Enabling sustainable public engagement in improving health and health equity (CHOICE)- Overview

18 February 2024

Summary

Background: There is a massive amount of information – including lots of misinformation – about what is good or bad for our health. Many people find it difficult to make decisions about what to believe or do.

Objectives: To design and evaluate an educational intervention to enable lower secondary school students (age 13-15) in Kenya, Rwanda, and Uganda to think critically about health claims and choices.

Methods: The project partners were the Tropical Institute of Community Health and Development in Kenya, Makerere University in Uganda, the University of Rwanda, the Epistemonikos Foundation in Chile, and the Norwegian Institute of Public Health. We engaged key stakeholders including teachers, students, and education authorities throughout the project. The design of the intervention was informed by context analyses and an overview of systematic reviews of teaching strategies. We prioritised Informed Health Choices (IHC) key concepts to include in the educational resources that we developed. We used a human-cantered design approach to develop the resources. We evaluated the effects of the intervention (using the resources) in cluster-randomized trials in Kenya, Rwanda, and Uganda. The primary outcome was a passing score on a test (≥9 of 18 multiple-choice questions answered correctly). We conducted a process evaluation alongside the trial to explore implementation and perceptions of the intervention.

Results: The digital resources include 10 lesson plans that can be taught in classrooms with no more than a blackboard. They can be taught with or without a projector. They are free to use, optimized for teachers to access with a smartphone or laptop, and work both online and offline. The lessons focus on nine key concepts that can help people assess claims about the effects of health actions and make informed health choices. The intervention included a 2-3-day teacher training workshops and ten 40-minute lessons taught over 10 weeks using the *Be Smart about Your Health* resources.

Altogether, 244 schools (11,344 students) took part in the three trials. Overall, 33% more students and 32% more teachers had a passing score in the intervention schools compared to the schools where we did not intervene. In total, 3397 (58%) of 5846 students and 118 (97%) of 122 teachers in the intervention schools had a passing score. Other outcomes also favoured the intervention.

The intervention was delivered largely as intended in all three countries. Factors that may have facilitated implementing the intervention and could facilitate scaling it up include the design of the resources and the perceived value of the lessons. Factors that impeded implementation of the intervention and could impede scaling it up are inadequate time to prepare for and teach the lessons, the lessons not being in the curricula or national examinations, and a lack of printed materials for students.

Conclusions: The educational resources can be accessed, downloaded, and used in contexts with minimal resources. The platform we developed for the resources facilitates translation and adaptation of the resources. The intervention led to a large improvement in the ability of students to think critically about health claims and choices. Scaling up the intervention may depend on including the lessons in national curricula and examinations. Future research should focus on strategies for scaling-up use of *Be Smart about Your Health* and reducing inequities in the extent to which learners benefit from the intervention. The IHC key concepts are relevant to decisions about many types of actions, not just health actions, and people value learning the concepts. Ideally, these concepts should be taught beginning as early as possible in a spiral curriculum that maps out what students should learn, where they should begin, and how they should progress.

Background

There is a massive amount of health information online, in addition to information disseminated through other channels of communication. Much of it is misinformation.[1, 2] This problem was exacerbated by the COVID-19 pandemic, which was accompanied by an "infodemic"—an overload of information including false or misleading information.[3] In the context of health, the skills people need to decide what to believe or do are sometimes referred to as critical health literacy.[4, 5] Although both critical thinking and health are widely included in primary and secondary school curricula,[6-8] critical thinking about health or critical health literacy is not.

Many people find it difficult to make decisions about what to believe or do regarding "health actions" (things they can do to care for their health or the health of others). Being able to understand and apply basic principles or concepts is essential for using reliable information appropriately and avoiding being misled by unreliable information The Informed Health Choices (IHC) Key Concepts framework includes 49 such concepts.

Until now, few educational interventions to improve people's understanding and use of such concepts have been rigorously evaluated.[9-11] To help address this gap, we developed and evaluated educational resources to teach some of these concepts in lower-secondary schools in Kenya, Rwanda, and Uganda.

Objectives

The objectives of this project were to:

- Further develop the IHC Key Concepts framework.[12-26]
- Inform the design of educational resources for teaching critical thinking about health to lower secondary school students in East Africa by ensuring that stakeholders were effectively and appropriately engaged,[27] exploring conditions for teaching critical thinking about health in lower secondary schools in East Africa,[28-30] prioritising the key concepts to be included in the educational resources,[31] and summarising what is known from systematic reviews about the effects of teaching strategies that can potentially be used to teach critical thinking about health.[32]
- Design educational resources and an intervention that is suitable for use in East African secondary schools and could be adapted for use in other contexts.[33]
- Develop and evaluate a tool for assessing the effects of the educational intervention.[34, 35]
- Evaluate the effects of the educational intervention.[36-39]
- Assess factors affecting the implementation, impacts, and scale-up of the intervention.[40-42]
- Assess potential adverse effects of the intervention.[43-45]
- Evaluate the effects of the intervention after one year.[46-49]

Results

Key concepts for informed health choices

The IHC Key Concepts provide a framework that is the basis for developing educational resources and evaluating people's ability to think critically about health actions. We developed the original Key Concepts framework as the starting point for developing the IHC primary school resources and a podcast for parents, as part of a previous project funded by the Research Council of Norway.[50] We revised the original 2015 framework yearly from 2016 to 2018 based on feedback and experience using the framework. As part of this project, we revised the framework and prepared the 2019 and 2022 versions.[16] For these versions, in addition to responding to feedback on the previous versions,

we reviewed other relevant frameworks[14] and the evidence base for each of the concepts.[16] Whenever possible, we referenced systematic reviews that provide a basis for the concept.

