Improving critical thinking about health: Development and evaluation of the Informed Health Choices secondary school intervention in Rwanda

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PhD Thesis

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Preface

In Rwanda, where I live, people share information, and particularly health-related information, primarily from person to person. There are many traditional and homemade remedies that we have believed in and used. Family, friends, traditional healers, trusted doctors, and spiritual leaders have given me lots of treatment advice for various conditions. For example, when my wife had a complicated pregnancy, we received more than 50 different recommendations for treatments from parents, other family, friends, and healthcare professionals. Similarly, during the Covid-19 pandemic, people around us gave lots of preventive and treatment advice.

I remember when I was a physiotherapy student, I was taught and encouraged to provide evidence-based healthcare to the patients. I don't remember considering patients' knowledge, personal experiences, preferences, or beliefs about treatment options, or how these might affect treatment choices and outcomes. I also did not consider how various sources of health information could influence people's decisions to believe in and use specific treatments.

When making treatment choices, people tend to focus on the benefits of treatments, without considering harms or thinking critically about what they know. At an exhibit at the UK Wellcome Collection museum, I saw how parents in Japan resisted the uptake of the HPV vaccine. The public believed information in mass and social media that was not consistent with evidence. Similarly, people resisted being vaccinated against Covid-19 due to mixed and contradicting health information and beliefs. People were overwhelmed with the overabundance of information about Covid-19, which the World Health Organisation has labelled an "infodemic".

Treatment decisions are no longer only in the hands of healthcare professionals – and probably have never been. Individual knowledge and beliefs, community beliefs, and personal experience influence treatment decisions, and frequently result in poorly informed decisions. The extent to which this is harmful, depends on how many people are affected, how harmful a treatment is, its cost, and whether better options are available.

In this thesis, I present my work on how we can help the public think critically about their health choices. I argue that people need knowledge and skills that can help them appraise information about treatments and make reliable health choices. I show that targeting students in school settings and building this topic into their curriculum, may be an effective strategy. Developing and evaluating educational resources to help students learn key concepts for making informed health choices can improve their critical thinking skills, and this can help realise an informed generation that bases its decisions on evidence.

Dedication

I dedicate this work to Jesus Christ, the son of God, the creator of heaven and earth. It is His grace, mercy, love and care that helped me throughout my journey of education.

I also dedicate this work to my lovely wife Melissa Uwase and our sweet daughter Geula Mugisha. Thank you for understanding and bearing with my absence. Thank you, my wife, for all your prayers and support in field work activities. You are an amazing woman.

Lastly I dedicate this work to my parents who laid a foundation by nurturing me and taking me to school. Thank you mum for your prayers and faith in God's word, *"All your children shall be taught by the Lord, and great shall be the peace of your children" Isaiah 54:13.*

Guess what, we made it, Amen!

Acknowledgement

I would like to start by expressing my appreciation of the Government of Rwanda for establishing a conducive learning environment from basic education to the University. I thank our leadership for its dedicated service to the people of Rwanda. My studies, and this research work in particular, is an example of how education for all is possible. I would like to acknowledge the University of Rwanda's leadership for supporting me in this work, including recommendations, approvals and financial support that made my work possible.

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I would also like to acknowledge the University of Rwanda's Centre of Excellence in Biomedical Engineering and E-health (CEBE), which co-funded my PhD work, supporting courses outside Norway, conference attendance, and some fieldwork.

I would like to express my heartfelt appreciation of Dr. Andrew David Oxman, my main supervisor for this PhD work. I have enjoyed your timely and excellent guidance in every step of this project, through which I have learnt a lot, which I will carry on in my profession. Special thanks to Prof. Laetitia Nyirazinyoye, my co-supervisor. Thank you so much for your support, guidance, and supervision. I value the time you invited me to work with you and encouraged me to work in this field at the master level. I would like to thank Atle Fretheim and Espen Bjertness, my co-supervisors for guidance and support in my studies. Furthermore, I would like to thank Prof. Nelson K. Sewankambo and Prof. Margaret Kasege for continued support and guidance.

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Sammendrag

Bakgrunn

Vi tar beslutninger hver dag, deriblant beslutninger om helsen vår. Påstander om hva vi kan gjøre for å forebygge, behandle eller forbedre helsen florerer. Sosiale medier og massemedier er fulle av informasjon om helse, inkludert mye villedende informasjon, og mye er rettet mot unge mennesker. I denne avhandlingen har jeg undersøkt hvordan elever kan lære å ta informerte helsebeslutninger. Sammen med kolleger har jeg utviklet og evaluert en intervensjon for å undervise ungdomsskoleelever i Rwanda i kritisk tenkning om helse.

Metoder

Vi brukte kvalitative metoder til å utforske konteksten for å undervise i kritisk tenkning i ungdomsskoler i Rwanda, og vi benyttet menneskesentrert design for å utvikle intervensjonen. Intervensjonen ble evaluert gjennom en klyngerandomisert studie. Vi brukte en skoleprøve («the Critical thinking about health test») for å måle primærutfallet (andelen elever som besto prøven). Vi benyttet metodetriangulering for å utføre en prosessevaluering parallelt med den randomiserte studien for å studere implementeringen og innvirkningene av intervensjonen, og faktorer som påvirker en oppskalering av intervensjonen.

Funn

I kontekstanalysen fant jeg at innføringen av det kompetansebaserte pensumet i Rwanda førte til etterspørsel etter undervisning om kritisk tenkning og ga en mulighet for å undervise i kritisk tenkning om helse. Kontekstanalysen bidro inn i utformingen av intervensjonen, som inkluderte både digitale læringsressurser og en workshop for opplæring av lærere. De digitale ressursene omfattet 10 leksjoner. Vi utformet ressursene så de kunne brukes under omstendigheter med lite utviklet infrastruktur for informasjonsteknologi og ustabil internett- og strømtilgang. Ressursene kunne både brukes online og lastes ned. Lærerne kunne bruke dem på smarttelefoner og datamaskiner. I den randomiserte studien fant jeg at flere enn halvparten (58%) av elevene i skolene som ble randomisert til å bruke læringsressursene besto prøven, og omtrent 23% av elevene oppnådde mestringskarakter sammenlignet med henholdsvis færre enn 20% og 1 % i kontrollskolene. I prosessevalueringen fant jeg at intervensjonen i stor grad ble implementert etter hensikten. Lærere, elever og andre interessenter opplevde intervensjonen som nyttig, verdifull, interessant og engasjerende. Dette gjorde implementeringen enklere. De største barrierene for en effektiv implementering var vansker med å forstå enkelte konsepter, tidsbegrensninger, at innholdet ikke var inkludert i nasjonale prøver og dermed ikke ble prioritert og konkurrerende prioriteter.

Konklusjon

I konteksten av ungdomsskoler i Rwanda er det mulig å undervise og lære bort ferdigheter for kritisk tenkning om helse ved bruk av digitale læringsressurser. Intervensjonen var effektiv, og lærere, elever og andre interessenter opplevde den som noe positivt. En oppskalering av intervensjonen avhenger sannsynligvis av at leksjonene innlemmes i nasjonalt pensum og prøver.

Summary-English

Background

Every day, we make decisions, some of which are health-related. Claims about actions we can take to prevent, treat, or improve health conditions are abundant. Social and mass media are full of information about health actions, including lots of misleading information, much of which is targeted at young people. This thesis has explored how students can learn to make informed health choices. With colleagues, I have developed and evaluated an intervention to teach critical thinking about health to lower secondary school students in Rwanda.

Methods

We used qualitative methods to explore the context for teaching critical thinking skills in secondary schools in Rwanda and employed human-centred design to develop the intervention. We evaluated the intervention in a cluster randomised trial. We used the Critical Thinking about Health Test to measure the primary outcome, i.e. the proportion of students who achieved a passing score. Mixed methods were used to conduct a process evaluation alongside the trial, to explore the implementation, impact, and factors affecting the impact and scaling-up of the intervention.

Findings

In the context analysis, I found that the introduction of the competence-based curriculum in Rwanda triggered the demand for teaching critical thinking skills and presented an opportunity to teach critical thinking about health. The context analysis informed the design of the intervention, which included digital resources and a teacher training workshop. The resources included 10 lesson plans. We designed the resources for use in settings with minimal information and communication technology infrastructure and unstable internet connectivity and electricity. The resources can be used online and downloaded. Teachers could access and use them via a web browser on a smartphone or a computer. In the trial, I found that 58%, i.e. more than half, of students in schools randomised to use the informed health choices (IHC) secondary school resources achieved a passing score and about 23% of students achieved a mastery score, compared to less than 20% and 1% respectively in the control schools. In the process evaluation, I found that the intervention was largely implemented as intended. Teachers, students, and other stakeholders perceived the intervention as useful, valuable, interesting, and engaging, and this facilitated its implementation. The main barriers to effectively implementing the intervention were difficulty understanding some concepts, time constrains, the content not being included in national exams and therefore not prioritised, and competing priorities.

Conclusion

In the context of lower secondary schools in Rwanda, it is possible to teach critical thinking about health skills using digital learning resources. The intervention was effective, and perceived as positive by teachers, students, and other stakeholders. Scaling up the intervention will likely depend on integration of the lessons into the national curriculum and exams.

List of acronyms

ASRH: Adolescent, Sexual and Reproductive Health

CERQual: Confidence in the Evidence from Reviews of Qualitative Research

Covid-19: Coronavirus Disease

EtD: Evidence to Decision

FGD: Focus Group Discussion

HPV: Human Papilloma Virus

ICT: Information, Communication and Technology

IHC: Informed Health Choices

MoE: Ministry of Education

MoH: Ministry of Health

NESA: National Examination and School Inspection Authority

REB: Rwanda Basic Education Board

RCN: Research Council of Norway

RNEC: Rwanda National Ethics Committee

WHO: World Health Organization

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List of Articles

This thesis is written based on the following three main papers:

I. **Mugisha M**, Uwitonze AM, Chesire F, Senyonga R, Oxman M, Nsangi A, et al. Teaching critical thinking about health using digital technology in lower secondary schools in Rwanda: a qualitative context analysis. *PLoS One* 2021; **16**: 1–18.

II. **Mugisha M**, Nyirazinyoye L, Simbi CMC, Chesire F, Ssenyonga R, Oxman M, et al. Effects of the Informed Health Choices secondary school intervention on the ability of students in Rwanda to think critically about health choices: a cluster-randomised trial. J Evid Based Med 2023;16(3):264-274. https://doi.org/10.1111/jebm.12551

III. **Mugisha M**, Nyirazinyoye L, Oxman AD, Uwitonze AM, Simbi CMC, Chesire F, et al. Process evaluation of the Informed Health Choices secondary school intervention for teaching critical thinking about health choices in Rwanda: a mixed methods study; submitted.

Other relevant publications contributed to by the author referred to in this thesis:

1. Agaba JJ, Chesire F, **Mugisha M**, Nandi P, Njue J, Nsangi A, et al. Prioritisation of Informed Health Choices (IHC) Key Concepts to be included in lower-secondary school resources: a consensus study. *PloS One* 2023; 18: e0267422.

2. Rosenbaum SE, Moberg J, Chesire F, **Mugisha M**, Ssenyonga R, Ochieng MA, et al. Teaching critical thinking about health information and choices in secondary schools: human-centred design of digital resources. F1000Research 2023, 12:481. https://doi.org/10.12688/f1000research.132580.1

3. Dahlgren A, Semakula D, Chesire F, **Mugisha M**, Ssenyonga R, Nakyejwe E, et al. Critical thinking about treatment effects in Eastern Africa: development and Rasch analysis of an assessment tool. F1000Research 2023, 12:887. https://doi.org/10.12688/f1000research.132052.1

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5. Ssenyonga R, Oxman AD, Nakyejwe E, Chelagat F, **Mugisha M**, Oxman M, et al. Use of the Informed Health Choices educational intervention to improve secondary students' ability to think critically about health interventions in Uganda: a cluster-randomised trial. J Evid Based Med. 2023;16(3):285-293 . https://doi.org/10.1111/jebm.12553

6. Chesire F, **Mugisha M**, Ssenyonga R, Rose CJ, Nsangi A, Kaseje M, et. Al. Effects of the Informed Health Choices secondary school intervention: a prospective meta-analysis.

J Evid Based Med. 2023;16(3):321-331. https://doi.org/10.1111/jebm.12552

7. Oxman M, Chesire F, **Mugisha M**, Ssenyonga R, Ngatia B, Nsangi A, et.al. Potential adverse effects of an educational intervention: Development of a framework; submitted.

I. Introduction

Every day we make decisions, including decisions about our health. When we make health decisions, we have options and information about those options – i.e. health actions that we can choose to take. The information includes claims about the effects of the options and suggestions about what to do, which may be true or false.

Directly or indirectly, people pass health claims made by others on to other people. Both reliable and unreliable claims are passed on by people whose intentions can be good or bad. The massive availability of information about health actions in social and mass media include a great deal of misleading information.

It is therefore important that the public has skills to critically appraise health claims. Failure to address this problem has several consequences, including harm caused by taking harmful health action, waste of resources on ineffective health action, and harm caused by not taking effective health action. Unfortunately, many people lack the skills required to critically appraise health claims and make informed choices.

It is therefore important to teach people to critically appraise health claims. To be able to critically appraise a claim, the person must understand and apply some basic concepts which can be used to evaluate a great variety of claims and can help us judge the reliability of those claims.[1] The Informed Health Choices (IHC) key concepts framework includes 49 such concepts[2] which are used by a network of people around the world as a starting point for developing, evaluating, and contextualising educational resources, especially resources targeted at school children.[3]

This thesis builds on the work of the IHC network. My focus is on the development and evaluation of the IHC secondary school resources in Rwanda. I discuss three linked papers and reflect on other related papers. In the first paper, a context analysis (Paper I), I have explored opportunities and challenges for teaching critical thinking about health in secondary schools. This work informed the development the IHC secondary school resources. In the second paper, I evaluated the IHC secondary school intervention in a randomised trial (Paper II). In the third paper, I conducted a process evaluation to explore implementation of the IHC secondary school intervention in the trial, perceived impacts of the intervention, and factors affecting the implementation and scale-up of the intervention (Paper III).

For clarity, I use these terms with the following meanings: **Critical thinking** means thinking clearly and rationally about what to do or believe.[4] **Critical thinking about health** means thinking rationally about what to do or believe about health decisions. A **health action** or **treatment** is an action that someone takes or can take to care for their own health or the health of others. A **health claim** is something said about health that is presented as if it is true, but that may be wrong.

This thesis is organised in six chapters. In this first chapter, I introduce the thesis and how it is structured. In the second chapter, I present background information about: the problem we try

to address and why it is important; critical thinking in health and education; frameworks for teaching critical thinking about health; young people and critical thinking about health; educational interventions for critical thinking about health; teaching strategies for critical thinking; Rwanda's health and educational context; the work of the IHC network and what my thesis adds; stakeholders' engagement; prioritisation of the IHC key concepts; development of the IHC resources and Critical Thinking about Health Test. In this chapter, I briefly describe the process of establishing the standards for passing and mastery of IHC key concepts, a prospective meta-analysis, and qualitative evidence synthesis. In the third chapter, I present the methods used in the three papers included in this thesis. In chapter four, I present the findings of the three papers. In chapter five, I discuss the findings of the three papers and reflect on how subjectivity and context may have influenced this research. In the last chapter, I draw conclusions based on this research. The thesis ends with references and appendices.

II. Background

What is the problem?

We are constantly surrounded by health claims, some of which are unreliable. Our health depends on the choices we make, and good health choices depend on our ability to think critically about what to believe and do. Friends, family members, people with the same health condition, health professionals, sellers, and public officials all make health claims. The Internet, mass media, and social media are replete with advertisements and have increased the spread of health claims and unreliable evidence.[5,6] Our ability to appraise health claims and make informed health choices is therefore vital.

Beliefs about treatments and health services that we develop at an early age, often persist. While people start to make health decisions at a young age and frequently access the Internet for health-related matters[7], many lack the capacity to appraise health claims and can be misled by unreliable claims.[8–11]

While health promotion and interventions that target the public will tell people what to believe and do, the claims and advice compete with people's prior beliefs and misinformation.[12] Unfortunately, health professionals may have their own biases, may not effectively communicate reliable evidence to inform decisions about clinical and public health interventions, and may communicate unreliable evidence.[13] As noted by Marcia Angell: "It is simply no longer possible to believe much of the clinical research that is published, or to rely on the judgment of trusted physicians or authoritative medical guidelines. I take no pleasure in this conclusion, which I reached slowly and reluctantly over my two decades as editor of The New England Journal of Medicine." Similarly, Richard Horton, editor of The Lancet, wrote: "The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue. Afflicted by studies with small sample sizes, tiny effects, invalid exploratory analyses, and flagrant conflicts of interest, together with an obsession for pursuing fashionable trends of dubious importance, science has taken a turn towards darkness."

Challenges accessing reliable evidence,[14] and the inability of many people to understand and apply key concepts for making health choices informed by reliable evidence, can result in harm, wasted resources, and inefficient use of health services.

Critical thinking in health and education

Over the past few decades, there has been a focus in health education on critical thinking or "critical health literacy" as a subcomponent of health literacy (the ability to access, understand and use information to promote and maintain good health).[15] There is evidence that low health literacy is associated with poor health outcomes and use of health services,[16] and basic education is associated with improved health outcomes. For example, a recent systematic review found that if a mother had at least 12 years of education, the mortality of children ages under five was reduced by 31%, compared to mothers with no education.[17]

Similarly, over the past few decades, health professional education has focused on critical appraisal of research evidence (systematic examination of evidence to judge trustworthiness, value and relevance in a particular context) and evidence-based medicine (use of best available research in clinical care).[18]

Critical thinking has been advocated in education for over a century.[19] It is a key competence in many basic education curricula around the world,[20,21] and health is taught either as a subject or as a component of several other subjects. However, teaching critical thinking generally is not the same as teaching critical thinking specifically about health, and resources to teach critical thinking about health are lacking.[4] As noted by Sharples and colleagues, there are opportunities and a need for cross-sector collaboration between education and health to start developing skills for thinking critically about health in primary school.[4]

Frameworks for teaching critical thinking about health

There are several frameworks for teaching critical thinking.[22] As found in a systematic review of frameworks by Oxman and Martínez Garcia,[23] there are also several frameworks that are relevant for teaching critical thinking about health. These include the IHC framework,[24] which is the foundation of this PhD work.

