Claims-to-Patterns Approach to Leverage Mobile Interaction Design for Low-Literacy Users

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ABSTRACT
This paper presents a method to leverage mobile interaction design knowledge for low-literacy, moving from falsifiable hypotheses (claims) to actionable solutions (patterns). In prior work, claims and patterns have been used separately for different application areas and in different contexts. This research asserts that the transition from claims to patterns will enhance the design value, leveraging claims for uncertain situations and inexplicit user behavior and patterns for proven solutions for recurrent problems. This paper examines how these two structures can be combined in a claims-to-patterns approach to leverage mobile interaction design for low-literacy. To demonstrate this method, an example that highlights how claims evolve into patterns through research and design is discussed.

CCS Concepts
• Human-centered computing →Interaction design • Interaction design process and methods→User interface design.

Keywords
Claims; Patterns; Mobile Interaction Design; Low literacy.

1. INTRODUCTION
Interaction design knowledge and experience has been acquired and applied for various technologies and in different contexts. This knowledge and experience is documented in design guidance that varies in form, level of complexity, and methods of use. Types of guidance include design principles, style guides, guidelines, claims, and patterns [1,2,3,4]. Many of these tend to address broad, general design principles; not so much concrete guidance on design specifics, alternatives, and competing forces or needs [1,3]. This work considers the last two—claims and patterns—to understand how hypothesis-focused guidance can communicate design experience in reusable ways [1,2,3].

Claims present a design feature or effect along with its pros and cons, often in a lightweight, ephemeral way meant to inspire debate [2,5]. Claims emerged from rhetoric, where they were used as a means for argumentation, and were adapted for use in interface design [10]. Claims tend to be short and easily understood in design situations both by design experts and domain experts, thus providing a bridge for discussion and debate. A brief example claim, from [2], is as follows: × tickering text in the periphery of a desktop computer monitor; + results in greater long-term knowledge gain of the displayed information than more static displays; — BUT leads to slower reaction times to changed information. This claim includes a feature (indicated by ×) along with a single upside (+) and downside (—) for the feature. Claims often have multiple upsides and downsides, along with rationale that supports them.

Patterns provide a detailed solution to a contextually rooted problem that is meant to capture a reusable or adaptable truth about a situation [1,2,5]. Patterns emerged from Alexander's work in architecture on reusable aspects of buildings and environments [29,16]. They have been applied by multiple researchers and practitioners in software engineering and interface design. Patterns tend to capture both what to do as well as the context for when to do it, and as such tend to be much longer than claims. An abbreviated example pattern, from [20], is presented as follows: × only use the part of the screen that will not be covered by the keyboard; *Use when:* This solution may be OK for dialog boxes as illustrated in the example figure, but is seldom practical for normal windows; *How:* Restrict the amount of information in the dialog*; Why:* The solution is simple and inexpensive. This pattern example includes a pattern name (indicated by ×) and *use when*, *how* and *why* to highlight pattern use. The way a pattern is presented varies from author to author; however there is general agreement that patterns should include a problem, its context, and a solution [1,2,32]. Patterns also often include pictorial examples.

Both design structures have been applied in many applications, technologies, and contexts. Different communities have chosen between design structures based on specificity and discipline [2]. Differences between structures are also discussed in the literature, highlighting advantages such as problem statement inclusion in patterns, balancing positive and negative consequences in claims, the treatment of context (presence and absence are sometimes highlighted as advantages), and explicit representation of design values [1,2,3].

1.1 Combining Claims and Patterns
Despite similarities in their goals, there are clear distinctions in what claims and patterns are intended to facilitate [1,2,5]. We hypothesize that transitioning between them will enhance the design value toward addressing core goals of interaction design

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[6] usability goals [4,7] and user experience [3], leveraging their respective strengths:

- Claims have implicit and patterns have explicit design value; the explicit representation of patterns can make it easier to use by the designer [1,2,5].
- Claims target broad and knowledgeable stakeholder sets (practitioners, researchers, educators) [2] while patterns target expert engineers who may desire knowledge about an area [1].
- Claims analysis is suggested as a fruitful approach to the identification of patterns [1,2], though methods for doing so have not been broadly identified and tested.
- Claims are largely theoretical while patterns are evidence-based.
- Claims are incomplete and hypothetical while patterns are complete and agreed-upon.

