Development of the Informed Health Choices resources to teach primary school children to assess claims about treatment effects in four countries

Nsangi A et al.

Working paper, April 2017

www.informedhealthchoices.org
Colophon

**Title**  Development of the Informed Health Choices resources to teach primary school children to assess claims about treatment effects in four countries

**Authors**  
Nsangi, Allen  
Semakula, Daniel  
Rosenbaum, Sarah  
Oxman, Matt  
Morelli, Angela  
Oxman, Andrew D  
Glenton, Claire  
Lewin, Simon  
Austvoll-Dahlgren, Astrid  
Kaseje, Margaret  
Mugisha, Michael  
Anne-Marie Uwitonze  
Nyirazinyoye, Laetitia  
Chalmers, Iain  
Fretheim, Atle  
Sewankambo, Nelson K

**Corresponding author**  
Nsangi, Allen  
allennsangi@gmail.com  
Telephone: +256 7733333629  
Makerere University College of Health Sciences  
New Mulago Hospital Complex, Administration Building,  
Second Floor  
P.O.Box 7072, Kampala, Uganda

**Keywords**  
user testing, user experience, pilot study, critical thinking, critical appraisal, teaching, education

**Citation**  

**Date**  
April 2017
Abstract

**Background:** People of all ages are bombarded with health claims. Many of these are not reliable and many people are not able to assess their reliability. Primary school is the ideal time to begin to teach these skills, to lay a foundation for continued learning, and to begin to enable children to make well-informed health choices as they grow older. However, these skills are rarely being taught in primary school, especially in low-income countries such as Uganda. Moreover, there are no resources for teaching these skills that have been rigorously developed and evaluated. To address this gap, we have developed the Informed Health Choices (IHC) primary school resources.

**Objectives:** To ensure that teachers and children experienced these resources as useful, usable, understandable, credible, desirable, and well-suited to them.

**Methods:** We employed a user-centred approach to designing the IHC primary school resources. This entailed multiple iterative cycles of development (idea generation, prototyping, testing, analysis and refinement) and close collaboration with teachers and children throughout this process. We prototyped, piloted, and user-tested resources in Uganda, Kenya, Rwanda, and Norway.

**Results:** We identified 24 Key Concepts that are important for children to learn. We initially prototyped learning games, but found that these were difficult to use. In addition, teachers who were teaching these concepts for the first time were not able to introduce and explain the concepts. To address this problem, we developed a comic book to introduce and explain the Key Concepts. This was combined with exercises and classroom activities. Major challenges included poor reading skills and insufficient time. We addressed these by simplifying the language that we used, explaining new terms, and reducing the number of Key Concepts that were taught. After addressing these and other problems, we produced a set of learning resources that includes a book to introduce and explain the Key Concepts, a separate exercise book, and a teachers' guide.

**Conclusion:** By employing a user-centred approach to designing resources to teach primary children to think critically about treatment claims and choices, we developed learning resources that teachers and children experienced as useful, usable, understandable, credible, desirable, and well-suited to them.
Background

People of all ages are bombarded by both reliable and unreliable information about how to care for their health, including claims about the benefits and harms of treatments (any action intended to improve health). Unreliable claims come from many sources, including journalists, experts, advertisements, friends, and family. People’s beliefs in unproven claims about treatments can lead to harm and waste [1].

Many studies have found that people’s ability to understand and assess health information is often lacking [2-5], although there are limitations in how this has been measured [6]. The Informed Health Choices project aims to enable people to assess claims about the effects of treatments, beginning with primary school children.

Why target primary school children?

There are several reasons for targeting primary school children. Children between the ages of 10 and 12 are capable of learning about fair tests and critical appraisal [7], and teaching these basic skills is already part of the curricula in some countries [8]. It is possible to reach a large segment of the population before they drop out of school, as large numbers of children drop out after primary level in low-income countries [9-11]. Finally, teaching children to assess information about treatment effects can lay a foundation for them to make informed health decisions as they grow older, as patients, future health professionals, citizens, and future policymakers.

A recent overview of six systematic reviews on education interventions in under-resourced countries included 227 studies in total, but none of these studies addressed health or science literacy, or critical thinking more broadly [12]. Systematic reviews of teaching children critical appraisal skills in health also have not found studies of strategies for teaching these skills to primary school children [6,13].

To address this gap, we have developed the Informed Health Choices (IHC) primary school resources. In this article, we describe the development of these resources. Our objectives were to ensure that users experienced these resources as useful, usable, understandable, credible, desirable, and well-suited to them.
Our starting point for developing the learning resources was to create a list of 32 Key Concepts that people need to understand and be able to apply to assess claims about treatment effects and make informed health choices [14]. A network of teachers in Uganda assessed the relevance of these concepts for primary school children [15]. Based on their input, we judged that 24 of the Key Concepts could be learned by primary school children and preceded to develop resources to teach those concepts to primary school children.

This work took place in the context of a project funded by the Research Council of Norway from 2013-2017, where researchers in Norway, the United Kingdom, Uganda, Kenya, and Rwanda collaborated to develop and evaluate learning resources for children and their parents. The development of a podcast for parents [16], a randomized trial of the effects of the primary school resources [17], and a process evaluation [18] are described elsewhere.
Methods

We employed a user-centred approach to designing the IHC primary school resources [19-22]. User-centred design is characterized by multiple iterative cycles of development (idea generation, prototyping, testing, analysis and refinement) and by close collaboration with end-users throughout all parts of these cycles (Figure 1).

Figure 1. Cycle of user-centred design [20]

Idea generation and prototyping
The types of questions we sought to answer in generating ideas and prototypes were: How might we help teachers (in Uganda) teach primary school children how to critically appraise claims about the benefits and harms of health care treatments? What are the challenges and facilitators, and how might insight into these influence resource design?

Creative thinking focuses on exploring ideas, generating possibilities and looking for many options. This contrasts with critical thinking, which focuses on analysis, figuring out the answer and eliminating incorrect options. Both types of thinking were necessary for generating appropriate options for the resources that we developed.
Since we were developing resources for schools in East Africa where beliefs and access to health care were very diverse and different from many members of our team, we needed to bring stakeholders and end users as close as possible into all phases of the work. We included teachers and children as co-creators through brainstorming and prototyping workshops [23]. We conducted multiple workshops in Uganda and Norway with the IHC research team and a network of teachers in Uganda [15]. These workshops resulted in ideas, insights about the context and stakeholders, sketches, and prototypes. We selected the ideas that we thought had the most potential and developed those ideas, combining them or building further on them to create new prototypes. These prototypes formed the basis for the next phases of pilot testing and user-testing.

**Pilot testing and user-testing**

We used qualitative methods to collect and analyse data to explore users’ experiences and perceptions.

We used participatory observation early in the project to facilitate participants’ engagement before we had stand-alone prototypes. Later, when we had developed stand-alone prototypes, we gave teachers materials several days in advance to prepare for their class. We conducted non-participatory observations of their teaching sessions to explore how teachers and children in four countries (Uganda, Kenya, Rwanda, and Norway) used these resources. We used a structured form to record observations. We also used video and photos.

The aim of user-testing is to explore a person’s experience when interacting with a product [19]. User-testing originated from the field of human factors, where effectiveness, efficiency and satisfaction of using a product is evaluated, often quantitatively [24]. We used a qualitative approach, building on Rosenbaum’s adaptation of Peter Moville’s honeycomb model of user experience [19,25] to develop the interview guides for exploring users’ experiences using the prototypes. We focused on six facets of the user’s experience: usefulness, usability, understandability, credibility, desirability, and identification (Table 1) [19].

<table>
<thead>
<tr>
<th><strong>Usefulness</strong></th>
<th>Does this product have practical value for this user?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usability</strong></td>
<td>How easy and satisfying is this product to use?</td>
</tr>
<tr>
<td><strong>Understandability</strong></td>
<td>Does the user recognize what the product is and do they understand the content? (own subjective experience of understanding)</td>
</tr>
<tr>
<td><strong>Credibility</strong></td>
<td>Is it trustworthy?</td>
</tr>
</tbody>
</table>

Table 1. Six facets from the adapted honeycomb framework
Desirability

<table>
<thead>
<tr>
<th>Desirability</th>
<th>Is it something the user wants? Has a positive emotional response to?</th>
</tr>
</thead>
</table>

Identification

<table>
<thead>
<tr>
<th>Identification</th>
<th>Does the user feel the product is for &quot;someone like me&quot; or is it alienating/foreign-feeling? (e.g. age, gender, culture-appropriate)</th>
</tr>
</thead>
</table>

Analysis and revisions

We entered observations from the pilot testing and feedback from the user-testing into a spreadsheet after each round of testing. Between two and five researchers from the IHC working group independently coded each observation based on the importance of the finding (Table 2) and its implications for changes to the learning resources. The coding was combined in a single spreadsheet and discussed, and a consensus was reached. Based on these findings, we generated a list of problems and suggestions for changes. We discussed major problems and brainstormed solutions to those problems with the rest of the IHC working group. After agreeing on the changes that we would make, we created new prototypes to be pilot tested and user tested.