Critical thinking frameworks include the taxonomy of critical thinking dispositions and abilities developed by Robert Ennis.[25] According to Ennis, critical thinking can help analyse important elements in deciding what to believe and do. Critical thinking should be characterised by assessing the certainty of sources, judging the argument thoroughly, and arriving at a conclusion with some reasons and assumptions.[26] Critical thinkers are inclined to believe and do what is right, to be clear and honest about their beliefs, and to consider others in their beliefs and actions.[27,28]

A second framework is Richard Paul's model of critical thinking.[29,30] For critical thinking to be taught in what he calls the "strong sense", Paul says one should focus on helping people to reflect on their self-deceptions, how they view issues (their world view), and dialectic reasoning.[31] He argues that critical thinking is a core need in life, given rapid changes in the world's dynamics and landscape that directly or indirectly affects our day-to-day decisions.[32]

In another framework, Diane Halpern lists critical thinking skills that would help college graduates to be better citizens.[33] The list includes verbal reasoning skills, argument analysis, hypothesis testing, using likelihood and uncertainty, decision making, and problem solving.

In a fourth critical thinking framework, "the model of a good thinker", Jonathan Baron proposed five phases of reflective thinking.[34–36] These include problem recognition, enumeration of possibilities, reasoning (search for evidence to support or not support the finding), revision (check the possibilities using the evidence), and evaluation (make a decision or evaluate to continue thinking).

All these frameworks agree that critical thinking skills encompasses the ability of a person to question an argument, to gather the best available evidence, and to arrive at a conclusion with sound reasons. Critical thinking is a concept emerged from the education field. While there is broad agreement that critical thinking should be taught at all levels, there is debate about whether it should be taught as a standalone subject or within subjects.[20–22,29,33,34,37,38] For example, critical thinking can be taught as a competence in the sciences, arts, or languages. Alternatively, it can be taught in standalone modules that focus on generic critical thinking skills. The IHC framework assumes that critical thinking must be taught in a specific context or field, but many key concepts and competencies can be applied across many different fields.[1]

Several frameworks related to evidence-based healthcare overlap with critical thinking frameworks. These include health literacy frameworks. There are many definitions and frameworks for health literacy.[39–45] One definition is the ability of an individual to access, understand, appraise, process, and use health information to improve or maintain good health.[15] Individuals can make decisions that help to maintain good health, but there are many social determinants of health.[12] Moreover, as noted by Squiers and colleagues, health literacy is influenced by moderators (prior knowledge, capabilities, and demographics), external influences, and mediators that impact the effect of health literacy on health outcomes.[39] Most health education programs that address health literacy focus on what Nutbeam calls functional health literacy, i.e. the ability to understand health information.[15] Few reported interventions directed at healthy (non-clinical) populations have focused on critical health literacy, i.e. the ability of an individual to access, understand and appraise health information to inform health decisions, which closely overlaps with critical thinking about health.[40,46]

Another evidence-based healthcare framework closely related to our work, is the set of core competences for evidence-based practice (EBP),[47] which targets health professionals. The aim of EBP is for health professionals to integrate the best available evidence, patient preferences, and values in healthcare decisions.[48] This framework's main competences are being able to understand what EBP and its rationale are, identify the preferred order of study designs for different types of questions, ask relevant questions, acquire evidence, appraise and interpret evidence, apply evidence, and evaluate one's practice.

A third framework related to evidence-based healthcare is the evidence to decision (EtD) framework[49–51], which aims to help people use evidence in a structured and transparent way to inform decisions in the context of clinical recommendations, coverage decisions, and health system or public health recommendations and decisions. The EtD framework provides a structure for formulating a question, assessing the evidence, and drawing conclusions, and includes explicit criteria for assessing evidence, the evidence used to inform judgements for each criterion, and explicit judgements for each criterion.

All of the above frameworks informed the development of the IHC Key Concepts framework,[2,23] which we used as the starting point for developing the IHC secondary school intervention. The IHC Key Concepts framework includes three sets of concepts that can help people assess claims about the effects of treatments and make informed health choices: 1. Concepts that can help you recognise when a claim about the effects of treatments has an untrustworthy basis; 2. Concepts that can help you recognise when evidence from comparisons (tests) of treatments is

trustworthy and when it is not; and 3. Concepts that can help you make well-informed choices about treatments. It also includes corresponding competencies and dispositions for making informed health choices. The framework's 49 key concepts are supported by evidence and logic.[2] Most of the concepts are relevant for decisions about other types of interventions, including agricultural, educational, environmental, management, nutritional, policing, and social welfare interventions.[1]

Adolescents and critical thinking about health

Adolescents and young people make up the largest segment of the world's population, in some countries far outnumbering other segments.[52,53] Adolescents increasingly engage with knowledge, experience, social norms, and resources which contribute to the shaping of individuals' health now and in the future.[54–56] Educational, technological, and health changes affect adolescents and their transition into adulthood, and investments in this age group will likely improve current and future health outcomes.[57] Although adolescents may have little or no independence in some choices, they are able to make decisions and choices on their own.[58] The increased social transitions, where families are no longer spending much of their time with their children, as well as exposure to the Internet and peer influence, will likely increase independent decisions, making the requirement for critical thinking skills to make good health choices more urgent. In addition, the Internet is increasingly becoming the major source of health information for people, including adolescents.[7] Furthermore, the low quality and bias in health reporting[6] pose additional threat to adolescents whose decisions are influenced by this potentially misleading information. With the increased availability of online information, much of which is unreliable, critical thinking skills and the ability to make informed health choices is becoming increasingly important.

Educational interventions for critical thinking about health

In a meta-analysis of evaluations of strategies for teaching students to think critically, Abrami and colleagues included 341 effect estimates.[38] They found both generic and specific strategies that are effective for teaching critical thinking skills at all educational levels and across subjects. Similarly, a systematic review by Cusack and colleagues found that educational interventions to improve people's understanding of key concepts for evaluating health intervention claims can improve their knowledge and skills, at least in the short term.[59] However, they found only 24 studies that met their inclusion criteria, 14 of which were randomised trials. Only three of the included studies were randomised trials of interventions in schools. One compared three types of leaflets for 9–11-year-old children in the UK. The other compared the effect of active learning in 7th graders in the USA. The third was a cluster-randomised trial of the IHC primary school intervention discussed below. An updated search in 2022 did not find any additional randomised trials. Another systematic review by Nordheim and colleagues found eight studies that evaluated the effects of school-based educational interventions for teaching students to critically appraise health claims.[60] The eight studies mostly reported positive short-term effects on knowledge and skills related to critical appraisal, but the certainty of evidence in the studies was very low.

Teaching strategies for critical thinking

Different teaching strategies for critical thinking skills have been evaluated.[38] To inform the design of the IHC secondary school intervention, Oxman and colleagues made an overview of systematic reviews of strategies to help primary and secondary school students learn to think critically.[61] They found 326 systematic reviews that met their inclusion criteria (unpublished work). They summarised 37 teaching strategies that they considered relevant to teach critical thinking about health.[62] Among those strategies, the certainty of evidence of the effects varied from very low to moderate. The strategies were grouped into seven categories, in addition to strategies for teacher training, and included didactic strategies (those in which the teacher presents the topic of learning), questioning and prompts (how the teacher asks questions to improve the learning process), assessment and feedback (assessing students' performance), individual learning, collaborative learning, games and role play, and problem-based and inquiry learning.

Rwanda's health and education context

Rwanda is situated in sub-Saharan Africa in the central eastern African region, bordering Uganda in the north, Burundi in the south, Tanzania in the east and the Democratic Republic of Congo in the west. With an area of 26,338 km^2 and a population of 13,246,394, it is one of the most densely populated nations in Africa.[63] Rwanda is subdivided into five provinces and 30 districts, with a central government, parliament, and judiciary. Implementation of government services is decentralised. The districts have primary responsibility, which is delegated hierarchically to the village level. The genocide against the Tutsi in 1994 destroyed the country's health, education and other societal structures, which have since been rebuilt.

The aim of the health sector is to ensure access to affordable and accessible quality health services, including preventive, curative, rehabilitative, and promotional services.[64] In the past 20 years, the country was overwhelmed with infectious diseases, claiming many lives and causing a burden of disease on the country. Management of infectious diseases, including HIV AIDS, was the primary focus, which resulted in significant improvements over the past three decades.[65,66] There has also been improvement in maternal and child health outcomes, including a reduction in child and maternal mortality, and an increase in skilled birth attendance.[67–69] These health benefits have been realised by improved healthcare coverage, health financing, community-based insurance, and human health resources.[70–73] As a result of healthcare investment and economic growth, life expectancy has increased from 54 years in 2002 to 69 years in 2022.[74] However, the country is currently facing a rapid epidemiological transition from communicable diseases to non-communicable diseases and mental health disorders. Social determinants of health, including gender-based violence, teenage pregnancy, and other sexual and reproductive health challenges, are also becoming more prominent.[75–79]

The Ministry of Education (MoE) is the policy making and supervisory authority of education at all levels in Rwanda. The implementation agencies of the MoE are the Rwanda Basic Education Board (REB) and the National Examination and School Inspection Authority (NESA), which are responsible for basic education in Rwanda. The basic education system is organised into pre-

primary education (three years), primary education (six years), and secondary education (six years). After lower secondary education, students can join vocational training or continue in ordinary secondary schools. Education is one of Rwanda's largest sectors. The government has invested heavily in education, and the education sector has steadily improved over the past three decades. The most recent Rwandan population and housing census indicated that 79% (6.5 million people) could read and write. Primary school net attendance was 89.3% and net attendance in secondary school was 22.3%.[63] By 2021, Rwanda had 4,033,047 students overall, of whom 782,846 in secondary school and 521,631 in the lower secondary segment.[80] Secondary education follows a competence-based curriculum, in which students cover nine subjects.[81] All subjects cover generic competences, including critical thinking, research and problem solving, creativity and innovation, communication, co-operation, interpersonal relations, life skills, and lifelong learning.

The Informed Health Choice network and what this thesis adds

The IHC Key Concepts framework was developed by the IHC network in 2013, as the starting point for developing and evaluating the IHC primary school intervention and a podcast for parents of primary school children. Twelve concepts were prioritised for the primary school intervention and nine for the podcast.[82,83]The primary school intervention was evaluated in a cluster-randomised trial in Uganda, which found a large effect that was sustained for at least one year.[84,85] A process evaluation conducted alongside the trial found that participants liked the resources and felt that the content was important. This, together with the children's enthusiasm for the lessons, motivated teachers. The main barrier to scaling up use of the resources identified in the process evaluation, was that the lessons were not incorporated into the national curriculum. The IHC network has translated, user-tested, piloted, and contextualised the primary school resources in at least 12 other countries, including Rwanda.[86,87] The primary school work demonstrated that it was possible to develop resources that were effective and that were found to be useful and valuable in multiple contexts.[84] However, it is uncertain to which extent primary school children were able to apply the concepts in their daily life. Also, the potential to scale up use of the resources is impeded both by the challenge of introducing new material into already overpacked curricula and the cost of printing the resources, which included a textbook in comic book format, an exercise book, and a teachers' guide.[88]

This thesis builds on lessons learned in the IHC primary school project. It is part of a larger project to develop low-cost, scalable digital resources for secondary schools and to rigorously evaluate the intervention in Kenya, Rwanda, and Uganda. I have had primary responsibility for the work in Rwanda, including:

- Engaging Rwandan stakeholders in the development and evaluation of the resources,[89]
- Exploring the context for using digital technology to teach critical thinking about health in Rwandan secondary schools,[9]
- Helping to prioritise the key concepts that should be taught to secondary school students in Rwanda, Kenya, and Uganda,[90]
- Helping to develop digital secondary school resources, using human-centred design,[91]
- Developing and validating a test to measure the effectiveness of the IHC secondary school intervention,[92]

- Conducting a cluster-randomised trial of the IHC secondary school intervention in Rwanda,[93]
- Contributing to a meta-analysis of the three trials of the intervention (in Kenya, Rwanda, and Uganda),[94]
- Conducting a process evaluation in Rwanda,
- Contributing to a qualitative evidence synthesis of the three process evaluations,
- Conducting a one-year follow-up of students who participated in the trial, and
- Contributing to a meta-analysis of the one-year follow-up in three countries.

This thesis consists of three of the above contributions: the context analysis, the randomised trial, and the process evaluation. In the following sections, I will briefly summarise the other work noted above and two additional studies that contributed to the development and evaluation of the IHC secondary school intervention.

Engaging stakeholders

I engaged stakeholders from Rwanda in each of the steps I took in the design, pilot and evaluation of the Informed Health Choices in secondary schools. I first mapped different stakeholders working in health and education in both public, private and non-governmental institutions. I sought collaboration with the Ministry of Health and the Ministry of Education, and each institution provided a focal person who worked closely with us in all stages of the project. These focal persons formed a national advisory committee, which met occasionally to advise on project matters.

Through Rwanda Basic Education Board, I formed a teachers network and a students network. Both networks included teachers and students from schools with different locations and academic performance characteristics. Through the networks, I engaged teachers and students in regular quarterly meetings. In addition, I sought regular feedback from a few teachers and students in the design, pilot and evaluation of the IHC secondary school intervention. With our colleagues in the IHC project, I prespecified the level of engagement and how to measure successful engagement of stakeholders, following a prespecified published protocol.[89]

Prioritising key concepts

My colleagues and I engaged national curriculum teams in Kenya, Rwanda, and Uganda to prioritise key concepts to teach to students. The concepts we prioritised informed the content of the IHC secondary school resources and the Critical Thinking about Health Test. We prioritised concepts that could be easily understood by students and were relevant and applicable in students' contexts. Lastly, we ordered the concepts and determined the chronology of which concept should be taught first, and which should follow. The details of this consensus study is reported in details elsewhere.[90]

Developing the IHC secondary school resources

To design the intervention, we employed human-centred design with three iterations. In each iteration, we generated ideas, made prototypes, collected feedback through user testing or piloting of the prototypes, and analysed the data, as illustrated in Figure 1.

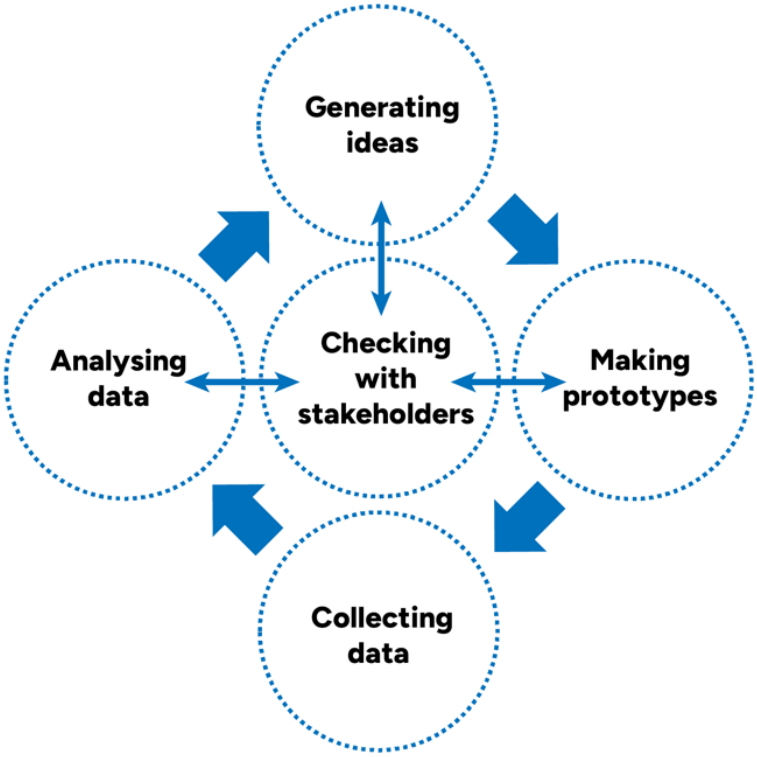


Figure 1: *Single development cycle*

In the first iteration, we developed prototypes of the first few lessons as PDFs or PowerPoint presentations. We user-tested those lessons with a few individuals and collected feedback. In the second iteration, we designed a full set of resources on a website. The resources were in three formats: computer-based lessons, projector-based lessons, and blackboard-based lessons. After piloting the full set of lessons in a classroom setting, it was evident that computer-based lessons would not be implemented in Rwanda, as it required time and resources to prepare the computer lab for each lesson, and as students were distracted by the computers. For these reasons, teachers clearly preferred the projector-based lessons. In the last iteration, we developed a set of 10 lessons in blackboard- and projector-based formats. This version was piloted in schools in a single term. Based on the feedback from stakeholders, we arrived at the final version of the resources. The lesson goals for the 10 lessons and the prioritised key concepts are shown in Table 1.

Table 1*: Outline of the lessons, learning goals, and the underlying prioritised key concepts*

#	*Title of the lesson*	*Lesson goals*	*Prioritised key concepts*
		THINKING CRITICALLY ABOUT CLAIMS	
1	**Health actions**	- Identify health actions - Explain why it is important to think critically about health actions	• Health actions can have helpful effects, but they can also have harmful effects and be expensive. • The effects of most health actions are not obvious, especially changes that do not occur right after the health action. • Usually, personal experience (something that happened to someone after taking a health action) is a weak basis for claims about the effects of health actions. • Health actions that have not been evaluated in a reliable comparison but are commonly used or have been used for a long time are often assumed to work. However, they might not work and might be harmful or wasteful. • Health actions that have not been evaluated in a reliable comparison but are new, expensive, or technologically impressive are often assumed to work. However, they also might not work and might be harmful or wasteful. • Knowledge about the effects of health actions depends on comparisons.
2	**Health claims**	- Identify claims about the effects of health actions	
3	**Unreliable claims**	- Identify claims about the effects of health actions that are only based on personal experiences, how commonly used something is, or how new or expensive something is - Explain why most such claims are unreliable	
4	**Reliable claims**	- Explain why knowledge about the effects of health actions depends on comparisons - Explain why we need researchers to make the comparisons	
5	**Using what we learned (1)**	- Remember what they learned in Lessons 1 to 4 - Use what they learned in these lessons in their daily lives - Recognise limits to what they have learned	
		THINKING CRITICALLY ABOUT COMPARISONS	
6	**Randomly created groups**	- Explain why groups of people in a comparison should be similar at the start	• In a comparison between health actions, important differences (other than the health actions) between comparison groups can be misleading. Randomly creating groups ensures that groups of people are as similar as possible at the start of a comparison and avoids unknown differences. • If a comparison between health actions is too small, we cannot be sure that the results reflect a true difference (or lack of difference) between the effects of the different health actions. The results could just be accidental.
7	**Large-enough groups**	- Explain what it means for comparisons between health actions that groups are large enough.	
		MAKING SMART CHOICES	
8	**Personal choices**	- Identify advantages and disadvantages of health actions for individuals	• People making a choice about whether to take a health action should consider the potential

#	*Title of the lesson*	*Lesson goals*	*Prioritised key concepts*
9	**Community choices**	- Identify advantages and disadvantages of health actions for communities	benefits and potential harms, costs, and other advantages and disadvantages. People making a community choice should also consider who will benefit, who will be harmed, who will achieve savings, and who will bear the costs.
10	**Using what we learned (2)**	- Remember what they learned in Lessons 1 to 9 - Use what they learned in these lessons in their daily lives - Recognise limits to what they have learned	

Development of the Critical Thinking about Health Test

Based on the prioritised key concepts,[95] we selected questions from the Claim evaluation tool item bank.[96] For each concept covered in the IHC secondary school resources, we picked three questions and formed a questionnaire. In addition, we included three questions that assessed intended behaviours, and four questions that assessed self-efficacy. The behaviour and self-efficacy questions had Likert response options.