Being able to understand and apply these basic concepts or principles is essential for using reliable information appropriately and avoiding being misled by unreliable information. As noted by Dewey, *"*it would be impossible to overestimate the educational importance of arriving at conceptions: that is, of meanings that are general because applicable in a great variety of different instances in spite of their difference; that are constant, uniform, or self-identical in what they refer to, and that are standardized, known points of reference by which to get our bearings when we are plunged into the strange and unknown."[51]

The original framework included 32 concepts in six groups. The 2019 and 2022 versions include 49 concepts in three main groups and 10 subgroups or higher-order concepts (Table 1).[12, 13] For each concept there is an explanation including one or more examples, the basis for the concept, and implications. For each concept there is an explanation including one or more examples, the basis for the concept, and implications. Over 600 references are cited that support the concepts, and over half of the references are systematic reviews.[13]

In addition to the concepts, we added to the framework 20 competencies (required skills, knowledge, or capacity to do something) that are needed to make good decisions about which claims to believe about the effects of things they can do for their health, the health of others or for other reasons, and about what to do. We also added 15 dispositions (frequent and voluntary habits of thinking and doing) to the framework.

We summarised the key concepts in a series of essays published in The James Lind Library and the *Journal of the Royal Society of Medicine*.[17-26]

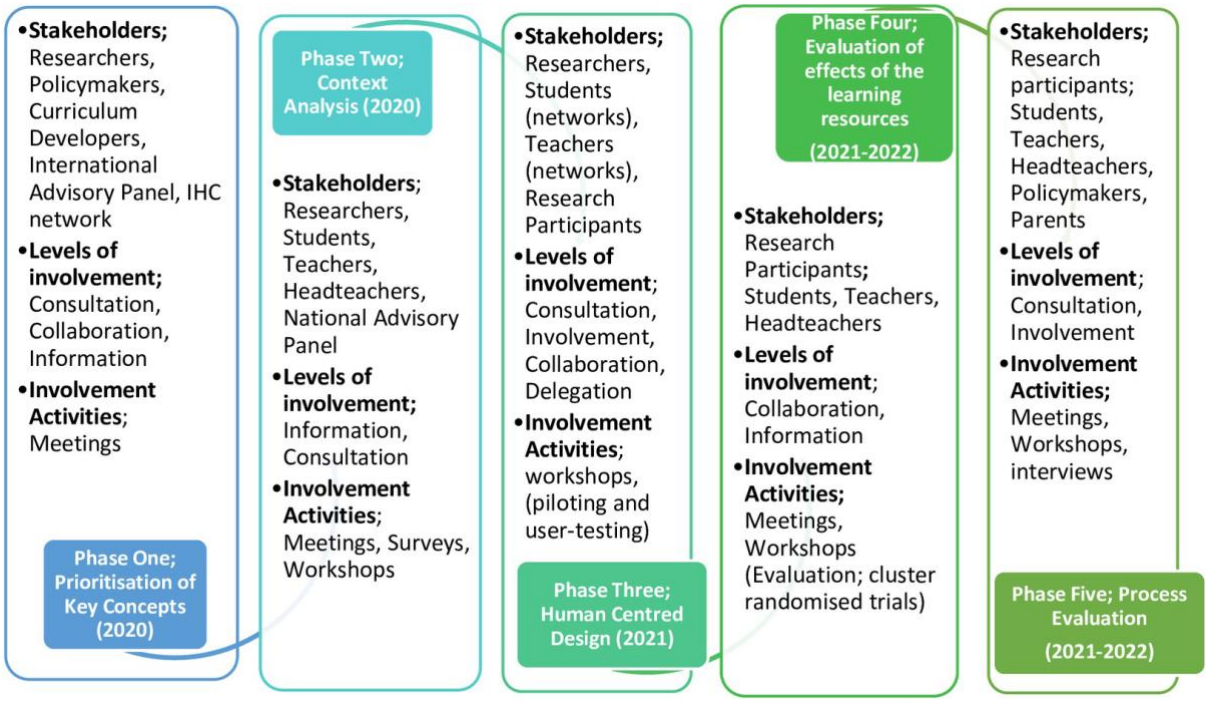
Table 9. Overview of the IHC Key Concepts

1. Claims *Claims about effects that are not supported by evidence from fair comparisons are not necessarily wrong, but there is an insufficient basis for believing them.*	**2. Comparisons** *To identify treatment effects, studies should make fair comparisons, designed to minimise the risk of systematic errors (biases) and random errors (the play of chance).*	**3. Choices** *What to do depends on judgements about a problem, the relevance of the available evidence, and the balance of expected benefits, harms, and costs.*
1.1 Assumptions that treatments are safe or effective can be misleading. Do not assume that a) treatments are safe, b) treatments have large, dramatic effects, c) treatment effects are certain, d) it is possible to know who will benefit and who will be harmed, or e) comparisons are not needed. **1.2 Seemingly logical assumptions about *research* can be misleading.** Do not assume that a) a plausible explanation is sufficient, b) association is the same as causation, c) more data is better data, d) a single study is sufficient, or e) fair comparisons are not applicable in practice. **1.3 Seemingly logical assumptions about *treatments* can be misleading.** Do not assume that a) treatment is needed, b) more treatment is better, c) a treatment is helpful or safe based on how widely used it is or has been, d) a treatment is better based on how new or technologically impressive it is, or e) earlier detection of 'disease' is better. **1.4 Trust based on the source of a claim alone can be misleading.** Do not assume that a) personal experiences alone are sufficient, b) your beliefs are correct, c) opinions alone are sufficient, d) peer review and publication is sufficient, or e) there are no competing interests.	**2.1 Comparisons of treatments should be fair.** Consider whether a) the people being compared were similar, b) the people being compared were cared for similarly, c) the people being compared knew which treatments they received, d) outcomes were assessed similarly in the people being compared, e) outcomes were assessed reliably, f) outcomes were assessed in all (or nearly all) the people being compared, and g) people's outcomes were analysed in the group to which they were allocated. **2.2 Reviews of the effects of treatments should be fair.** Consider whether a) systematic methods were used, b) unpublished results were considered, c) treatments were compared across studies, and d) important assumptions were tested. **2.3 Descriptions of effects should clearly reflect *the size of the effects*.** Be cautious of a) verbal descriptions alone of the size of effects, b) relative effects of treatments alone, c) average differences between treatments, and d) lack of evidence being interpreted as evidence of "no difference". **2.4 Descriptions of effects should reflect *the risk of being misled by the play of chance*.** Be cautious of a) small studies, b) results for a selected group of people within a study, c) p-values, and d) results reported as "statistically significant" or "non-significant".	**3.1 Evidence should be relevant.** a) Be clear about what the problem or goal is and what the options are. Consider the relevance of b) the outcomes measured in the research, c) fair comparisons in laboratories, animals, or highly selected people, d) the treatments that were compared, and e) the circumstances in which the treatments were compared. **3.2 Expected advantages should outweigh expected disadvantages.** a) Weigh the benefits and savings against the harms and costs of acting or not. Consider b) the baseline risk or severity of the symptoms when estimating the size of expected effects, c) how important each advantage and disadvantage is when weighing the pros and cons, d) how certain you can be about each advantage and disadvantage, and e) the need for further fair comparisons.