Table 2. Coding of the importance of observations and feedback

| Very important negative finding (“show stopper”) | A problem that we should address for the resources to be effective |
| Important negative finding | A problem that we should probably address for part of the resources to be effective |
| Negative finding | A problem that we can easily address and probably will not prevent the resources from being effective |
| Very important positive finding | Praise that probably should inspire changes |
| Important positive finding | Praise that maybe should inspire changes |
| Positive finding | Praise that probably should not inspire changes |
| Very important constructive finding | A suggestion that probably should inspire changes |
| Important constructive finding | A suggestion that maybe should inspire changes |
| Constructive finding | A suggestion that probably should not inspire changes |

Study profile and overview of the development process

A flow chart showing the development process, beginning with prioritisation of the Key Concepts for the learning resources to address in 2013, is shown in Figure 2. Each step is briefly described in Table 3.
**Figure 2. IHC primary school resources development flow chart**

**Table 3. Overview of development: methods, participants, and brief descriptions**

<table>
<thead>
<tr>
<th>Methods and dates</th>
<th>Participants</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IDEA GENERATION AND EXPLORATORY PROTOTYPES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Review of existing resources</strong>&lt;br&gt;February 2013 to September 2014</td>
<td>The research team (AA, AM, AN, AO, CG, DS, SL, SR)</td>
<td>We searched for and reviewed existing resources.</td>
</tr>
<tr>
<td><strong>Idea generation workshop</strong>&lt;br&gt;(Participatory collaboration)&lt;br&gt;February 2013</td>
<td>Researchers, teachers, and journalists from Indonesia, Nepal, Norway, Uganda, and the United Kingdom</td>
<td>At the 3-day kick-off meeting for the project, the research team together with invited teachers and journalists (18 people) discussed which concepts to focus on and brainstormed about potential resources.</td>
</tr>
<tr>
<td><strong>Pilot testing in Norway</strong>&lt;br&gt;(Participatory observation)&lt;br&gt;February 2013</td>
<td>Approximately 30 ten-year old children and 2 teachers at an international school in Norway, and the research team (AA, AM, AN, AO, CG, JM, SP, SR, TT)</td>
<td>We developed materials and pilot tested an exploratory prototype (an experiment with colored candies) [26].</td>
</tr>
</tbody>
</table>
| **Prototyping workshop**  
*Facilitation & non-participatory observation*  
September 2013 | The teachers’ network in Uganda (24 teachers)  
[15] | This was a full-day workshop at which teachers brainstormed and created prototypes. |
|-----------------|-----------------------------------------------|-----------------------------------------------------------------|
| **Pilot testing in Uganda**  
*Participatory observation*  
September 2013 | 46 children and two teachers at a private school and 129 children and two teachers at a government school | We pilot tested the same exploratory prototype that was tested at the international school in Norway. |
| **Meeting with the Ugandan National Advisory Board**  
December 2013 | 15 members of the National Advisory Board for the project | This was a half day meeting during which ideas and barriers and facilitators to implementing these were discussed in the Ugandan context. |
| **Analysis of findings and idea generation**  
December 2013 to January 2014 | The research team (AA, AM, AN, AO, CG, DS, SL, SR) | We reviewed ideas that had been generated and their pros and cons. Based on this, we coded the ideas as ‘good’, ‘not sure’, or ‘drop’, and we identified principles to guide development of the resources. |
| **Pilot testing in Uganda and Norway**  
*Participatory observation*  
April 2014 | 27 nine to 13-year-old children and two teachers at 1 private school in Uganda and approximately 30 10-year-old children and 4 teachers at an international school in Norway | We developed and piloted a game designed to teach what a “testable question” is, using charts with relevant examples. The game included instructions, score sheets, timers, and a question bank. We also tested an activity where the children designed and carried out an experiment using paper airplanes. |
| **Prototyping and pilot testing in Norway**  
*Participatory observation*  
May to September 2014 | Four 12-year-old girls | We prototyped a series of eight games and piloted these. We first tested each game by playing it ourselves. At each meeting with the children we introduced the relevant Key Concepts using a PowerPoint presentation, then played the game, then collected feedback. |
| **Meeting and discussions with the members of the teachers’ network**  
September 2014 | 24 members of the teachers’ network and 2 teachers that participated in the piloting of the materials | We updated the teachers about the prototypes we had user-tested and piloted. We asked them to try out the games in small groups of three before giving us feedback on what they thought about the progress being made so far. We also asked two teachers who had participated in the piloting of the materials to share their experiences with the rest of the group. The teachers discussed the challenges they faced and how they handled them. |
| Analysis of findings and idea generation  
| September 2014 |
| The research team (AA, AM, AN, AO, CG, DS, MO, SL, SR) |
| We reviewed our experience from prototyping and piloting the series of games. Based on this, we decided to develop a children’s book to introduce the Key Concepts using a comic story and a teachers’ guide. |

| Development of a partial prototype  
| April to May 2014 |
| We developed two chapters of the children’s book and teachers’ guide, including activities MO prepared a manuscript for each chapter, which was converted to a comic book by SR with exercises and activities. MO prepared a draft of each chapter of an accompanying teachers’ guide and AM designed the guide. Each chapter was reviewed by the research team and went through three iterations. |

| Pilot testing (non-participatory observation) and user-testing in Uganda  
| October 2014 |
| 73 year-5 children and two teachers at a government school and 28 year-5 children and one teacher at a private school piloted the prototype |
| We pilot tested the first chapter of the children’s book and teachers’ guide, including activities, at both schools and the second chapter at the private school. We interviewed four 10 to 15-year-old children (two from each school) and all three teachers. |

| Analysis and idea generation  
| November 2014 |
| The research team (AA, AM, AN, AO, CG, DS, MO, SL, SR) |
| We coded findings from the pilot and user-testing as “show stoppers” (very important problems), important problems, minor problems, positive feedback, or specific suggestions. |

| Feedback gathering meetings  
| December 2014 to January 2015 |
| National Advisory Board for the project and the teachers’ network |
| AN, DS, and NS presented plans for a complete prototype of the IHC primary school resources and sought feedback and input. We conducted a half-day meeting with the National Advisory Board and a full-day meeting with the teachers. AN, DS and NKS recorded the sessions as the policymakers and stakeholders discussed. |

