

Co-Creation and Prototyping of An Intervention Focusing On Health Literacy In Management of Malaria At Community-Level In Ghana

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Abstract

Introduction: Collaborating with end-users to develop interventions tailored to fit unique circumstances is proposed as a way to improve relevance and effectiveness of an intervention. This study used a local needs driven approach to develop a health literacy intervention for caregivers in Ghana concerning management of malaria in children under five years.

Method: A three-phase framework including: 1) needs assessment based on data from questionnaires, focus groups, individual interviews and observations, 2) Co-creation of a board game and brochures for health education at Child Welfare Clinics to address needs in health literacy concerning malaria and 3) Development of a prototype of the game, brochures as well as determining user feasibility.

Findings: The needs assessment resulted in a useful intervention to bridge the gaps in health literacy among caregivers. Co-creation of the materials and prototyping yielded a varying sense of ownership among stakeholders. End-users' engagement and participation in developing the intervention resulted in a high interest and adherence to interventions. However, high attrition rates of health workers and caregivers' inconsistent use of the Child Welfare Clinics challenged sustainability of this intervention.

Conclusion: The interactive nature of this approach to health delivery interventions resulted in a better caregiver-health provider relationship and a sense of recognition of a more participatory approach to health delivery. A stronger buy-in at the top-level of health management and scaling it out into communities would improve sustainability and reach a larger audience.

Plain English Summary

Introduction: To develop useful interventions, it is important to involve the users of the intervention in its development. Such interventions address the unique needs of the users. This study reports on the design and evaluation of an intervention which was designed to meet the health literacy needs of caregivers with children under five years in the management of malaria in Ghana.

Method: The development process involved three phases. Firstly, the study identified the health literacy needs of caregivers using questionnaires, focus group discussions, interviews and observations. Secondly, there was collaboration with stakeholders in the design of a board game and brochures as health education tools to be used at the Child Welfare Clinics and lastly, assessment of practicality of the designed materials as health education tools for caregivers.

Findings: The intervention addressed the identified health literacy needs of caregivers. Stakeholders involved in the development process expressed ownership in varying degrees depending on the extent of their involvement. Users of the board game and brochures showed high interest and participation in the intervention delivery. Sustainability was challenged with periodic transfer and loss of health workers to career development, as well as irregular visits by some caregivers to the Child Welfare Clinics.

Conclusion: The use of interactive game and brochures at the Child Welfare Clinics improved caregiver and health worker relationship and encouraged a participatory method of healthcare. For long-term sustainability and scale-out of the intervention, there is the need for more support of top-level management of health in the country.

Introduction

This paper describes the development of a community-based intervention in Ghana, a low-income setting, focusing on health literacy to increase knowledge in malaria prevention and early treatment practices among mothers with children under five years.

In 2018, about 93% of the estimated 228 million malaria cases worldwide were traceable to Africa(1). In the same year, malaria in Ghana accounted for 4% of the global disease burden and 7% of the malaria disease burden in West Africa(2). Ghana still battles with eradication of the disease although there has been a reduction in the percentage of deaths due to malaria in children under five years old from 15% in 2010 to 11% in 2016(2). One barrier to eradicate malaria is the misunderstanding of information, which hinders use of preventive measures and appropriate response to the disease(3). This calls for attention to access the right health information and understand health information as important for early treatment and prevention of malaria.

When working with knowledge transfer, the ability of people to make informed health decisions is central to promote good health. The World Health Organisation (WHO) defines health literacy as the cognitive and social skills which determine the motivation and ability of an individual to gain access to understand and use information to promote and maintain good health(4). Low levels of health literacy are associated with poor patient-provider communication, medicine adherence, treatment, self-management, use of healthcare and information and low uptake of preventive measures(5). Okan et al. recommended that tailored health literacy interventions should be systematically developed and described in detail for possible replication in similar contexts to meet the needs of people with similar backgrounds(5).

The aim of this study was to develop a relevant intervention, to meet the practical needs of caregivers related to health literacy to inform prevention and early treatment of malaria in children under five years.

There are several approaches to developing public health interventions(3, 6–8), though with considerable overlap in the actions required(7). O’Cathain et al. categorised intervention development into eight categories each consisting of three or more approaches. The theory-driven and evidence-based category was mostly recommended for its systematic steps to intervention development. Two of the most cited approaches in this category include the UK Medical Research Council’s Framework for developing and evaluating interventions (9, 10) and intervention mapping (3, 11, 12). It is important that the adopted approach to develop an intervention fits the context, rationale of the intervention as well as maximises the likelihood of relevance and sustainability(7, 13). In this study, the intervention mapping approach was applied similar to the OPTimal HEalth LIterAcy (Ophelia) protocol. The Ophelia protocol is a theory- and evidence-based protocol for health literacy profiling and engaging of a community to create and

implement a health reform (13). The Ophelia protocol builds on needs assessment, which is in line with the first step in the intervention mapping and further draws on the concept of co-creation in the development of a health literacy intervention (13, 14). Using needs assessment as the basis for intervention development will help to ensure the relevance of the intervention tailored to the needs of the target population.

Secondly, the Ophelia protocol recommends a co-creation approach for development of solutions that meet identified needs to achieve positive health and equity outcomes for clients as well as ownership of the intervention (13, 14). Co-creation is here defined as the collaboration between academics or researchers and society in the development of knowledge or a product useful to the society(8, 15). Involvement of users of the intervention promotes acceptability and feasibility (8, 15). Thus, this approach as opposed to a one size fits all intervention, is likely to increase effectiveness(7). It increases satisfaction, participation, ownership and sustainability towards positive societal changes on the part of users(7).

In addition to needs assessment and co-creation, this study adds the concept of prototyping as the third phase based on the framework of Hawkins et al. for public health interventions, which involves creation of materials or products(16). This third phase uses prototyping to assess the feasibility of draft materials or products from an intervention prior to piloting and evaluation(16). This both improves the usefulness of the materials to the target users and increases acceptability(16).

In summary, this study used a three-phase intervention mapping approach, a needs assessment, co-creation and prototyping to produce feasible materials acceptable to improve health literacy of mothers with children under five years in the prevention and early treatment of malaria.

The Intervention

Our Malaria Health Literacy intervention is a community-tailored intervention to address three health literacy dimensions using interactive materials consisting of a board game and brochures. The board game is played by mothers in groups of two to four and both game play and brochure discussions are facilitated by community health nurses at the child welfare clinics. Basically, it involves the use of malaria brochures, a snakes and ladders board game (mosquitoes and ladders), with supporting information on malaria as well as breastfeeding, complementary feeding and the hospital referral system. The intervention was intended to address the health literacy needs of mothers in three health literacy dimensions: having health provider support, navigating health system and understanding health information; respondents had low average mean scores in these three dimensions in the needs assessment. The design of this intervention sought to meet the health literacy needs of mothers using the socio-cultural strength of the society.

Method

Study design

In this study and in line with co-creation, stakeholders were introduced to the process after the needs assessment to deliberate on the relevance of the intervention concept.

In accordance with Hawkins et al. (2017)(16), the method used in the design of this intervention is described in three phases: 1. Needs assessment; 2. Co-creation (Co-production is used often in this study to emphasize production of the materials); 3. Prototyping (16). The three-phase approach was based on evidence from scientific literature as well as knowledge of the key stakeholders and their expertise. The key stakeholders included the Ejisu district health directorate (Ghana Health Service, GHS), the unit of health resource and learning materials (GHS), community health workers (GHS), community-based agents, a communication design researcher, public health researchers and ultimately mothers with children under five years who were also the intended beneficiaries of the intervention.

