reporting Qualitative Research (SRQR) checklist. (DOCX 39 kb)

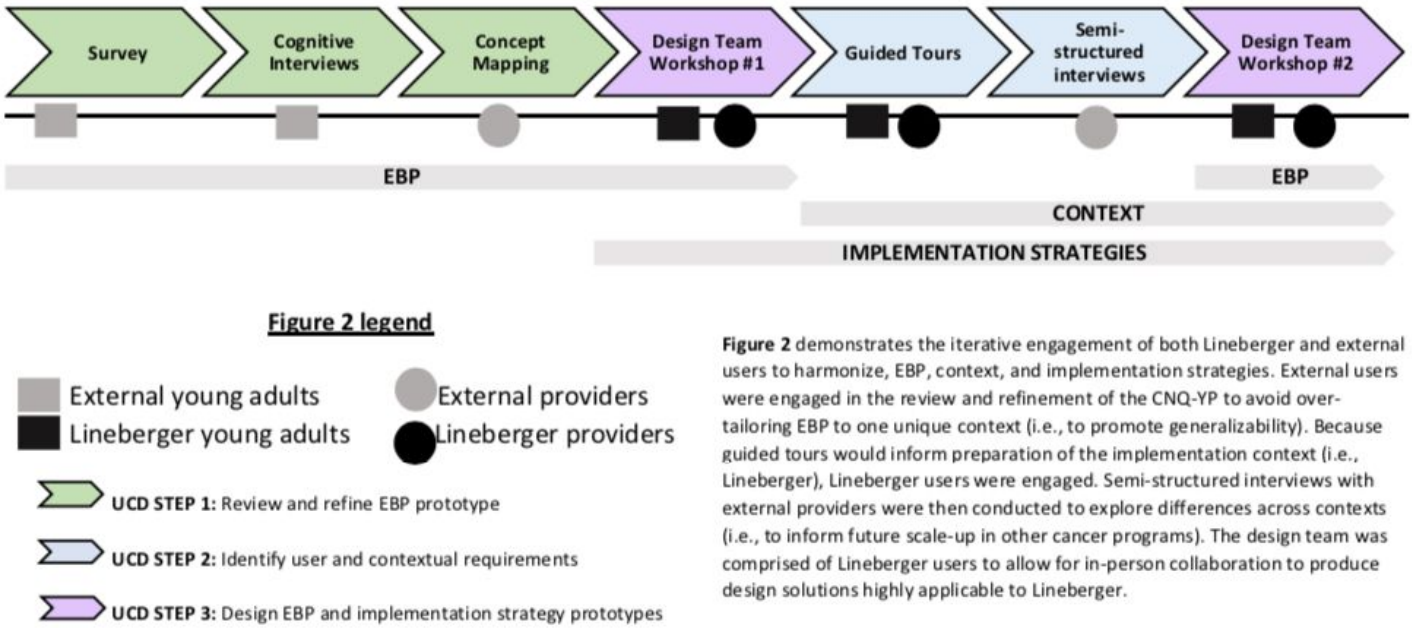
# Figures




In this Figure, the **black thread** represents an **EBP** and the **blue fabric** represents **context**. Just as an embroiderer must first understand the fabric with which they are working, researchers and practitioners must obtain a nuanced understanding of context before selecting and adapting EBPs and implementation strategies[7, 28-30]. The **red needle** represents the **implementation strategies** deployed to facilitate implementation. Just as the thread cannot weave itself into the fabric, an EBP is unlikely to embed itself into highly complex health care contexts, even if EBP usability and contextual appropriateness are high. In sum, embroidering requires harmony among **thread**, **fabric**, and **needle**. Analogously, the successful implementation and sustainment of EBPs requires alignment among **EBP**, **context**, and **implementation strategies**.

**Figure 1**

User-centered design and implementation




### Figure 2

Data collection timeline and users engaged

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1.docx
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