We explore how these differences complement each other toward providing design guidance for new technologies and user groups.

1.2 Design Structure for Emerging Needs

Designing for emerging technology and new users is challenging, with unique challenges when designing for low-literate users with minimal computing experience [8]. Furthermore, there are limited best practices available in the area (though see [8,30,31]), and these efforts are not yet well documented as design knowledge that encourages reuse and extension. Moreover, those experiences from one context should be tested for another. Thus, designing easy-to-use applications for such user groups requires thorough understanding of user needs and cognitive patterns [8,31]. The experiences would benefit from being documented as design knowledge in some form, bolstered either from different sources or through prototype evaluation.

Considering this, design guidance for designers that is specific to emerging technology and user groups has significant advantages. On one hand, it will facilitate adoption and diffusion of this emerging technology and enhance social and economic services especially for developing counties. On the other hand, it will also benefit both local designers with little experience with new technology as well as experienced designers with little or no knowledge of the context.

General design guidance and principles are of limited use for new technology and contexts [1,2,3]. However, claims are suggested as a better option to capture design features in uncertain situations when context of user and use is not well understood [2]. Claims help provide insight on emerging technology and users while patterns can capture the established solutions that are easier to process by the designer. Moreover, claims analysis is suggested as a fruitful approach to the identification of patterns [1,2].

A claims-to-patterns approach may benefit interaction design for new technologies and provide an evolutionary process for identifying proven design solutions. Such an approach may lead to design guidance as a result of collaboration between interface specialists, designers, and users through the exploration of usability goals and user experience. This work focuses on this approach as it applies to population-relevant in low-resource settings such as energy efficient design [6], mobile banking, and voice interaction systems. This work enhances pre-existing concepts of design toward overcoming the challenges of human-computer interaction.

The remainder of this paper is organized as follows. Section 2 briefly reviews some basic work about claims and patterns. Section 3 presents the claims-to-patterns approach and how it applied in mobile interaction design for low-literacy. Section 4 concludes and suggests future work.

2. RELATED WORK

Design knowledge capture has an extensive history in human-computer interaction. Various design structures have been developed over the years, including principles, heuristics, rules of thumb, style guides, claims, and patterns. Each has distinct features that include level of abstraction, context, problem articulation, and use of concrete examples [1,2,3]. This work focuses on claims and patterns, two structures similar in their ways of knowledge capture and sharing, though with important differences. The two mechanisms have been applied in many interaction design domains [1,2,9-15,17-24]. This work extends our previous efforts in low-literacy design, deployment, testing and knowledge capture [33,28].

Claims encapsulate pros and cons of design features [9,10] such that they can be shared, debuted, rebutted, and connected [2]. The falsifiable and hypothetical nature of claims encourages dialogue [2,9,10] and provides practicality in different contexts of use and user [2]. Every claim captures the features and its effects (upsides and downsides) [2,10], though by themselves claims typically lack context and, as such, tend to be associated with scenarios to provide this context [2,11]. Claim significance is enhanced when presented as a collection rather than in isolation [2]. Carroll and Kellogg [10] introduced the notion of a psychological claim to human computer interaction as a way to link theories and psychological human response to artifacts. Carroll and Rosson [11] included claims as a core feature in their scenario-based design. Sutcliffe and Carroll [12] explored how claims could be used as a reusable form of knowledge. Haynes et al. [13] investigated a scenario-based approach for the evaluation of collaborative system. Chewar [14] created an extensive claims library for the interaction domain of notification systems. Wahid [15] explore how claims using an image-centric card set can be more accessible and easier to process. Claims have been applied to a variety of work domains; e.g., for technologies to support young people with autism spectrum disorder [9].

Interaction design patterns can generally be defined as an invariant, demonstrably-successful solution for recurrent design problems within a context [1,16]. Patterns have the potential in recording and communicating design knowledge and supporting the design process, with much attention given to them in the HCI community [1,17]. HCI patterns are recognized as an effective way to produce usable systems [18] and have many advantages, such as capturing best practice, teaching basic guidelines for HCI design, as a communication to the designer [1,19]. Generally, it is a format for capturing and sharing design knowledge between practitioners and a very suitable medium to communicate design experiences and design value [1,3,17,18]. Interaction design patterns contributions include Kunert's [3] interaction design patterns language for interactive digital television applications, Nielsen's [20] collection of user interface design patterns for mobile application, Borcher's [21] pattern collection for interactive music exhibits, Van Duyne et al.'s [22] patterns for creating web sites, Van Welie's [23] structure and organization of the pattern language, and Tidwell's [24] patterns collection for designing user interfaces.