Phase 1. Needs assessment

The needs assessment drew on a health literacy survey, focus group discussions, individual interviews, stakeholder consultation and observations of current practices at the child welfare clinics. This provided the researchers with knowledge on the present situation at the time of the study.

Baseline survey

To assess health literacy needs and knowledge of the caregivers on malaria, a survey was carried out in November - December 2017 in two peri-urban districts in the Ashanti region of Ghana (Ejisu-Juaben and Kwabre East). Both are farming communities where most women are petty traders of farm products. A questionnaire was administered to 1234 caregivers with children under five years, including questions to assess general health literacy level as well as knowledge and practices of management of malaria based on the existing malaria community programmes.

Health literacy was measured using the Asante-Twi version of the Health Literacy Questionnaire (HLQ) (17).

The Health Literacy Questionnaire is a multi-dimensional tool designed to provide practitioners, organisations and governments with data on health literacy strengths and limitations at individual and population level(13, 18, 19). The tool has been used in various groups of people ranging from the general population to policy makers, which makes it applicable to caregivers in this study(13, 19). The tool stands out for its excellent psychometric properties, construct validity and strong reliability with an unbiased mean estimate of group differences(19).

The HLQ is a 44-item questionnaire using a Likert scale score(19) to classify respondents' health literacy on nine dimensions (scales):

1. Feeling understood and supported by health provider
2. Having sufficient information to manage my health

3. Actively managing my health
4. Social support for health
5. Appraisal of health information
6. Ability to actively engage with healthcare providers
7. Navigating the healthcare system
8. Ability to find good health information
9. Understand health information so much to know what to do

Health literacy levels are assessed based on responses to the 44-item questionnaire with response categories 'strongly disagree, disagree, agree to strongly agree' in scales 1 to 5 (part 1); and 'cannot do, very difficult, difficult, easy and very easy' in scales 6 to 9 (part 2)(19). High scores mean the respondents agree or find tasks easy, reflecting high health literacy; low scores mean that the respondents disagree or find task difficult, reflecting low health literacy(19). The average mean score for the scales was used to select the dimensions of interest for the intervention. Thus, the scales with the lowest average mean score in each part of the questionnaire (Parts 1 and 2) were selected.

With health literacy as the variable of interest, it was necessary to translate the questionnaire into the local language (Asante-Twi) to avoid any bias concerning interpretation. The validation study of the original version(19) as well as the translated versions, including the translation and psychometrics of the Asante-Twi version, are reported elsewhere(17, 20–24).

Stakeholder consultation

After the baseline survey, we organised a stakeholder meeting for the heads of the health directorate, mothers, community health nurses and community-based agents. This was to get ideas on what was currently happening and how and what could be done. We presented and discussed the findings concerning identified health literacy gaps and their relevance in developing an intervention.

Focus group discussions

To assess the perceptions of key stakeholders on malaria management in the communities, primarily community case management of malaria, we organised three focus group discussions for three different five-member groups of key stakeholders: mothers, community health nurses and community-based agents. The focus group discussions(25) were moderated by research assistants to ensure that the five themes (Box 1) in the interview guide were discussed.

Box 1: Themes for focus group discussions

1. Knowledge of community-based malaria programmes for children under five years
2. Experiences with managing malaria through the community-based programmes
3. Perceived benefits of the programme in managing malaria
4. Perceived challenges of the programme in managing malaria
5. Perception of the community-based programme on:
 - a. Access to health information
 - b. Understanding of health information
 - c. Application of health information

We analysed the responses from each group to understand the perception on the status of malaria management for children under 5 years and the health literacy potency of the existing programmes. Each group discussion lasted one hour. The responses were recorded, transcribed verbatim and analysed thematically.

Individual interviews

Three individual interviews were carried out to gain knowledge in managing community-based programmes on malaria for children under five. The health administrators interviewed included the health director, the disease control officer and the health promotion officer. The interview with the director was conducted to gain insight into existing malaria programmes and the challenges related to community cooperation. From the interview with the disease control officer, our interest was to get insight into the existing strategies to control malaria in the community. The interview with the health promotion officer helped us know how the community promotes early treatment and preventive measures on malaria. The interview guide included themes on strengths and limitations of existing malaria programmes in the communities according to the different health administrators. These interviews also lasted one hour each. The responses were recorded and transcribed verbatim for analysis.

Observations at the Child Welfare Clinics

Identification of intervention setting

In addressing health literacy in the management of malaria among mothers with children under five years, we sought to build on existing community programmes with similar target groups. During interviews and discussions, Child Welfare Clinics were identified as one other good setting for an intervention for caregivers with children under five years.

What is a Child Welfare Clinic?

Child Welfare Clinics are set up in communities and health facilities, and all new mothers are recommended to visit the clinic once a month. Services at the clinics include growth monitoring, immunization against childhood illnesses, vitamin A supplementation, first aid, and referral of

complicated cases(26). They also provide health promotion and education activities including health talks in relation to mother and child, as well as counselling sessions on planned parenthood(26). In rural communities with no fixed infrastructure, clinics are mobile (27). They are led by community health nurses and mostly assisted by community health volunteers trained in management of childhood illnesses including malaria (27). The clinics also provide an integrated management of the childhood illness programme, which also covers malaria(26).

What we did at the Clinics (observations)

Following the UNICEF recommended checklist (28) developed on positive counselling skills, two researchers conducted observations (29, 30) of current activities at three of the child welfare clinics in the study communities. We observed how child welfare services were provided to several mothers from arrival at the clinic to departure. Hence, our observations lasted for more than an hour for each clinic.

After the observations, there were informal interviews with some of the mothers (randomly selected). The interview regarded the age of the child, and the services mothers received at the clinic. Furthermore, the analysis from our focus group discussions hinted on game boards and leaflets as ideas for intervention materials. During the informal interviews, the mothers' opinions were sought on the health information presented in the form of a game.

These observations and informal interviews aimed at identifying gaps in the services at the clinics, perceptions on using a game as a health education tool and how to integrate our intervention into the current services at the clinic. Fieldnotes were taken during both observations and interviews, summarized and analysed after the visits.

Stage 2. Co-production of materials

The second stage involved design of the intervention suitable for the subject of interest and the target population in consultation with stakeholders. The key stakeholders at this stage comprised all researchers (public health experts and communication designer), Ghana Health Service directorate staff (district directorate and health resource and learning materials unit), and community health nurses.

Stakeholder consultation

Depending on the topic of discussion, each stakeholder consultation included the relevant stakeholders:

Game (co)-design

The idea of this particular board game was inspired by literature on how the game has been adapted to educate children in schools(31–33). Based on their positive outcomes(31–33), low literacy levels in our target population and the interactive focus of our intervention, the snakes and ladders board game was selected. The game was adapted to suit this study.

In developing the board game, discussion on the rules, manual and the design of the board game took place between the communication design expert and the other researchers. An iterative approach to design was used in line with the principles of co-designing. As such, the activities consisted of a non-linear process to define the problem and develop a solution. This involved formative evaluation throughout the processes of the design as well as a summative evaluation during testing of the game intervention by stakeholders. Based on the feedback from the stakeholder consultations, the researchers continued to brainstorm to generate ideas on the design of the entire intervention. This involved an interactive discussion of ideas and creation of mind maps and further visualising these into concepts. With the objectives of the intervention as a focus, the ideation resulted in the creation of draft layouts, colour schemes, graphic elements, rules for the gameplay and identification of available materials for the development of the game. The ideation process proved useful in understanding the problem to better meet the needs of users. Furthermore, the layout ideas were refined, and one was selected. This comprised a flat panel game of numbered squares with pictured mosquitoes and ladders.