Stakeholder engagement

We have actively engaged teachers, students, curriculum developers, and other key stakeholders throughout the project (Figure 1).[27] At the start of the project, we established national advisory panels, teacher networks, and student networks in Kenya, Rwanda, and Uganda. In addition, we established an international advisory panel. We consulted these groups throughout the project. Curriculum developers and teachers from all three countries were members of the panels that prioritised the key concepts included in the educational resources,[31] Curriculum developers and teachers also were members of the panel that determined standards for passing and mastery based on the multiple-choice questions used in the instrument used to measure the effects of using the educational resources.[35] Perhaps most importantly, teachers and students were actively involved in user testing and piloting the educational resources and providing feedback on prototypes.

Figure 1. Engagement of key stakeholders



Stakeholders evaluated the extent to which their engagement was successful using agreed upon success criteria.[27]

Context analyses

We conducted context analyses in Kenya, Rwanda, and Uganda to help ensure that the educational resources we developed were well-suited to conditions for teaching critical thinking about health actions to lower secondary school students in those settings.[28-30] The context analyses included document analyses, key informant interviews, focus group discussions, observations of secondary schools, and surveys. The key findings of the three context analyses and our solutions for addressing them are summarised in Table 2.

Table 2. Key findings of the context analyses[33]

Opportunities and challenges	Solutions
Motivation to teach or learn the content	
Curricula in Kenya, Rwanda, and Uganda included learning goals related to 'critical thinking' as a generic competence and to 'health', but none related specifically to 'critical thinking about health'. Curriculum developers, teachers, and students said it was important for students to learn to think critically about health information and choices. However, teaching was largely exam-focused, so teachers and students were unlikely to prioritise content not included in exams.	In the teachers' guide, we included descriptions of how the content mapped onto each country's national curriculum. We communicated regularly with curriculum development offices to facilitate alignment with curricula, ownership of the resources, and future uptake of them.
Capability to teach the content	
Teachers lacked prior knowledge of the IHC Key Concepts.	We created a teachers' guide with an introduction and more detail about the IHC Key Concepts. In each lesson plan, we created a detailed background section describing the respective IHC Key Concepts for that lesson.
Teachers said they lacked experience teaching and evaluating critical thinking in general. We did not identify any existing resources in use for learning or teaching critical thinking.	We created lessons drawing on teaching strategies for critical thinking that we identified in our overview of systematic reviews and included descriptions of these in lesson plans and Extra resources.[32]
Capability to use digital resources	
Teachers had varied experience using ICT for teaching. Many lacked ICT training.	To facilitate ease of access we developed open-access web-based resources. The design is responsive, therefore suitable for any screen size. To increase ease of use, we dropped log-in functionality and simplified the interface as much as possible. We used large font sizes, consistent formatting, and minimized the amount of text to facilitate ease of use during teaching. In the teachers' guide, we included a help section explaining the navigation and technical features of the site. We created sets of optional, downloadable printouts for each lesson for teachers who preferred or had the opportunity of making paper copies.
Opportunity to teach the content within existing curricula using digital resources	
We identified subjects in the Kenyan, Rwandan, and Ugandan curricula where the IHC Key Concepts could fit in the event of future uptake. Curriculum development offices would need to approve the use of any new teaching resource. Resources must be possible to download, adapt and republish on national platforms.	To facilitate tailored implementation, we created an adaptable, translatable solution using Google drive as an editing platform. Curriculum development offices can install their own versions of the resources for future translations or adaptations.
Schools had very different levels of access to ICT infrastructure for teaching and learning, ranging from almost no access to well-equipped computer labs. About half of Rwandan secondary schools have "smart classrooms": computer labs with laptops and Internet access. Poor Internet connectivity and unstable electricity were persistent barriers to use of digital resources in many schools, in all three countries.	To accommodate for varied access to ICT across schools, we created resources for delivering lessons in three different versions: Blackboard, Projector, and Computer-lab. Blackboard lesson plans were optimised for teachers on mobile devices. These could also serve as a back-up in the event of electricity outages. Projector lesson plans included downloadable Google Slides presentations. Computer lab lessons were designed for students to use individually or in groups, in a class led by a teacher.

Prioritisation of key concepts

We used an iterative consensus process to prioritise which key concepts should be included in the educational resources we developed.[31] A panel of curriculum specialists, teachers, and researchers from Kenya, Uganda, and Rwanda familiarised themselves with the IHC Key Concepts, pilot-tested draft criteria for selecting and ordering the concepts, agreed on the criteria, assessed all 49 concepts,[16] and reached an initial consensus. We then sought feedback on the draft consensus from other stakeholders, including teachers. After considering the feedback, the panel reassessed the prioritised concepts and reached a consensus on 17 concepts. We had initially planned on including the 17 concepts in two sets of lessons to be taught over two school years. However, due to the COVID-19 pandemic and school closures, we were only able to develop and evaluate one set of lessons. The final set of nine concepts included in that set of lessons was determined after user-testing prototypes and pilot-testing the resources (Table 3).