Rarely are claims and patterns considered together except [5,7], which empirically analyzed and compared them. This work addressed the effectiveness of patterns and claims on interaction design guidance, comparing their relative strengths. The work also

suggested that a more robust structure could emerge through combining the "strengths (or differences)" of the two [7].

3. FROM MAKING CLAIMS TO ESTABLISHING PATTERNS

The previous sections explained both theoretical and practical background and insights of claims and patterns. This section presents the claims-to-patterns framework and its application in mobile interaction design for low-literacy.

The goal of this approach is to identify a path from the falsifiable hypotheses nature of claims to contextualized design guidance found in patterns. This framework considers both theoretical foundations and practical application of claims and patterns. It is envisioned especially for emerging technologies where the context of use and user are not well understood. One such area includes mobile interaction design for low-literacy, as explained previously.

The claims-inspired pattern development result in design guidance that integrates theoretical and practical foundations of interaction design. Figure 1 shows how these inputs are integrated, impacting the design guidance development process and product. Claims can be extracted from resources with theoretical or practical foundations. This section focuses on design features (pieces of the artifacts). Features can aggregate to create a certain design artifact that can be empirically validated to form patterns. The framework has three essential elements that focus on problem-solution association linked by concrete design rationale, as the user interface design solution should not only be the artifact but also a rationale for why the interface is the way it is [26].

3.1 Identifying and Presenting the Design Problem

Defining the design problem is the leading motivation toward providing an invariant solution. The recurrent design issues that has to be addressed within the design space should be well recognized, pinpointed, and agreed-upon. Identifying and presenting the design problems will support designers to better understand core issues and rationale of the design solution. It is especially important for practitioners who have less context knowledge and various levels of design expertise.

Aim

The aim is to clearly define the design issue that are found a certain context of use. It is advantageous to understand 'what design issues' are addressed in the solution. This interaction design problem should specify human interaction concerns whereas the solution states 'perceivable interaction behavior' [1].

Theory

One of the 'three-part rule' in the original description of patterns by Alexander is inclusion of problem statement [16]. HCI patterns also typically include the statement of a problem, whereas claims do not include this type of context [1]. However, some interaction design pattern collections such as [24] tend to leverage a design problem implicitly (problems are described in 'What' section of the patterns), but other pattern collections such as [19-23] addressed the problem statement explicitly in their 'Problem' section of a pattern.

Other sections of the pattern attempt to present guidance on how to solve the design problem [7]. This can also be leveraged in use and reuse perspectives [27].