Brochure co-design

The decision to cover the three themes on malaria, breastfeeding and referral system was based on the needs assessment. With respect to the brochure design, the researchers worked closely with the Health Resource and Learning Unit of the Ghana Health Service (GHS), a unit in charge of developing all materials on health education for the GHS. The malaria brochure was designed from scratch whereas the content of the breastfeeding leaflet was based on the UNICEF brochure on breastfeeding and complementary feeding(34). Prior to collaborating with Ghana Health Service, the researchers deliberated on the layout of the brochures. We agreed that the brochures should be appealing to mothers with simple and precise messages and stimulating interaction among people. This decision was based on recommendations in other studies on design of health education and promotion brochures (35, 36).

Several drafts of the board game and brochures were discussed among the researchers before presented to other stakeholders. Thus, drafts of the intervention package were presented to the District Health Directorate and community health nurses for discussions on content and their opinion on feasibility.

Stage 3- Prototyping

The third stage involved testing of the materials for the intervention, intervention roll out and the fidelity. Here, the malaria health literacy game (Mosquito and ladders) in addition to the supporting brochures on malaria, breastfeeding and referral system were finalised. In August 2018, the researchers and key stakeholders met to go through the intervention and the roll out. The participants at the meeting were community health nurses from the selected communities, researchers, research assistants and representatives from the Health Directorates. Thus, the meeting served as both an introduction to the intervention as well as training of key facilitators of the intervention. The community health nurses facilitated the six- month intervention roll out by adding on the game play and use of brochures during health talks as a part of the activities at the child welfare clinics. Research assistants were trained at this stage to be observers of the intervention. This was to assess how much of the intervention was

completed as planned. They worked together with the community health nurses to plan the schedule and to coordinate the logistical materials (brochures, and game boards and accessories).

Stakeholders' reflections post intervention

Stakeholders were interviewed during and after the intervention to reflect on the development of the intervention, its feasibility and sustainability. During the intervention delivery, 404 mothers, basically those who played the game (4 mothers per game for 101 clinic visits) ,were asked to comment on both the game play and the discussions based on the brochures. On the other hand, a representative from the District Health Directorate, the community health nurses and the research assistants, respectively were interviewed online post intervention delivery (via Zoom) as they reflected on the entire development and delivery of the intervention. Zoom interviews were conducted by a researcher outside of this study team to avoid bias in response due to familiarity. These interviews were transcribed with the interpretation presented in themes.

The entire process has been captured in a framework as shown in Fig. 1, which includes the activities carried out at each stage of the development. The entire period from co-creation to prototyping lasted 16 months (November 2017-February 2019). To add on the reporting quality, the Guidance for Reporting Involvement of Patients and the Public (GRIPP2) checklist is attached for transparency in accordance to International patients and public involvement study standards.

Results

This section includes a descriptive summary on the baseline survey and the qualitative study (focus group discussions and individual interviews), a summarised table of results for the three phases in the development of the intervention and an elaborate presentation of the findings from the fidelity data and reflections from stakeholders.

1. Background description of respondents

Baseline survey

Table 1 presents demographic characteristics of respondents. Most of respondents were female (98%), and the majority ranged between 20 and 39 years of age (85%). More than half of respondents (72%) had little to no education and a little over half (54%) were employed. Almost a quarter (38%) reported that they had some kind of illness or long-term disability.

Table 1
Background characteristics of survey respondents (N = 1234)

CHARACTERISTICS		
	EJISU-JUABEN (N = 631)	KWABRE (N = 598)
AGE *	4.1	3.7
15–19	39.8	46.3
20–29	42.8	40.6
30–39	11.2	8.5
40–49	1.1	0.5
50–59	1.0	0.3
60–69		
SAMPLE	EJISU-JUABEN (635)	KWABRE (599)
EDUCATION	65.8	79.6
≤ 9 years	20.7	19.0
12 years	3.5	1.4
≥ 12 years		
EMPLOYMENT	56.6	52.4
Employed	39.8	41.1
Unemployed	3.6	6.5
Retired		
GENDER	97.3	97.8
Female	2.7	2.2
Male		
LIVING ALONE	29.8	20.0
Yes	70.2	80.0
No		

Note* Sample size for age is less than other characteristics because some of the reported ages were either too low or too high.

CHARACTERISTICS		
LONG TERM ILLNESS	9.6	9.0
Chronic	34.5	22.5
Non-chronic	55.9	68.5
None		
LANGUAGE	90.1	88.7
Local language	9.9	11.3
English		
Note* Sample size for age is less than other characteristics because some of the reported ages were either too low or too high.		

Qualitative study respondents

Focus group discussions

The mothers in this study were petty farm product traders aged between 20 and 45 years with different educational backgrounds from little or no education to tertiary-level education.

Four (4) mothers were married and one was divorced but co-habiting with a new partner; the number of children for each woman ranged between 1 and 4.

The community health nurses included four (4) females and one male with an age range between 28 and 36 years. Seniority among community health nurses ranged between three (3) and nine (9) years.

The community-based agents in the study had other occupations: three were farmers, one was a teacher and one was a trader. The age range for the community-based agents was wide, 30–72 years, and out of the five (5), three (3) were females and two males.

Individual interviews

All three administrators: the health director, the disease control officer and the health promotion officer, had long experience in their functions, with at least eight years of experience in health systems management (8). The director and health promotion officer were both women.

In summary, the baseline survey, together with the focus group discussions, interviews, observations and discussions resulted in the need to design an interactive health literacy intervention to address understanding health information, navigating the health system and having health provider support for caregivers. The child welfare clinics were recommended as suitable setting for this intervention. Details of the findings can be found in Table 2.

Table 2

Summary of results from the application of the 3-stage framework for co-production and prototyping of game and brochures

Activity	Stakeholders	Objectives	Results
Stage1: Needs assessment	• Caregivers with children under 5 years	• Assess health literacy needs and challenges in malaria management in the community	• Out of the nine dimensions, three scales were selected based on the average mean score. Scale 1 Having Health Provider Support (2.44); Scale 7 Navigating Health System (3.33) and; Scale 9 Understanding Health Information (3.35).
Survey	• Research assistants		
Stakeholder consultation	• Researchers • Mothers	• Brainstorm on possible intervention concept based on findings from survey	• On the management of malaria, 96% of caregivers had knowledge on the main symptom of malaria (fever); 23% ; 47% of caregivers had children with recent episode of malaria and their treatment sources included 69% self-treatment; 31% hospital treatment and 0.3% did nothing as their first response to the disease. Most important challenge identified was seeking the right treatment source.
Focus group discussions	• Community health nurses		
Individual interviews	• Community- based agents (volunteers)		
Observations at Clinics	• Research assistants • District health director staff • Researchers • Mothers • Community- based agents • Community health nurses • District health promotion officer • District disease control officer • District health director • Mothers at child welfare clinics • Community health nurses	• Assess perceptions on community case management of malaria with focus on health literacy • Gain insight on existing malaria community programmes, challenges and strengths • Observe activities at child welfare clinics	• Identified child welfare clinic as the suitable setting for the intervention “I think if we include the programme and volunteers on the Community Health Nurses weighing sessions and reach out to and educate mothers on the programme it will be successful.” (Community health nurse) • Perceptions on existing malaria programmes were grouped into five themes: 1) Mothers valued the programmes due to possibility of education; “I was involved in the malaria programme because of my work as a prophetess (a religious female leader). People in the community do come to me with all kinds of sickness, so I thought it wise to involve myself to get the chance to be educated and to educate other people in the community in sleeping in the mosquito nets”. 2) Nudging and reaching out through existing social platforms to promote healthy practices; “I’ve heard about the malaria programme because even last year, they came to share mosquito nets to us”. 3) Health education presented as instruction; “Some of the mothers did not follow the instructions that was giving to us. They were supposed to dry the net in the sun before sleeping in but some of the mothers didn’t follow the instruction and there were complaints of facial itching.”