**VERSION 1 OF THE IHC PRIMARY SCHOOL RESOURCES**

| Development of a complete prototype  
<p>| December 2014 to April 2015 |
| The research team (AA, AM, AN, AO, CG, DS, MO, SL, SR) |
| We outlined a children’s book with 10 chapters that would cover 24 Key Concepts. MO prepared a storyboard for each chapter, which was converted to a comic book by SR with exercises and activities. MO prepared a draft of each chapter of an accompanying teachers’ guide and AM designed the guide. Each chapter was reviewed by the research team and went through three iterations. |</p>
<table>
<thead>
<tr>
<th><strong>Pilot testing (non-participatory observation) and user-testing in Uganda</strong></th>
<th><strong>January to May 2015</strong></th>
<th>67 grade five children and one teacher at a government school, and 32 year-5 children and one teacher at a private school</th>
<th>We gave the teachers a chapter a week before they taught each lesson. The teachers who taught the lessons were not given any instruction other than what was in the teachers’ guide. AN and DS observed each lesson. They recorded their observations using a semi-structured guide. They interviewed three children from each school and both teachers after each chapter was pilot tested using a semi-structured interview guide. There was an observer who took notes at each interview. All interviews were audio recorded.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feedback gathering meeting with the teachers’ network</strong></td>
<td><strong>May 2015</strong></td>
<td>24 members of the teachers’ network, 2 teachers that had participated in the piloting of the materials, and 2 teachers that had participated in the user-testing of the materials</td>
<td>This was a one day meeting where we grouped the teachers in small groups of about three teachers per group and asked them to read a chapter and give us feedback on what needed to be improved and what should be dropped. AN, DS, and NKS recorded the sessions as teachers gave their feedback.</td>
</tr>
<tr>
<td><strong>Analysis and idea generation</strong></td>
<td><strong>May 2015</strong></td>
<td>The research team (AA, AM, AN, AO, CG, DS, IC, MK, MO, NS, SL, SR)</td>
<td>AN and DS entered the findings in a spreadsheet. For each finding, AN, AO, DS, MO, and SR coded its importance (very important, important, or less important); whether it was a problem, an idea, or positive feedback; and whether it applied to the entire book, a specific chapter, or was a repeat of a previous finding. The findings were summarized for the research team and the major findings and plans for the second version were discussed and agreed.</td>
</tr>
<tr>
<td><strong>VERSION 2 OF THE IHC PRIMARY SCHOOL RESOURCES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Development of the second complete prototype</strong></td>
<td><strong>June to August 2015</strong></td>
<td>The research team (AA, AM, AN, AO, CG, DS, IC, MK, MO, NS, SL, SR)</td>
<td>MO prepared a revised draft for each chapter, SR revised the drawings and AM revised the design of the guide. Each chapter was reviewed by the research team and went through three iterations.</td>
</tr>
<tr>
<td><strong>Pilot testing (non-participatory observation) and user-testing in Uganda</strong></td>
<td>96 year-5 children and one teacher at a government school and 109 children and one teacher at another government school</td>
<td>We gave the teachers the materials in two parts (chapters 1 to 4 and chapters 5 to 10). The teachers who taught the lessons were not given any instruction other than what was in the teachers’ guide. AN and DS observed each lesson. They recorded their observations using a semi-structured guide. They reviewed the children’s completed exercises from the previous lesson and they interviewed two children from each school and the two teachers after each chapter was pilot tested using a semi-structured interview guide. They also interviewed an additional teacher who did not teach the lessons. There was an observer who took notes at each interview. All interviews were audio recorded.</td>
<td></td>
</tr>
<tr>
<td><strong>Pilot testing (non-participatory observation) and user-testing in Kenya</strong></td>
<td>30 children between 10 and 14 years old and one teacher</td>
<td>The teacher was initially provided with the teachers’ guide prior to the pilot and user-testing to enable him to familiarize himself with the materials. The relevant lesson for each week was covered by the children under the guidance of the teacher. Following each lesson, between 4 and 6 pupils were interviewed using a semi-structured guide. An observer recorded the interviews with the children. A semi-structured guide was used to report the lesson findings. Some of the lessons and interviews with pupils were recorded.</td>
<td></td>
</tr>
<tr>
<td><strong>Pilot testing (non-participatory observation) and user-testing in Rwanda</strong></td>
<td>33 year-5 children (10 to 12-years old) and one teacher</td>
<td>MM, AM and LN used the same methods for the pilot study as described above for Uganda and Kenya. One of them interviewed and the other observed three of the children in a focus group and the teacher (individually) using a retrospective think aloud technique, going through each page of the book with a semi-structured interview guide. The interviews were audio recorded.</td>
<td></td>
</tr>
</tbody>
</table>
| **Pilot testing (non-participatory observation) and user-testing in Norway**  
September to December 2015 | Three year-7 classes with 15 to 18 children from many different countries in each class and two teachers (one that taught two different classes) at an English-language international school | One or two researchers observed each lesson in each class using a structured data-collection form and then entered findings into a spreadsheet. We interviewed four children selected by one of the teachers with one person conducting the interview and one observer; we interviewed each teacher twice, and we collected verbal feedback from each class after they completed all 10 chapters; we reviewed their completed exercises, and we interviewed the school's head of science. All the interviews were semi-structured using interview guides and were recorded. |
| **Update on current activities and feedback gathering meeting of teachers’ network members**  
December 2015 | 24 members of the teachers’ network | At this full-day meeting, teachers were updated on the progress before being divided in groups of about three. We asked each group to look at the entire chapter of the teachers’ guide assigned to their group and provide the research team (AN, DS, and NKS) with feedback on what needed to be addressed. |
| **Analysis and idea generation**  
December 2015 to January 2016 | The research team (AA, AM, AN, AO, CG, DS, IC, LN, MK, MM, MO, NS, SL, SR) | For each finding, AN, AO, DS, MM, MO, and SR coded its importance (very important, important, or less important); whether it was a problem, an idea, or positive feedback; and whether it applied to the entire book, a specific chapter, or was a repeat of a previous finding. The findings were summarized for the research team and the major findings and plans for the second version were discussed and agreed. |
| **VERSION 3 OF THE IHC PRIMARY SCHOOL RESOURCES** | | |
| **Development of the final set of learning resources**  
January to March 2016 | The research team (AA, AM, AN, AO, CG, DS, IC, LN, MK, MM, MO, NS, SL, SR) | MO prepared a storyboard for each chapter with exercises and activities. This was converted to a comic book by SR. MO prepared a draft of each chapter of an accompanying teachers’ guide and AM designed the guide. Each chapter was reviewed by the research team and went through three iterations. |

**Participants**
We sought to include year-5 students (10 to 12-year-olds) and their teachers in Uganda, Rwanda, Kenya and Norway. We recruited schools that were geographically accessible to our team, where teaching was in English, and that were willing to make time in their schedules for piloting. We contacted head teachers, who identified science teachers and classes of children who were prepared to
pilot the resources. An overview of all the participants is provided here. The participants in each step are described in Table 3.

- **Researchers, teachers and journalists from several countries**: The initial brainstorming session at the kick-off meeting for the project included 18 people from Indonesia, Nepal, Norway, Uganda, and the United Kingdom with various backgrounds, including teachers, journalists, medical doctors, information designers, anthropologists, public health specialists, and health service researchers.

- **Teachers’ network**: The teachers’ network included 24 Ugandan primary school teachers (10 women and 14 men) in active practice from both rural and urban schools that were either government owned or privately owned schools. The teachers were recruited from a representative sample of schools, selected by educational authorities, including government and private schools; and rural and urban schools [15].

- **National Advisory Board**: The Ugandan National Advisory Board for the project included fifteen members (2 women and 13 men) representing various stakeholders, including the Ministry of Education, Ministry of Health, and Ministry of Gender and Social Development (which is responsible for children’s affairs in Uganda), and representatives from civil society and local government.

- **Children in Norway (exploratory prototyping and pilot testing)**: A convenience sample of four 12-year-old girls who knew each other, from a nearby school participated in piloting a series of eight games together with the research team, partly in Norwegian and partly in English.

- **Schools in Uganda**: Of the five schools that participated in both phases of the development process (pilot and user-testing), four were government (public) schools and one was a private school. One of the government schools was one of the biggest schools in the country, with a teacher-student ratio of 1:250. The other three government schools were of average size, with a teacher-student ratio of 1:120. The private school was small in comparison with the average Ugandan school, with a teacher-student ratio of 1:35 children. For logistic purposes (travel by the investigators), three of the schools that participated were located in the Kampala urban area and two were in the semi-urban area surrounding Kampala. All of the schools were poorly equipped. Lessons were in English, although English was not the primary language spoken at home for most of the children. All of the classes were year-5, for which the official starting age was 10.

- **School in Norway**: The school in Norway was a private international school, with 18 children in each class. It was well equipped. Lessons were in English, although English was not the primary language spoken...
at home for most of the children. The three classes were year-7, for which the typical starting age was 11.

• School in Kenya: The school in Kenya was a government school with about 400 children attending year-1 to year-8 classes. The year-5 children were mostly between 10 and 14 years old.

• School in Rwanda: The school in Rwanda was a government (public) primary and secondary school with over 3000 children. The language of instruction was English and the age range for year-5 children was 10 to 15 years old.

Consent and ethics approval
Teachers who were invited to participate in the pilot testing and user-testing were informed of the purpose of their participation before written permission was obtained. The children were given information about the project to take home for their parents and written permission was obtained for children selected to participate in the user-testing. Consent for the children to participate in the pilot testing was given by the head teachers and teachers. Children and their parents had the same right to refuse participation in piloting the IHC learning resources as they do for the use of any other learning resources used in the schools.