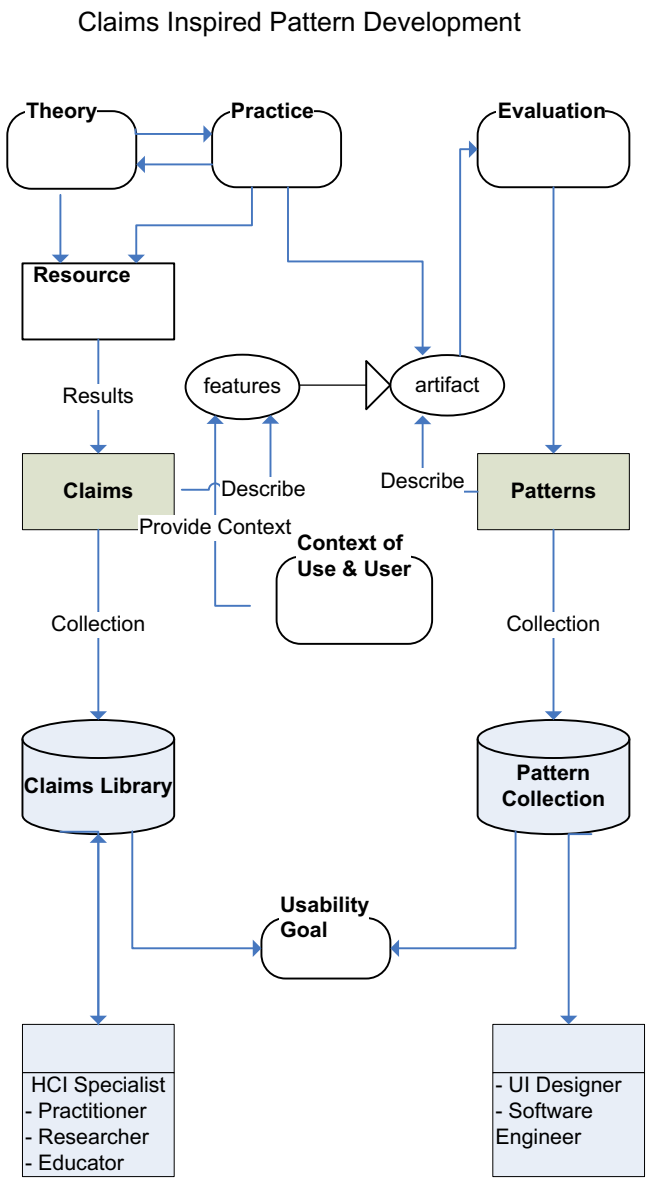

Figure 1 Claims-to-Patterns Framework

Approach

Interaction design problems should be identified systematically from different perspective to address key and relevant problems in order to move closer to a pattern library [3]. Alexander's early work proposed a systematic approach that involves analytic decomposition of the problem into sub-problems, each described by a set of competing forces [29]. Addressing and combining these sub-problems help to solve the bigger problem.

In problem abstraction, when considering the abstract and broader view of the problem and its implications, identifying recurrent design problems from one perspective may not show the complete picture. Thus, this framework suggests three possible recurrent problem identification strategies that consider pieces of claims to create a fairly complete and concrete problem abstraction for such situations:

- Examine literature written on the theme that are found to be either possible presumptions or empirically sought as a possible candidate. This provides one perspective of the problem [28] and should be done by informed HCI practitioners/researchers.
- Identify and analyze the different stakeholder (e.g., user and designer) perspectives to get another picture of the recurrent design problem. From the user perspective, the context of use components (e.g., ISO 9241) can be analyzed to define the design problems, including users, user tasks, equipment and environment [4].
- Explore and support the practice with theoretical grounding of the problems in general and claims in particular.

These will provide a broad problem statement that will led to detailed analysis and discussion of the rationale, including the empirical ground and evidence (the motivation for the resulting pattern) and the "forces" involved in the resolution of the problem. In the process of problem abstraction, building and maintaining context and technology require HCI specialist involvement.

Analyzing Mobile Interaction Design for Low-Literacy Users

As discussed previously, we have applied this approach in an effort to develop mobile interaction design for low-literacy. We started by considering the broad context of mobile users in developing countries (as this user group often shares economic and infrastructure issues). We then specifically focus on our working context (that may differ in terms of linguistic, social, and cultural values). This working context comprises important characteristics of the user and context of use. This definition of use and user will encourage capture of essential and possible mobile user interface guidelines for low-literacy.

Initially we built lists of claims using a four-step claims extraction method: understand and summarizing the source, identifying possible claims concept, reviewing and defining claims, producing organized claims [28]. As claims are hypothetical design concepts found in diverse sources, our data set ranges from academic literature (document sources) to data collected from different stakeholders. In the next sub-sections, we present claims of specific features and positive and negative consequence.

Identified claims for specific design features

Several claims emerge for specific design features. This example identifies interaction mechanisms that demonstrate our premises. The claims collection is voice-focused part of a bigger effort for design guidance for low-literacy mobile-interaction design.

Interaction mechanisms are different ways to interact with mobile devices for handling input and output. Our claims hypothesize that input and output mechanisms for low-literacy should be made in the form of either graphical or voice interaction rather than textual representation. Literature in mobile user interface for low-literacy support these techniques [30,31], requiring customization to incorporate behavior of similar users in different context [30].

The sources of each of the claims has been listed in our claims collection. Tables 1-3 are simplified versions of claims feature description for interaction mechanism to/from mobile interface. Multiple variants of voice interfaces are extracted as claims. These variants have their own design tradeoffs that can compete with each other within the related claims; for example:

- Interaction mechanism option chosen via numeric keyboard
- Interaction mechanism option chosen via speech

The former variant is considered in this example.