Activity	Stakeholders	Objectives	Results
			<p>4) Strong agency of mothers willing to support peers to understand and use health information; "I and other mothers were also doing the sweeping of the venue every morning and evening to enhance or facilitate the sharing of the mosquito nets. We also saw it wise to come together to educate ourselves and other mothers in the community to prevent malaria".</p> <p>5) Possible cultural barriers for health promotion.</p> <p>Recommendation on future intervention was focused on interactive health education during social gathering like the child welfare clinic; inclusion of community health volunteers with incentives.</p> <p>• The health administrators shared that: 1) the community case malaria programme has been put on hold for the past 2 years due to logistics on medical supply; "they brought the medicine for them to use and after the medicine was finished, that was the end of the programme, they did not receive any thing for the treatment, the challenges had to deal with the logistics that were never supplied." Health administrator1</p> <p>2) Social gatherings like churches or child welfare clinics appropriate for malaria programmes; "I think for a health literacy programme, we have to use the community health nurses, because you know the mothers will bring their children for weigh-in if nothing at all, for immunization." Health administrator 2</p> <p>3) Non-functional but existing mother support groups and;</p> <p>4) Possible use of social media applications for health education.</p> <p>• During the visit to 3 clinics we observed that: 1) two nurses facilitated activities with support of community health volunteers at each site; 2) Activities included those outlined in the UNICEF checklist but they were not in the same order as the checklist; 3) Each site started with health education and; 4) Long waiting time for mothers.</p> <p>We planned to engage mothers in the game play while waiting. In addition, we plan to use brochures during the health education sessions.</p>

Activity	Stakeholders	Objectives	Results
			<ul style="list-style-type: none"> Mothers seemed to have knowledge of the proposed board game and found it interesting; “Are you referring to Ludo’s snakes and ladders? I don’t know if it will work, (giggles) but I like the game and it sounds like an interesting idea”. (Mother at CWC).
Stage 2: Co-production of materials Stakeholder consultations for game co-design Brochure design	<ul style="list-style-type: none"> Communication design researcher Mothers District health directorate Researchers Health Resource and Learning Unit, GHS District health directorate Researchers 	<ul style="list-style-type: none"> To design a game useful for caregivers to manage malaria and suitable for use at the clinic Design of brochures was useful, promoted interaction and was easy for caregivers to understand 	<ul style="list-style-type: none"> Consultations with communication design researcher on an iterative approach to adhere to principles of co-designing. Formative evaluation in process of design and summative evaluation from other stakeholders. Discussions on ideas and creation of mind maps based on objective intervention resulted in draft layout, colour schemes, graphic elements, rules for game play and identification of materials to develop the game. The flat panel game comprised one hundred (100) squares in a ten by ten grid, shaded in colours of white, yellow, red, green and blue. Questions and answers to be used in the board game were designed as colour coded flash cards for participants. In total, 56 questions and answers were categorised under causes, symptoms, treatment and prevention of malaria. This study used three brochures for health education. Researchers engaged with the health resource learning unit of the Ghana Health Service to develop the malaria brochure. By theory and discussions on layout, the team developed a brochure with precise messages, picture for each topic on malaria with an appealing and welcoming cover. Front page was captioned as “Avoid malaria, keep your child healthy and happy” displayed together with a picture of a happy mother and her baby. This was deliberate to attract users. Brochure on breastfeeding was retrieved from the UNICEF website and restructured to meet the objective of the intervention (not lengthy text, more pictures). The brochure on navigation of health system outlined the levels of healthcare options for seeking appropriate care. It showed a bottom-up approach which begins from community health volunteers, through the CHPS compounds and mapped up to the tertiary hospital accessible in the district.

Activity	Stakeholders	Objectives	Results
Stage 3. Prototype of game and brochures	<ul style="list-style-type: none"> • Mothers • Community health nurses • District health directorate • Research assistants • Researchers 	<ul style="list-style-type: none"> • Assess feasibility of game and brochures 	<ul style="list-style-type: none"> • Finalized on the drafts for the game (mosquitoes and ladders) and brochures. • Stakeholders, including a mother played the game to assess its feasibility; this resulted in some changes to the rules and rephrasing of some questions. • This session addressed the need to translate all questions to the local language and present both languages to avoid misinterpretations. • Training of community health nurses in the use of these materials and with role play sessions useful to assess feasibility. These sessions added the need to clarify some questions and responses and further rephrasing of other questions.

2. Development of board game and brochures

Several simulations of the game play and versions of the brochures allowed the researchers and stakeholders to better understand how learners would interact with these materials as well as with other participants. The final versions of the board game were designed using a vector graphics software to ensure high-quality output and the ability to make changes after feedback from stakeholders. Finally, the board game with questions and answers were printed on card and laminated to prevent degrading of printed ink and wear out of the paper material during use. Brochures were as printed and packaged to avoid wear and tear as well as misplacement.

3. Fidelity Assessment

The pilot covered a six-month period from August 2018 to February 2019 in the 10 selected communities. Below, the observations by the research assistants on the fidelity of the intervention are shown.

Table 3
Intervention Fidelity Assessment: Compliance with intervention implementation design (N = 101 clinic visits)

Item	Intervention Fidelity Assessment (101 respondents)	Yes %	No %
1	Did community health nurses give a recap of previous months' sessions?	85.1	14.9
2	Was the first hour of the day's session covered by brochure discussions and game play?	83.2	16.8
3	Was the brochure discussion held before the game discussion?	91.1	8.9
4	Did all caregivers present have brochures for discussions?	87.1	12.9
5	Did the Community Health Nurse engage mothers during the discussions?	93.1	6.9
6	Did caregivers participate in the brochure and game discussions?	94.1	5.9
7	Were caregivers given time for questions with feedback?	92.1	7.9
8	Was the game played in groups?	87.1	12.9
9	Did community health nurses explain the rules of the game to caregivers?	86.1	13.9
10	Did the community health nurses facilitate the game discussions?	81.2	18.8
11	Did the game lead to further interactions with or questions to community health nurse?	86.1	13.9
12	Did the community health nurse use the platform to elaborate further on the questions and answers to the caregivers?	86.1	13.9
13	Were caregivers interested in the game?	86.1	13.9
14	Did the game promote group interaction?	89.1	10.9
15	Did the community health nurses refer to illustrations and pictures in the brochure in the discussions?	79.2	20.8
16	Did the facilitator introduce the topic for the next discussions session to caregivers?	82.2	17.8

The table shows sixteen (16) steps outlined in the intervention manual for the intervention delivery and whether research assistants could observe them as planned. The percentages were based on a "yes or no" response. For all items, at least 79% of the observations showed that the intervention was carried out as planned. The least carried out activity concerned brochure illustrations, which meant that in 21 out of the 101 observations carried out, the CHNs did not go through the brochure illustrations with caregivers as expected. However, 90% of observations showed that the game was interactive, and participation and interest was high in the intervention as observed.

4. Stakeholder reflections on intervention development

The following summary describes reflections by some stakeholders based on their involvement in the design and roll out of the intervention in the pilot phase. These interviews were pre-coded with the themes on the advantages of adapting co-creation in the design of the intervention. The summary here does not touch on effectiveness as it did not result in any quantified outcomes. The themes included usefulness, ownership and sustainability of the intervention.

4.1 Usefulness of intervention

The intervention resulted in producing health education materials with messages that were easy to understand and promoted a good relationship among caregivers and their healthcare providers.