The study was approved by Makerere University Institutional review board and the Uganda National Council of Science and Technology as part of the “Supporting Informed Healthcare Choices in Low-income Countries” project (Grant no. ES498037) in August 2013. Ethical approval was sought by the IHC project representatives in each of the other countries in compliance with national requirements.
Results

Key Concepts
Our starting point for developing the learning resources was to identify the Key Concepts that would be included in the resources [14]. We made an initial list of Key Concepts by reviewing Testing Treatments [27] in February 2013. During the idea generation and exploratory prototypes phase of the development, which started at the same time, the research team selected which Key Concepts the prototypes should address. We first consulted with the teachers’ network at a workshop in August 2013. They found all six groups of concepts to be relevant for year-5 (10 to 12-year-old) children [15]. Based on input from the teachers, we judged that 24 of the 32 concepts could be learned by primary school children. These judgements were made by members of the research team in a face-to-face meeting in September 2013, using informal discussion to reach a consensus.

After prototyping, piloting and user-testing learning resources for those 24 Key Concepts in versions 1 and 2 of the IHC primary school resources, we concluded that that they were too numerous to teach in a single school term. We considered the importance of the concepts and the difficulty that the children had learning them when we piloted the resources. The importance of the concepts was based on judgements made by members of the research team by:

- Each person individually identifying which of the 24 Key Concepts they considered most important
- Compilation and discussion of those judgements
- Voting on the concepts
- Reaching a consensus by informal discussion

At a face-to-face meeting in May 2015, we reached agreement that eight of the concepts were “core”; i.e. the most important. Three members of the research team then reviewed data from our piloting and user-testing and identified concepts that appeared to be too difficult to teach to 10 to 12-year-old children. In addition, we considered how the concepts were grouped in the lessons and the number of concepts being taught in each lesson. Based on this, three of the team members selected 12 of the 24 concepts (Box 1), with plans to develop a second learning resource for teaching the other 12 concepts, in a subsequent school term. This was then discussed with the rest of the team and agreement reached.
### Box 1. Key Concepts that are relevant for primary school children

<table>
<thead>
<tr>
<th>Key Concepts taught in The Health Choices Book</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLAIMS: ARE THEY JUSTIFIED?</strong></td>
</tr>
<tr>
<td>• Treatments may be harmful</td>
</tr>
<tr>
<td>• Personal experiences or anecdotes (stories) are an unreliable basis for assessing the effects of most treatments</td>
</tr>
<tr>
<td>• Widely used treatments or treatments that have been used for a long time are not necessarily beneficial or safe</td>
</tr>
<tr>
<td>• New, brand-named, or more expensive treatments may not be better than available alternatives</td>
</tr>
<tr>
<td>• Opinions of experts or authorities do not alone provide a reliable basis for deciding on the benefits and harms of treatments</td>
</tr>
<tr>
<td>• Conflicting interests may result in misleading claims about the effects of treatments</td>
</tr>
<tr>
<td><strong>COMPARISONS: ARE THEY FAIR AND RELIABLE?</strong></td>
</tr>
<tr>
<td>• Evaluating the effects of treatments requires appropriate comparisons</td>
</tr>
<tr>
<td>• Apart from the treatments being compared, the comparison groups need to be similar (i.e. 'like needs to be compared with like')</td>
</tr>
<tr>
<td>• If possible, people should not know which of the treatments being compared they are receiving</td>
</tr>
<tr>
<td>• Small studies in which few outcome events occur are usually not informative and the results may be misleading</td>
</tr>
<tr>
<td>• The results of single comparisons of treatments can be misleading</td>
</tr>
<tr>
<td><strong>CHOICES: MAKING INFORMED HEALTH CHOICES</strong></td>
</tr>
<tr>
<td>• Treatments usually have beneficial and harmful effects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Key Concepts prioritised for children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLAIMS: ARE THEY JUSTIFIED?</strong></td>
</tr>
<tr>
<td>• An outcome may be associated with a treatment, but not caused by the treatment</td>
</tr>
<tr>
<td>• Increasing the amount of a treatment does not necessarily increase the benefits of a treatment and may cause harm</td>
</tr>
<tr>
<td>• Hope or fear can lead to unrealistic expectations about the effects of treatments</td>
</tr>
<tr>
<td>• Beliefs about how treatments work are not reliable predictors of the actual effects of treatments</td>
</tr>
<tr>
<td>• Large, dramatic effects of treatments are rare</td>
</tr>
<tr>
<td><strong>COMPARISONS: ARE THEY FAIR AND RELIABLE?</strong></td>
</tr>
<tr>
<td>• People in the groups being compared need to be cared for similarly (apart from the treatments being compared)</td>
</tr>
<tr>
<td>• If possible, people should <em>not</em> know which of the treatments being compared they are receiving</td>
</tr>
<tr>
<td>• It is important to measure outcomes in <em>everyone</em> who was included in the treatment comparison groups</td>
</tr>
<tr>
<td>• Results for a selected group of people <em>within</em> fair comparisons can be misleading</td>
</tr>
<tr>
<td>• Reviews of treatment comparisons that do not use systematic methods can be misleading</td>
</tr>
<tr>
<td>• Well done systematic reviews often reveal a lack of relevant evidence, but they provide the best basis for making judgements about the certainty of the evidence</td>
</tr>
<tr>
<td><strong>CHOICES: MAKING INFORMED HEALTH CHOICES</strong></td>
</tr>
<tr>
<td>• Fair comparisons of treatments should measure outcomes that are important</td>
</tr>
</tbody>
</table>
Idea generation and exploratory prototypes
The first phase, lasting two years, was highly exploratory. We collected ideas from our own experiences teaching critical appraisal to children [26] and adults (including health professionals, policymakers, journalists, and patients), a systematic review of interactive resources for teaching critical appraisal skills to consumers [28], and searching the TES database and other sources for relevant resources. We had a series of brainstorming sessions with members of the research team, informed by the resources that we found and workshops that we conducted with teachers and other researchers. In October 2015, we organized an international workshop with others interested in helping people to assess claims about treatments where a variety of resources was discussed. This workshop led to the development of the Critical thinking and Appraisal Resource Library (CARL) [29].

We conducted workshops and meetings with groups of researchers, teachers and journalists from several countries, teachers and policy makers in Uganda to generate ideas, insights, personas, prototypes and feedback. We created prototypes of classroom games and facilitated pilot tests with classes of children both in Uganda and Norway. We also piloted a series of eight games over the period of 2 months with a small group of girls in Norway. Finally, we developed a preliminary version of two chapters of a children’s book and teachers’ guide that we piloted and user-tested in schools in Uganda and Norway.

Idea generation workshop with researchers, teachers and journalists
In this meeting, we generated a broad range of ideas, from holding science fairs to creating interactive videos (Figure 3). Some ideas we generated were: use of drama and storytelling, board and field games, getting children to run a trial over several months, building a collection of familiar examples, translating already existing resources into local languages, holding teacher training workshops.

Figure 3. One of the note sheets from the idea generation workshop
The main challenges we identified included: the need to teach the teachers; developing resources that would work in schools without digital equipment and where languages other than English were spoken; finding time in the curriculum, and gaining buy-in from stakeholders (including teachers, parents, and policymakers). As one of the teachers at a meeting in February 2013 put it:

“If you leave parents out, you are wasting your time. Parents can be very critical - they ask critical questions about the curriculum.” (Ugandan teacher)

“Teachers’ resistance may be a problem, in Indonesia there is already resistance about a new curriculum because teachers are complaining there are too many topics.” (Indonesian researcher)

We decided to focus the next step on developing interactive classroom games that could be carried out with simple equipment that was readily available, like blackboards or paper and pencil.

**Pilot testing games in classrooms**

We developed presentation materials and prototypes for two games to be used in classrooms: tossing coins to explain the concept of ‘chance’ and a game involving comparing the effects of two different coloured candies to explain Key Concepts related to fair comparisons. Children worked together in small groups. We piloted the games in classes at three schools – one in Norway and two in Uganda, with numbers of children ranging from 30 to 129. We participated by taking the role of teachers.
The children clearly enjoyed these activities. They were engaged, asked relevant questions and came up with some of the concepts by themselves, like blinding. But the exercise tended to get out of hand when the children were required to work on their own and discuss in small groups. This was a problem even in Norway, despite the smaller class size. The children also needed more structured materials and more facilitation than we had anticipated. Their understanding of the concept ‘fair’ was different than what we meant when talking about fair comparisons which we referred to initially as “fair tests”. One child said:

“For the test to be a fair test, everyone should get a candy.”

Although we were encouraged by the apparent ability of the children to understand many of the concepts, we also experienced first-hand that it could be challenging to explain the concepts correctly, even with semi-structured presentation materials. Teachers who were unfamiliar with the concepts would likely have even more difficulty.