Claim 1 – Voice Interface

Table 1. Voice Interface Interaction

Claims:	Voice interface for interaction
Upsides:	• Facilitate local language communication (*localization*) • minimum skill and knowledge (*minimum cognitive load*)
Downsides:	• environment distraction may cause miss information (*difficult to pause*) • auditory and cognitive challenges (individual capability)
Effects:	avoid assistance and promote the use of required mobile functionalities by the user him/herself
Consideration	m-illiterate, applications (m-Agriculture, m-Health, m-Education)

Claim 2- Local Language option

Table 2. Local Language Option

Claims:	Local language option
Upsides:	• easier to comprehend with its own language (*understandability*) • seems talking to other person on the phone (*minimum skill*)
Downsides:	• require professional voice talent (*listening ability*) • language selection added another depth to the navigational hierarchy (*navigability and time*) • computing terms are not standardized in local language (*computing jargon*)
Effects:	It is natural to communicate with one's own language and to encourage its use in the application
Consideration	m-illiterate, application domains (m-Agriculture, m-Health, m-Education)

Claim 3- Hierarchical Menu Option

Table 3. Hierarchical Menu Option

Claims:	Depth of Navigation/Communication
Upsides:	• easier to go the option you choose (*avoid unwanted information*) • easy for fewer options (*less time and less error*)
Downsides:	• require numeric literacy (*numeric literacy*) • possibility of error that start all over again (*add time and frustration*)
Effects:	Avoid assistance and promote the use of implemented mobile functionalities
Consideration	m-illiterate and m-semi-literate, applications (m-Health, m-Agriculture, m-Education)

Context of Use

The ISO 9241-11 framework provides guidance on how the context of use is well described, including ways the usability of the artifacts should be specified and evaluated [4]. Our qualitative analysis extracts the existing context.

User Description: Mobile phone users can be classified into three groups based on different parameters. These comprise m-literate, m-semi-literate, m-illiterate [28]. In this brief example we have used and explain the latter user group, m-illiterate.

User type – Most of the current m-illiterate user group in the context of use are interacting with their mobile with the help of the other even to make a simple phone calls [28].

Skills and knowledge – the skills and knowledge of this user group are described as (education: illiterate, computing skills: no previous experience, technology exposure: no/rarely exposed, level assistance required: yes) [28].

Physical attributes - there is no numerical evidence available on physical characteristics. However, our qualitative data shows most users in rural Ethiopia are adult men (age above 15).

User Goal and Task Description: Currently most of the people have a mobile phone to make and receive phone calls, but there is a vast demand to make use of the technology for other social services such as health (like child vaccination), agriculture (such as agronomic information; alert and advice on erratic events) and education. Educational illiteracy is one characteristic of the m-illiterate, and most rural parts of Ethiopia is known for that. Most of this user group uses their mobile phone to communicate with people who live in urban areas, but recently more people convey plans to use them for socio-economic services.

For simplicity, the general task considered here focuses on functional needs of users, information seeking, and agricultural education. This requires user actions like entering input to the mobile interface, initiating an action, viewing/listening to information, and responding to information. Although there are user tasks which might differ in content between applications, there are also common tasks that apply to other services.

Equipment Description: There are a very diverse mobile phone models and types that are used by these users. Most are low cost mobile devices. To provide some level of classification among the different mobile equipment, we broadly categorize it as:

Low end mobile device (including feature phones) – limited capability and functionality devices with smaller screens, mobile physical keyboard, rarely touchscreen interfaces.

High end mobile device (that include smartphones) – better capability, performs much of the functionality of a computer with relatively large screen size, typically has touchscreen interface.

Environment Description: *Social and cultural environment* – mobile phones are considered as a personal device that can be possessed and used individually. However, sometimes users share devices, either for social reasons or to get assistance.

Technical environment – Ethiopia has a state-run telecom monopoly, which has no telecom option. Most if not all of the rural areas where most illiterates reside has 2G network infrastructure. The second generation (2G) technologies enabled mobile phone networks to provide services such as text messages, picture messages and multimedia messages. Recent upgrades from 2G to 3G (rural area) and 3G to 4G (cities) is under way.