We conducted cognitive interviews among students, teachers, and members of the public in Kenya, Rwanda, and Uganda. We aimed to ensure that the students and teachers would be able to read and understand the questions and that there were no linguistic, terminology, or format barriers. We then conducted a Rasch analysis to assess the validity and reliability of the test.[92]

The final questionnaire included the two multiple choice questions for each of the nine key concepts. Each question comprised a scenario with a claim, comparison, or choice, a question about the scenario, and three response options (Figure 2). The test also included questions about English reading proficiency, intended behaviours, and self-efficacy.

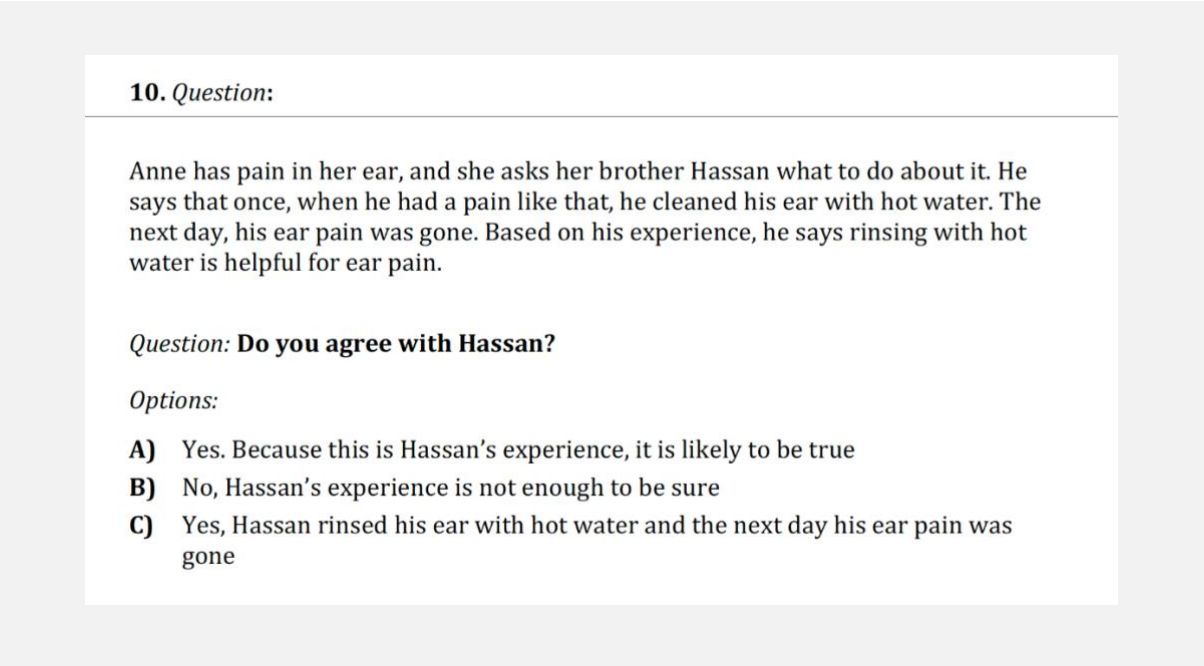


***Figure 2**: Example of a question in the outcome assessment tool*

Establishing a standard for passing and mastery

Having prioritised key concepts and developed the Critical Thinking about Health Test, the IHC team established a cutting score for passing and mastering key concepts covered in the IHC secondary school resources.[97] A multidisciplinary team of researchers and teachers from East Africa and Norway determined which minimum score indicated students' basic understanding of the key concepts and ability to apply them (passing score). In addition, the team determined which score indicated a mastery of the key concepts covered in the resources. The absolute standard score, i.e. the minimum passing score, in the Critical Thinking about Health Test, was determined to where a participant answered nine out of 18 questions correctly. In addition, answering 14 out of 18 questions correctly indicated mastery of key concepts covered in the IHC resources.

Meta-analyses

With my colleagues, I planned a prospective meta-analysis of three cluster-randomised trials of an intervention designed to teach lower secondary school students in Rwanda, Kenya and Uganda.[94] We measured the effect of the intervention on students and teachers. In the three trials included in this meta-analysis, 244 schools with 11,344 students participated in trials. The intervention had a large effect on students' and teachers' ability to think critically about health choices.

Qualitative evidence syntheses

We conducted three process evaluations alongside each of the three trials that assessed the effect of the IHC intervention in Rwanda, Kenya and Uganda. In future, we plan to conduct a qualitative evidence synthesis to explore how the intervention was delivered, and factors that may affect the effective delivery and scaling up of the intervention. Furthermore, we will explore participants' and investigators' experience of potential benefits of the intervention.

Aim and objectives of the thesis

Aim

The aim of this PhD thesis was to develop and evaluate the IHC secondary school intervention in Rwanda.

Specific objectives

1. In a context analysis, to assess the Rwandan context in which the IHC digital secondary school resources were to be used and inform the development of the resources.
2. In a randomised trial, to evaluate the effects of the IHC secondary school intervention.
3. In a process evaluation, to explore the implementation, impacts, factors affecting effective delivery, and factors potentially affecting scaling up the intervention.

III. Methods

The methods used for each of the main papers in this thesis are described in this chapter.

Context analysis (Paper I)

In this context analysis,[9] I used a qualitative descriptive method to explore how teaching critical thinking about health could be done in Rwandan secondary schools.[98] This method was appropriate because most of the data we collected were factual. I used document analysis, observations, focus group discussions, and key informant interviews. My objectives were to explore:

1. Demand for learning resources that teach critical thinking about health in Rwanda,
2. The extent to which the IHC key concepts fit or relate to the curriculum in Rwanda, and
3. The ICT conditions in secondary schools and how they are used in teaching and learning in Rwanda.

Sampling and selection of participants
I reviewed curriculum documents, learning resources, and ICT policy and implementation plans. I limited myself to the curriculum used in basic secondary learning resources approved by the Rwanda Basic Education Board. In total we reviewed 29 documents.

In addition, I interviewed students and teachers selected from five schools using convenience sampling. I selected schools which varied in terms of school location (urban/rural), ownership (private/public), equipment, performance on national exams, and whether they were day or boarding schools. Due to time and budget constraints, I limited myself to five schools, and I found little variation, because the central government supports and equips all schools similarly. With support of the school administration in each school, I selected 10 students, varying by sex and age, and two to three teachers, focusing on science, language, and ICT teachers. Using purposive sampling, I selected eight policy makers working in the curriculum development and ICT departments of the Rwanda Basic Education Board.

Data collection
Document analysis
I explored the curriculum used in basic education, focusing on the lower secondary school curriculum. I explored the learning resources (books, prints and e-learning resources) approved for use at lower secondary levels. For any health topic or subject, I compared the content covered by the resources and how critical thinking is taught in those topics, to the higher-level concepts and corresponding competences in the IHC Key Concepts framework (Table 2). I reviewed the policies, documents, and guidelines for ICT use in education, focusing on lower secondary levels and the implementation and use of e-learning resources.

***Table 2**: IHC concept and competences that formed a framework for document analysis*

No	*IHC higher-level concepts for critical thinking about treatments*	*Competence*
1	**Claims concepts**	
1.1	It should not be assumed that treatments are safe or effective – or that they are not.	*Recognise when a claim has an untrustworthy basis*
1.2	Seemingly logical assumptions are not a sufficient basis for claims.	
1.3	Trust in a source alone is not a sufficient basis for believing a claim.	
2	**Comparison concepts**	
2.1	Comparisons of treatments should be fair.	*Recognise when evidence used to support a treatment claim is trustworthy or untrustworthy*
2.2	Syntheses of studies need to be reliable.	
2.3	Descriptions should clearly reflect the size of effects and the risk of being misled by the play of chance.	
3	**Choices concepts**	
3.1	Problems and options should be clear.	*Make well-informed decisions about treatments*
3.2	Evidence should be relevant.	
3.3	Expected advantages should outweigh expected disadvantages.	

Key informant interviews, focus group discussions, and observations

I conducted key informant interviews with curriculum development and ICT policy makers, teachers, and school staff. Informed by what we found in the document analysis, I explored how critical thinking about health is taught and how teachers perceived and experienced teaching critical thinking and health topics. I also explored how they used ICT for teaching and learning.

I conducted focus group discussions with lower secondary school students. I explored with them how they acquire health information, and their basis for deciding what to believe and do. My particular attention was on decisions related to treatment claims. I explored how students were exposed to health claims, particularly treatment claims, and how they deal with misinformation. I explored students' interest in learning critical thinking about health, and how they used ICT for learning in schools.

I made school visits and observed the ICT infrastructure and its use for teaching and learning. I observed ongoing class where possible. My focus was on the equipment, rooms, Internet access, and use of ICT for learning.

Data analysis

I used the framework analysis method.[99] This method was appropriate because it helped to analyse data deductively, using the pre-set objectives, and to analyse, classify, and summarise data in a thematic framework.[100,101] The initial thematic framework was the study objectives (demand for learning resources to teach critical thinking about health, links between critical thinking framework and the curriculum, and current and expected ICT conditions in secondary schools). Informed by the data, I derived the subthemes under each main theme above. Another

researcher and I coded the data independently and discussed our initial findings by comparing how we each thought about the codes and subthemes.

Assessing confidence in findings

I used the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) Confidence in the Evidence from Reviews of Qualitative Research (GRADE-CERQual) approach to assess the confidence of our findings.[102] GRADE-CERQual is used primarily for qualitative evidence syntheses and was modified for use in a single study using multiple methods. GRADE-CERQual is a systematic and transparent method with four components:

- Methodological limitations – the extent to which there are concerns about the sampling and collection of the data that contributed evidence to an individual finding;
- Data adequacy – an overall determination of the degree of richness and quantity of data supporting a finding;
- Coherence – an assessment of how clear and compelling the fit is between the data and the finding that brings together these data; and
- Relevance – the extent to which the body of evidence supporting a finding is applicable to the context, e.g perspective or population, phenomenon of interest, and setting.103,104

Another researcher and I conducted the CERQual assessment. For each finding, we identified any concerns related to each of the four components. We assumed "high confidence" for each finding and downgraded the confidence to moderate, low, or very low when there were concerns.

Evaluation of the effects of the IHC secondary school intervention (Paper II)

Design

I used a two-arm cluster randomised trial to evaluate the effect of the informed health choices secondary school intervention on the ability of students to think critically about health.[93] I described the methods in a pre-published protocol, and there were no deviations from the protocol.[105]

Setting and participants

This study was conducted in 10 among Rwanda's 30 districts, based on random selection of two districts from each of the country's five provinces. A district is one of the main decentralised units of Rwanda, and is responsible for basic education, with technical oversight from the Rwanda Basic Education Board (REB) and the National Examination and School Inspection Authority (NESA). The study was conducted in public, government-aided, and private lower secondary schools in the 10 districts. Only schools that teach using the national curriculum were included. The inclusion and exclusion criteria for schools, students, and teachers are summarised in Table 3.

Table 3: *Inclusion and exclusion criteria for the randomised trial*

	Inclusion criteria	**Exclusion criteria**
Schools	• Publicly funded, privately funded, or government-aided school • Schools with electricity • Schools using the national competence-based curriculum • Schools with a lower secondary school section • Schools with computers and an Internet connection • Schools with over 100 students • Schools with over 10 teachers	• Schools that participated in the user testing and pilot of the digital resources • International schools • Schools that provide special needs education • Schools that are geographically hard to reach
Students	Senior-two (S2) students	S2 students who opt not to attend the lessons
Teachers	• Teachers teaching one of the following subjects: biology and health sciences, physics, chemistry, or mathematics • Teachers who have access to a smartphone or computer	• Teachers who do not provide informed consent

Sampling

I used multistage cluster sampling to select schools, where the school was the cluster. Using the list obtained from the REB and NESA, I randomly selected two districts from each of the five Rwandan provinces. I visited each district and cross-checked the REB list with updates from the district. Using a list of eligible schools, I randomly selected 84 schools from the 10 districts

(figure 2). I stratified the schools by their performance (low versus high performance as defined by NESA) and the sample was proportionate to the number of schools in each district. With support of each school director in each selected school, I selected one class from senior two level and one science teacher. Students in each selected class were included in the study.

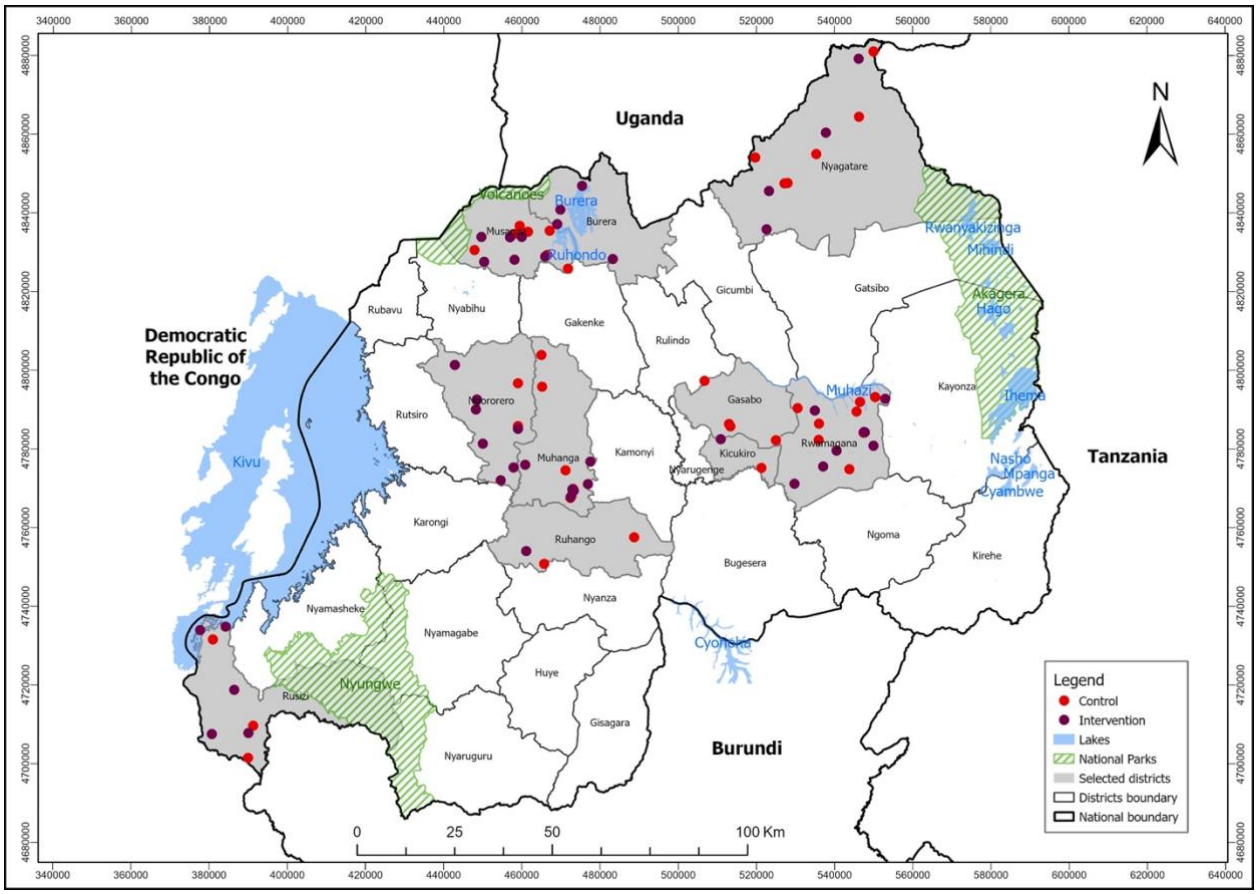


Figure 3: *Map of Rwanda indicating 84 selected schools from 10 districts*

Sample size calculation

I powered the trial for the primary outcome using the University of Aberdeen Health Services Research Unit's Cluster Sample Size Calculator.[106] I used the following assumptions: 39 students per cluster (one class in each school) based on education statistics,[107] an intraclass correlation of 0.19 and 30% of students achieving a passing score in the control arm, based on the IHC primary school trial,[108] a minimally important difference of 20% based on at least 50% of students in the intervention arm having a passing score, an alpha of 1%, power of 90%, and a maximum 10% loss to follow up (schools where it would not be possible to administer the test). Based on these assumptions, I estimated the need for a sample size of 84 schools.

Study procedures

Random allocation and masking

We used a computer-generated sequence to allocate schools (clusters) in a 1:1 ratio to the intervention or control arm. We used block randomisation to balance for school performance, with block sizes of six and four, and equal numbers in each arm. A statistician who was not

involved in the recruitment of schools or the analysis of data, conducted the allocation. I did not change the list after random allocation by the statistician. I did not mask the trial participants or investigators.

Intervention delivery
The intervention included a three-day teacher training workshop for teachers in the intervention arm and the digital educational resources. The educational resources included ten lessons in two versions (blackboard and projector versions) and a teachers' guide. They were accessed and downloaded via web browser from https://besmarthealth.org/.

Each intervention school planned how to deliver the lessons in one school term, and one teacher in each school taught all 10 lessons. Each lesson was intended to take 40 minutes (one period). Teachers were free to extend the lesson time or modify the lesson plans to achieve the lesson goals.

Teachers in the control arm continued with the usual curriculum without any additional training or educational resources. We introduced them to the trial in a meeting to recruit schools. Teachers in both the control and intervention arms of the trial continued with the standard competence-based curriculum. The curriculum includes nine subjects and key generic competences that are taught across subjects, including critical thinking.