We identified several important questions:

- How could we adapt resources for bigger classrooms? (The average class size in Uganda is 70 children.)
- How could we ensure that teachers with incorrect understanding would not lead the children astray?
- Would this approach fit a very traditional “teacher-centric”, didactic school culture?
- Would children who were more familiar with didactic forms of teaching be open and willing to discuss?
- Could we develop something to effectively train the teachers?

**Prototyping workshop with Teacher’s network in Uganda**

All 24 members of the teachers’ network attended this full-day workshop, facilitated by eight members of the IHC team (Figure 4). We guided the teachers through a structured process that led them to create a persona, identify barriers and facilitators, generate ideas about resources, and rapidly prototype some of the ideas. Personas are fictional characters created to represent a user type, often used in digital design development [30].
Some of the categories of ideas teachers came up with were: assemblies, community involvement, family involvement, debates, use of drama, games, experiments, reading materials, video, teacher education, and curriculum development.

Although the resulting prototypes did not represent resource ideas we could use directly (as the ideas depended too much on teacher’s in-depth prior knowledge), this workshop provided us with a better understanding of teachers’ perspective on our work as well as many insights into the school and community setting in Uganda. Key messages were that:

- There was a paucity of available materials in schools, including paper and printers.
- Songs, drama, and story telling were popular methods for conveying health messages.
- Children might be expected to share their knowledge with their family or community.

We found that it was difficult for some people to grasp that we were focusing on teaching health literacy (specifically critical thinking about treatment claims) and not health promotion (teaching about the benefits of specific “treatments” such as handwashing or using insecticide treated bed nets).

Drawing on what we learned, we focused our next efforts on creating prototypes of highly structured materials that we could produce and provide cheaply for each school, and that did not rely on teachers’ prior knowledge about the Key Concepts. We continued to try to create games.
Prototyping and pilot testing in Norway and Uganda
We developed and piloted a game designed to teach what a “testable question” is and tested an outdoor activity where the children designed and carried out an experiment using paper airplanes. We piloted and user-tested these games at a Ugandan school and at an international school in Norway.

We also developed eight prototypes for simple games with increasing difficulty, designed to teach one concept each. These were based on materials that could be printed on paper. We tested these out in a series of meetings over two months with a group of four 12-year-old girls in Norway.

Figure 5. Example of a game description and pilot testing with children

Level 1 – asking testable questions
Make a set of cards with questions that are testable and ones that are not. Take turns picking cards and saying whether the question is testable or not.

Round 1 – Start with a prepared set of questions with correct answers and a teachers’ guide.

Round 2 – Kids make up their own questions + correct answers (+ a teachers’ guide).

• Scoring option 1 (competitive): 1 point per correct answer and -1 point for wrong answers. Person or team with the most points wins.

• Scoring option 2 (collaborative): 1 point per correct answer and -1 point for wrong answers. Class/group needs to get a fixed number of points before moving on to the next level.

At each meeting with the children we introduced the relevant Key Concepts using a PowerPoint presentation, then played the game, then collected feedback.

We found that although some of the games appeared to be promising, several were still too complicated to carry out in large classrooms. We also still had not solved the problem of how to transfer our presentation role to a teacher who was unfamiliar with the concepts without relying on electronic equipment like PowerPoint or video.
We decided to produce a highly-structured narrative for presenting the concepts that the teacher and children would read together, as well as a guide for the teacher. We decided to make a narrative in the form of a comic book with game-like activities and individual exercises included. We developed five characters to build the story around: two school children, two professors and a parrot who made unreliable claims about treatments, in an unspecified setting that would look like a rural east African village. Our thinking was that the narrative and use of drawings would engage the children, make the Key Concepts easier to understand, and help them to retain what they learned [31,32].

**Development of a partial prototype of a comic book and teacher’s guide**

We developed two chapters of a children’s comic book and teachers’ guide, with an activity description in each and a separate “activity booklet”. We carried out pilots (with non-participatory observation) and user-tests in two Ugandan schools as described in Table 3, followed by data analysis.

**Figure 6. Testing a sketch of a partial prototype of the children’s book**

![Testing a sketch of a partial prototype of the children’s book](image)

**Negative user experiences**

We categorized several findings as very important negative findings (“show stoppers”). For example, in one of the schools, the class spent three and a half hours on the first chapter alone, with the teacher often improvising off-script and coming up with examples that led the children to ask many unrelated and misleading questions; for example:
“Does using the pit latrine while pregnant cause some mothers to lose their children, true or false?“.

At the second school, the outdoor activity became very chaotic and took too long, leaving no time for discussion about what the children had learned. Also, some of the key terminology (e.g. ‘treatment’ and ‘outcome’) was too complicated for the children.

Other important negative findings related to trouble reading. The size of the text was too small in both books. Some children were reading a comic book for the first time and had difficulty following the flow of text and understanding the relatively complex comic layout. We also observed that some of the examples we used misled the children, for example:

“[I’ve learned that you should] not to eat so much if you want to run fast”.

Other negative findings included some of the words we had used that were unfamiliar to both teachers and children (e.g. ‘Prattle’ and ‘gobbling’), as were typical comic book sound words like ‘bling’ and ‘whoosh’. In addition, some of the children did not want to identify with some of the characters, because they were not like them; for example:

“The girl has not combed her hair”. “John’s shirt is not tucked in”.

When asked about the usability of the product, the teacher said:

“First experience was difficult, will be better next time.”

Positive user experiences
A very important positive finding was the fact that both teachers and children were enthusiastic about the use of comics. They liked the pictures and the way the information was presented which broke the routine of blackboard teaching.

“We didn’t just talk and use the chalkboard, there was a book for each child.”

When we asked teachers about the desirability of the product and its suitability for their pupils, there were several positive findings:

“The way the children were thinking, it was extraordinary.”

“The level is good for these children.”
However, it became clear to us from classroom observations and user-testing interviews, that the children had obviously not understood some of the content in the book; for example:

“The question I have about what John and Julie learn in this chapter is: Why did John and Julie use a coin to divide ten and a hundred people? Why didn’t they use counting to divide the people?”

Many children coloured in their books. The use of animals (e.g. “Prattle”, the parrot) seemed to be interesting to them, but there was disagreement among teachers and children about the appropriateness of including animals that could talk in the story. It was “not real” as stated by some teachers:

“What is the talking bird doing here?”

“The children will not take this seriously because of this bird here, they will think it is a joke.”

The children, however, liked Prattle; as one stated during a user-testing interview:

“I think that bird is so funny because it is saying many funny claims.”

Suggestions from teachers categorized as very important constructive findings included: re-describing comparison, adding numbers to the frames so that the children know which direction to read, having a thicker paper on the cover of the teachers’ guide, colouring the pictures, and breaking the content into smaller teachable units.

Consequences for development

Despite many problems, there was enough enthusiasm for the comic format that we felt it had the potential to work in a Ugandan classroom. But it needed to be much simpler, and the explanation of each concept needed more space. Based on our findings and observations, we agreed to make the following changes in the next version:

• Rewrite/redraw the children’s book with
  — Much simpler story, language, and drawings; and shorter chapters with larger text
  — No magical elements or complicated comic language (but keeping the talking parrot)
  — Glossary explanations where terms first occur, with definitions translated to Luganda
  — Examples that were less likely to be misleading
• Keep activities, but drop the activity booklet and
  — Simplify all activities so they do not require extra resources, are not
difficult to organize, and do not require being outdoors
• Revise the teachers’ guide by
  — Making it less “selling” and more like a recipe
  — Integrating the children’s book in the teachers’ guide to facilitate the
lesson flow

We decided to produce the final version of the books in colour, but continued
sketching prototypes in black-and-white.

**Version 1 of the IHC primary school resources**

We created a complete version of the children’s book and teachers’ guide, with
11 chapters. We carried out pilot tests and user-testing at two schools in Ugan-
da (see Table 3).

*Figure 7. Version 1 of the children's book and teachers' guide*

**Version 1 - Negative user experiences**

The objective of the lessons and materials was greatly misunderstood, as we
found out in our interviews with some of the children. Several had an incorrect
understanding of what the book was about. Some children expected they were
going to evaluate treatments themselves or learn about practicing medicine.

“I am going to learn being a scientist and being a health treater and treating
other people”

“I think I will learn more about science and health. The needs of being a doc-
tor and how I will become one”.
Two chapters were too long to be completed in one school hour (lesson), and a teacher said there were too many lesson goals. There was much concept-related vocabulary that some children did not understand despite the definitions and translations; e.g. claim, outcome, substitute outcome, assumption, unreliable, careful summary. Additionally, some children struggled with simpler English words; e.g.: expert’, also, normally, reward. Feedback suggested that English skills would likely be even poorer in more rurally located schools, especially for the children. One stated during an interview:

“This book is for a school like ours which knows hard English, but not for the village schools”.