I. Usefulness of intervention (local needs driven)

The co-creation process of developing the intervention and the adaption of the Ophelia approach to develop an intervention based on local needs led to a useful intervention among the users. The relevance of this intervention lies in the materials developed based on needs and the intervention delivery approach adopted. When asked whether the intervention was local needs driven, one stakeholder said:

"I think it was 100%. It was because the issue that we are talking about relates to mothers in Ghana. Issues on malaria, breastfeeding and visiting the nearest hospital as first facility to seek health care. So, it was tailored to mothers in Ghana". Research assistant

"This has been reflective of our lives. We are grateful to be partakers in this programme". Mother

These quotes suggest that the intervention matched the needs of caregivers as identified through the needs assessment with the second quote showing a mother's content with the relevance of the intervention in her life.

II. Useful content of materials for health education

In relation to the content, the health information helped to debunk some perceptions on treatment of malaria and inappropriate health seeking behaviours:

"During this intervention, we were able to clear so many fallacies on malaria, for example the perception that every fever is malaria". Then some of them came to realise that; so, when my child has fever that does not mean he or she has malaria. It could be due to other reasons, so I have to take him or her to the hospital to have some tests taken to confirm whether it is malaria or something else troubling my child". Nurse

"I think it is a good game because there were things I didn't know about using mosquito nets, like, how long a mosquito net should be used before treatment but now through the game I do". Mother

"The game is educative. I have learned that you should visit the hospital when you have malaria and not buy drugs from drug or chemical shops". Mother

From the quotes above, the content of the materials used in the game and brochures helped to change wrong attitudes among some mothers on management of malaria in children under five years. In the first quote, mothers' perception on treating every fever as malaria was addressed based on the content of the brochures and games. Thus, the content of the materials was useful in addressing mismanagement of malaria in children under five years.

III. Useful communication tools for understanding health information

In this intervention, both English and the local language (Asante-Twi) were used especially for the question and answer cards for the game to make it easy to read even for people with low literacy levels. The use of precise and simple sentences together with the illustrations in the brochures made it easy to communicate and interact with the caregivers.

"It was very simple for them to understand with guidance; they (researchers) didn't use jargon they (mothers) did not understand. They (researchers) used everyday things which mothers were familiar with, so for me I will recommend it to others". Health directorate representative

"I have learned a lot about the things to do to prevent malaria; like the man weeding on the ludu (game) which tells me that when I weed around my house it can prevent mosquitoes from breeding". Mother

The above quotes show how simple sentences with illustrations in the brochures and the game made it easy to understand the information and set the pace for interactions. The use of the brochures resulted in efficient discussions because mothers could see visually the things being discussed in the brochures.

"... most of our weighing, we don't get those things we only go and deliver our message with our mouth. What we have written, we only go and deliver it to them. But this time, there is something that we have, the person has, I also have so we are all looking through it together. Whatever we need to discuss, there is an illustration, one could ask, oh madam this one, what does it mean?" Nurse

This quote adds to the usefulness of the brochure in health education sessions at the child welfare clinics through the illustrations and by providing a tool to improve discussions.

IV. Intervention approach and health provider support

The interactive nature of the intervention changed perceptions on the role of health providers among both health providers and caregivers. As a community health nurse describes:

"We need to interact with them, consult them and know, what is happening with them, because through this some of them were able to come out with what their problems are. Initially they would think that the nurse is only interested in weighing my child and know how heavy he or she is, and that is it. But now we are teaching something different so when the person has a problem, she can come to you oh madam, this and that is what is happening to me and so what could I do? And then the advice that you have you can give to the person." Nurse

"I would say that it has made caregivers assertive. Nurses had interactions with caregivers and so caregivers come freely to ask questions. They (caregivers) call on nurses because they have had some relationship with them (nurses)." Health directorate

"The game is fun, and the questions are good, interactive and informative. The nurse was good at explaining the answers for me to understand. I have learned a lot". Mother

These three quotations illustrate how the interactive approach led to a better relationship between nurses and caregivers. This made it possible for caregivers to approach their health care providers with other health concerns and seek advice on how to manage these. Hence, this intervention improved the relationship between health care providers and their clients to ensure better health care.

4.2 Ownership

As stakeholders were involved at different stages during the development of the intervention, all stakeholders expressed ownership in different ways. The directorate representative shared her view:

"...at any point in time, they (researchers) came to us, discussed it with us and received our input as to how we can get the community members to participate and we looked at what we have already. So, I believe we made an input to the development of the intervention, I believe that together we actually own it". Health directorate representative

The representative from the health directorate shares how the directorate was involved throughout the co-creation and adaptation of the intervention. However, a nurse expressed it differently:

"So, through the workshop (training of community health nurses on materials and delivery approach) the whole thing started. If I could remember, they brought the things (brochures and the board game) and they taught us to use it. So, we made demonstrations during the workshop". Nurse

"A lot has been taught over the six-month period and we have learned a lot during the period where we were engaged. We feel proud to be part of this programme. I have learned a lot. Now we are waiting for the competition. We will bring the prize home". Mother

Thus, the nurse expresses that she was not involved in the development of the materials but rather in the delivery of the materials. The mother in this quotation expressed her satisfaction with being a part of the pilot phase, but the quotation actually shows that mothers' motivation to ownership was an inter-community competition of the game play and they looked forward to claim the victory. This inter-community competition was organized for the caregivers after the pilot phase of the intervention. Thus, stakeholders shared the sense of ownership differently.

4.3 Sustainability

The strength concerning sustainability of this intervention concerns the usefulness to both users (nurses and caregivers); its weakness, however, lies in the unavailability of resources and administrative buy-in.

The quotation below explains the issues of sustainability.

“Sustainability means once we own it, it becomes part of us, something we will practice. It has its own advantage for health providers, like something they have learned, and it becomes part of them.” Health directorate representative

“Any outreach that we go to especially with the brochures, we start with health education, so that one was a plus for us because we have flyers and other things which we can use to educate mothers”. Nurse

“Such an informative programme. How we wish every mother took this programme seriously. It is good to understand some basic health needs and this programme is a big help”. Mother

The above quotations show user buy-in and a high interest in the sustainability concerning use of the materials and the approach to information delivery. However, sustainability is challenged by the structure of health delivery services in Ghana where there is high attrition rate of health personnel at community level.

“What we are experiencing now is a high attrition rate. If a community health nurse goes into midwifery and is no more at the service area for child welfare, this means we lose, especially when the knowledge is not passed on”. Health directorate

“I used to go to the outreach facility but now I don’t go because I have taken over as an in-charge (higher position). The person who took over was in school and had just graduated so she has not started work yet. The one who filled in for her was also temporary, so I didn’t introduce it to her”. Nurse

“Sustainability is of concern, just as I said, if you go today and there is a different nurse and probably, they don’t know what is going on, they just do their thing and leave”. Research assistant

The quotations above show that the barriers to sustainability depend on the high attrition rate and regular reposting of health workers in the health district.

The representative from the health directorate suggested that in their routine review of health promotion activities in the district, they would include this interactive approach as one of the activities to be reviewed.

“So, during our reviews in fact, it’s an area we will review. And once it’s something that we are reviewing, it means it’s on our radar as one of the methods of service provision. Then we need to put in more effort to scale it up, otherwise, your guess is as good as mine”. Health directorate.

In summary, the sustainability strength of this intervention lies in its usefulness to users (nurses and caregivers) but its weakness lies in availability of resources and administrative buy-in.

Discussion

This paper describes the development of a community-based intervention focusing on health literacy to increase knowledge on prevention and early malaria treatment practices among mothers with children under five years in Ghana.