Data collection
At the end of the term in which the intervention was delivered, students and teachers in the intervention and control arms completed the Critical Thinking about Health Test. The test was administered by trained research assistants from the University of Rwanda School of Public Health within one to two weeks after the intervention was delivered. Each research assistant had a questionnaire and answer sheet for each student and teacher, and a unique code was assigned to each participant. The research assistant supervised the test and ensured that students answered the questions independently. After the test, the research assistant scanned the answer sheet. The data were kept at the University of Rwanda School of Public Health.

Outcomes measures
The primary outcome was a passing score (≥ 9 out of 18 questions answered correctly) for students on the Critical Thinking about Health Test. Secondary outcomes were: a passing score for teachers, a mastery score (≥14 out of 18) for students and teachers, student and teacher scores on the test (percent of correct answers for the 18 multiple choice questions), answering both questions correctly for each of the nine concepts (students only), and measures of intended behaviours and self-efficacy.

Statistical analysis
We used the intention-to-treat analysis principle (all students and teachers who completed the test were included and analysed in the arms to which they were allocated). We used the adjusted odds ratios and differences in means in the analysis for binomial and continuous outcomes, respectively. We estimated adjusted odds ratios using mixed effects logistic regression, and adjusted differences in means using mixed effects linear regression, and reported the 95% confidence intervals and two-sided p-values. We accounted for the cluster-randomised design

using random intercepts at the level of school (the unit of randomisation) for student-level outcome measure. We did not account for clustering for outcomes measured in teachers because there was a one-to-one relationship between teachers and schools. We adjusted for the variable used in the stratified random allocation (low versus high school performance) in all of the analyses.

We did two pre-specified sub-group analyses. We estimated the treatment effect on the primary outcome in higher- versus lower-performing schools, and based on English reading proficiency (advanced, basic, and lacking). For intended behaviours and self-efficacy questions, we estimated the adjusted odds ratios comparing dichotomized responses (e.g. very unlikely or unlikely, versus very likely or likely). A statistician performed all the statistical analyses using Stata 16 (StataCorp LLC, College Station, Texas, USA).

Process evaluation (Paper III)

I aimed to evaluate the implementation, perceived effects, and factors affecting effective delivery and scale-up of the IHC secondary school intervention in Rwanda.

Objectives:

1. To evaluate the extent to which the intervention was delivered as intended
2. To explore effects of the intervention as perceived by the participants
3. To explore factors affecting the effective delivery and potentially affecting scale-up of the intervention

Methods

I used mixed methods (quantitative and qualitative) in a process evaluation alongside a parallel two-arm cluster randomised trial. For quantitative methods, I collected and analysed descriptive data from teachers' feedback on the training workshop and lesson evaluations collected after each lesson. For qualitative methods, I conducted non-participatory observations of lessons, key informant interviews, and focus group discussions (FGDs) with teachers, students, parents, and other stakeholders.

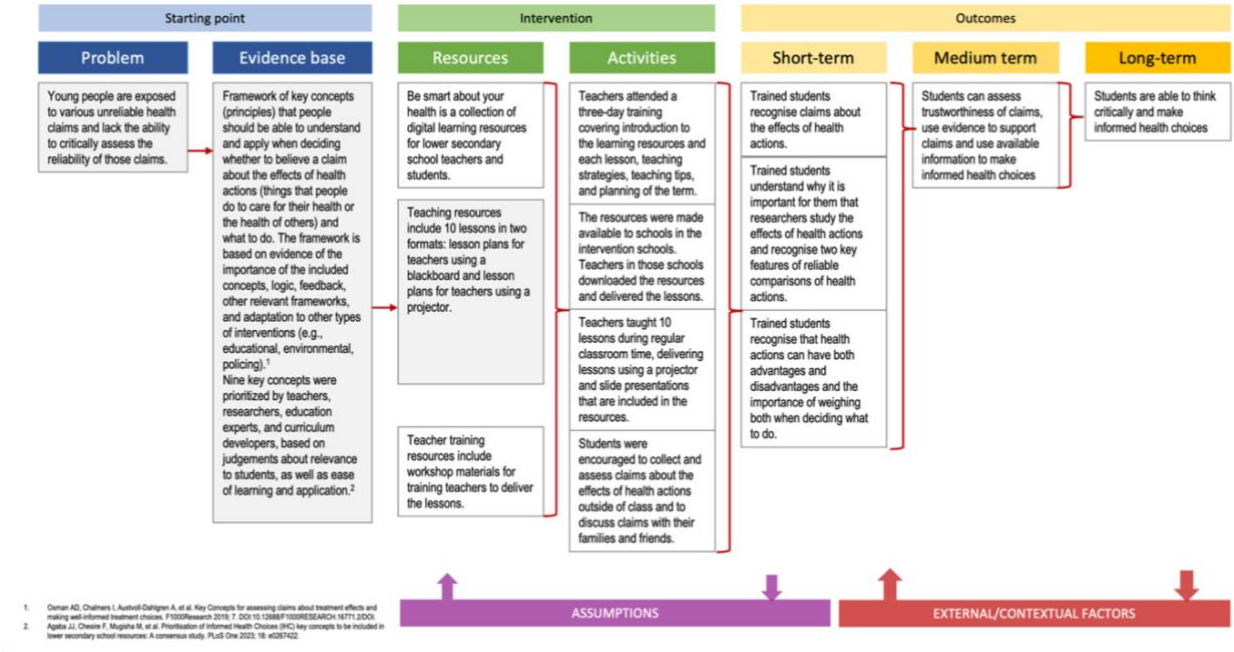
Study setting and participants.

The process evaluation was conducted in 42 schools randomly assigned to the intervention arm of the trial described in paper II. All schools were lower secondary level and each school enrolled one year-two class and one teacher in the trial. Each school in the intervention arm planned to teach the ten lessons in one term (12 weeks). All the teachers planned to use the projector-based version of the lessons and were free to adapt the teaching plan or extend the time for each lesson, and to switch to the blackboard version of a lesson when necessary.

The study participants included students, their science teachers, and school administrators from schools in the intervention arm of the trial. I included parents of students who participated in the trial and policy makers familiar with the implementation of the trial. Students were recruited through teachers who delivered the intervention.

Logic model

I developed a logic model to describe our problem, evidence, inputs, outputs, and outcomes (short term, medium term, and long term). The problem was that young people encounter health claims and lack skills to help them think critically about those claims. Learning concepts in the IHC Key Concepts framework can improve students' ability to assess health claims and make informed health choices. We developed the educational resources to teach nine such concepts to lower secondary school students. The resources include 10 lesson plans and training materials for teachers. The teachers received training at a three-day workshop, after which they taught the 10 lessons. Students were encouraged to collect and assess claims about the effects of treatments. The main outcomes of interest were, in the short term for students to have knowledge and understanding of the key concepts taught, in the medium term for them to be able to apply what they learned, and in the long term for them to be able to think critically and make informed health choices. The Logic model and corresponding assumptions for the IHC secondary school intervention in Rwanda are shown in Figure 4.



ASSUMPTIONS	EXTERNAL/CONTEXTUAL FACTORS
1. Lessons developed are useful and fit for the context.	1. ICT factors (computers, projectors, internet) and their use for teaching and learning
2. Teacher training enables them to deliver the intervention as intended.	2. School administration support (avail class, dedicate time, support teacher in lesson delivery)
3. Teachers can teach lessons with support of the lesson plan.	3. National curriculum and demand for the teaching critical thinking skills
4. Students participate fully in learning the resources.	4. Educational leaders at the district and national level support the intervention delivery.
5. Schools are willing to dedicate time and resources for learning the content.	5. Parents and home members discuss the content of the intervention with students.

***Figure 4**: Logic model for teaching critical thinking about health*

Data collection

The methods, timing, sources, sampling, process, and tools used to collect data are summarised in Table 4.

***Table 4**: Data collection for the process evaluation*

Method *and timing*	Source and sampling	Data collection process and tools
Workshop evaluation to assess teachers' perceptions of the	All teachers from the intervention arm who attended the training (n=42)	Teachers completed an online questionnaire with 5-point Likert response options that assessed the quality of the

training they received ***(immediately after the teacher training workshop)***		training, the extent to which training goals were achieved, and their readiness to deliver the intervention as intended.
Lesson evaluations to assess the delivery of each lesson ***(immediately after each lesson)***	All teachers in the intervention arm (n=42) for each of the ten lessons.	Teachers completed an online lessons evaluation form, describing how they prepared for and taught the lesson, and the extent to which the lesson objectives were achieved.
Non-participatory observation of lessons to observe how the lessons were taught ***(during intervention delivery)***	In schools from the intervention arm (n=16) that were purposively sampled to ensure variation in ownership (private, public, or government-aided) and performance (high or low), as defined by the National Examination and School Inspection Authority (NESA). We observed all the lessons (1-10) at least once.	We sat in classes during lesson delivery and used a structured observation form to note how the lesson was taught. We recorded how the teacher delivered the lesson and how students responded.
Key informant interviews to explore how participants experienced the intervention ***(after intervention delivery)***	We purposively sampled teachers (n=10) from schools that varied by type (day or boarding), ownership (private, public, or government-aided) and performance (high or low). In each school, we selected the head teachers or director of studies (n=10). We selected policy makers from the Rwanda Basic Education Board who had experience with the development and implementation of the intervention (n=2).	We used semi-structured interview guides to conduct the interviews. We interviewed participants at their workplace in a place of their convenience to ensure privacy and quality recording of discussions. Each interview lasted for an hour to an hour and a half. Two researchers conducted each interview. One person led the discussion, and another took notes and recorded the discussion. We transcribed verbatim all the recordings, and translated to English if the interview was conducted in Kinyarwanda.
Focus group discussions to explore how students and their parents or caregivers experienced the intervention ***(after intervention delivery)***	We purposively sampled schools as described above for key informant interviews. In each of the ten schools, we conducted one focus group for students (n=10 FGDs). Students varied in terms of age, sex, and performance. Each FGD included 8–10 students. For parents, we focused on five of the 10 selected schools which were day schools. In those schools we used purposive sampling to select the parents who were invited to the FGDs. We invited parents who had had discussions with their children on the intervention. Each FGD included 8–10 parents.	We used semi-structured FGD guides to conduct discussions with students and their parents, respectively. The discussions were held at the students' school, in a room where no teachers or school authorities were present. For all FGDs, one researcher moderated and another took notes and recorded the discussion. The duration of each FGD was an hour to an hour and a half. We transcribed verbatim all recordings and translated to English.

Data analysis

We analysed the data in relation to each study objective.

For the first objective, to explore to which extent the intervention was delivered as intended, we collected quantitative and qualitative data. For the quantitative data, I calculated frequencies, percentages, means, and standard deviations. For the qualitative data, a research assistant and I read all the notes and transcripts to familiarise ourselves with the data. We then coded all data

inductively, deriving initial codes from the notes. Using a thematic analysis approach, we then summarised themes and sub-themes that emerged from the data.

For the second objective, we analysed perceived effects in the same way as for the qualitative data related to objective one. We began by coding the data inductively, and then summarised themes and sub-themes that emerged from the data. For perceived adverse effects, which are reported separately in a qualitative evidence synthesis of the three process evaluations from Kenya, Rwanda, and Uganda, we used framework analysis.[109] We deductively coded and summarised findings using a framework that we developed for potential adverse effects.[110]

For the last objective, we used framework analysis[111] to analyse factors affecting effective delivery and scale-up of the intervention. We used the "Framework for factors that could affect the implementation, impact, and scaling up of the school resources" from the process evaluation of the IHC primary school intervention.[112] We read all notes and transcripts to familiarise ourselves with the data. Before coding, I coded two transcripts for review by another researcher. Any disagreements were discussed and agreed upon. Using the Atlas ti. software to assist with coding, we then indexed all the data using the framework and rearranged them within and across the themes (charting). We mapped the findings from different participants and interpreted them. We then summarised our findings under categories of the framework. We grouped our findings under the main categories of factors affecting implementation and factors affecting scaling up the IHC secondary school intervention.

Assessing confidence in the findings of the process evaluation

We assessed confidence in the main findings using a version of GRADE-CERQual, as described in detail in the methods section of Paper I.

Ethical considerations

We obtained ethics approval for the project from the Rwanda National Ethics Committee (RNEC) (approval No. 691/RNEC/2019), with subsequent annual renewal and amendment in 2020 (No. 1019/RNEC/2020) and 2022 (No. 41/RNEC/2022 and No. 231/RNEC/2022). The approval included the consent and assent forms for the research participants. We explained to the participants the study aim, objectives, benefits, and harms that may result from participation. We obtained all consents before data collection.

IV. Results

Context analysis (Paper I)

Demand for learning resources to teach critical thinking about health in Rwanda

Students' needs to learn critical thinking about health

In the focus group discussions with students, we found that they were exposed to claims about treatments from their peers and family members and that they seek health-related information from their friends and others through the Internet. Students held beliefs about some common treatments that others in their communities believed were effective. They recognised that critical thinking skills could help them to think critically about health and they were unsure about how to learn such skills. They also recognised that critical thinking skills would help them to be more confident about their treatment choices.

> *"You can ask elders, your parents, your elder brothers/sisters, neighbours, and you know what they used which healed them quickly or you do research on Google."* ***14-year-old student***

> *"… when you are sick with flu or cough, you take ginger and lemon, you boil them, then you mix with honey."* ***13-year-old student***

Teachers' needs for resources to teach critical thinking about health

Teachers' understanding of critical thinking, and how they could help students develop such skills, varied. Some teachers thought they could help students develop critical thinking skills by helping them to reflect on what was covered in class through students' discussions. Others thought they could do this by helping students search for further information through the library or the Internet. Others thought they could help students learn critical thinking skills by helping them connect what they learned in school with what they saw in the community.

Curriculum developers believed that teachers lacked skills to help their students develop critical thinking skills in general, and critical thinking about health specifically. They identified three reasons for this. First, most teachers were trained in a knowledge-based curriculum. Second, teachers had diverse understandings of what critical thinking skills are and how they should be developed in students. Third, there were no resources to help them develop critical thinking in general, or critical thinking about health specifically.

> *"We give them health topics to search on the Internet or in books. They discuss in class and present [what they find] during debates."* ***English teacher***

> *"For example, we teach infectious and non-infectious diseases. We can ask them [about] some diseases they see at home, we ask a nurse to explain these diseases, so they think beyond class and get understanding of what infectious diseases are."* ***Biology and health sciences teacher***

> *"Critical thinking is reflected in the curriculum but teaching it is still problematic, because teachers' understanding of critical thinking varies and some don't even understand it. Yes, you*

need to develop critical thinking, but how do you do it and what materials do you use? Which books do you use? You see it is a problem." ***Policy maker***

Demand for critical thinking in the curriculum and subjects taught in lower secondary schools

In 2016, Rwandan basic education shifted from a knowledge-based curriculum to a competence-based curriculum with specific competences that must be developed and nurtured in all subjects taught in basic education. The competences most relevant to our work were critical thinking and research and problem-solving skills. The curriculum requires that textbooks and learning resources must be made available to teachers and students to ensure that these skills are developed.

> *"**Critical thinking descriptors:** Think reflectively, broadly, and logically about challenges encountered in all situations. Weigh up evidence and make appropriate decisions based on experience and relevant learning. Think imaginatively and evaluate ideas in a meaningful way before arriving at a conclusion. Explore and evaluate alternative explanations to those presented by others."* ***Rwanda competence-based framework.***
>
> ***"Research and problem-solving descriptors:** Be resourceful in finding answers to questions and solutions to problems. Produce new knowledge based on research of existing information and*
> *concepts and sound judgment in developing viable solutions. Explain phenomena based on findings from information gathered or provided"* ***Rwanda competence-based framework.***

Of the 14 subjects taught in lower secondary school, three subjects include health topics (biology and health sciences, home sciences and English). The included health topics are sexual and reproductive health, infectious and non-infectious diseases, food and nutrition.

In general, science subjects (mathematics, physics, chemistry, and biology and health sciences) develop competences such as critical thinking in relation to the subject, including competences related to those in the IHC Key Concepts framework (Table 5).

***Table 5**: Links between the Rwandan lower secondary school curriculum and concepts and competences in the Informed Health Choices Key Concepts framework*

IHC competences	Corresponding IHC concept categories and sub-categories	Competences in the biology (B), chemistry (C) and mathematics (M) curricula
Recognise when a claim has an untrustworthy basis	**Claims** - It should not be assumed that treatments are safe or effective – or that they are not. - Seemingly logical assumptions are not a sufficient basis for claims. - Trust in a source alone is not a sufficient basis for believing a claim.	**Recognise that science is evidence based** and understand the usefulness and limitations of a scientific method (B). **Develop attitudes on which scientific** investigations depend, such as honesty, persistence, critical thinking, and tolerance of uncertainty (C, M). **Analyse scientific phenomena** relating to real life experiences (B, C, M). **Acquire sufficient knowledge** and understanding to use ICT skills effectively to enhance learning and communication to become confident citizens in a technological world and develop an informed interest in scientific matters (B) **Apply the knowledge of chemistry** to make scientifically informed decisions about the choice of chemical products on the market (C).
Recognise when evidence used to support a treatment claim is trustworthy or untrustworthy	**Comparisons** - Comparisons of treatments should be fair. - Syntheses of studies need to be reliable. - Descriptions should clearly reflect the size of effects and the risk of being misled by the play of chance.	**Use the principles of scientific methods** and the application of experimental techniques to solve specific problems (B, C). **Apply acquired knowledge in mathematics** to solve problems encountered in everyday life (M). **Interpret simple diagrams and statistics,** recognising the ways in which representations can be misleading (M).
Make well-informed decisions about treatments	**Choices** - Problems and options should be clear. - Evidence should be relevant. - Expected advantages should outweigh expected disadvantages.	**Recognise that science is evidence based** and understand the usefulness and limitations of a scientific method (B). **Develop attitudes on which scientific** investigations depend, such as honesty, persistence, critical thinking and tolerance of uncertainty (C, M). **Analyse scientific phenomena** relating to real-life experiences (B, C, M).

Current and expected ICT conditions to facilitate teaching and learning

Policy and guidelines for use of ICT in teaching and learning
We found policy, guidelines, and directions for investments to improve ICT infrastructure and use in teaching and learning. The Rwandan government made a strategy to improve teaching and learning by equipping all schools with a minimum set of ICT infrastructure.

Devices and connectivity for teaching and learning
By 2019, the government had supplied over 50% of schools with a standard package of computers, projectors, and Internet access for two computer labs ("smart classrooms"), and planned to supply all schools with this equipment by 2024.