Theoretical Grounding for the Task

There are various theoretical groundings for the context of use and user from psychology and other disciplines to support practice with theoretical explanations. For our case study, the following are some theoretical groundings that are considered.

Affordances- used when designing novel interaction element. The psychological idea of this theory proposes things may suggest by their form and other attributes what you can do to them.

GOMS (Goals, Operators, Methods, Selections rules) - used to model cognition and behavior of individuals interacting with keyboards, simple displays, and pointing devices (in this example with phone keyboards).

Human short-term memory – to determine the limits of attention and the information chunk capacity limit when the users attend voice and other communication.

3.2 The Interaction Design Rationale

After defining the problem, it is important to explain the different assumptions, constraints, tradeoffs, and negotiations that support to connect problem with its solution to capture the reasons behind the interaction design solution.

Aim

The goal is to clearly define the design decisions and provide reasons why those decisions were made. Good interaction design solutions are a balanced tradeoff between different requirements and constraints [3]. They will support usability by providing a compromise between context of use specifics, user tasks, and requirements [3,6,27].

Theory

Claims are hypothetical in nature and generally related to some psychological consequence of a system feature, which can be evolved through claims analysis [2,11]. This reveals how a claim affects users (positive and negative consequences). Claims associated with context will further help in pattern development which is more context oriented and invariant solution to the situation under consideration [2].

Approach

There are various schemes to record patterns relative to claims [9-15,19-24]. Taking the most common and complete scheme description of two pieces of design structures, basic and concise justification comes after defining the problem statement and before identifying the solution. So, in this framework, questions of why, when, and how to apply the solution based on the needs and constraints can be explained by further claims analysis. Detailed analysis of context of use, drawing from specific scenarios associated with claims, leads to pattern context to further describe the choices both from empirically and theoretical perspective. Resolving the conflicts in sub-problems and combining the individual solutions can lead toward a solution to the overall problem [29]. The rationale in the framework, on the other hand, has to address issues of conflicting forces, which may be of social, economic, natural, or physical nature [21,27]. The interaction design patterns that emerge from this framework describe designs for one problem and discuss specific tradeoffs in the form of pros and cons, thus supporting an informed design approach.

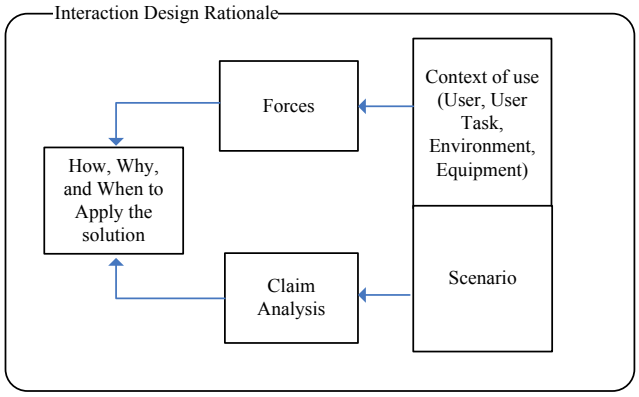

Figure 2. Interaction Design Rationale

Analyzing Mobile Interaction Design for Low-Literacy Users

The problem is seen from different perspective and the reasoning should also follow the problem identification to explain the design tradeoff of the resulting outcome/solution. Table 4 shows a brief summary of the rationale for the problem. Since this is not a comprehensive view of the resulting outcome our demonstration only demonstrates the process rather than providing a comprehensive solution.

Interaction mechanism - the different interaction mechanisms (textual, voice, and graphic) are explained and their tradeoff are noted in terms of forces and the claims are also analyzed using scenarios see Figure 2.

Mobile low-literacy scenarios on selected areas (such as m-Agriculture, m-Health) are developed. These scenarios support further analysis on the assumptions, constraints, tradeoffs and negotiations of the rationale.

The analysis should have either theoretical or practical groundings to justify design decisions.

Table 4. Brief Summary of the Rationale

Problem Category	*Interaction Mechanism*
Why:	• Users are illiterate (unable to read) results avoid textual representation of information • Audio interface results in minimum cognitive load • Verbal local language results natural communication
When:	• No/fewer hierarchy • No/minimum numerical input • Instructions and content are limited • Professional voice and recording is used
How:	• Provide a voice interface to the application
Grounding:	• Both theoretical and practical

3.3 Solution and Evaluation

The development of proven design solutions considers previously analyzed and justified design issues, with the emerged solution to be a candidate design pattern (subject to community validation).