Co-creation is a collaborative approach to develop public health interventions including both academics and stakeholders (non-academics)(8, 15). Unlike traditional top-down approaches to intervention development(37), co-creation leads to tailored interventions which address locally identified problems with local solutions(8, 37). The needs assessment phase in this study outlined gaps in the health literacy levels of caregivers as well as gaps in the management of malaria in the communities for children under five years. These findings resulted in the design of an interactive approach to health education through development of a game and brochures. Thus, the content of the materials developed were practically useful to caregivers and the delivery of the intervention fitted the setting of child welfare clinics. Hawkins et al(16) pointed out that the participation of stakeholders in the co-creation of intervention content provides a way to tailor intervention content to the context and target population, thus maximising acceptability and reducing challenges concerning implementation(16). This study achieved a high patronage with almost 90% of caregivers showing interest through high participation in this interactive approach to health education. The high patronage could be attributed to the setting (Child Welfare Clinics). The acceptance of the game and brochures can be ascribed to their usefulness in meeting the knowledge gap in the appropriate management of malaria.

In addition to content relevance, the layout and design of the game and brochures with precise messages facilitated understanding of the message, which was part of the aim for developing the materials. In the development of health education materials the content, layout, text construction and lexical comprehension impacted on the legibility(36). A study by Michel et al in the United Kingdom showed that parents' understanding of information influenced child care(38, 39). In their study, parents who understood the meaning of 'wheezing' were more likely to report 'wheezing' in their children(38). The use of simple messages, pictorial layout of the materials as well as translation of some of the messages in the local language in this study, enhanced the understanding and relevance of the materials developed.

The use of these interactive materials also influenced perceptions on the roles of a health provider in health care delivery. The use of interactions in health education is a way to confirm comprehension of information and it improves provider-patient communication(39). In addition, low patient oral and aural literacy is associated with poor health outcomes. Thus, Nouri et al stipulated that oral exchange is relevant to improve health provider relationship and health outcomes(40). Health provider support was one of the dimensions in health literacy identified as the primary concern in terms of health literacy. Thus, the aim of the interactive materials was to break barriers of communication and improve the relationship between the health provider and caregivers. As shared in the reflections, caregivers after such interactive sessions reached out to nurses to share other health concerns and sought advice. In other words, the social nature of the intervention, which is opposite to the previous one-way didactic approach to health education, broke barriers in the communication between nurses and caregivers.

Ownership is a concept within co-creation, a state, right or act of possessing something (8, 16, 41). The varying range of possible engagements with different kinds of stakeholders (8) yields varying degrees of ownership in the co-created intervention. This study engaged the different stakeholders based on the aim at each phase and activity in the development process. While stakeholders from the health directorate were involved during the entire study, other stakeholders were consulted when necessary especially during the development of the materials; for some stakeholders like mothers, different mothers were consulted at different times. Therefore, although stakeholders including mothers shared a sense of ownership of the intervention, the degree of the sense of ownership was stronger for those who were more engaged. This is possible in co-creation as O'Cathain et al(7) shared that the principles of when, where and how to engage stakeholders in co-creation is still an open question to be addressed. Ownership is said to promote adherence and results in sustainable interventions, and the high participation and interest that users showed in this study promotes sustainability.

The sustainability strengths of this intervention lie in the interest of users and the individual stakeholders, but leaves more room for long term sustainability at health system level. Unfortunately, the challenges in the health system in this context also challenges the sustainability of this intervention. Specifically, issues of high attrition rate and regular reposting of nurses challenge the sustainability of this intervention. The high attrition rates of community health workers in most developing countries is well documented(42, 43). Abbey et al(44), reported an attrition rate of 22% in a 30-day period for community health nurses. This relatively high rate was associated with influence by immediate family, remuneration, and other job opportunities(44). However, training of more health workers and Ghana Health Service's approval of these interactive materials as recommended tools for health education in the communities, could address the limitations on sustainability of this intervention resulting from high attrition rates. This study recommends that, if possible, other community health workers like the well-known community-based agents (volunteers) should be trained to use these materials to educate mothers in the community.

Strengths

We adapted this pragmatic approach to reporting on the intervention as it makes room for reporting on the development of the materials and steps of the intervention, which is sometimes difficult to capture using other guidelines(3, 9, 10, 45). This study recommends this approach as useful in reporting on interventions in relation to both process and content.

To our knowledge, this is the first study to adopt the combination of a game and brochures as useful health education tools for caregivers to promote understanding of health information and health provider support. Considering the social nature of the context, the study used the strengths of the society to meet the needs and makes it possible for other researchers to explore how to best use this principle to address gaps in the society.

The use of interdisciplinary researchers in the development of the game and brochures improved the usefulness of the layout and design of the materials as well as provided better solutions to societal

problems.

Limitations

From the translated version of the HLQ, one of the identified health literacy scales did not seem to fit well in the confirmatory factor analysis(17). Specifically, in the factor analysis, the construct 'understanding health information' did not seem to measure what it was intended to measure which influences its interpretation(17). However, in this study, the qualitative findings also influenced the selection of the scales and this showed that understanding health information was a relevant theme for the intervention.

The use of co-creation and a sense of ownership sometimes becomes a disadvantage. As noted from the table on the fidelity assessments, none of the planned activities was 100% observed during the intervention delivery. Thus, for each activity planned, community health workers deviated from the required process of delivery, showing that the concept of co-creation was still in use in the pilot phase. However, this might also be observed during implementation after piloting probably to suit current conditions; hence, it calls for monitoring to improve impact of the intervention.

Again, in our approach, we might have lost some good ideas because the stakeholders were not always consulted together, as the deliberations might have yielded constructive suggestions. In addition, it would have been appropriate for all stakeholders to be involved from the onset to give each stakeholder an equal chance to contribute. Therefore, better approaches to obtain useful inputs from experts individually and as a team in the design of interventions could be useful.

Conclusion

This study outlines the three stages involved in the development of a tailored health literacy intervention for mothers with children under five years in the management of malaria at community level in Ghana. The interactive nature of this approach to health delivery interventions led to better caregiver-health provider relationship and a sense of recognition of a more participatory approach to health delivery. A stronger buy-in at the top-level of health management and scaling it out to communities would improve sustainability and reach a larger audience.

Abbreviations

- HLQ HEALTH LITERACY QUESTIONNAIRE
- CHPS COMMUNITY-BASED HEALTH PLANNING AND SERVICE
- CHN COMMUNITY HEALTH NURSE
- OPHELIA OPTIMAL HEALTH LITERACY
- GHS GHANA HEALTH SERVICE
- UNICEF UNITED NATIONS CHILDREN'S FUND
- CWC CHILD WELFARE CLINIC

Declarations

Ethics approval and consent to participate:

We received ethical approval from the Committee for Human Research and Publication Ethics, an institutional review board of the Kwame Nkrumah University of Science and Technology (CHRPE/AP/506/17). We obtained informed consent verbally from all respondents as was approved by ethics committee.

Consent to publish: Not applicable

Availability of data and material: The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: MAB is the corresponding author. She worked on the study design, data analysis and drafted the manuscript.

UE contributed to study design, analysis and review of the paper.

PAB contributed to the design and review of the paper.

SA contributed to the review of the paper.

BP contributed to the game design and review of the paper.

OA contributed to data collection and review of the paper.