Digital content for teaching and learning
The Rwanda Basic Education Board has an e-learning platform to provide digital content to schools. Teachers and students can freely access the platform. In 2020, the e-content supplied on the platform consisted of simple PDF files. There was ongoing development of interactive content to be hosted on the platform.

Use of ICT for teaching and learning
The use of ICT for teaching and learning in schools was limited by high student-to-computer ratios. Access to the computer labs must be scheduled for classes and for times when individual students can use the computers. Based on our interviews with teachers, most teaching appears to be conducted without ICT.

Evaluation of the effects of the intervention (Paper II)

Participants

Between February 25, 2022 and March 29, 2022, we recruited 84 schools in 10 of the 30 districts in Rwanda. In these schools, we recruited in total 3,128 students in the second year of lower secondary education and 84 science teachers. We randomly assigned 42 schools (1,556 students and 42 teachers) to the control arm and 42 schools (1,572 students and 42 teachers) to the intervention arm. Figure 5 shows the flow of schools, teachers, and students through the study. The schools, teachers, and students in the intervention and control arms had similar characteristics.

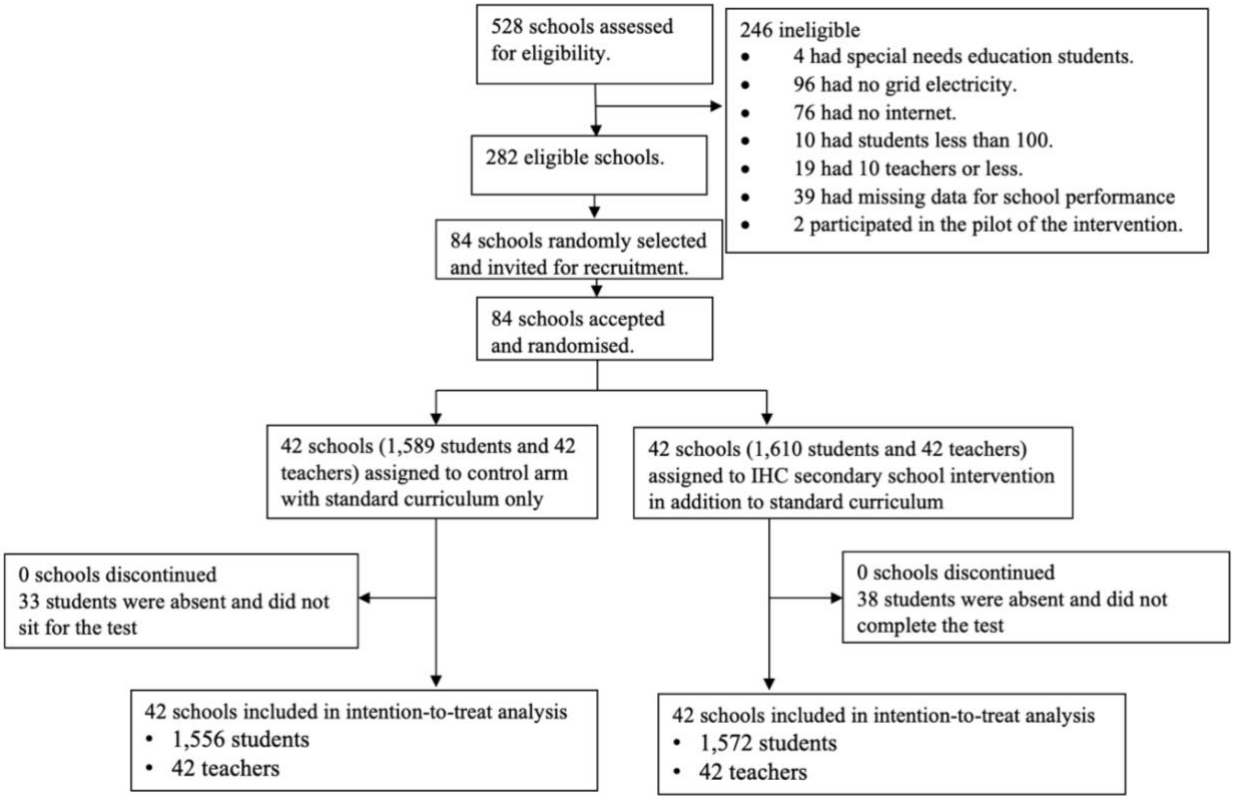


***Figure 5**: Trial profile*

Primary outcome

The proportion of students in the intervention arm who achieved a pre-determined passing score (≥9/18 correct answers) was 915/1572 (58.2%), compared to 302/1556 (19.4%) in the control arm (adjusted odds ratio 10.6 [95% CI: 6.3–17.8], p<0.0001, adjusted difference 37.2% [95% CI: 29.5–45.0]).

Secondary outcomes

Students

The proportion of students in the intervention arm who achieved a pre-determined mastery score (≥14/18 correct answers) was 370/1572 (23.5%), compared to 16/1556 (1.0%) in the control arm (adjusted odds ratio 102.5 [95% CI: 31.9–329.1], p<0.0001, adjusted difference 22.3% [95%CI: 16.6–28.1]).

The mean test score for students in the intervention arm was 55.4% (SD 23.1), compared to 33.8% (SD 15.9) in the control arm (adjusted mean difference 20.8% [95% CI: 16.6%–25.0%], P<0.0001).

For all nine key concepts, students in the intervention arm correctly answered both questions for each of the nine concepts more often than those in the control arm (Figure 6). The largest effect was for the concept "Do not assume that comparisons are not needed", for which 627/1572 (39.9%) students in the intervention arm answered both questions correctly, compared to 70/1556 (4.5%) in the control arm (adjusted odds ratio 17.9 [95% CI: 10.9–29.4], p<0.0001, adjusted difference 34.4% [95% CI: 28.3–40.5]). The smallest effect was for the concept "Do not assume that treatments are safe", for which 493/1572 (31.3%) students in the intervention arm answered both questions correctly, compared to 292/1556 (18.8%) in the control arm (adjusted odds ratio 2.2 [95% CI: 1.5–3.2], p<0.0001, adjusted difference 11.8% [95% CI: 6.1–17.4]).

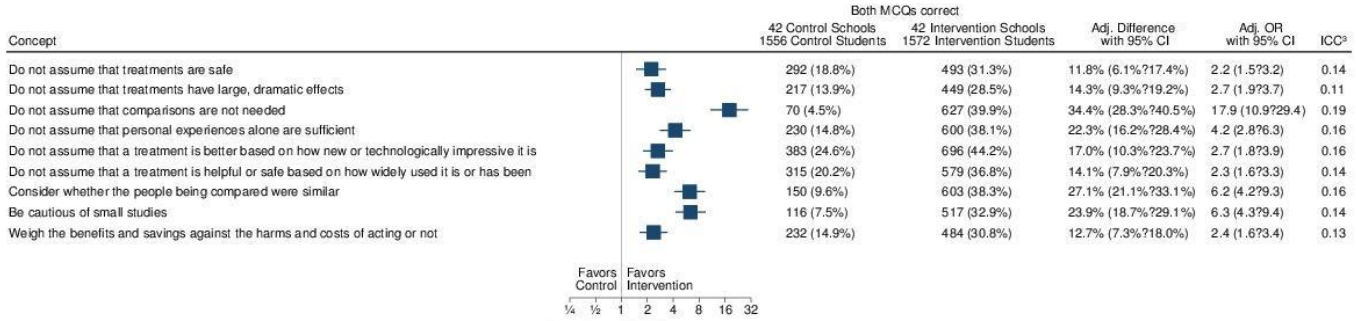


***Figure 6**: Performance of students on each key concept*

There was little difference in the proportions of students in the intervention arm, compared to the control arm, who found it easy or very easy to know if a claim about treatments is based on research studies comparing treatments (4.0% [95% CI: -2.3–10.2]), to find information about treatments that are based on research (0.5% [95% CI: -4.9–5.9]), to judge the trustworthiness of the results of a research study comparing treatments (4.0% [95% CI: -0.8–8.8]), or to judge the relevance of a research study comparing treatments (2.7% [95% CI: -1.8–7.2]).

More students in the intervention schools, compared to the control schools, said they were likely or very likely to find out if a claim was based on a research study (adjusted odds ratio 1.4 [95% CI: 1.2–1.8)], adjusted difference 8.8% [95% CI: 3.5%–14.1%]). There was little difference in how likely they were to find out what a claim is based on (adjusted difference -1.5% [95% CI: -6.1–3.1]) or how likely they were to participate in a research study if asked (adjusted difference 3.3% [95% CI: -8.2–1.7]).

Most students in the intervention arm liked the lessons a little or very much (85.8%), found the lessons easy or very easy to understand (71.7%), and found what they learned helpful or very helpful (86.7%).

Teachers

The proportion of teachers in the intervention arm to achieve a passing score (≥9/18 correct answers) was 41/42 (97%), compared to 20/42 (47.6%) in the control arm (adjusted odds ratio 45.6 [95% CI: 5.7–363.9], P<0.0003, adjusted difference 50.0% [95% CI: 34.2–65.8]).

The proportion of teachers with a mastery score (≥14/18 correct answers) was 32/42 (76.2%) in the intervention arm, compared to 2/42 (4.8%) in the control arm (odds ratio 64.4 [95% CI: 13.1–315.9], P<0.0001), adjusted difference 71.4% [95% CI: 57.0–85.8]).

The mean test score for teachers in the intervention arm was 83.9% (SD 15.2), compared to 47.0% (SD 16.3) in the control arm (adjusted mean difference 36.9% [95% CI: 30.3%–43.5%], P<0.0001).

Subgroup analysis

In the first of two prespecified subgroup analyses, we compared the effect of the intervention in low- and high-performing schools. The results were inconclusive (adjusted odds ratio for an interaction between the intervention and school performance (low vs high) 0.8 (95% CI: 0.3–2.3, p=0.72)

In the second subgroup analysis, we compared the effect of the intervention in students with three levels of English reading proficiency (high, basic, lacking). The effect was similar for students with advanced and basic English reading proficiency (odds ratio for an interaction between the intervention and English reading proficiency (basic vs advanced) 0.9 (95% CI: 0.5–1.4, p=0.57). The intervention also was effective for students lacking English reading proficiency (adjusted odds ratio 5.6 [95% CI: 3.2–9.9], p<0.0001, adjusted difference 22.9% [15.4–30.4%]). However, the effect was less for students lacking English reading proficiency, compared to students with advanced proficiency (adjusted odds ratio for an interaction between the intervention and English reading proficiency [lacking vs advanced] 0.3 [95% CI: 0.2–0.6], p<0.0001).

Process evaluation (Paper III)

Implementation of the intervention as intended

Teacher training

All 42 teachers from the intervention arm attended the teacher training workshop prior to teaching the lessons. After the training, teachers felt that they understood the general overview of the content for each lesson and the underlying concepts. They understood the teaching strategies for critical thinking and felt confident to deliver the intervention as planned.

Lesson preparation

We anticipated it would take teachers at least 30 minutes to prepare for each lesson. Based on data collected using the lesson evaluation form, they spent 30 minutes to an hour preparing for each lesson. Most of the teachers felt they were very much prepared to deliver each lesson.

Delivery and achievement of lesson goals

All 42 schools taught all 10 lessons within one school term. Most of them delivered the lessons using the projector version. On average, the lessons were attended by 38 or 39 students across schools and lessons. The lessons lasted 42–46 minutes on average across schools and lessons. Most teachers felt that the lessons were easy to deliver, and the lesson objectives were very much achieved. The teachers were able to follow the lesson plans and adapt the lesson delivery to fit the context in their schools. This included, for example, switching to the blackboard version of a lesson when there was a power outage, or using a different teaching strategy, depending on the time and resources available.

In very few lessons did teachers not deliver the intervention as planned, due to not being adequately prepared. They sometimes skipped important parts of a lesson. Nonetheless, most of the teachers felt that they achieved the learning goals of each lesson. They attributed this to students being motivated and the lessons being interactive and engaging. According to the teachers, other factors that helped achieve the lesson goals were use of the projector version of the lessons and school support to access the required resources.

Perceived intended effects of the intervention

Understanding of the key concepts covered in the resources

Students who participated in the trial understood the IHC key concepts covered in the resources and felt that the resources were helpful to understanding some of the claims they encountered. They also understood concepts related to reliable evidence and the need to balance benefits and harms of treatment before deciding. Teachers also confirmed that students were able to understand the concepts taught, based on their students being able to give relevant examples and contribute in the class sessions.

Students' application of their learning in relation to health

Students indicated that what they had learnt was useful and they showed interest in applying this to health claims and practices they encountered in their day-to-day lives.

Although not intended, students said that the IHC lessons led them to use healthcare services instead of herbal or home-made remedies. They explained that they trusted healthcare services as reliable sources of treatments that have been researched. They also explained that skilled professionals would give reliable advice and could help them to know which condition they have and what treatment to use for that condition.

In addition, students indicated that they applied what they learned by refusing to use treatments based on common claims by other students (e.g., using toothpaste to treat heartburn or using herbal medicines to treat skin rashes). Parents of students shared how the intervention influenced their children's thinking and openness in sharing ideas about health decisions.

Students' application of their learning in contexts unrelated to health
Some students reported using what they learned in contexts other than health. The concept that students transferred most easily was weighing the benefits and harms of doing something. The concept appeared to change how some students evaluated other types of choices they were making. For example, students said that the lessons helped them to think critically about personal decisions, priorities, and adherence to school rules.

Reflecting on how students might be applying critical thinking in contexts unrelated to health, teachers said that students who participated in the IHC lessons were more thoughtful, questioning, and open-minded in class. The same experience was shared by some parents who indicated their children were more open-minded than before because of the lessons.

Teachers' views on how the intervention impacted them
Some teachers also believed that teaching the IHC lessons had influenced them. Some teachers said that the lessons helped them to apply what they taught in real life by "thinking out of the box", not believing everything, and applying critical thinking skills.

Perceived adverse effects of the intervention
The unintended effect of learning these lessons were misunderstanding of the content taught, misapplication of the content learned, and conflicts between students and their parents or friends when students applied what they learned or gave advice about treatment choices.

Factors that could affect the impact and scaling-up of the intervention
IHC resources factors
Students' experience of the IHC resources facilitated the impact of the intervention and could potentially facilitate scaling up the intervention. Students felt that the resources were interesting, and easy to understand and relate to everyday life. The digital (projector-based) delivery of the lessons encouraged them to learn because the presentations engaged them and helped them to understand the content. Students found value in learning the content of the IHC lessons and felt that they could change how their communities think about health decisions. Similarly, teachers and parents felt that the lessons helped students to gain important skills for assessing what others advise them to do.

The fact that the resources were digital was also a barrier to implementing the intervention and is a potential barrier to scaling it up. Students could only access the resources during class hours. In addition, some of the content was problematic. Students felt that some lessons were hard to understand, and some teachers felt that some lessons were difficult to explain.

Teacher factors
Teachers felt that the training they received, their motivation, how relevant they felt the content was to science subjects, and flexibility to adapt the lessons to their teaching style were the main factors that helped them to deliver the intervention well. Students felt that the teachers engaged them, provided relevant examples, and helped them to understand the content.

Student factors
Students felt motivated to learn the lessons, citing that the content addressed important health issues they experienced. The motivation to learn was also evidenced by students' high attendance rates for the lessons. However, students' attitude towards the lessons being non-examinable was the main barrier to implementing the intervention and is a barrier to scaling it up.

School factors
Support from the school administration positively affected delivery of the intervention. Most importantly, this included providing resources, in the form of time to teach the lessons. School leaders noted that they could justify allocating time to the lessons, because they addressed a cross-cutting topic (health) and generic competences (critical thinking and research) in the curriculum.

However, competing priorities, competing demand for ICT resources (computer labs) and time constraints were identified as barriers to implementing and scaling up the intervention. The intervention was delivered soon after reopening of schools following nearly a year of school closures due to the Covid-19 pandemic. Because of this, there was increased pressure to complete required subjects, and additional time constraints for lessons that were not included in the curriculum and were not examinable.

Home environment
Some students and parents reported that their home environments helped students to understand the content in the IHC lessons. Some parents encouraged their children to learn the lessons and helped them. Also, the home environment was a good place for discussing health claims. On the other hand, some parents discouraged spending time on the IHC lessons because the lessons were not examinable, and some parents with a low level of education were not able to help their children with the lessons.

Factors that may affect scale-up of the IHC secondary school intervention
In addition to the factors noted above, participants identified several factors that could facilitate or impede scaling up the intervention. They noted that the lessons addressed skills that are needed in the community, and that the resources fit in the curriculum, especially in science subjects. Their suggestions for scaling up the intervention included training teachers, using

extra-curricular activities at school, such as health clubs, for the lessons (rather than taking classroom time), and making printed materials available in the schools. Other suggestions outside of school contexts were to use mass media and social media platforms like radio, television, mobile applications, and YouTube channels to promote the resources and reach young people.

V. Discussion

Summary and discussion of the main findings

In this thesis I have described the development and evaluation of the IHC secondary school intervention in Rwanda. The three papers included in the thesis are part of this larger body of work. They address analysing the Rwandan context for teaching critical thinking about health in lower secondary schools as a first step to inform the development of the intervention, evaluating the effectiveness of the intervention in a randomised trial, and exploring the implementation, impacts, and factors affecting effective delivery and scale-up of the intervention in a process evaluation.