Another important negative finding in this version was the volume of the teachers’ guide and the content in the children’s book. Some teachers suggested that the chapters should be split into manageable units. One of the pilot teachers attending the network meeting stated:

“I found the information in the chapter to be too much when delivering the lesson, it was difficult to have the children read the chapter and also do all the exercises in the 45 minutes of the lesson.”

A member of the teachers’ network said:

“This lesson plan is difficult to follow.”

Other important negative findings for this version included the use of the English language, which the target audience (teachers and children) still found difficult to understand. One of the children said in an interview:

“The difficult word was ingredients. I don’t know what it means.”

In addition, teachers were not comfortable with some of the English words used in the teachers’ guide and in the children’s book. One stated:

“The children’s book had some confusing and difficult words like ‘effects’. Yet, in my own understanding, I had a different meaning of the word effect.”

Other negative findings included that the illustrations sketched in pencil were unclear and the hand-written text was difficult for many to read. Some of the children were unsure about how to fill in the answers to the exercises and others struggled to read the comic in the right direction, despite the simplified layout.
In addition, we also observed teachers improvising from the text and offering incorrect examples and analogies. Teachers expressed wanting step-by-step instructions that could also be followed by a stand-in teacher who was unfamiliar with the project and more in-depth information to help them be prepared if challenged by children.

One teacher suggested making the professor characters in the story doctors, and others suggested changing their names.

**Version 1 - Positive user experiences**

The teachers felt this version was a big improvement over the partial prototype, and that the content became clearer from chapter to chapter.

Using a combination of pictures and text seemed to be helpful both from the teachers’ and children’s perspective. One child stated:

“*The words help you understand the pictures.*”

Another important positive finding was that the exercises seemed to be the right level of difficulty. Both teachers and children valued them and suggested that more exercises should be included. One of the teachers said this about the exercises in the book:

“*Good, perfect, children will be able to do this and it even helps them improve on the area of English.*”

The exercises in the book seemed tuned to the children’s literacy levels with many children correctly completing the exercises within 5-10 minutes.

The Luganda translation was also perceived as helpful. One child said:

“*Effect - it means Ekivaamu. It is good to tell us the meaning of the word.*”

Children loved the parrot. One of them suggested:

“*More pictures about birds.*”

**Version 1 - Consequences for development of Version 2**

We agreed to make the following changes to the next version of the children’s book:
• Make usefulness more apparent by placing the story in the context of real life decision making (e.g. the children in the book making a poor decision in the beginning and making a more informed decision at the end)
• More emphasis on “critical thinking” rather than becoming a “junior researcher”
• Add a new first chapter that introduces some of the basics, like “health” “treatments”, “effects” and “claims” - in more depth.
• Adjust chapter content so that lessons can be fit into 40-minute periods
  o Take out some concepts/content and spread some over two chapters
• Repeat learning goals from the previous chapter and introduce new characters at the beginning of each chapter
• Add more exercises
• Continue to simplify vocabulary, add a glossary in the back of the book
• Use a computer font instead of handwriting
• Consider using colour
• More expressive and differentiated characters

We agreed on the following changes to the Teacher’s guide:
• Introduce more structure
• Add more background information
• Decrease the number of lesson goals in each chapter

Version 2 of the IHC primary school resources
We created Version 2 of the children’s book and teachers’ guide (Figure 8), which had 10 chapters divided into two books. We carried out pilot tests and user-testing at schools in Uganda, Rwanda, Kenya, and Norway (see Table 3) and analysed the data from all these locations together. We were particularly looking for indications of whether schools outside of Uganda would find the resources understandable, appealing and relevant to their context.

Figure 8. Version 2 of the children’s book and teachers’ guide
Version 2 - Negative findings
Some of the very important negative findings for this version included feedback from the pilot teachers who felt that some chapters in this version were very long, particularly chapter 8. One pilot teacher stated:

“Some of these chapters, like chapter 8, need to be divided into smaller chapters. They take a lot of time.”

A member of the teachers’ network said:

“The content is too wide”.

Another very important negative finding arose from observations. In a class of about 109 children, a teacher took a lot of time organizing the children into groups to participate in the “CLAIM Game”. When asked about this during the interview after the lesson, the teacher said:

“Organising children and preparing them for the game is difficult in a class like mine.”

An important negative finding observed during the lessons was that the use of the teachers’ guide differed from teacher to teacher in the pilot schools. One of the teachers was observed not using the guide during the lesson. The teacher only glanced through when needed and mostly used the children’s book as the class read aloud. During our interview after the lesson, the teacher said:

“Having to use two books in a lesson is very hard. You have to look at the guide and also see what the children are reading. Why don’t we make this into one book?”

The language used in this version of the resources was still found to be a bit complicated for the children, as this was observed during the lessons when children were required to read aloud and struggled with some of the words they found difficult to read and to pronounce; for example, “surrogate outcome”. During our consultations at meetings with members of the teachers’ network, one said:

“Some of the chapters have very many new words; for example, chapter 2. Words like health research, claim, experience, reason, eh, those are so many for the children.”

During one of the pilot lessons, we observed that the teacher was hurriedly marking a few of the children’s books as they were attempting the exercises
during the lesson. This allowed no time for the children to read and understand, if they were to be among the few whose books would be marked. The teacher said during the interview:

“There are so many exercises for the children to do after each lesson, it makes it very difficult for me to mark all of them.”

We observed a negative finding when one of the pilot teachers struggled to organize a class of over 100 children to participate in the CLAIM game. The children struggled to understand the instructions as they were laid out. In the interview after the lesson, the teacher said:

“I am worried about what you thought when you were watching me. I tried to organize myself last night for this activity but it was very difficult. I had to mark the children’s exercise books and also prepare for the activity. It is very difficult to do in this big class.”

**Version 2 - Positive findings**

A positive finding was that the exercises in the children’s book were considered appropriate for year-5 children and engaged the children. One of the pilot teachers said:

“The exercises are very well suited for these children.”

Having new terms in three different languages in the textbook (English, Luganda, and Swahili) and explaining difficult words in language year-5 children could understand was improved comprehension of the content being taught. A pilot teacher said:

“Using Luganda to explain the word ‘effect’ - ‘ekivaamu’ - made it simple for me to understand and then also explain to the learners.”

**Version 2 – Consequences for development of Version 3**

We agreed to make the following changes in the next version of the children’s book:

- Revise the CLAIM game and make it less demanding on the teacher to organise materials to be used during the game
- Introduce a glossary that explains all the new terms in the children’s book in a language simple enough for them to understand
- Reduce the number of exercises at the end of each lesson and the burden on teachers to mark these
- Further simplify or remove chapters that were difficult for the children to understand, like chapter 8 on “careful summaries”
• Reformat the teachers’ guide to include the children’s book
• Add more examples in the teachers’ guide
• Revise the content and restructure it in a manner that would enable the teachers to carry out the lessons in the specified time, using a structured lesson plan

The most important problem that we identified was insufficient time to teach all the content included in Version 2. To address this we decided to cut the number of Key Concepts that were included from 24 to 12 and to increase the time for each lesson from one period (40 minutes) to two (80 minutes).

We reviewed these changes with the teacher’s network to make sure we were not introducing new problems in the final version of the resources.

**Version 3 of the IHC primary school resources**

We created Version 3 of the children’s book with 10 chapters, and a teachers’ guide (Figure 9). We also created a separate exercise book, a classroom poster of the key learning objectives (the 12 Key Concepts), and a set of activity cards for one of the chapters. These open access resources can be viewed or downloaded here. The contents of the children’s book and the teachers’ guide are summarised in Box 2.