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Figures

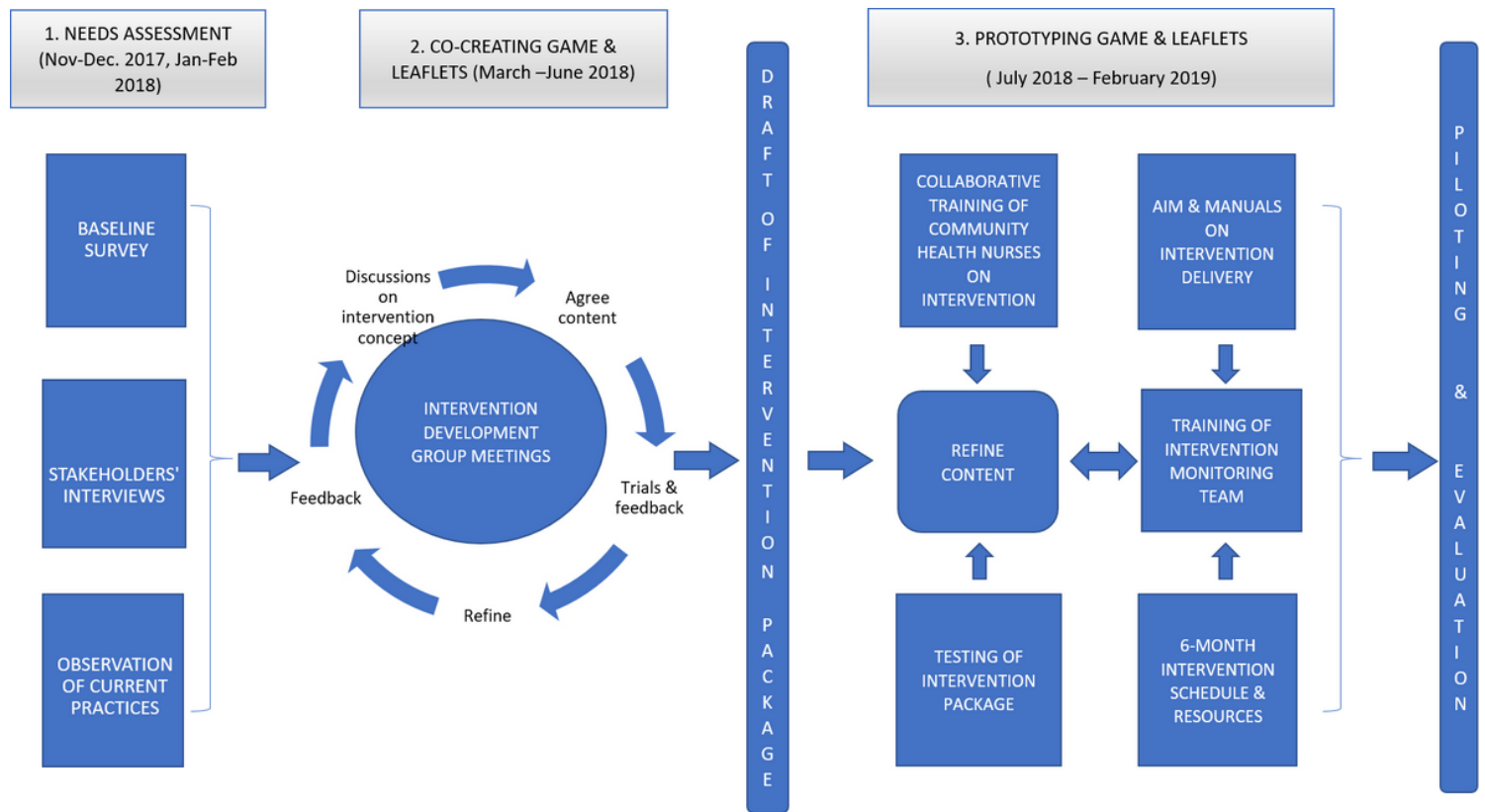


Figure 1

Conceptual Framework of Intervention Design

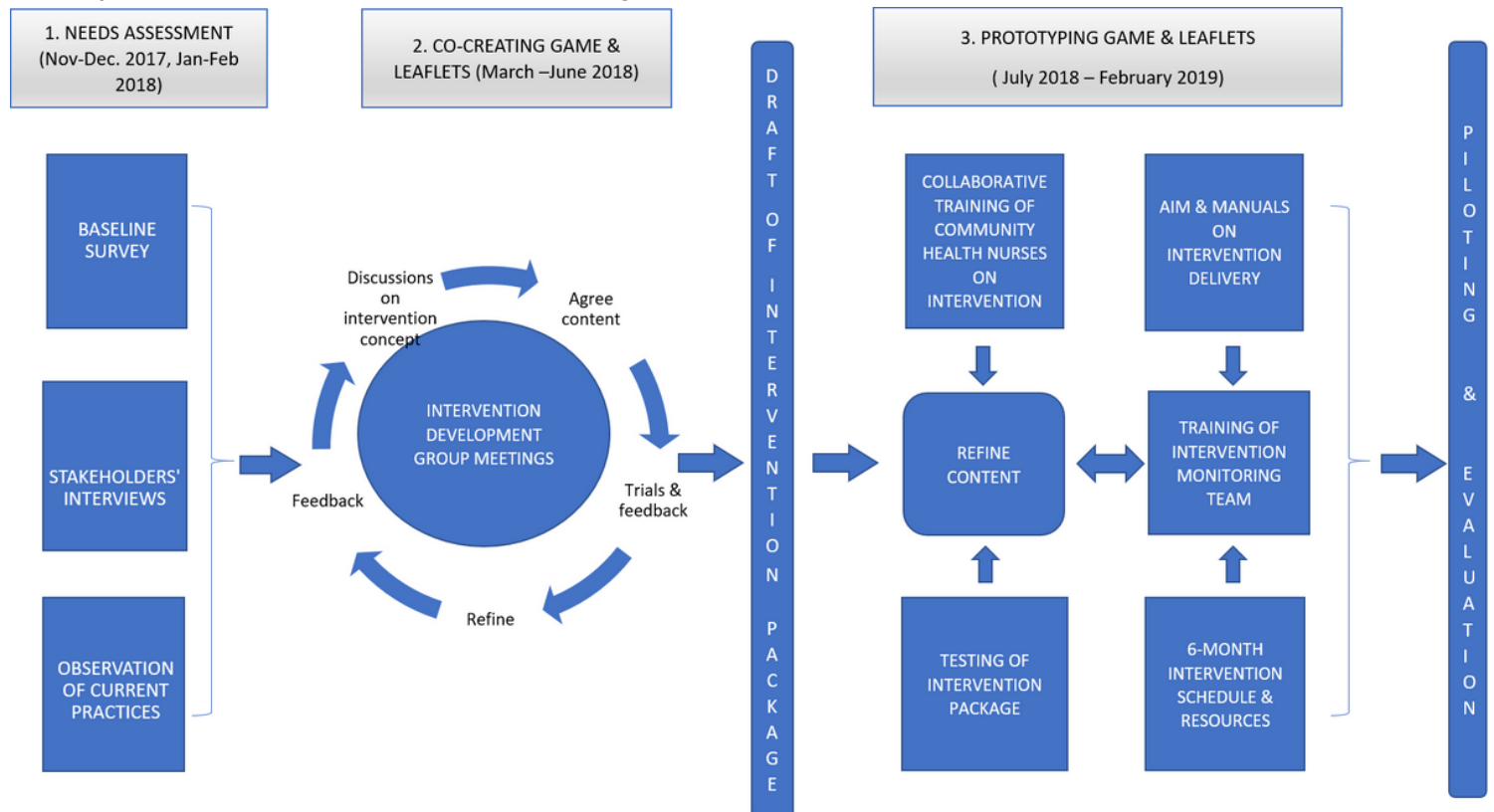


Figure 1