I found that the introduction of the competence-based curriculum in Rwanda was an important opportunity that triggered the demand for teaching critical thinking about health skills in a school setting.[9] This demand was expressed by teachers and students, as well as by education authorities. Teachers had no experience in developing critical thinking about health and students were confronted with health claims that required critical thinking skills. These findings were similar to the findings of parallel context analyses in Kenya and Uganda.[10,11]

The main challenge I found for teaching critical thinking, was that the competence-based curriculum was being implemented by teachers who had been trained and taught in the previous, knowledge-based curriculum. In addition, the curriculum defines competences generically. There is ambiguity and variation in how teachers understand, develop, and evaluate competences within and across subjects. Similarly, the global move to competence-based curricula is intended to equip students with skills they need in the 21st century, but conceptualisation of the competences that are included, and implementation of competence-based curricula, varies substantially.[20,113–119]

I found significant progress towards providing schools with ICT for teaching and learning in Rwanda. However, the number of computers being supplied to schools was small, compared to the number of students. There were few digital learning resources in general and those available were PDF files. The context analyses in Kenya and Uganda also found little to no use of ICT in teaching and learning. The high cost of purchasing and maintaining ICT equipment in low-resource settings hinders wider access and use of ICT for teaching and learning. Furthermore, low levels of ICT literacy among teachers and students may also affect the use of ICT in teaching and learning. Although the use of ICT in education can have many benefits, implementing a national policy requires major changes at the individual, classroom, school, and administrative levels.[120–124]

Based on findings from the IHC primary school project, we proposed to develop digital resources for secondary schools. This was because of the prohibitive cost of printing the primary school resources. Based on the findings of our context analyses, we concluded that it was feasible to develop digital resources that could be widely used, but that it had to be possible to use the resources in schools with minimal ICT (a smartphone and access to the Internet) by teachers and students with minimal experience using ICT for teaching and learning. This led us

to design resources that teachers could access and download using a web browser, and that could be used in classrooms with no more than a blackboard or a projector. We initially included a version of the lessons that could be used by students in a computer lab. However, when that version was piloted, we found it impractical, because of the time and resources required to prepare the computer lab for each lesson, and because students were distracted by the computers during the lessons. Moreover, in Kenya and Uganda, most secondary schools did not have computer labs.[10,11]

The finding that teachers had little training and experience teaching critical thinking generally, and no experience teaching critical thinking about health, led us to design resources that addressed this. They included a teachers' guide with background sections for each lesson, with explanations and examples of the key concepts. Information about the teaching strategies used in the resources was also included. The intervention included a teacher training workshop, and materials for the workshop was included in the resources.

In the trial, I found that of students who were exposed to the IHC lessons, 58%, i.e. more than half, achieved a passing score and about 23% of students achieved a mastery score, compared to less than 20% and 1% respectively in the control schools. The intervention was effective in both low- and high-performing schools. However, it was less effective among students lacking basic English reading proficiency, compared to students with advanced reading proficiency. All teachers (n=42) except one in the intervention arm had a passing score, compared to less than half (48%) in the control arm. About three quarters (76%) of the intervention teachers mastered the nine key concepts, compared to 5% of the control teachers.

These findings are consistent with those of trials of the IHC secondary school intervention in Kenya and Uganda. In Kenya and Uganda, respectively, 61.7% and 55.1% of students in the intervention arm had a passing score.[125,126] In the meta-analysis of the three trials of the secondary school intervention, we found that 33% (95% CI: 25–40) more students in the intervention schools passed the Critical Thinking about Health Test and 32% (95% CI: 6–57) more teachers in the intervention passed the test. Overall, among 5,846 students and 122 teachers who were in the intervention arm, 3,397 (58%) and 118 (97%) respectively had a passing score.[94] In the trial of the IHC primary school intervention in Uganda, 69% of the pupils had a passing score.[84] All these findings are consistent with two systematic reviews, which found that educational interventions may have short term effects on people's ability to think critically about the effects of health interventions.[59,60] They are also consistent with a meta-analysis of strategies for teaching critical thinking generally, which found that both generic and specific strategies are effective for teaching critical thinking skills at all educational levels and across subjects. The Rwandan trial, together with the trials in Kenya and Uganda, show that digital educational resources for teaching critical thinking skills for informed health choices can be used effectively in secondary schools with minimal ICT, by teachers with little training and experience teaching critical thinking generally, and with no prior experience teaching critical thinking about health.

In the process evaluation, I found that the intervention was largely implemented as intended. This was facilitated by the teacher training workshop, and teachers dedicating time to prepare for each lesson and following the lesson plans, making adjustments where needed. It was also

facilitated by the willingness of schools to support delivery of the ten lessons within one school term, despite competing demands, including recovering from schools being closed for the prior year due to Covid-19.

Students and teachers felt that they had understood the content covered in the lessons and that they had started to use what they learned, for both health choices and other types of choices. However, there were adverse effects for some students, including misunderstanding of some of the content, misapplication of some of what was learned, and conflict between them and their friends and families when they applied what they learnt.

A factor that facilitated implementation of the IHC secondary school intervention was that the intervention was perceived as useful, valuable, interesting, and engaging. This can be attributed to the work that we invested in designing the resources, using human-centred design, to ensure a positive experience. In addition, teachers and students were motivated to learn the content. Support from school administrations and home support also contributed to effective delivery of the intervention.

The main barriers to effective implementation of the intervention were the fact that some concepts were hard for students to understand, constraints on the time available to teach the lessons, the fact that the content was not examinable, and competing priorities for schools. The fact that the intervention addressed skills needed in the community and was compatible with the curriculum, were identified by participants in the process evaluation as factors that could facilitate scaling up. Suggestions for scaling up the intervention included teaching the lessons in extracurricular activities (rather than using classroom time) and using mass and social media to promote the resources and reach young people.

Implications of the main findings

Implications for designing educational resources

It was important to learn and understand the current state and context of teaching and learning critical thinking about health in Rwanda and East Africa in general. The explicit demand for teaching of critical thinking as a main generic competence and health topics as cross-cutting issues in the curriculum, made clear that there is a demand for such resources as the IHC secondary school resources in Rwanda. In addition, the teachers' lack of experience and the recent introduction of the new curriculum indicated the need for resources to help teach key concepts for critical thinking about health. Additionally, the intervention exposed the status of ICT in secondary schools, with limited student access to computers, little experience of using ICT for teaching and learning, and a need for digital resources.

The findings of my process evaluation underline the importance of engaging key stakeholders in the development of educational resources and show the value of an iterative process with user testing and piloting of the resource prototypes. The input from stakeholders and from testing prototypes led to multiple changes to the initial prototypes and ideas for the resources. This resulted in positive experiences from the resources for teachers, students, and other stakeholders. Use of the resources was shown to be effective in the Rwandan randomised trial,

as well as in trials in Kenya and Uganda. Findings from my process evaluation, and from process evaluations in Kenya and Uganda, indicate that the experience from using the IHC secondary school resources was a key contributor to the effectiveness of the intervention.

While I believe my findings and the findings from Kenya and Uganda are likely to be applicable in other East African countries, context analyses, user testing and piloting of the IHC secondary school resources are warranted prior to scaling up their use in other contexts.

Implications for teaching critical thinking about health

The findings in this thesis show that it is possible to teach students in a representative sample of Rwandan secondary schools to think critically about health. Moreover, at least some students used what they learned in their daily lives. This was possible despite the IHC lessons being an add-on to a packed curriculum, and not being examinable. In addition, the lessons were taught in a school term when schools were recovering from being closed for a year due to the Covid-19 pandemic. This was also the first time that teachers taught critical thinking about health, with little prior training and experience teaching critical thinking. These factors suggest that the effect might be more substantive if the lessons were embedded in the curriculum. The process evaluation findings also suggest that scaling up the intervention is likely to be difficult unless it is incorporated in the curriculum and exams. Not all students benefited equally from the lessons and less than one fourth (24%) of the students mastered the nine key concepts. This suggests a need for more than 10 lessons taught in a single school term, both to reinforce what was taught in the lessons and to teach additional concepts that can help people decide what to believe and do.

In the Rwandan trial, nearly all the lessons were taught in computer labs using a projector. Findings from my process evaluation suggest that both teachers and students valued this version of the lessons, and this may have contributed to the effectiveness of the intervention. In addition, the meta-analysis of the three trials found that the projector versions of the lessons may be more effective than the blackboard version.[127] However, this is uncertain, since that finding was driven by a comparison between the trials and there may have been confounding due to other differences between the trials.

Implications for future research

Based on the findings of my research and the rest of the IHC secondary school project, the objectives of future research should be to:

- Develop and evaluate IHC lessons that can be taught across multiple subjects
- Explore how other concepts could be taught over multiple years and school terms in a spiral curriculum, to reinforce what students learn and introduce more concepts to improve their ability to think critically about health choices
- Explore and understand the context of extracurricular activities in schools as a potential avenue to teach critical thinking about health in school settings
- Explore ways of integrating the IHC lessons in the curriculum and examinations
- Develop and evaluate ways of improving students' access to and use of reliable sources of health information

- Evaluate ways to measure what students learned in class and how they use it to make informed decisions and how that affects or improves health outcomes
- Explore ways of teaching critical thinking about health outside of schools, to benefit other populations

This implies that the area of teaching critical thinking about health to the public is still new and open for further research efforts, at least in low-resources settings.

Strengths

A strength of this thesis is the use of multiple quantitative and qualitative methods to develop and evaluate the IHC secondary school intervention in Rwanda. Throughout this project, we have employed multiple methods, allowing us to triangulate the findings and address questions that could not be answered using a single research method. This helped develop robust knowledge about the IHC secondary school resources specifically, and teach critical thinking about health more generally.

I prepared and published protocols for each of the studies in this thesis.[128–130] This helped ensure transparency, as well as clarity regarding what I planned to do and what I did.

The IHC secondary school intervention was informed by understanding the Rwandan secondary school context, as well as by context analyses in Kenya and Uganda. This contributed to the development of an intervention that was suited to the East African context and would work in that context.

Also boosting the quality of the intervention is the fact that the it was developed in close collaboration with end users (teachers and students) and other stakeholders. In Rwanda, this included a national advisory group, a teacher network, and a student network, which I established for this project, in addition to the teachers and students that user tested and piloted prototypes of the resources. Building on the findings of the context analyses and the use of human centred design, we were able to develop an intervention that was useful, usable, and trusted.

To evaluate the intervention, I conducted a large trial in a random sample of schools. Few other educational interventions have been evaluated in randomised trials in Rwanda and there is limited evidence from other low-income countries.[131–133]

Alongside the trial, a process evaluation was conducted. This explored the fidelity of the intervention, pathways to the intervention's impact, and contextual factors that can explain the impact and potential for scaling up the intervention.

Lastly, in the qualitative studies (paper I and III), I used CERQUAL assessments to evaluate the certainty of the findings. This provided systematic and transparent reflections on confidence in the findings based on methodological limitations, data adequacy, coherence, and relevance.

Limitations

A potential limitation to the evaluation of the intervention, is that the intervention was implemented within six to 10 weeks in selected schools. Teachers and school authorities were willing to dedicate the time for the trial, but whether or not they would commit time and resources outside the evaluation context is uncertain. The projector version of the lessons required the use of computer labs. These were largely available for the IHC lessons in the participating schools, but this may not be the case if the intervention is widely implemented outside of the trial, due to other demands for the computer labs.

In addition, the qualitative methods may have had social desirability bias. In the first paper, I evaluated the extent to which critical thinking about health is covered in the curriculum and taught by teachers. Teachers and curriculum developers may have wanted to defend the extent to which critical thinking about health is covered in the curriculum and taught in practice. In Paper III, using a self-reported questionnaire, teachers may have overreported the extent to which they delivered the intervention as intended. Also in that paper, students may have overreported the extent to which they achieved the lesson goals and applied what they learned.

In paper II, we developed and used the Critical Thinking about Health Test to assess the effect of the intervention on critical thinking at the end of the school term, when the lessons were taught. The test measured the extent to which the students understood and could apply the nine key concepts in the short term. It did not measure the extent to which students applied the knowledge and skills that they learned in their daily lives, nor behavioural changes, or health outcomes. We have collected data in a one-year follow-up study that will measure retention of what was learned and application of what was learned in their daily lives. Those results are not yet available.

The test that was used was a treatment-inherent outcome measure. That is, it measured what was taught in the intervention schools, and not in the control schools. Treatment-inherent outcome measures are associated with larger effect sizes than treatment-independent measures.[134] Consequently, it is problematic to compare the size of the effect in this study with studies in
which both comparison groups were taught the knowledge and had skills tested.

Because I both helped develop and evaluate the intervention, I could be biased towards exaggerating desirable findings and downplaying undesirable findings. I mitigated this risk by publishing and adhering to a protocol for each of the studies, involving multiple colleagues in preparing the research reports, having the reports reviewed by external referees both before and after submitting the papers for publication, and through reflexivity, as described below.

Reflexivity

Reflexivity can be defined as “a set of continuous, collaborative, and multifaceted practices through which researchers self-consciously critique, appraise, and evaluate how their subjectivity and context influence the research processes”.[135] Researchers approach a particular

question with a worldview, assumptions, and beliefs about the phenomenon of interest.[136] This shapes or orients the methods we choose, the questions we ask, and the approach we take to interact with our research questions. Epistemological differences in how people view and value research findings stem from their appreciation of different paradigms, including positivism (mainly focusing on explanatory causal relationships, using largely quantitative methods),[137] interpretative (focusing on people's behaviour and interpretation of phenomena, using mostly qualitative methods),[138–141] constructionism (viewing results from our experiences and social, historical, and political processes),[136,142–146] and naturalism (exploring a phenomenon in its natural environment) paradigms.[147–149]

Our research used both qualitative and quantitative research. In this section, I reflect on personal, interpersonal, methodological and contextual domains of reflexivity, as described in Walsh.[150]

Personal

This PhD work builds on my experience of having piloted the IHC primary school resources in Rwanda as part of my masters training.[87] With this prior experience, I had expectations, assumptions, and reactions regarding the development and evaluation of the IHC secondary school resources. My assumption was that secondary school students would understand the key concepts better than primary school children and would find them relevant in their daily lives. In addition, I expected secondary school students to be more engaged with health decisions than primary school children. I had planned to develop and evaluate the resources in English, unlike the primary school resources, which I piloted in Kinyarwanda (the local language). My initial reaction to the resources being in English, was that this would be a barrier for students, especially those from rural and low-performing schools, and that they therefore would not understand the content. Furthermore, I felt that if the outcome assessment was in English, they would likely fail. Therefore, I initially thought that we were likely to find the intervention to be ineffective due to low English proficiency. I also did not think that it would be effective in low-performing schools.

Interpersonal

This thesis is part of a larger project that developed and evaluated the IHC secondary school resources in three East African countries (Kenya, Rwanda, and Uganda). We had a multidisciplinary team of researchers with backgrounds in health, design, journalism, ICT and qualitative and quantitative research. The team included senior people, early career researchers, and PhD students. In addition, this work engaged teachers, students, curriculum developers, and ICT people from three different countries. Therefore, our motivations, expectations, assumptions, and views differed in many ways. My motivation as a student was to develop and evaluate the intervention and successfully complete my PhD training in the time for which I had funding. In addition, I was motivated by seeing my research output being scaled up in the country. My initial expectation and assumptions during the context analysis and early development stage of the intervention was that we needed to develop interactive digital resources for students. In our group meetings and after synthesis of the findings from all three countries, we found it logical and realistic to develop low-tech IHC resources that teachers

would access and use to deliver the lessons, and to not further develop the computer-based version for students that we piloted.

I anticipated that stakeholders would think that we were developing a health promotion intervention to teach adolescent, sexual and reproductive health (ASRH). This was because school health projects have focused on ASRH. As a result of this anticipation, I was careful to repeatedly clarify to stakeholders and research participants the difference between the educational resources we intended to develop and ASRH resources.

Methodological

This thesis included a context analysis, a randomised trial, and a process evaluation. We initially referred to the context analysis as a market analysis. This is based on applying qualitative market research in the education sector (which is commonly done, for example, by publishers) to understand the customer's needs and to develop products that cater for their needs.[151–153] Our focus was on understanding the educational context and needs for critical thinking about health resources. Although the methods we used were like those used in market research, our objectives were different from those of a commercial company undertaking market research. Subsequently we referred to this as context analysis, a term that has been used elsewhere in educational and design research.[154,155]

The context analysis used qualitative methods. Initially, I planned to conduct a survey in schools to better understand the availability and use of ICT in schools. However, the document analysis and interviews with teachers, curriculum developers, and policy makers made it clear that due to a government initiative, most schools had similar ICT and the use of ICT was similar across schools.

For the randomised trial (paper II), I wanted to evaluate the effects of the intervention in a representative sample of schools. Therefore, I decided to include all types of schools (private, public, and government-aided) from 10 districts representing the five provinces in Rwanda. Given my personal assumptions that students from low-performing schools and students with low English proficiency would likely not benefit from the intervention, I planned a sub-group analysis for low- and high-performing schools, based on English reading proficiency (Advanced vs basic or lacking English proficiency).

Contextual

This research was conducted in schools that had recently implemented the competence-based curriculum. The understanding and conceptualisation of critical thinking differed to some extent from the IHC Key Concepts framework. Nonetheless, the conceptualisation of critical thinking in the curriculum provided a strong foundation to build on for teaching critical thinking about health. Other school health interventions, unlike this research, focused on telling students and teachers what to do. This frequently led participants to assume that we were also teaching them what to do, rather than how to think critically about health choices.

VI. Conclusions

This thesis has found that it is possible to teach critical thinking about health in lower secondary schools in Rwanda by providing teachers with digital resources and training. The intervention built on the newly implemented competence-based curriculum and ICT provided to schools by the government. At least some students were able to apply the skills that they learned in their daily life. The teacher training, which can be provided by teachers who have participated in developing and evaluating the resources and by use of low-tech digital resources, makes it possible to scale up the intervention at a low cost.

Some students acquired important skills and have started to apply them to both health choices and other types of choices. Students and teachers found the intervention to be valuable and useful. The facilitators and barriers that we identified can inform the development of plans to scale up the intervention in Rwanda. Teaching critical thinking about health can reduce the risk of being misled by unreliable claims about treatment effects, increase trust in evidence-based information, and help to make decisions about health interventions more well-informed.

Future research should focus on exploring ways to scale up the intervention, have it integrated into the curriculum, and develop additional lessons to reinforce what was learned in the 10 lessons that we evaluated and introduce other key concepts. Research should also focus on developing resources that target other groups of people, including parents and health professionals.

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VIII. Appendices

- **Main papers**
- **Study tools**
- **Approvals**

Main papers

1. Context analysis

Mugisha M, Uwitonze AM, Chesire F, Senyonga R, Oxman M, Nsangi A, et al. Teaching critical thinking about health using digital technology in lower secondary schools in Rwanda: a qualitative context analysis. PLoS One 2021; 16: 1–18.

2. Randomised trial

Mugisha M, Nyirazinyoye L, Simbi CMC, Chesire F, Ssenyonga R, Oxman M, et al. Effects of the Informed Health Choices secondary school intervention on the ability of students in Rwanda to think critically about health choices: a cluster-randomised trial. J Evid Based Med 2023;16(3):264-274. https://doi.org/10.1111/jebm.12551

3. Process evaluation

Mugisha M, Nyirazinyoye L, Oxman AD, Uwitonze AM, Simbi CMC, Chesire F, et al. Process evaluation of the Informed Health Choices secondary school intervention for teaching critical thinking about health choices in Rwanda: a mixed methods study; submitted.