*Figure 9. Version 3 of the children’s book and teachers’ guide*
### Box 2. Contents of the textbook and the teachers’ guide

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>The teacher’s guide includes an introduction to the project and the resources, and the following for each lesson, in addition to the embedded chapter from the textbook:</td>
</tr>
<tr>
<td>• Lesson 1: Health, treatments and effects of treatments</td>
<td>• The objective of the lesson</td>
</tr>
<tr>
<td>John and Julie learn about CLAIMS about treatments</td>
<td>• A lesson preparation plan</td>
</tr>
<tr>
<td>• Lesson 2: Someone’s experience using a treatment</td>
<td>• A lesson plan</td>
</tr>
<tr>
<td>• Lesson 3: Other bad bases for claims about treatments (Part 1)</td>
<td>• A list of materials that the teacher and children will need</td>
</tr>
<tr>
<td>• Lesson 4: Other bad bases for claims about treatments (Part 2)</td>
<td>• A synopsis of the story</td>
</tr>
<tr>
<td>John and Julie learn about COMPARISONS of treatments</td>
<td>• Keywords in the chapter</td>
</tr>
<tr>
<td>• Lesson 5: Comparisons of treatments</td>
<td>• Review questions to ask the children after reading the story</td>
</tr>
<tr>
<td>• Lesson 6: Fair comparisons of treatments</td>
<td>• Extra examples for illustrating the concepts</td>
</tr>
<tr>
<td>• Lesson 7: Big enough fair comparisons of treatments</td>
<td>• Background about examples used in the story</td>
</tr>
<tr>
<td>John and Julie learn about CHOICES about treatments</td>
<td>• Teacher instructions for the classroom activity</td>
</tr>
<tr>
<td>• Lesson 8: Advantages and disadvantages of a treatment</td>
<td>• Answers and explanations for the activity</td>
</tr>
<tr>
<td>Review</td>
<td>• Answers and explanations for the exercises</td>
</tr>
<tr>
<td>• Lesson 9: Review of what is most important to remember from this book</td>
<td>• Background information, examples, and keyword definitions for teachers</td>
</tr>
</tbody>
</table>
Discussion

The aim the user-centred development process that we used was to ensure that users of the IHC primary school resources (teachers and children) experienced the resources as useful, usable, understandable, credible, desirable, and well suited for them. We discuss here key findings in relation to each of these facets of users’ experiences.

**Usefulness**

Findings from the idea generation and exploratory prototypes phase of the project highlighted the need to clarify the usefulness of the resources for both teachers and children. Teachers’ initially assumed that the purpose of the resources was to convey public health messages about the benefits of specific interventions, such as handwashing. This emerged at the prototyping workshop with the teachers’ network in Uganda. Many of the ideas and prototypes generated at that workshop focused on communicating typical public health messages, rather than teaching children to think critically about health claims and choices. There are several plausible explanations for this. These include that teaching is largely didactic in East Africa, in part due to large student-to-teacher ratios. This makes it difficult to use more interactive teaching strategies that are used to teach critical thinking skills [33]. Teaching critical thinking skills has not been a priority in primary school curricula or for evaluations of interventions to improve primary school education [12,34,35]. Previous public health interventions in schools have also tended to focus on promoting specific behaviours, rather than teaching children to think critically. This contrasts with our findings in Norway. Critical thinking was a priority for older children (in the International Baccalaureate (IB) programme) at the international school where we piloted the second version of the resources. However, they had found that students entering the IB programme were not sufficiently prepared. They wanted to test our resources specifically to find out if they might help to address this problem, which they had identified.

Expectations of the children in response to early prototypes were different from those of the teachers. They assumed, based on their experiences, that the purpose of the resources was to help them do better in science and to learn to become scientists or health professionals.
We addressed these misunderstandings about why the resources are useful in several ways. We added introductions to both the children’s book and the teachers’ guide clarifying the purpose of the resources. These went through several iterations and we obtained feedback from teachers and children to ensure that the introductions clarified the purpose of the resources and why they are useful. We ensured that the examples we used would not be misunderstood and that they clearly illustrated how each Key Concept could be used to assess relevant claims and to make informed choices. We modified the structure of the book, and subsequently how we organised the Key Concepts, to clarify and reinforce the purpose and usefulness of understanding and applying them. We had initially organised them in six groups, which did little to convey their usefulness:

- Recognising the need for fair comparisons of treatments
- Judging whether a comparison of treatments is a fair comparison
- Understanding the role of chance
- Considering all the relevant fair comparisons
- Understanding the results of fair comparisons of treatments
- Judging whether fair comparisons of treatments are relevant

By reorganising the concepts into three groups, we simplified and clarified their purpose and usefulness:

- **Claims**: “questions you should ask when someone says something about a treatment”
- **Comparisons**: “questions that health researchers ask to find out more about the effects of treatments”
- **Choices**: “questions that you should ask when you are choosing whether to use a treatment”

When testing the first and second versions of the resources we found that teachers and most children found the resources useful and correctly understood their purpose by the end of the lessons. However, some teachers and children did not start out with a clear understanding of the purpose of the resources. In addition to the above changes, we also developed a workshop for teachers to introduce them to the resources and to help ensure that they started out with a clear understanding of the purpose and usefulness of the resources.

Illustrations that children found the resources useful include these quotes describing how they had used one of the concepts they had learned in making choices:

“When I was grocery shopping with mom, mom was like, ‘Buy this toothpaste! It’s new and it’s really good!’ I looked at another one and it was exactly the same, so I actually bought the cheaper one.”
“You know that our father likes us. He bought shoes, new shoes, and I start saying to him that the new shoes are not better than the old ones.”

Another child said that the book is about:

“Things we might actually use instead of things we might use when we are all grown up and by then we’ll forget.”

**Usability**

We found that our initial ideas and prototypes were difficult to use, even in well-resourced schools with low student-to-teacher ratios. We also found that many of the Key Concepts were not well understood by the teachers. They were sometimes learning together with the children. Frequently they went off script, making unsubstantiated claims themselves rather than helping the children learn how to assess claims. Using a comic book to introduce the key concepts solved the problem of ensuring that the Key Concepts were introduced and explained correctly. The illustrations facilitated understanding and made it easier for the children to read and understand the text, as well as engaging them. This is consistent with previous research, which has shown that adding pictures to written language can increase attention, comprehension, and recall [32]. However, pictures can also be misunderstood and feedback we received on the illustrations resulted in many changes - both specific and general. For example, feedback from several children resulted in changes to Julie, one of the two children who are main characters in the comic book. As one child remarked when asked about the drawings in an early version: “Julie looks like a rumour monger.”

However, we also discovered important changes that were needed to make the comic book usable in Uganda. Many of the children were not familiar with reading comics and were confused about the order in which the frames should be read. They also were not familiar with speech and thought bubbles. To address this problem, we added arrows to the comic, showing the order in which frames should be read and we explained speech and thought bubbles in the introduction.

Using a comic book to introduce the Key Concepts functioned well both in East Africa, where it is common for classes to read aloud in class, and in Norway, where role playing was used when reading aloud in class. Based on our observations and interviews, we concluded that there were several ways of reading the book. Rather than recommending one of these, we provided the advice shown in Box 3, summarising what we had observed.
Our observations and feedback from the teachers resulted in several changes to the teachers’ guide to ensure that teachers found it useful. One change was to incorporate the children’s book in the teachers’ guide. This facilitated using the guide, which includes instructions and suggestions for the teachers, while reading the comic together with the children or doing the activities. Others included providing lesson plans, suggestions about how to use the resources, explanations written for the teachers, and extra examples that the teachers could use to illustrate the Key Concepts.

The most important problem that we found with the second version of the resources was insufficient time. Teachers struggled to get through the lessons in 40 minutes and, therefore, the children often were confused and had not learned some of the Key Concepts. To address this problem, we reduced the number of concepts that were included from 24 to 12 and we doubled the amount of time for each lesson. This required us to step back and acknowledge that we had made a classic mistake of trying to teach everything about a topic at once, thereby overloading both the children and the teachers with too much information. By recognising that the resources are just one cycle in a spiral curriculum [36], we could make this dramatic change. Resources for subsequent cycles can build on what was learned from these resources, reinforcing what was learned, while introducing new concepts.

Other changes that we made to the resources to improve their usability included greatly simplifying the activities to ensure that they could easily be managed.
by a single teacher with many children and ensuring that the exercises could be done by the children without placing a substantial burden on the teacher. In the same way that we gave teachers several options for reading the book, we also gave them options for the exercises (Box 4).

**Box 4. Excerpt from the introduction to the teachers’ guide - options for exercises**

*Exercises and activities*

If you prefer, you can have the children do the exercises before you do the activity as a class, finish the exercises as homework or do the exercises together in groups.

There are different ways of marking the exercises:

- You mark the answers during the lesson
- You mark the answers after the lesson
- You write the right answers on the board and the children mark their own answers
- You write the right answers on the board and the children swap books and mark each other’s answers
- You give the right answers to a group of children who mark all of the books

Just make sure that you explain the right answers to the children.