Aim

The goal of evaluating instantiations of design solutions provide patterns that are empirically validated within the context of use and user. These instantiations are applications existed in real systems, prototypes developed, or both.

Theory

It is widely accepted that design solution can be evaluated through usability testing. Evaluating the usability of the patterns in HCI ends up either in practice gain through experience or by testing that will ultimately maintain the invariant and rigor of the solution [1,3]. By contrast, claims lack rigor as they are meant to be falsifiable hypotheses that can change depending on the context [2]. In interaction design, running a lab-based usability evaluation or conducting a field study provides empirical evidence that may help to move from claims to patterns. Integrating findings with the initial claim within a context will lead toward a pattern [3].

Approach

Prototyping to present design alternatives that can help specify a pattern, as learned from established design solutions for new technologies in low-resources settings. Applying testing or deployment will further exercise it [3]. Alternatively, if the solution is derived from practice and that rationale supports the claim, the community may feel a usability test may or may not be necessary [1,22-24].

Mobile Interaction Design Pattern for Low-Literacy Users

As we have seen in the previous two sections, the design issues are presented, defined and justified within the context of use and user. Claims and the context of use analysis provide an instantiation that can be further tested and validated toward making proven solution to design problem. Our initial version of design pattern collection evolved as a result of this efforts. Table 5.0 shows this initial design patterns emerged and considered based on main recurrent design problem of mobile low-literacy.

Table 5. Initial Pattern Collection

Pattern Group	***Pattern***
Low Literacy User Group	*A1: m-Illiterate* *A2: m-Semi-Literate*
Input and Output Interaction	*B1: Voice Interaction* *B2: Image Interaction* *B3: Multimedia Interaction*
Navigation	*C1: Audio Menu Navigation* *C2: Image Menu Navigation*
Content Presentation	*D1: Pull Content* *D2: Push Content*
Communication	*E1: Local Language* *E2: Key Representation*
Service Availability	*F1: Online Content* *F2: Offline Content*

Each design solution is assessed using different low-literacy mobile applications. For evaluation, we have used some existing low-literacy applications that are up and running. We have also prepared prototypes. We chose a mobile low-literacy project over a prototype (in most cases) since it is functional and can facilitate learning from real experiences of use. We have conducted field evaluations of the different functionalities to understand the solution space for the context to posit as a pattern. Then we can further refine and document the solution.

Pattern Name	*A1: m-Illiterate*
Context:	Mobile application developed for m-illiterate (those unable to read with no computing experience) should be different than other user groups. This group necessitates non-textual interaction design where all elements are lightweight and consider cognitive affordances.
Problem:	The main problem for this user group is reading and writing difficulties needed to understand textual information, requiring other ways to interact with the mobile system. ***Input/output Interface:*** Interaction mechanism should **not** be textual. It should consider other viable options based on nature of content. • ***Audio option*** - Speech communication, though users may miss content due to concentration, memory, or other factors. • ***Image option*** – Images can be associated with physical world but require some level of detail. The size and quality of image may affect the understanding. • ***Multimedia option*** - Communication with multiple ways but needs space & bandwidth ***Menu option:*** hierarchy navigation supports structuring multiple contents but content may be deep in the hierarchy and hard to fine functions. ***Communication:*** Avoid keyboard interaction; otherwise numeric literacy required ***Language Option:*** Avoid language option in communication but support local languages
Solution:	For this user group, minimum design consideration has to be met: ***Input/output Interface:*** The interaction mechanism can be decided based on, the type information, the cost and type of connection, the device itself. • ***Audio interaction (B1)*** - Provide 2-3 minutes content by considering human short-term memory (5-7 items) for temporary recall of the information with a possibility of repeating the information. • ***Image interaction (B2)*** - Provide image that are easily recognized and familiar. The image should be small and easily presented. • ***Multimedia interaction (B3)*** – Provide multiple ways of communication and for offline services (F2). ***Menu Option:*** The depth of navigation (menu navigation) should be flat (all items in one menu) – if menu is a must then not more than two (C2). ***Communication:*** Use as few numeric key interaction as possible (for numeric literate) otherwise use key representation (with color) (E2) to make minimal keyboard interaction ***Language:*** provide a local language specific to the user based on location.
Related Patterns:	B1, B2, B3, C2, E2, F2

3.4 Discussion

Various interaction design pattern formats can document the design solution [1]. Given the claims-to-patterns framework represented and emphasized on the resulting problem-solution relationship, it is easier for us to adopt the Kunert's format [3] to document our design solution. An example that shows wider picture of the documented pattern (A1) is shown here.