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PLOS ONE

RESEARCH ARTICLE

Teaching critical thinking about health using digital technology in lower secondary schools in Rwanda: A qualitative context analysis

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Abstract

Introduction

Adolescents encounter misleading claims about health interventions that can affect their health. Young people need to develop critical thinking skills to enable them to verify health claims and make informed choices. Schools could teach these important life skills, but educators need access to suitable learning resources that are aligned with their curriculum. The overall objective of this context analysis was to explore conditions for teaching critical thinking about health interventions using digital technology to lower secondary school students in Rwanda.

Methods

We undertook a qualitative descriptive study using four methods: document review, key informant interviews, focus group discussions, and observations. We reviewed 29 documents related to the national curriculum and ICT conditions in secondary schools. We conducted 8 interviews and 5 focus group discussions with students, teachers, and policy makers. We observed ICT conditions and use in five schools. We analysed the data using a framework analysis approach.

Results

Two major themes found. The first was demand for teaching critical thinking about health. The current curriculum explicitly aims to develop critical thinking competences in students. Critical thinking and health topics are taught across subjects. But understanding and teaching of critical thinking varies among teachers, and critical thinking about health is not being taught. The second theme was the current and expected ICT conditions. Most public

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schools have computers, projectors, and internet connectivity. However, use of ICT in teaching is limited, due in part to low computer to student ratios.

Conclusions

There is a need for learning resources to develop critical thinking skills generally and critical thinking about health specifically. Such skills could be taught within the existing curriculum using available ICT technologies. Digital resources for teaching critical thinking about health should be designed so that they can be used flexibly across subjects and easily by teachers and students.

Background

We are confronted all the time with claims about the world. Many of these claims are not directly testable by most of us. We must figure out how to evaluate other people's arguments to come to our own conclusions, particularly about causal claims [1]. Adolescents, like adults, encounter a wide range of health-related claims in their daily lives, and many of those are claims about health interventions, i.e., statements or messages about purported benefits or harms of actions people can take to protect or improve health. When confronted with such claims, most people are not trying to be scientists. Rather, they are trying to figure out what to believe and what to do.

Such claims are obtained from peers, families, the community, social and mass media. Misleading claims can lead to bad decisions about health, if they are believed. For example, there are endless claims about what people can do to prevent or treat COVID-19 [2]. Acting on unreliable claims can lead to unnecessary suffering and wasted resources [3–7]. Conversely, failure to believe and act on reliable claims about health interventions also leads to unnecessary suffering and inefficient use of health services [8–10].

Making good decisions about health depends on critical thinking, people's ability to obtain, process and understand health information needed to make informed decisions [11–14]. Additionally, people need to think critically about health information, for instance to assess the trustworthiness of claims about health interventions or to understand how to deal with conflicting claims [15]. Many countries have moved towards competence-based curricula and include critical thinking as a key competence [16, 17], although not specifically critical thinking about health. A strong case can be made for investing in health education for adolescents based on developmental science [18]. However, few educational interventions to improve adolescents' ability to think critically about health have been evaluated rigorously [19].

We are a team developing and evaluating resources to enable young people to think critically about health claims. The team includes researchers from East Africa, where the resources are being developed and evaluated, as well as from Chile and Norway. The team is part of the Informed Health Choices (IHC) network, which includes researchers from over 20 countries who are developing and testing learning resources for primary and secondary schools [20].

We first identified key concepts (principles) that people need to understand and apply when deciding what health claims to believe and what to do [21]. Together with teachers in Uganda, we prioritised concepts that were relevant for primary school children [22]. We have also prioritised concepts for secondary schools, together with national curriculum committee members and teachers in Rwanda, Uganda, and Kenya [23]. We developed and tested learning resources in Ugandan primary school children [24, 25]. In a follow up study, we showed that

children retained what they had learned for at least one year [26]. The team has translated primary school learning resources to Kinyarwanda and Kiswahili and piloted their use in Rwanda and Kenya. Key findings from the Rwandan pilot study indicated that IHC resources were useful and feasible to use in Rwandan primary schools [27]. The primary school resources have also been translated to other languages, including Chinese, Croatian, French, Greek, Italian, Norwegian, Persian, Portuguese, Spanish and pilot testing of translated resources is ongoing in several countries [28].

In a process evaluation, researchers found that lack of time in the curriculum and printing costs were major challenges to scaling up use of the IHC primary school resources [29]. One way of reducing the cost of the intervention would be to use digital resources. Digital learning resources are much cheaper to distribute than printed resources because they eliminate printing costs, and they do not need to be physically shipped. However, schools may not be equipped to use digital resources and teachers and students may prefer printed learning materials. Further, we conducted a context analysis in Norway to explore the demand for teaching critical thinking about health in primary schools [30]. We found that although teachers were interested, there was little time available for teaching new content outside the curriculum and little time for teachers to seek out and test new resources.

Building on what we learned in our work with primary school resources, and in collaboration with stakeholders in education, we are developing digital learning resources for secondary school students in East Africa that can be easily adapted for use in other countries. To inform the development of the resources and ensure that they are well suited for the Rwandan context, we conducted a context analysis to explore 1) the demand for learning resources, 2) the extent to which these fit with the curriculum and 3) ICT conditions in secondary schools. Researchers in Kenya and Uganda carried out similar context analyses [31–33]. While our focus is on understanding the context for developing suitable learning resources for critical thinking about health, our findings can also inform the design of other digital learning resources in low resource educational settings.

Methods

We used a qualitative descriptive study approach [34]. This entails describing a phenomenon without moving far from or into the data; it requires less interpretation than an "interpretive descriptive" approach. We chose this method because the nature of the data we sought was primarily factual. We employed four qualitative methods: document review, key informant interviews, focus group discussions, and observations.

Document review

The document review included analysis of the existing curriculum, of approved learning resources in lower secondary schools, and of current documentation on ICT for education (ICT for education policy, ICT implementation plans, and guidelines for use of ICT in education). We searched for relevant documents on the official websites of the Rwanda Education Board (REB) and Ministry of Education. We consulted REB to retrieve and obtain clarifications of documents that could not be found on the official website. In total, we reviewed 29 documents for curriculum, resources and ICT use in Rwanda.

We reviewed the national curriculum for lower secondary schools. We read syllabuses for each subject taught in lower secondary schools. For each subject, we reviewed its rationale, competences, objectives, topic areas and units taught. We explored what health topics are covered in the curriculum and in which subjects and course units these health topics are located. We reviewed how critical thinking is generally covered in the curriculum and specifically in

Table 1. IHC key concepts that formed a framework for curriculum document analysis.

No	Short description of IHC concepts for critical thinking about treatments	Informed Health Choices Competence
1	**Claims concepts**	
1.1	It should not be assumed that treatments are safe or effective—or that they are not.	Recognise when a claim has an untrustworthy basis
1.2	Seemingly logical assumptions are not a sufficient basis for claims.	
1.3	Trust in a source alone is not a sufficient basis for believing a claim.	
2	**Comparison concepts**	
2.1	Comparisons of treatments should be fair.	Recognise when evidence used to support a treatment claim is trustworthy or untrustworthy
2.2	Syntheses of studies need to be reliable.	
2.3	Descriptions should clearly reflect the size of effects and the risk of being misled by the play of chance.	
3	**Choices concepts**	
3.1	Problems and options should be clear.	Make well-informed decisions about treatments
3.2	Evidence should be relevant.	
3.3	Expected advantages should outweigh expected disadvantages.	

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relation to health topics. We mapped if there were any IHC concepts and competences reflected in the curriculum. We used the IHC Key Concepts as a framework for reviewing the curriculum, mapping where in the curriculum IHC concepts are relevant explicitly or implicitly. The IHC Key Concepts includes 49 principles grouped in three categories, each with three high level concepts, and corresponding competences (see Table 1). We did not review international or special needs curricula used in Rwandan lower secondary schools.

We reviewed e-books approved by REB. We started by reviewing all books used in lower secondary schools of Rwanda. For each electronic book used in lower secondary schools, we reviewed whether the content included health topics or critical thinking about health.

We reviewed existing documentation on ICT use in secondary education, including existing national policy for use of ICT in education, and strategic and implementation plans for ICT in secondary schools. We also reviewed existing e-learning platforms and digital learning resources available through the REB gateway. We explored the status of the rolling out of ICT infrastructure in Rwandan secondary schools, and the availability of resources (equipment, Internet access, e-learning content, etc) in schools where ICT has been rolled out.

Key informant interviews

We interviewed key informants such as curriculum development and ICT for education at REB, secondary school teachers, and school ICT support officers. We explored how the competence-based curriculum is implemented in Rwanda, focusing on critical thinking and health topics, and how competence-based learning is evaluated. We asked secondary school teachers and ICT support officers at schools to describe how they teach competence-based curriculum with a focus on critical thinking and health related topics. We also explored ICT use for teaching and learning, and challenges using digital learning resources.

Focus group discussions

We conducted focus group discussions with students to explore how they obtain health information, what they use as a basis for making health decisions, and claims they hear in everyday

life. We explored whether critical thinking about health is something they would be interested to learn in school. We also explored how they search for information about health and other topics at school. Finally, we explored how they access and use ICT for learning in school.

Observation

We visited selected schools and observed what ICT infrastructure is available and how it is used for teaching and learning. We observed existing ICT labs, digital equipment, Internet access, and content. Where we were able to access ongoing classes, we observed how ICT was used in teaching and learning.

Sampling

First, we sampled documents to review according to the objectives. We purposively selected curriculum documents, approved learning resources and ICT policy and implementation documents (n = 29). For the curriculum and learning resources we selected those used in lower secondary schools in Rwanda. Second, we used convenience sampling to select five schools to conduct observations, interviews with teachers, and focus group discussions with students. Due to time and budget constraints, we applied convenience sampling to select five schools. We took care to choose schools that varied as much as possible in terms of ownership (private/public), day/boarding, equipment, and location (urban/rural). In each school, the school administration identified at least 10 students from lower secondary school with whom we conducted a focus group discussion. Two of the five focus group discussions were conducted out of school premises due to the Covid-19 pandemic. In each school, we purposively selected two to three teachers of biology and English because the current curriculum informed us that health topics were mainly taught in those subjects. We also interviewed people in charge of ICT at each school. Lastly, we purposively selected 5–10 key informants from REB's departments of curriculum development and ICT for education. In order to capture the opinions, views and experiences of a wide range of participants, we selected participants that were of direct relevance to our study objectives.

Data collection procedures

For the document review, we used the study objectives and IHC Key Concepts as frameworks for collecting data. We extracted statements pertinent to each study objective. We summarised all findings in a single table, including the name of the document, the extracted statement, and the page number where the statement was found. This exercise was done independently by two researchers who then compared the data they extracted and resolved any disagreement through discussion.

For key informant interviews, we used semi-structured interview guides to collect information from the study participants, one for teachers and one for policy makers. Guides included questions that covered critical thinking about health, resources for teaching critical thinking, and ICT infrastructure used in teaching and learning. Guides also explored existing challenges and opportunities for using ICT for teaching and learning. We piloted the two interview guides with a few participants first and slightly modified them as needed. We interviewed participants face to face in a private place of their choice. Participants were encouraged to express their views freely and take discussion in a new relevant direction. We conducted some interviews with two or three teachers or REB key informants at the same time.

We also used an interview guide to conduct focus group discussions with students. We asked questions to explore how they learn to think critically, what claims about treatment effects they are familiar with, which sources of health information they use, and how they use

ICT for learning purposes. We approached and conducted interviews at the workplace of study participants in a designated room that assured privacy of participants and recording of discussions. Interviews and focus group discussions were moderated by a male PhD fellow with Master of Public Health and experience qualitative research (first author). Each interview lasted at least an hour and the focus group discussion lasted between one hour and half. At least two researchers conducted each interview and focus group discussion. One person guided the discussion, and another took notes and recorded the discussion. Interviews and focus group discussions were recorded, transcribed verbatim and translated to English if the interview was conducted in Kinyarwanda. We collected observations using a checklist that covered ICT equipment, internet-connectivity, and e-learning content used in schools.

The amount of data we collected was guided by considerations of the variation in issues emerging from the data and the extent to which we were able to explain these variations. We considered our time and resource constraints and the need to avoid large volumes of data that cannot be easily managed or analysed as highlighted in the literature [35, 36].

Data analysis

We compiled and analysed all data from the document review, key informant interviews, focus group discussions, and observations together, using a framework analysis approach for applied research [37]. This approach differs from thematic content analysis in that it is deductive in nature with pre-set objectives [38]. It also involves analysing, classifying and summarising data in a thematic framework [39]. We began by reading all notes, transcripts, and documents to familiarise ourselves with the data. Then we conducted an analysis based on a coding scheme of initial themes derived directly from the objectives of our study: 1) demand for learning resources to teach critical thinking about health, 2) links between critical thinking about health and the curriculum, and 3) current and expected ICT conditions for teaching and learning in secondary schools. We determined sub-themes from data within each initial theme. We indexed all the data using the initial themes and sub-themes and rearranged data within and across themes (charting) to compare summaries of data during analysis. Two researchers independently analysed the data and compared their findings. The two researchers discussed disagreements in codes and themes and agreed on the final themes.

We summarized the key findings and assessed our confidence in these using a version of the Confidence in the Evidence from Reviews of Qualitative research (GRADE-CERQual) approach [40]. GRADE-CERQual was modified for primary qualitative studies [29, 41]. GRADE-CERQual is a systematic and transparent method for assessing the confidence in evidence from reviews of qualitative research through the lens of four components: methodological limitations, data adequacy, coherence and relevance [42]. Although CERQual has been designed for assessing findings emerging from qualitative evidence syntheses, the components of the approach are also suitable for assessing findings from a single study with multiple sources of qualitative data. We modified the components slightly as follows: 1) Methodological limitations: the extent to which there are concerns about the sampling and collection of the data that contributed evidence to an individual finding, 2) Coherence of the finding: an assessment of how clear and compelling the fit is between the data and the finding that brings together these data, 3) Adequacy of the data contributing to a finding: an overall determination of the degree of richness and quantity of data supporting a finding and 4) Relevance: the extent to which the body of evidence supporting a finding is applicable to the context (perspective or population, phenomenon of interest, setting) specified in the study question.

Two authors applied the modified GRADE-CERQual approach to each study finding and made a judgement about our overall confidence in the evidence supporting the finding. We

judged confidence as being high, moderate, low, or very low. All findings started as high confidence and were graded down if there were important concerns regarding any of the components described above [43].

Ethical considerations

The study was performed in accordance with the protocol and regulatory requirements, guidelines, and principles for conducting studies involving human subjects in Rwanda. Ethical clearance was obtained from the Rwandan National Ethics Committee (RNEC) for the entire informed health choices project (approval number 916/RNEC/2019). Study participants signed a written informed consent before participating in the study. Students under the age of 18 signed assent forms and consent was obtained from their corresponding school administration at school.

Results

We reviewed 29 documents related to the curriculum, syllabuses, textbooks, and ICT for education in Rwanda. We interviewed 27 key informants, including policymakers, and teachers. We conducted five focus group discussions with groups of nine to 11 students, and we made observations in five schools. Characteristics of the schools, students, teachers, and policymakers are summarised in Table 2. We categorised our findings in themes and sub-themes as described below. CERQual assessments are in parentheses.

Demand for resources to teach critical thinking about health

Demand in the curriculum. The competence-based curriculum requires that students develop generic competences including critical thinking, research and problem solving in all subjects (high confidence). In 2016, Rwanda switched from a knowledge-based curriculum to a competence-based curriculum. The current curriculum emphasises developing learners' knowledge, skills, and attitudes that together build competences needed in real life. It also places the learner at the centre of teaching and learning processes. The learner is considered a source of information and is expected to drive learning processes, while the teacher's role is to guide.

> *"The former curriculum was objective-based, where the teacher was the source of everything, He/she was the one teaching students, providing all the information, and students could write all that the teacher said, But now in the current competence-based curriculum, the focus is more on learners, where students participate more in learning and teaching process than the teacher himself."*
>
> ***Policymaker 03***

The current curriculum aims for learners to develop generic competences that promote higher order thinking skills. These competences are expected to impart learners with understanding of subjects and skills needed in the job market, as well as to promote life-long learning. The curriculum describes generic competences that include critical thinking, research, and problem solving.

In developing critical thinking competence, learners are expected to demonstrate that they "*think reflectively, broadly and logically about challenges encountered in all situations, weigh up evidence and make appropriate decisions based on experience and relevant learning, think imaginatively and evaluate ideas in a meaningful way before arriving at a conclusion and explore and*

Table 2. Demographic characteristics of schools visited, and participants interviewed.

Schools characteristics	**Number (n = 5)**
Ownership	
Public	2
Private	1
Public/private	2
School type	
Day school	2
Boarding school	3
Students characteristics	**Number (n = 51)**
Age	
13–15 years	43
16–18 years	8
Gender	
Male	18
Female	33
Teachers characteristics	**Number (n = 19)**
Subject taught	
Sciences	13
Languages	6
Gender	
Male	15
Female	4
Policymakers characteristics	**Number (n = 8)**
Gender	
Male	5
Female	3
Work domain	
Curriculum	4
ICT for education	3
Stakeholder in education	1

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evaluate alternative explanations to those presented by others." Similarly, for research and problem-solving skills competence, learners should *"be resourceful in finding answers to questions and solutions to problems, produce new knowledge based on research of existing information and concepts and sound judgment in developing viable solutions, explain phenomena based on findings from information gathered or provided."* ***Rwanda Curriculum framework***, page 11.

According to the curriculum, these generic competences and others must be reflected and developed in all subjects taught in lower secondary schools in Rwanda.

The current curriculum lays out the demand for development of new textbooks and teachers' guides to facilitate a learner-centred approach (high confidence). REB's department of curriculum and material production is developing learning resources for each subject to increase the availability of such resources in schools.

> *"The learner-centred approach required for the new curriculum demands a variety of teaching and learning textbooks and resources, Teachers' guides for textbooks and the National Curriculum Syllabuses will provide subject teachers with advice and guidance on effective strategies*

Table 3. Units covered in lower secondary school that teach health.

Subject	Units
Biology and health sciences	• Classification of diseases. • Human reproductive system.
	• Reproduction, pregnancy and childbirth • Puberty and sexual maturation.
	• Sexual behaviour and sexual responses • Immunity and vaccination
	• Infectious and non-infectious diseases. • Pregnancy prevention
	• Reducing risks of STI and HIV • Social factors that affect good health
	• Decision making regarding sexual relationship
	• HIV and AIDS, stigma, treatment, care and support.
Home Science	• Personal health and etiquettes.
English	***Oral and written communication***
	•Food and nutrition • Health
	• Diet and health • Traditional beliefs and practices

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for teaching their subjects and for optimising students' progress in terms of subject knowledge, skills, attitudes and competences."