Table 3. Prioritisation of key concepts[31]

	IHC Key Concepts	Consensus 1	2a	2b	Final
	Claims				
	It should not be assumed that treatments are safe or effective - or that they are not.				
1.	Treatments can cause harms as well as benefits.	✓	✓	✓	✓
2.	Large, dramatic effects are rare.	✓	✓	✓	✓
3.	It is rarely possible to be certain about the effects of treatments.	✓	✓		
	Seemingly logical assumptions are not a sufficient basis for claims.				
4.	Treatment may not be needed.	✓	✓		
5.	Beliefs alone about how treatments work are not reliable predictors of the presence or size of effects.	✓	✓	✓	
6.	Assumptions that fair comparisons of treatments in research are not applicable in practice can be misleading.				
7.	An outcome may be associated with a treatment but not caused by it.	✓	✓	✓	
8.	More data is not necessarily better data.				
9.	Identifying effects of treatments depends on making comparisons.	✓	✓	✓	✓
10.	The results of one study considered in isolation can be misleading.	✓	✓		
11.	Widely used treatments or those that have been used for decades are not necessarily beneficial or safe.	✓	✓	✓	✓
12.	Treatments that are new or technologically impressive may not be better than available alternatives.	✓	✓	✓	✓
13.	Increasing the amount of a treatment does not necessarily increase its benefits and may cause harm.	✓	✓	✓	
14.	Earlier detection of 'disease' is not necessarily better.				
15.	It is rarely possible to know in advance who will benefit, who will not, and who will be harmed by using a treatment.				
	Trust in a source alone is not a sufficient basis for believing a claim.				
16.	Your existing beliefs may be wrong.	✓	✓	✓	
17.	Competing interests may result in misleading claims.	✓	✓	✓	
18.	Personal experiences or anecdotes alone are an unreliable basis for most claims.	✓	✓	✓	✓
19.	Opinions alone are not a reliable basis for claims.	✓	✓	✓	
20.	Peer review and publication by a journal do not guarantee that comparisons have been fair.				
	Comparison				
	Comparisons of treatments should be fair.				
21.	Comparison groups should be as similar as possible.	✓	✓	✓	✓
22.	Indirect comparisons of treatments across different studies can be misleading.				
23.	The people being compared should be cared for similarly apart from the treatments being studied.	✓	✓	✓	
24.	If possible, people should not know which of the treatments being compared they are receiving.	✓			

	IHC Key Concepts	Consensus 1	2a	2b	Final
25.	Outcomes should be assessed in the same way in all the groups being compared.	✓	✓	✓	
26.	Outcomes should be assessed using methods that have been shown to be reliable.				
27.	It is important to assess outcomes in all (or nearly all) the people in a study.				
28.	People's outcomes should be counted in the group to which they were allocated.				
	Syntheses of studies need to be reliable.				
29.	Reviews of studies comparing treatments should use systematic methods.				
30.	Failure to consider unpublished results of fair comparisons may result in estimates of effects that are misleading.				
31.	Treatment claims based on models may be sensitive to underlying assumptions.				
	Descriptions should clearly reflect the size of effects and the risk of being misled by the play of chance.				
32.	Verbal descriptions of the size of effects alone can be misleading.	✓	✓		
33.	Relative effects of treatments alone can be misleading.	✓	✓		
34.	Average differences between treatments can be misleading.	✓			
35.	Small studies may be misleading.	✓	✓		✓
36.	Results for a selected group of people within a study can be misleading.				
37.	The use of p-values may be misleading; confidence intervals are more informative.				
38.	Deeming results to be "statistically significant" or "nonsignificant" can be misleading.				
39.	Lack of evidence of a difference is not the same as evidence of "no difference".				
	Choices				
	Problems and options should be clear.				
40.	Be clear about what the problem or goal is and what the options are.	✓	✓	✓	
	Evidence should be relevant.				
41.	Attention should focus on all important effects of treatments, and not surrogate outcomes.				
42.	Fair comparisons of treatments in animals or highly selected groups of people may not be relevant.	✓	✓		
43.	The treatments compared should be similar to those of interest.				
44.	There should not be important differences between the circumstances in which the treatments were compared and those of interest.				
	Expected advantages should outweigh expected disadvantages.				
45.	Weigh the benefits and savings against the harms and costs of acting or not.	✓	✓	✓	✓
46.	Consider the baseline risk or the severity of the symptoms when estimating the size of expected effects.	✓	✓		
47.	Consider how important each advantage and disadvantage is when weighing the pros and cons.	✓	✓		
48.	Consider how certain you can be about each advantage and disadvantage.	✓	✓		
49.	Important uncertainties about the effects of treatments should be addressed in further fair comparisons.				
	Number of concepts	*29*	*27*	*17*	*9*

* ✓= *Included*

1 = First consensus

2a = Concepts assessed by the second consensus panel. Two concepts prioritised by the first panel "If possible, people should not know which of the treatments being compared they are receiving."" and "Average differences between treatments can be misleading.") were not considered after feedback from teachers, students, curriculum developers, and other members of the research team.

2b = Concepts prioritised by the second consensus panel

Final = Prioritised concepts after collecting feedback on prototypes of the learning resources and agreed on by the second consensus panel. One concept that was not initially prioritised by the second consensus panel ("Small studies may be misleading.") was included as one of the nine IHC Key Concepts included in the secondary school resources.

Teaching strategies

To inform decisions about which teaching strategies to use in the educational resources, we mapped characteristics of systematic reviews of teaching strategies and summarised findings from the most relevant reviews to teaching students to think critically about health.[32] We included reviews that assessed the effects of teaching strategies that could potentially be used in primary or secondary schools to teach students to think critically, had a Methods section with explicit selection criteria, reported at least one outcome measure of the ability to undertake one of four basic types of cognitive tasks (memory, procedural, comprehension, or opinion), and were published after 1999.

We included 326 systematic reviews. The reviews evaluated a wide range of teaching strategies for a variety of purposes. Important limitations of the reviews included not considering adverse effects (99% of the reviews), not assessing the risk of bias for included studies (93% of the reviews), and not assessing the credibility of subgroup effects (100% of the reviews). We summarised the findings for 37 teaching strategies that we considered most relevant to teaching students to think critically about health. We included those summaries as an Extra resource in the educational resources. Our assessment of the certainty of the evidence of the effects of those strategies varied from very low to moderate. We tested using different strategies in each lesson, but found it added too much to teachers' and students' procedural cognitive load. Therefore, in the final version of the educational resources, we used a limited set of teaching strategies to minimize variation. We used most of those strategies across all 10 lessons (Table 4).