Patterns are grouped together based on their main design problems. Our full example includes six pattern groups; one of this pattern groups is 'input and output interaction'. In this group, we have a sub-problem called voice interaction. To test and validate solutions of some of the design issue, we have chosen real project (agricultural mobile information system project within the context of low-literacy) which is recently deployed and functional throughout the entire country. It is the first m-agricultural system in Ethiopia envisioned to empower smallholders living in the rural area with low-resource setting.

Currently this mobile application has two modules: agronomic information inquiry and notification message component (one is to pull information and the other is to push information). This automated hotline is free, providing information on a wide range of agricultural activities. Keypad menu options are used to select farmers' particular area of interest. This application also includes three local languages options (Amharic, Oromiffa, and Tigrigna).

The preliminary evaluation result of the specified feature—voice interaction mechanism—showed promising result to produce proto-pattern [19] that can be further refined and produce complete pattern solution. Further evaluation is needed to ensure broad community acceptance, but we believe that the evaluation conducted suggests confidence in its use.

General information on the usage statistics of the solution - in less than two years of the project period, there are about 1.27 million registered users with more than .92 million identified as farmers (who generally satisfy our user profile). These users made about 8.5 million information enquiries, which means on average a user used the system at least 8 times. Considering the time and the content of the application, the number of user and usage seems promising.

A challenge presented in this application and addressed in the prototype are: menu navigation. This application is 11 levels deep, with 7 helping to build the profile. Within the 7, 1 is to set the language and 6 are to get the location of the user (country administrative levels that helps provide specific information to the location of the user). Only 4 are for the actual content. Even within a menu itself there are a number of sub-menu choices; for instance, one sub-menu has 18 options. The profile-building process is only for the first use; after that you can go directly to the content. In our evaluation, we observed that first-time profile building helps provide customized information but also took significant time and keypad interaction to reach the content level. The burden is useful but undesirable for the user and should perhaps be fully redesigned, but is out of the control of this effort.

In the previous initial evaluation, we only keep qualitative data for the application to confirm and refine the results of our claims and context analysis. We then developed prototypes to test and validate each feature. We used three metrics (efficiency, effectiveness, and satisfaction) which are commonly used in usability evaluation. The result of this evaluation is based on the subjective (cognitive workload for task completion and user

satisfaction) and objective data (the rate of task completion) analysis of the specific solution.

4. CONCLUSIONS AND FUTURE WORK

This paper presents a claims-to-patterns approach that explores mobile interaction design for low-literacy. The approach provides a combined capability to improve the design value especially in new situations. The paper also demonstrates how the two design structures features are important and their integration encouraged.

In exploring this, we have presented an example demonstrating how the approach is being applied. The paper also presents the pattern collection that are emerged from this work. Each of the resulting solutions are also tested on real applications and prototypes developed for this purpose. An example of patterns that are begin documents are also presented.

Future work should apply our claims-to-patterns framework in other situations and domains, to gauge its effectiveness. Thus far, the framework has been used only within our team, and use by others—particularly within emerging areas like low-literacy, m-health, and m-banking—would reflect tremendous benefit to reveal the challenges of shifting from claims to patterns. Another area of future investigation is to seek to maintain benefits of claims within patterns. Claims seek to be designer digestible; whereas patterns can be harder to understand but more complete in the amount of information conveyed [2,5,10]. A solution similar to claims maps could connect patterns with claims to help designers understand key issues [34]. Finally, future work should seek to encourage creativity in exploring solution spaces, both for claims and for patterns [35]. Domain-specific solution spaces, such as a handbook and web repository for low-literate users that includes claims and patterns, would provide an important resource for the design community.

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