**Understandability**

We discussed understanding the purpose of the resources in relation to its perceived usefulness and how that affected the extent to which teachers and children valued the resources. We also found substantial problems with understanding of the content. Many of the children read poorly and English was a second language for most. We found that words that we assumed 10 to 12-year-old children would understand, such as ‘health’, were new words for many children in East Africa. Although using a comic book with illustrations helped to improve understanding, we still needed to continue to simplify the language that we used and to explain terms. We addressed this by iteratively testing and rewriting the text, adding a glossary, adding translations of key terms, adding a list of new keywords used in each chapter (Figure 10), and adding explanations and translations of key terms to the text on the page where they were first used (Figure 11). Together with teachers and children, we also generated a list of terms that were difficult for the children. We avoided using those terms, if there was a good alternative, or explained them.
We also made several changes to the teachers’ guide to ensure their understanding. These included adding a background section to each chapter that we wrote for the teachers (Figure 12) and background information about the examples that we used (Figure 13), in addition to the workshop for teachers noted above.
Background about lesson for teachers

A “claim” can mean different things. In this book, it only means one thing: something that someone says that can be right or wrong. Everyone makes claims like this. Most times, when we claim something, we make the claim as if it is completely reliable. In other words, we say something as if it were a fact, when it really is a claim. Many claims are unreliable, so it is important to recognize when someone is making a claim. If you believe an unreliable claim about the effects of a treatment, you could make a bad choice about that treatment.

To avoid being misled by unreliable claims, we must always ask: What is the basis for the claim? A “basis” can mean different things, but in this book it means why someone says or does something. There are many different bases for claiming something. Whether a claim is reliable depends on the basis. Health researchers sometimes say the “evidence” supporting a claim, rather than “basis” for the claim.

Researchers ask questions and look for answers to find out more about the world. There are many different types of researchers who do many types of research. Health researchers look for answers to questions about health. There are many different types of health research as well, but this book is about one type: asking questions and looking for answers about the effects of treatments.

Someone’s personal experience is one of the most common bases for claims about the effects of treatments. Many types of personal experiences are important enough that we should learn something from them. For example, most treatments have small effects, but a few have big, obvious effects. For many people, wearing glasses has a big, obvious effect on how well they see. Their experience wearing glasses is enough to know that they should wear glasses.

Most treatments do not have big effects. Therefore, most times, someone’s personal experience using a treatment is a bad basis for a claim about the effects. Researchers sometimes say “anecdotal evidence” or a “case study,” rather than “personal experience.” An “anecdote” is a short story about something real. An anecdote is a bad basis for a claim about the effects of a treatment, even if the anecdote is true. For example, during an outbreak of bird flu (avian influenza), some people infected with bird flu were given a drug called Tamiflu. It is true that some of those people got better. However, those true anecdotes are bad bases for the claim that Tamiflu cures bird flu. It is possible those people would have got better without the medicine.
**Figure 13. Examples of explanations for teachers**

13a Background information about an example used in an activity

**About the example in this activity:** Most times, a sore throat will go away on its own. However, if a child has a high fever in addition to the sore throat or if the child does not want to eat or drink because it is too painful, they should be taken to see a doctor or nurse. If the child is struggling to breathe or swallow, is drooling a lot or has a stiff or swollen neck, the child should be taken to a hospital or clinic. For reducing pain from less serious sore throats, like the one John has in the story, drinking warm tea, soup or a cold drink can help. The child must drink enough water, even if the child feels some pain when drinking. Painkillers (tablets that reduce pain), such as Panadol, can help, but the child should not get aspirin.

13b Extra example and background information about why “how long people have used a treatment and how many people have used it is a bad basis for a claim about effects”

---

**Extra example**

*Ronald's claim:* “Drinking fish oil keeps you healthy! I am sure because lots of people, for many years, have drunk fish oil to stay healthy!”

*Treatment:* Drinking fish oil

*Effect:* Having better health

*Basis for Ronald's claim:* How long people have used fish oil and how many people have used it

*Explanation:* Ronald's basis for his claim is bad, so his claim is unreliable. It is possible that fish oil does not make your health better, even though many people have used it for many years.

---

Background: Health researchers have found that some herbs have good effects. For example, cream of hot pepper reduces back pain. However, they have found that other herbs have little or no good effects, and some have bad effects. For example, chewing betel nut causes cancer in the mouth. There are many herbs that they have not studied carefully.

---

Lesson 3: Other bad bases for claims about treatments (Part 1)
**Credibility**

We did not identify very important problems ("show stoppers") with the credibility of the resources. Two problems that we did identify were the use of magical elements in the comic (Figure 14) and the inclusion of a talking parrot. We eliminated the first, but elected to keep the parrot for two reasons. First, although teachers were concerned that a talking animal would result in a loss of credibility amongst the children, none of the children perceived this as a problem. Second, the children responded very positively to the parrot, which both brought humour into the story and served as a source of claims. We did, however, review our use of the parrot to ensure that it was used consistently and that it was not included unnecessarily; e.g. simply repeating something that one of the other characters said.

**Desirability**

Many of our initial ideas, which focused on games, were clearly not something that the teachers wanted. They were difficult to organise and to manage, especially in classes with large student-to-teacher ratios and few resources.

We found that the book was highly desirable both in East Africa and in Norway. This was, perhaps, not surprising in East Africa where the schools had few books. However, the children at the international school in Norway also were very positive about the book. They uniformly responded that they would prefer the book to a computer game. It is uncertain to what extent this was because they had been exposed to poorly designed learning games or because the book was well designed. Children in both settings had not previously been exposed to use of a comic book to teach science. One of the children in the international school said:

“I like it how you guys thought from the perspective of a kid about how you could make it interesting, ’cause like normally other books are just like, ’Oh, this then that,’ and boring.”

The rationale for using a narrative in the book to explain the Key Concepts is that people often make sense of their lives through stories they hear and share with others [31]. Providing information in a story may resonate with people who might struggle to understand abstract concepts. Furthermore, characters in the narrative can role model new behaviours, enhancing self-efficacy [37]. Evaluations of the effects of narrative interventions supports their use. For example, evaluations of the use of narratives in the context of health promotion have found that narrative interventions improve knowledge about health-promoting behaviours and health-promoting behaviours [31].
Although we received consistent feedback from the children and teachers that they wanted colour drawings, we also observed that the children immediately would colour the drawings in the book and clearly enjoyed this. Another problem was that while we had hoped the children would take the books home and share what they were learning with their families, the teachers were worried about the books getting lost and the children not having them in class when they were needed. Our solution to both these problems was to separate the exercise book from the textbook. The final version of the children’s (text) book was in colour, could be kept at school, and could be re-used by other classes (Figure 9). The exercise book was not coloured, could be coloured by the children, and could be taken home.

Identification
Initially we received many comments from the children in Uganda about the drawings, particularly about John and Julie, with whom they did not identify. However, with subsequent iterations of the children’s book the children identified with John and Julie. Similarly, both the teachers and children felt like the resources were appropriate for them increasingly with each iteration.

We were uncertain to what extent children at the international school in Norway would find the characters and the story, which was set in an East African context, relevant to them. To our surprise, we found that they found it desirable that the story was set in Africa rather than in North America or Europe, which was the setting for most of the books they used. We were even more surprised to find that most of the children, when asked where they thought the setting for the story was, had not recognised that it was in Africa.

Reasons why users experienced the resources positively
Our findings suggest that with the iterative revisions of the IHC primary school resources, users - both children and teachers - experienced the resources as useful, usable, understandable, credible, desirable, and well suited for them. We believe there are two closely related reasons why we could achieve this. First, our grant application did not include specification of the intervention. Instead, we described the methods that we would use to develop the resources. This allowed us ample time (two years) and resources to generate and prototype ideas and then to iteratively design, pilot and user-test, analyse, and redesign the resources.

Second, we used a user-centred design approach with a multidisciplinary team and engagement of users throughout the development process. The research team included health service researchers with diverse backgrounds, designers, and a journalist, and we collaborated closely with a teachers’ network, a jour-
nalists’ network [38], policymakers, and education researchers. We also piloted and user-tested the resources in schools in four countries. We have evaluated the effects of using the resources in a randomised trial, which showed a large improvement in the ability of both the children and their teachers to assess claims about treatments [17].
Conclusion

We employed a user-centred approach to design resources to teach primary children to think critically about treatment claims and choices, and we engaged users throughout the development of the resources. This ensured that both teachers and children experienced the learning resources positively. The input of teachers and children, and iterative revisions based on their input was critical for ensuring that they experienced the resources positively and that they were effective.
References


15. Nsangi A SD, Oxman DA, Sewankambo KN, et al. Teaching children in low-