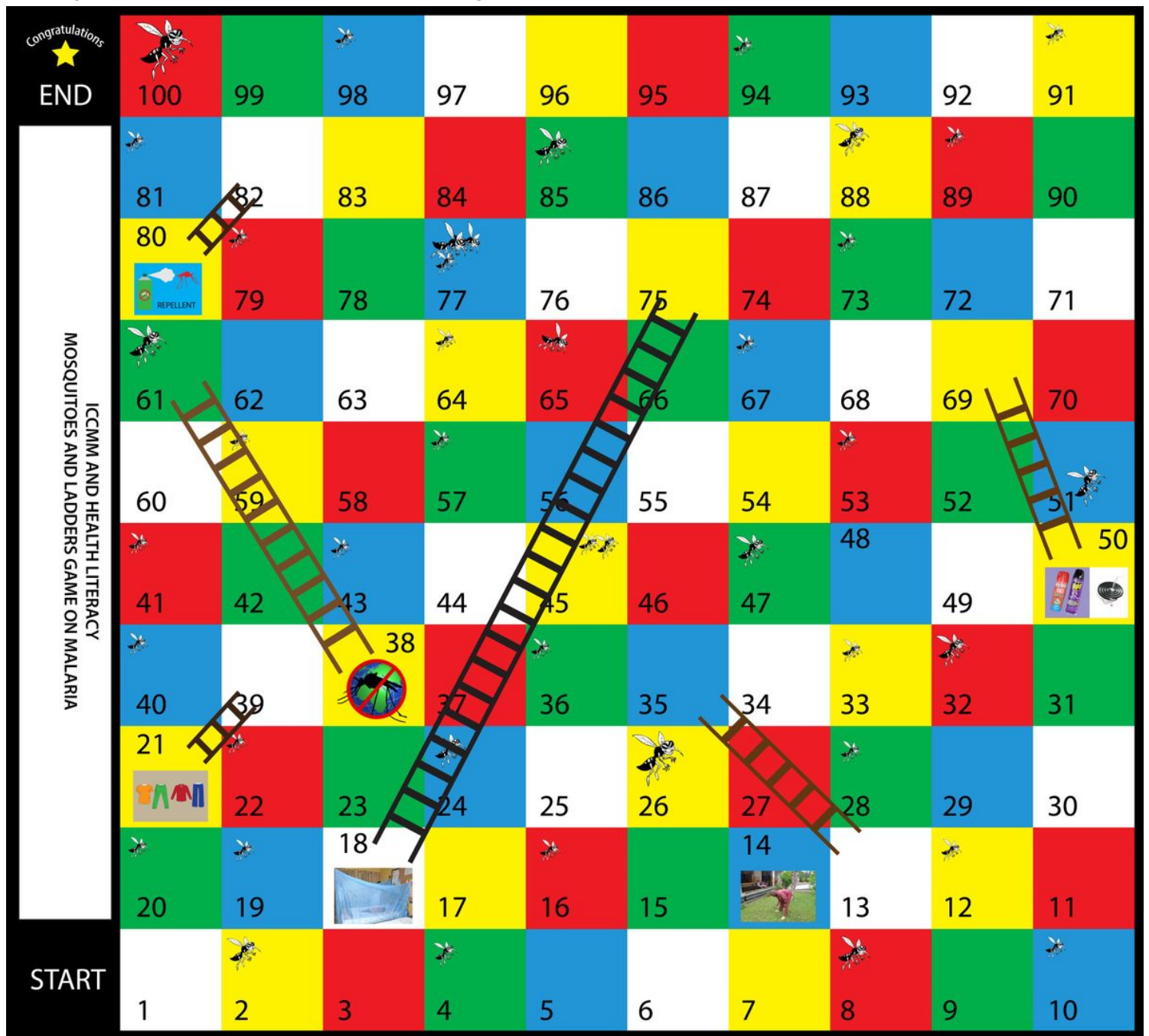


Figure 2

The Mosquitoes and ladders game.

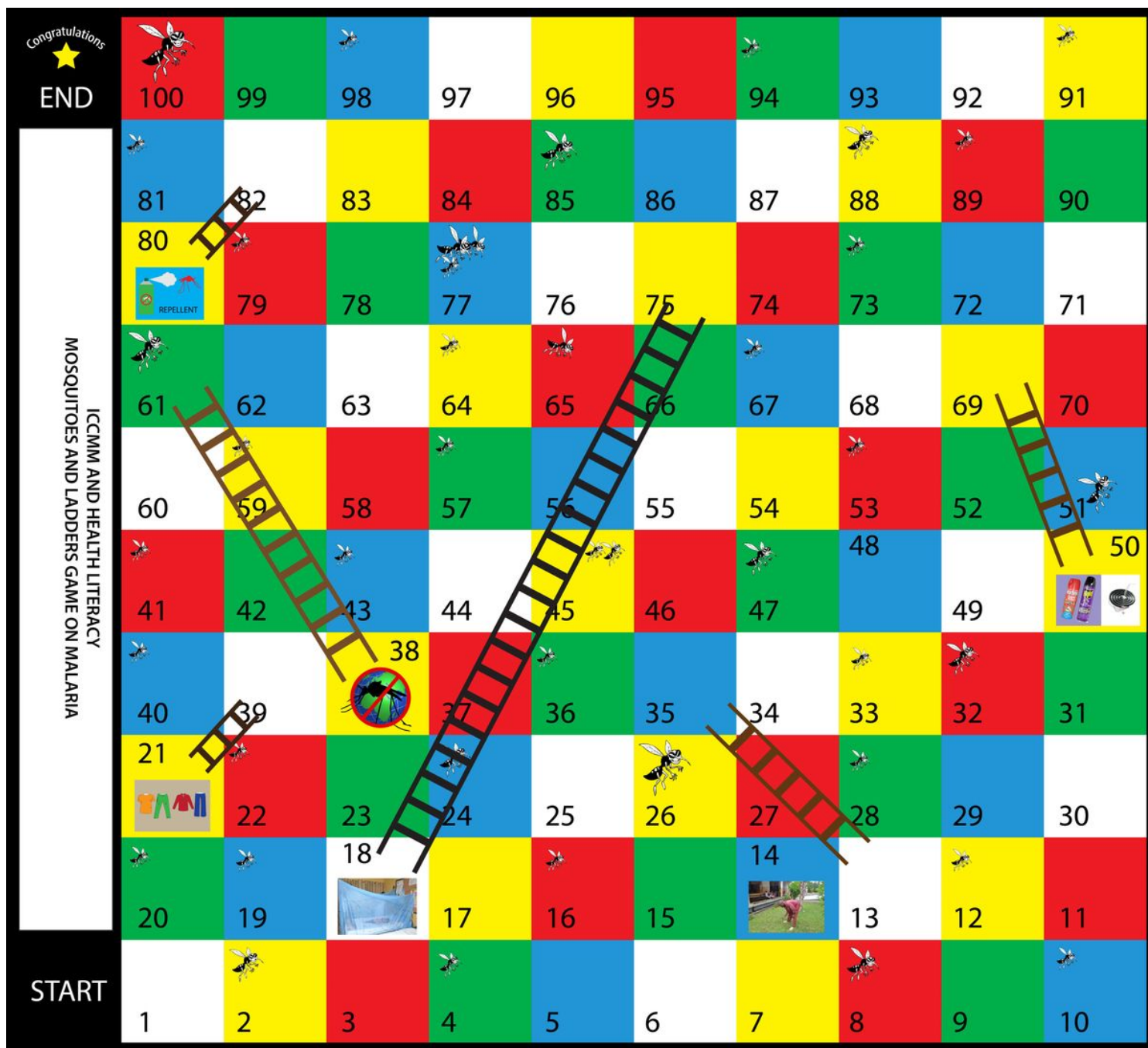


Figure 2

The Mosquitoes and ladders game.

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