Table 4. Teaching strategies used in the lessons[33]

Strategies used across all lessons	Strategies used in individual lessons
• Guided notetaking • Small group work • Response cards • Homework – collecting claims and choices about health actions • Standard lesson structure • Setting objectives and providing feedback • Multimedia design	• Concept mapping • Concept cartoons • Inquiry-based instruction • Quiz • Role play

Development of the intervention

We collected examples to illustrate the concepts included in the educational resources and developed the lessons and guidance iteratively, informed by data from user-testing, individual and group interviews, and pilot testing.[33]

The final educational resources – *Be smart about your health* - include 10 online lesson plans, a teachers' guide, and extra resources. There are two versions of each lesson plan: a Blackboard version for use in classrooms equipped only with a blackboard and a projector version for classrooms equipped with a projector. The projector version includes downloadable Google Slides presentations. We also developed a computer-lab version for classrooms equipped with computers for students. However, we found several problems with that version. It took time to set up the computer lab, equipment problems were common, students were often distracted by other online content, and teachers found class discussions difficult to organise when students were using computers. In addition, teachers who had tried both the computer lab and projector versions preferred the latter. We therefore decided to drop the computer lab version. Teachers who tried both the blackboard and projector versions also preferred the projector version, as it provided structure and a focal point for class attention.

Feedback on the educational resources was largely positive, with teachers and students appreciating the learning and experiencing it as relevant. Three main challenges included a lack of time to teach the lessons, misunderstandings, and finding appropriate examples to illustrate the concepts.

School schedules lacked time to teach lessons that were not in the curriculum, and teachers struggled to complete lessons within the allotted 40 minutes (a single period). To address this, we simplified and shortened lesson content as much as possible and developed modules for teacher training workshops to increase teachers' confidence and capability to teach the lessons.

Students had varying degrees of difficulty understanding lesson content, sometimes displaying a misunderstanding that was exactly the opposite of what they were intended to learn. To address this, we added "Common misunderstandings" to the lesson background, and designed lessons to include more review opportunities and informal assessment questions.

We initially struggled finding appropriate examples of reliable and unreliable claims, as students often thought the lesson was about the example rather than the underlying concept. Our solutions included finding a balance between real and fictional, well-labelled examples, guidance and prompts for teachers (including suggestions to find their own examples), and developing an example collection for teachers to find alternatives.

The content of the educational resources is summarised in Table 5. They are accessible offline for use when electricity or Internet is lacking. They are open access, licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license. The educational intervention consisted of a 2-3 day teacher training workshops and the ten 40-minute lessons. The teacher training workshops were taught by teachers who participated in pilot testing the educational resources. Both the teacher training workshops, and the 10 lessons were taught using the educational resources.

Table 5. Content of the educational resources

Content	Description
Teachers' guide • Introduction • Overview of the lessons • Using the resources • Development and evaluation • Other relevant resources	The Teachers guide includes: • What the resources are about and why they are important • An overview of the learning goals, limitations, and how the learning goals fit to the curricula in Kenya, Rwanda, and Uganda • An overview of the resources, how to use the resources, how to prepare for teaching the lessons, and teaching tips • How the resources were developed and evaluated • Other educational resources and sources of information about the effects of health actions
Lesson plans 1. Health actions 2. Health claims 3. Unreliable claims 4. Reliable claims 5. Using what we learned (1) 6. Randomly-created groups 7. Large-enough groups 8. Personal choices 9. Community choices 10. Using what we learned (2)	There is a blackboard and a projector version of each lesson. Each lesson includes three sections: an Overview, the Lesson, and Background for teachers. • Each Overview includes the learning goals key terms, teaching strategies and optional printouts for the lesson. • Each Lesson includes an introduction, and activity, and a wrap-up. The introductions include a review of the key messages from the previous lesson and what the lesson is about. The activities are designed to help students achieve the learning goals. The wrap-ups include key messages for the lesson, the homework assignment if there is one, and what the next lesson is about. • Each Background for teachers includes a detailed explanation of what the lesson is about, common misunderstandings, and important content that is closely related to the content covered in the lesson but is excluded because there is not enough time to cover it or it is too advanced. • Lessons 5 and 10 are reviews of the previous lessons.

Content	Description
Extra resources • Glossary • Examples of health actions • Printouts • Teacher training materials • Teaching strategies • Underlying principles	• The Glossary includes all the key terms that may be new or difficult for students. • The Examples of health actions include claimed effects, the actual effects (based on the evidence), a summary of the evidence, and references. • The Printouts include a teacher summary and poster for each lesson. For Lessons 5 and 10 there is a quiz and questions to ask handout for students: questions for finding out how reliable a claim is for Lesson 5, and questions for thinking critically about health actions for Lesson 10. • The Teacher training materials include 19 workshop presentations. • The Teaching strategies include a summary of what the strategy is, when and why it should be considered, and what is known about how effective it is (based on the findings of systematic reviews) for each of the 37 teaching strategies we considered using in the resources. • The Underlying principles summarises the nine key concepts included in the resources and provides links to more information about the IHC Key Concepts.

Assessment tool

We used the Claim evaluation tools item bank as a starting point to develop and evaluate an assessment tool for trials of the intervention in Uganda, Kenya, and Rwanda.[52, 53] The Claim evaluation tools item bank was developed by the IHC project team to objectively measure participants' ability to apply the IHC key concepts after a systematic mapping review did not identify any suitable outcome measures for the trial of the IHC primary school intervention.[54] It includes a flexible battery of multi choice questions (MCQs) for each of the IHC key concepts.

We conducted cognitive interviews in which learners in Kenya, Rwanda, and Uganda were encouraged to verbalize thoughts and feelings as they read MCQs for the nine key concepts included in the educational resources.[34] This identified questions that were not suitable or needed editing and ensured that the questions were suitable and understandable. We then validated the outcome measure using Rasch analysis.[34] We administered two sets of questions with two MCQs for each key concept. We also included questions about intended behaviour and self-efficacy. We recruited children (over 12 years old) and adults through universities, market groups, and our networks in the three countries. The analysis included responses from 1,671 participants. We calculated summary and individual fit to the Rasch model and Cronbach's Alpha using the RUMM2030 software.

We found that both item sets had a good fit to the Rasch model and were acceptable to the learners and adults. The reliability of over 70% (Cronbach's alpha >0.7) was good. We selected 18 MCQs (two for each key concept) with the best fit. The resulting assessment tool - the Critical Thinking about Health (CTH) test was used to measure outcomes in randomized trials of the intervention.

We used a combination of two widely used methods (Angoff's and Nedelsky's) to determine cut-offs for passing and mastery. A panel of eight individuals, including East African curriculum specialists, educational and health researchers, and East African secondary school teachers judged the likelihood that an individual on the border of passing and another on the border of having mastered the key concepts would answer each MCQ correctly.[35] The cut-off scores were determined by summing up the probability of answering each MCQ correctly. The panel's independent assessments were summarised and discussed, and a nominal group technique was used to reach a consensus. The panel agreed that for a passing score, a student had to answer at least 9 of the 18 questions correctly. For a mastery score, a student had to answer at least 14 out of 18 questions correctly.

Evaluation of the intervention

We conducted cluster-randomized trials of the educational intervention in Kenya, Rwanda, and Uganda. We did not intervene in control schools. The primary outcome was a passing score on the CTH test (≥9 of 18 MCQs answered correctly). We performed random effects meta-analyses to estimate overall adjusted odds ratios across the three trials and re-expressed the effects as adjusted differences. Secondary outcomes included effects of the intervention on teachers.

Altogether, 244 schools (11,344 students) took part in the three trials. The main results are shown in Table 6. The overall adjusted odds ratio for the primary outcome was 5.5 (95% CI: 3.0–10.2; p < 0.0001) in favour of the intervention (high certainty evidence). This corresponds to 33% (95% CI: 25–40) more students in the intervention schools passing the test. Overall, 3397 (58%) of 5846 students in intervention schools had a passing score. The overall adjusted odds ratio for teachers was 13.7 (95% CI: 4.6–40.4; p < 0.0001), corresponding to 32% (95% CI: 6–57) more teachers in the intervention schools passing the test (moderate certainty evidence). Overall, 118 (97%) of 122 teachers in intervention schools had a passing score.

Table 6. Summary of findings

Outcomes*	**Control schools†**	**Intervention schools‡ (95% CI)**	**Relative effect** odds ratio (95% CI)	**Number of participants (effective sample size)§**	**Certainty of the evidence** (GRADE)**
Students					
Passing	34.1%	66.9% (59.5-74.2)	3.6 (2.5-5.2)	11,325 (1173)	⨁⨁⨁⨁ High certainty
Mastery	1.3%	19.7% (16.9-22.5)	25.9 (6.8-98.8)	11,325 (875)	⨁⨁⨁⨁ High certainty
Mean score	37.1%	54.2% (50.5-57.9)		11,325 (1126)	⨁⨁⨁⨁ High certainty
Harms††	-	-	-	-	⨁◯◯◯ Very low certainty
Teachers					
Passing	65.6%	97.5% (71.9-100)	13.7 (4.6-40.4)	244	⨁⨁⨁◯ Moderate certainty††
Mastery	9.8%	86.1% (67.7-100)	51.9 (17.4-154.4)	244	⨁⨁⨁◯ Moderate certainty††
Mean score	53.6%	85.1% (76.6-93.7)		244	⨁⨁⨁◯ Moderate certainty††
Harms‡‡	-	-	-	-	⨁◯◯◯ Very low certainty

* Passing: ≥9 of 18 correct answers. Mastery: ≥14 of 18 correct answers. Mean = average percent correct answers.

† Average of the proportions and means for the three trials.

‡ Average for control schools + adjusted difference. 95% CI account for uncertainty of the control odds as well as the odds ratios for proportions, and the control mean as well as the mean difference for means. The values in this table differ slightly from values reported in the text, which are the observed proportions in the intervention schools.

§ 3 cluster randomised trials and 244 schools were included for all six outcomes. The effective sample size, which accounts for clustering, is the original sample size divided by the 'design effect' (Supplementary table 13)

** Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group grades of evidence – judgements made independently by two researchers who had no other involvement with the research.

⨁◯◯◯ **Very low certainty**: The research does not provide a reliable indication of the likely effect. The likelihood that the actual effect will be substantially different is very high.

⨁⨁◯◯ **Low certainty evidence**: The research provides some indication of the likely effect. However, the likelihood that the actual effect will be substantially different is high.

⨁⨁⨁◯ **Moderate certainty**: The research provides a good indication of the likely effect of a treatment. The likelihood that the actual effect of the treatment will not be substantially different is moderate.

⨁⨁⨁⨁ **High certainty**: The research provides a very good indication of the likely effect of a treatment. The likelihood that the actual effect will be substantially different from this is low.

†† Downgraded due to insufficient sample size.

‡ No adverse effects were reported by teachers. However, potential adverse effects are being explored in process evaluations and the one-year follow-up study.

The following secondary outcomes also favoured the intervention: a mastery score on the CTH test (≥14 of 18 MCQs answered correctly) for both students and teachers, the mean score on the CTH test for both students and teachers, and the proportion of students who answered both questions correctly for each key concept. Based on self-report, if someone claimed that a treatment might help them get better, students in the intervention schools were more likely to find out if the claim was based on a research study comparing treatments. Intervention students also were more likely than control students to respond that they found it easy or very easy to know if a claim about a treatment is based on a controlled trial, and to judge the trustworthiness of the results of a controlled trial. There was little difference for other questions about intended behaviours and self-efficacy.

Most of the students in the intervention schools liked the lessons and found them helpful. The teachers did not report any adverse effects in the intervention schools.

Using the projector version of the lessons may be more effective than using the blackboard version (low credibility), and the intervention probably is more effective for high or moderate performing students than for low performing students, for smaller class sizes, and for boys (moderate credibility) Table 7.

Table 7. Credibility of the effect modifier analyses for the primary outcome

Criteria*	**Potential effect modifiers†**			
	Version	Performance	Class size	Sex
1: Is the analysis of effect modification based on comparison within rather than between trials?	No	Yes	Yes	Yes
2: For within-trial comparisons, is the effect modification similar from trial to trial?	-	No	Yes	Yes
3: For between-trial comparisons, is the number of trials large?	No	NA	NA	NA
4: Was the direction of the effect modification correctly hypothesized a priori?	Yes	Yes	Yes	No
5: Does a test for interaction suggest that chance is an unlikely explanation of the apparent effect modification?	Yes	Yes	No	Yes
6: Did the authors test only a small number of effect modifiers or consider the number in their statistical analysis?	Yes	Yes	Yes	Yes
7: Did the authors use a random effects model?	Yes	Yes	Yes	Yes
8: If the effect modifier is a continuous variable, were arbitrary cut points avoided?	NA	NA	Yes	NA
9 Optional: Are there any additional considerations that may increase or decrease credibility?	-	-	-	-

10: How would you rate the overall credibility of the proposed effect modification?	Low‡	Moderate§	Moderate**	Moderate††

* Instrument for assessing the Credibility of Effect Modification Analyses (ICEMAN) criteria for meta-analyses of randomized controlled trials.

Schandelmaier S, Briel M, Varadhan R, et al. Development of the Instrument to assess the Credibility of Effect Modification Analyses (ICEMAN) in randomized controlled trials and meta-analyses. *CMAJ* 2020; **192**(32): E901-e6.

†Version = use of projector vs blackboard versions of the lessons. Performance = low vs moderate or high performance on end-of-term examinations for the previous school term. Class size = number of students in the class where the lessons were taught. Sex = female vs male.

‡Version: A within country comparison was only possible in the Ugandan trial (Supplementary table 6c), where there was not evidence of an interaction. Although there is evidence of an interaction in the IPD meta-analysis (table 5), this is driven by a comparison between the trials. None of the schools in Kenya used the projector version, all the schools in Rwanda used the projector version, and stratified random allocation was used to ensure a fair distribution of schools with and without a projector in Uganda. There were only three trials and there may be confounding due to other differences between the Kenyan and Rwandan trials.

§Performance: The evidence of an interaction is based on just one of the three trials. Performance was measured at the level of student in Kenya (where there was evidence of an interaction) and at the level of school in Rwanda and Uganda (where there was not evidence of an interaction) (Supplementary tables 6a-6c).

**Chance could explain the apparent effect modification. However, the unit of measurement for class size was student. Larger differences in class size probably reduce the effectiveness of the intervention. For example, the odds ratio for a class size with 10 more students is 0.90 (95% CI 0.80-1.02).

††This analysis was not specified in the protocol, and we did not have an a priori hypothesis.

Process evaluations

We conducted a process evaluation alongside the trial in each country.[40-42] These explored:

- Factors that may affect the implementation, impact, and scale-up use of the intervention,
- Potential adverse and beneficial effects that were not measured quantitatively, and
- How users and other stakeholders experienced and perceived the lessons and the educational resources.

The process evaluations included interviews and focus group discussions with teachers, students, parents, head teachers, and key stakeholders. We also observed at least one lesson in all the intervention schools. In addition, we collected feedback from teachers using a teacher training evaluation form and a lesson evaluation form that teachers in the intervention schools completed after each lesson.

The main findings of the process evaluations are summarised in Table 8. Factors that may have facilitated implementing the intervention and could facilitate scaling it up included the teacher training workshop, completing all the lessons, the design of the resources, the perceived value of the lessons, and administrative support. Three major factors impeded implementation of the intervention and are barriers to scaling it up: inadequate time, the lessons not being in the curriculum or national examinations, and a lack of printed materials for students. Perceived benefits of the intervention included students and teachers understanding the concepts and using them in their daily lives. Other potential benefits included students being more confident, thoughtful, open minded, and interested in STEM subjects and health professions. Potential adverse effects include conflicts with parents and other students, misunderstanding the lessons, and misapplying what was learned.

Table 8. Main findings of the process evaluations

Factors & Potential impacts	Findings
Facilitators	

Factors & Potential impacts	Findings
Teacher training workshop	Nearly all the teachers in intervention schools found the workshop helpful or essential. They felt that it improved their understanding, motivation, and confidence to teach the lessons.
Delivery of the lessons	Teachers reported completing all the lessons and using the educational resources with minimal adaptation. They sometimes used the local language instead of English and used some local examples instead of the ones provided in the lessons. Most students attended most of the lessons. The teachers perceived that the students achieved the lesson goals (apart from the lessons on random allocation and random error).
Design of the resources	Teachers found the educational resources easy to access, understand, and use. Most of the teaching strategies were familiar and easy to adapt. A couple of teaching strategies were new to them and appreciated. Students found the lessons enjoyable and understandable.
Value of the lessons	Teachers, students, and other stakeholders all considered the lessons relevant to daily life and valuable. This motivated both teachers and students. They felt the lessons addressed skills that are important for students, teachers, and the public.
Administrative support	Teachers in Kenya and Rwanda reported receiving support from their school's administration, including time and resources to teach the lessons.
Barriers	
Inadequate time	Teachers were unable to complete the lessons in a single 40-minute period and generally used more time – sometimes as much as 120 minutes. Some teachers also reported not having enough time to prepare sufficiently due to competing demands on their time. The fact that it was an otherwise busy school term following school closures may have contributed to this.
Curricula and examinations	Students, teachers, curriculum developers, and education authorities all identified the lessons not being in the curriculum or national examinations was a major barrier to implementing and scaling up the intervention.
Lack of printed material	Teachers, students, and some education authorities viewed the lack of a textbook or printed materials for students was a barrier to scaling up the intervention, since students lacked access to resources outside of the classroom.
Potential benefits & harms	
Understanding of the concepts	Nearly all the students that participated in the process evaluations demonstrated correct application of most of the concepts. However, teachers felt less confident about teaching the lessons on random allocation and random error, and students found those concepts difficult – particularly low-performing students.
Use of what was learned	Students and teachers that participated in the process evaluations reported using at least some of the key concepts they learned in their daily lives.
Other potential benefits	Other potential benefits that were reported included students being more confident to be in front of people and defend their contributions in arguments, students being more thoughtful and open minded, and students being more interested in STEM subjects (biology, physics, chemistry, ICT, and math) and health professions.
Adverse effects	Some students reported conflicts with their parents or other students because of applying what they learned. A few students reported that their parents appreciated engaging with them in making health and social decisions. However, most parents were not comfortable with students questioning their decisions. Some students misunderstood the lessons or misapplied the concepts.

Adverse effects

Educational interventions, like medical and other types of interventions, can have undesirable as well as desirable effects.[43] However, researchers rarely evaluate potential adverse effects of educational interventions.[44] We developed a framework of potential adverse effects of educational interventions to improve critical thinking about health choices,[43] and conducted a meta-epidemiological study of the evaluation of adverse effects in evaluations of interventions to improve critical thinking about health choices.[44] We are using the framework in a qualitative evidence synthesis of adverse effects reported in the process evaluations,[45] and in developing questions about adverse effects to include in one-year follow-up studies of the effects of the educational intervention.[46]

We developed an initial framework based on two other tools. We surveyed experts for quantitative and qualitative feedback, including researchers and others in a variety of relevant fields. We analysed the quantitative data using descriptive statistics and conducted a thematic analysis of the qualitative data. To preliminarily prioritise undesirable outcomes for the evaluation in the one-year follow-up study, we interviewed a convenience sample of three teachers: one from each country where we developed and evaluated the intervention (Kenya, Rwanda, and Uganda). For the meta-epidemiologic study, we sampled all study reports included in two systematic reviews. We extracted any mention of adverse effects from the protocols and reports of those studies and protocols and reports of any qualitative evaluations linked to those studies.

The framework includes categories of adverse outcomes; outcomes within those categories; sub-outcomes; potentially affected individuals, groups, and populations; corresponding beneficial outcomes; and descriptions of potential mechanisms (Table 9).[43] The categories are decision-making harms, psychological harms, equity harms, group and social harms, waste, and other harms. Based on the interviews and preliminary findings of the process evaluations, we prioritised four potential adverse effects to assess by incorporating additional questions for students and teachers in the CTH test that we administered one year after the initial evaluation (at the end of the school term when the lessons were delivered):[46]

- Wasted time
- Conflict due to students challenging the beliefs of others
- Stress associated with teachers preparing for and teaching the lessons
- Decision-making harms due to misunderstandings.

We also included a question about any other undesirable effects. Only the students and teachers in the intervention schools were asked these questions.

Table 9. Categories of adverse outcomes[43]

Category	Definition
Decision-making harms	Behaviours and beliefs that might contribute to poor choices
Psychological harms	Uncomfortable thoughts and feelings
Equity harms	Inequities in the distribution or size of effects
Group and social harms	Harmful interactions between individuals, groups, populations, and systems
Waste	Waste of time and resources
Other harms	Other adverse outcomes than those in the categories above

The two reviews in the meta-epidemiological study and an updated search for one of the reviews included 26 reports of quantitative evaluations, and one report of a mixed-methods evaluation.[44] One of those 27 reports included a quantitative evaluation of a potential adverse effect: an increase in unnecessary pressure. The evaluation showed no such effect. Four reports included or referenced a qualitative evaluation of potential adverse effects. In the reports of the four qualitative evaluations, some participants said they had experienced adverse effects of the intervention. A minority of all reports included references to protocols, and a minority of those references included the location of a publicly available copy. Researchers who mentioned potential adverse effects in their protocols also reported evaluating such effects.

Analysis of the qualitative evidence synthesis of adverse effects and the questions asked in the one-year follow-up study are not yet completed.

One-year follow-up

We measured the same outcomes measured at the end of the school term when the lessons were delivered one year later, using the CTH test. As noted above, we included additional questions about potential adverse outcomes for students and teachers in the intervention schools. We also included questions about transfer – use of what was learned – for students and teachers in the intervention schools. In addition, we asked students in both intervention and control schools to recall a claim about the effects of a health action using a "diary".[46] For each claim we asked eight questions to assess their ability to identify and assess the claims and decide what to do. The diaries were completed by a random sample of 10 students in each school. We anticipate that analysis of the one-year follow-up data will be completed by the end of February.

Anticipated benefits

We have demonstrated that it is possible to teach adolescents to think critically about health in settings with minimal access to ICT and printed materials. The digital educational resources can easily be accessed using a smartphone or laptop, and they can be used offline. In this way we minimised the cost of using the resources and maximised access. We are working with educational authorities to find ways to scale up use of the resources in Kenya, Rwanda, and Uganda. We created a platform for the resources that facilitates translation and adaptation of the resources for use in other contexts. The platform also can be used to develop new lessons.

We have documented the benefits of using the resources. In addition, we have illustrated the value of context analyses, the IHC Key Concepts framework, and using a human-centred design approach to ensure that educational interventions are experienced positively and valued by teachers, students, and other stakeholders. We also developed a framework to improve consideration of potential adverse effects of educational interventions.

The IHC network that we coordinate now includes people from 26 counties who are developing, evaluating, or contextualising IHC resources. The primary school resources that we developed have been translated to 13 other languages and there is interest in translating and adapting the resources developed in this project.

Dissemination and utilisation of the results

Our partners in Kenya, Rwanda, and Uganda are working with their national curriculum development offices to find ways to scale up use of the educational resources. They also are planning activities to disseminate the results of this project to teachers and other stakeholders. Our international dissemination plan includes webinars; dissemination through the IHC network, website, and newsletter; presentations at conferences; and dissemination through organisations such as Cochrane, the Campbell Collaboration, Health Information for All (HIFA), WHO, the Education Endowment Foundation, the Norwegian Centre for Science Education, Teacher Education in Sub-Saharan Africa (TESSA), and TES. We are preparing reports targeted at teachers and education authorities. The International Initiative for Impact Evaluation (3ie) March 21st that will include a panel of curriculum developers and education policymakers from Kenya, Rwanda, and Uganda.

Pending results

The following results are pending and will be finalised in the first half of 2024:

- Stakeholders' evaluation of the extent to which their engagement was successful using agreed upon success criteria.[27]

- Qualitative evidence synthesis of the findings for adverse effects in the three process evaluations. .[40-42, 45]
- Evaluation of the effects of the educational intervention after one year.[46-49]

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