Rwanda curriculum framework, page 24.

Demand for critical thinking learning resources in subjects taught in lower secondary schools. Health related topics taught in secondary school subjects provide opportunity for developing competences for critical thinking about health among learners (high confidence). We explored all subjects in the lower secondary curriculum to determine where health topics are covered. Among 14 subjects taught in lower secondary schools, three subjects (biology and health sciences, home science, and English) covered health topics in their syllabuses. Broad health themes are included, such as sexual and reproductive health, infectious and non-infectious diseases, food and nutrition. Table 3 provides an overview of which subjects and units in the curriculum cover health topics.

In reviewing the content and activities for health-related topics, we found opportunities for teaching critical thinking about health. In addition, statistics and probability, which are taught in mathematics are linked to concepts for critical thinking about health research.

We did find some competences of biology, chemistry, mathematics subjects that aligned with competences in the IHC Key Concepts framework. These competences are rooted in generic competences described in the curriculum framework. They include "critical thinking, research and problem solving, creativity and innovation, communication, lifelong learning, cooperation, interpersonal relations, and life skills." Specific broad competences in the syllabuses for subjects are based on these generic competences (see Table 4). The learner studying those subjects is expected to appreciate that science is evidence-based and should apply science in real life to make good choices and find solutions. Students use small-group discussions to conduct class activities and reflect on content delivered in class, a learning strategy that is aligned with critical thinking. At the end of lower secondary school, students should be able to apply science in advocating for personal, family and community health (high confidence).

Students should be able to *". . .apply basic mathematical concepts, principles and processes to solve problems; analyse and explain scientific phenomena relating to real life experience; use and experiment with a range of scientific and technological tools and equipment and draw*

Table 4. Links between the Rwandan lower secondary school curriculum and concepts and competences in the informed health choices key concepts framework.

IHC competances	Corresponding IHC concept categories and sub-categories	Competences in the Biology (B), Chemistry (C) and Mathematics (M) curricula
Recognise when a claim has an untrustworthy basis	**Claims**	**Recognise that science is evidence based** and understand the usefulness and limitations of a scientific method (B).
	• It should not be assumed that treatments are safe or effective—or that they are not.	
	• Seemingly logical assumptions are not a sufficient basis for claims.	**Develop attitudes on which scientific** investigations depend, such as honesty, persistence, critical thinking and tolerance of uncertainty (C, M).
	• Trust in a source alone is not a sufficient basis for believing a claim.	**Analyse scientific phenomena** relating to real life experiences (B, C, M).
		Acquire sufficient knowledge and understanding to use ICT skills effectively to enhance learning and communication to become confident citizens in a technological world and develop an informed interest in scientific matters (B)
		Apply the knowledge of chemistry to make scientifically informed decisions on the choice of chemical products on the market (C).
Recognise when evidence used to support a treatment claim is trustworthy or untrustworthy	**Comparisons**	**Use the principles of scientific methods** and the application of experimental techniques to solve specific problems (B, C).
	• Comparisons of treatments should be fair.	
	• Syntheses of studies need to be reliable.	**Apply acquired knowledge in Mathematics** to solve problems encountered in everyday life (M).
	• Descriptions should clearly reflect the size of effects and the risk of being misled by the play of chance.	**Interpret simple diagrams and statistics**, recognizing the ways in which representations can be misleading (M).
Make well-informed decisions about treatments	**Choices**	**Recognise that science is evidence based** and understand the usefulness and limitations of a scientific method (B).
	• Problems and options should be clear.	
	• Evidence should be relevant.	**Develop attitudes on which scientific** investigations depend, such as honesty, persistence, critical thinking and tolerance of uncertainty (C, M).
	• Expected advantages should outweigh expected disadvantages.	**Analyse scientific phenomena** relating to real life experiences (B, C, M).

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appropriate conclusions; advocate for personal, family and community health, hygiene and nutrition. . .”

Rwanda curriculum framework, page 14.

Teachers' needs in relation to resources to teach critical thinking about health. Understanding and developing critical thinking about health varies among teachers (moderate confidence). The teachers we interviewed noted that they understand critical thinking as a way of reflecting on class lectures through discussion among learners. Some teachers we interviewed also develop research and problem-solving skills by encouraging learners to search the Internet and books to get further information beyond what is taught in class. Other teachers understand critical thinking as a way of reflecting on topics learned in class and how these apply in real life.

“We give them health topics to search on the Internet or in books, They discuss in class and present [what they find] *during debates.***”**

English teacher

"For example, we teach infectious and non-infectious diseases, We can ask them some diseases they see at home, we ask a nurse to explain these diseases, so they think beyond class and get understanding of what infectious diseases are."

Biology and health sciences teacher

We interviewed five staff from the REB curriculum department to explore the need to develop learning resources to teach critical thinking about health. They noted that, in their view, teachers have little experience in teaching critical thinking and other new competences. This, they stated, is because most teachers have been trained in the previous knowledge-based curriculum. They also noted that teachers have different understandings of what is meant by critical thinking, and their competences vary. The curriculum department staff suggested that teachers do not know how to develop their competences in this area, and that there are no learning resources to help them.

"Critical thinking is reflected in the curriculum but teaching it is still problematic because understanding of teachers for critical thinking varies and some don't even understand it, Yes, you need to develop critical thinking, but how do you do it and what materials do you use? Which books do you use? You see it is a problem."

Policymaker

Students' needs in relation to learning about critical thinking for health. We found that students are aware that critical thinking would help to make decisions about health for themselves and others (high confidence). Most students said that they search for health information on the Internet or ask their peers or family. Some said they could find out which treatments are better by trying them out and seeing what the effect was, or by asking friends or parents. Students shared their experiences of treatments they were familiar with for common conditions. Students commonly heard about treatments claims from peers, and that they generally accepted and believed them.

"You can ask elders, your parents, your elder brothers/sisters, neighbours, and you know what they used which healed them quickly or you do research on Google."

14-year-old student

They had a general belief regarding what people can eat or drink to improve their health and which treatments they can use to improve common health conditions. Their beliefs about treatments were influenced by peers, the community, media and their families.

". . . when you are sick of flu or cough, you take ginger and lemon, you boil them, then you mix with honey."

13-year-old student

When we asked them whether it is important to learn critical thinking about health, they responded that it is important because it would give them confidence in their treatment choices. They also mentioned that knowing critical thinking, they can help themselves or others to make better choices. When we asked them how they can apply critical thinking about

health in their daily lives, they said they would use medicines with caution and not accept every suggestion.

"In order to avoid a person who can mislead you, because some can even give you wrong information on the treatment, Then when you take it without critical thinking, you have bad effect, which can even lead to death or you become disabled."

14-year-old student

Current and expected ICT conditions

Policy and guidelines for use of ICT in teaching and learning. There are policy and guidelines in place that promote ICT use in teaching and learning (high confidence). The Government of Rwanda recognises ICT as a key pillar for national transformation. In 2016, the government approved the *ICT for education policy* [44]. The policy aimed to mobilise use of ICT in teaching and learning processes by developing ICT literacy and providing devices, connectivity, and digital content. In the education sector, ICT is regarded as a key strategy to drive teaching and learning.

REB has produced guidelines for establishing "smart classrooms" in schools to facilitate teaching and learning. Smart classrooms are computer laboratories with laptops, an Internet connection, and learning materials that develop 21st century skills. There was an ICT implementation plan to provide all schools with smart classrooms by 2019.

"Development and acquisition of digital content, aligned with the curriculum and that [. . .] is fully integrated with the use of ICT, [. . .] eventual shift from print to digital content as infrastructure is deployed in schools [. . .] Digital content has advantages of reducing costs of printing, distribution, replacement due to wear and tear and enriching the learning experience."

ICT in education policy, page 4.

Devices and connectivity for teaching and learning. The government of Rwanda has provided computers, connectivity and other ICT devices to more than 50% of schools for supporting teaching and learning (high confidence). According to the REB ICT for education department, over 50% of secondary schools in Rwanda have at least two smart classrooms and laptops for teachers in each department. Most schools have at least 100 computers for students and five computers for teachers in each department. The laptops are supplied by the government and have similar features, and the government pays for Internet access at the schools. Some schools have additional computers not supplied by the government. At the five schools we visited, there was also at least one data projector in the smart classrooms. Based on interviews with teachers, few students or teachers own a computer. Only one of the five schools we visited had some students who owned laptops.

Digital content for teaching and learning. There is an e-learning platform for schools that hosts non-interactive digital content in pdf formats. Some work is going on regarding interactive digital content (high confidence). All books developed for the competence-based curriculum are freely available. Interactive digital content is under development in pilot projects, according to the REB.

"Well, we have not done so much on digital materials, what we have now is soft books in PDF, Digital content is different from soft content of the book because in digital content we should

have animation, audio, Yeah, digital materials look like that, But we have that project, where we will make digital content for primary and secondary."

Policymaker 3

"So far we have developed few interactive digital resources for each unit in a chapter, but we are now developing virtual labs."

Policymaker 2

Use of ICT for teaching and learning. Use of ICT for teaching and learning in Rwandan schools is limited due to limited ICT resources. Therefore, use of ICT in teaching is done in combination with traditional teaching (without ICT). Schools' ICT facilities are available for teaching and learning on a rotating schedule, since there are not enough computers for all students to use at the same time (high confidence). In each school there is a timetable indicating when each class is scheduled to use a smart classroom. During breaks and weekends, smart classrooms at boarding schools are open for students to use. Students reported that their use of computers for teaching and learning outside of ICT classes occurs once or twice a week. Students use computers primarily for searching the Internet and for learning ICT skills. Teachers we interviewed reported that teaching and learning across subjects occurs mostly in classes without computers.

"It might not always be possible for all classes to access smart classrooms in a bigger school but the need for it is weighed and classes are allowed accordingly, For boarding schools, they can even extend the learning hours to weekend program where students can have access to computers depending on the school timetable."

Policymaker 3

Confidence in the findings. Details of our assessment of confidence in the findings are summarised in the (S1 File). We judged that it is possible to have high confidence in all but one of the findings (which we rated as 'moderate').

Discussion

The study aimed to explore the demand of teaching critical thinking about health conditions in Rwandan lower secondary schools using digital technology. We found that critical thinking is a key competence in Rwandan curriculum and health topics cut across different subjects. Furthermore students, teachers, and policy makers agreed there is a need for students to learn to think critically about health, and a need for learning resources to help teach critical thinking about health. We found that ICT devices and connectivity has already been supplied by the Rwanda Education Board to more than half of the schools in the country. However, use of ICT in daily teaching activities is limited by high computer to student ratios.

Internationally, there has been a shift towards competence-based curricula, and critical thinking is identified as a key competence in most curricula [16]. Critical thinking is a priority competence across subjects taught in lower secondary schools in Rwanda. However, critical thinking about health is not addressed explicitly and is not being taught. In the curricula, health is not a stand-alone subject, but health is included in three subjects: biology and health sciences, home science, and English. For English, health topics are used as a context for teaching English.

Teachers and curriculum developers did not express a direct 'demand' for these learning resources, likely because critical thinking about health is not explicitly described as a subject in the curriculum. However, both teachers and curriculum developers expressed a need for resources to help teachers teach critical thinking. We also uncovered opportunities in several subjects where teaching this content would fit with the existing curriculum.

Though critical thinking about health is not being taught, students recognise the importance of learning to think critically about health. They encounter many claims in their daily lives about the effects of health interventions and lack skills to critically appraise those claims. People have access to a massive amount of health information and need skills to know what is trustworthy [19].

We found that challenges to teaching critical thinking generally and critical thinking about health specifically include teachers' lack of experience, training, and resources to help them. Similarly, a context analysis in Norway found that both critical thinking and health are emphasised in the curriculum, but teachers lack experience teaching critical thinking about health [45]. Other research has identified a lack of experience and training as a challenge to teaching critical thinking generally [46]. Our analysis suggests that to address these challenges, critical thinking learning resources should include support or training for teachers. In addition, because critical thinking and health are taught across subjects, resources are needed that can be used across subjects. If teaching critical thinking about health is distributed across subjects, teachers are likely to need a tool for coordinating this.

We also found challenges to using ICT for teaching and learning. Although more than half of the public schools in Rwanda now have smart classrooms, most schools have only two smart classrooms. This makes it hard to use them in daily teaching activities. Also, digital learning resources are limited to PDF textbooks provided by REB and available on their website. The use of digital learning resources, and particularly resources not provided by REB, is uncommon. Our results are similar to those of other studies which have found that barriers to using ICT for teaching and learning include poor infrastructure, lack of Internet connection, and sporadic electricity; teachers' lack of competence, confidence, technological literacy, and pedagogical skills; and teachers' perceptions and beliefs [47, 48]. Our findings suggest that close collaboration with policymakers—in Rwanda, the REB—is important in addressing these challenges, to ensure that digital learning resources are suitable for and integrated into the national platform, which would facilitate scaling up and sustaining use.

UNESCO has highlighted four mistakes to avoid when people want to integrate ICT in teaching and learning: "*installing learning technology without reviewing students' needs and content availability*, *imposing technological systems from the top down without involving faculty and students*, *using inappropriate content from other regions of the world without customizing it appropriately*, *and producing low quality content that has poor instructional design and is not adapted to the technology in use*" [49]. This context analysis will help us to avoid those mistakes. In addition, we will develop learning resources iteratively, with continual in-depth feedback from students, teachers, and the curriculum committee.

Strengths and limitations

A strength of this study is the use of multiple sources of data, including documents, interviews, focus group discussions, and observation. This provided a basis for triangulating the findings. In addition, data from our document review informed our collection of data from key informants' interviews and focus group discussion. Another strength was the use of a modified version of CERQual to assess confidence in our findings.

A potential limitation is the possibility of social desirability bias among interview participants, particularly curriculum developers and teachers who teach critical thinking. They may have wanted to defend the extent to which critical thinking about health is covered in the curriculum and taught in Rwandan schools. We tried to mitigate this by emphasizing to all participants that we were not assessing the curriculum or teaching performance, but rather seeking to inform the development of our learning resources.

Conclusion

This qualitative context analysis identified a need for learning resources to teach critical thinking about health to students in Rwanda. Students saw critical thinking about health as important for making better choices and are therefore likely to be motivated to engage in this learning. They are confronted with many claims about the effects of health interventions and recognize their need to know how to assess the trustworthiness of those claims. Critical thinking is a priority competence in the Rwandan curriculum. However, teachers need support for teaching critical thinking skills generally, and critical thinking about health specifically. Experience from elsewhere suggests that digital learning resources can reduce costs compared to printed material, and interactive resources may have additional advantages. However, widespread use and sustainability of digital learning resources depends on support from the Rwanda Education Board. Resources also need to be designed in a way that makes them adaptable for use in schools with limited ICT resources, as well as suitable for use by teachers with limited ICT experience.

Supporting information

S1 File. CERQUAL assessment of key findings for context analysis.
(DOCX)

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ARTICLE

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Effects of the Informed Health Choices secondary school intervention on the ability of students in Rwanda to think critically about health choices: A cluster-randomized trial

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Abstract

Aim: The aim of this trial was to evaluate the effects of the Informed Health Choices intervention on the ability of students in Rwandan to think critically and make Informed Health Choices.

Methods: We conducted a two-arm cluster-randomized trial in 84 lower secondary schools from 10 districts representing five provinces of Rwanda. We used stratified randomization to allocate schools to the intervention or control. One class in each intervention school had ten 40-min lessons taught by a trained teacher in addition to the usual curriculum. Control schools followed the usual curriculum. The primary outcome was a passing score (≥ 9 out of 18 questions answered correctly) for students on the Critical Thinking about Health Test completed within 2 weeks after the intervention. We conducted an intention-to-treat analysis using generalized linear mixed models, accounting for the cluster design using random intercepts.

Results: Between February 25 and March 29, 2022, we recruited 3,212 participants. We assigned 1,572 students and 42 teachers to the intervention arm and 1,556 students and 42 teachers to the control arm. The proportion of students who passed the test in the intervention arm was 915/1,572 (58.2%) compared to 302/1,556 (19.4%) in the control arm, adjusted odds ratio 10.6 (95% CI: 6.3–17.8), $p < 0.0001$, adjusted difference 37.2% (95% CI: 29.5%–45.0%).

Conclusions: The intervention is effective in helping students think critically about health choices. It was possible to improve students' ability to think critically about

health in the context of a competence-based curriculum in Rwanda, despite challenging postpandemic conditions.

KEYWORDS
adolescents, critical health literacy, health literacy, Informed Health Choices, Rwanda

1 | INTRODUCTION

Adolescence is a critical stage in life where young people start to make choices on their own, including health choices. Most of the health choices that adolescents and adults make stem from claims that family members, peers, communities, and Internet, media, and social media sources believe to be true.[1–3] Young people and many adults are unable to assess the trustworthiness of health claims.[4,5] Failing to base decisions on reliable evidence when making choices can result in waste of resources and unnecessary suffering. The ability to make an informed health choice requires health literacy skills—the ability to obtain, process, and understand information needed to make informed decisions.[6,7] There is an opportunity to develop such skills among young people in school settings, particularly critical thinking skills—reasonable reflective thinking focused on deciding what to believe or do.[5,8–10]

There are several reasons for teaching critical thinking about health in secondary schools. First, young people are eager to learn and adapt easily.[11] Second, critical thinking is among the key competences that many countries, including Rwanda, have included in their primary and secondary school curricula.[5,12] Furthermore, young people are already exposed to health information but lack necessary skills to think critically about that information and make well-informed choices. Fourthly, health is important to everyone, and it is necessary to understand and apply key concepts to assess the reliability of claims about health. In addition, other none health interventions have largely same key concepts for assessing the reliability of claims.[13] Lastly, young people make up 16% of the world population, and 50% of Rwanda's population is less than 20 years old.[14] Investing in their health education, specifically improving their ability to think critically about health, may potentially improve health decision making in a large segment of the population.

A systematic review of the effectiveness of interventions to teach people key concepts required to assess claims about the effects of health interventions found that well designed educational interventions can improve people's ability to apply such concepts.[15] However, the included studies had important limitations, and the review found only three randomized trials that were conducted in schools. Another systematic review of the effects of school-based educational interventions that teach adolescents to critically appraise health claims found that school-based interventions may have an effect on knowledge and skills required for critical appraisal of health claims.[16] However, the certainty of the evidence for all comparisons and outcomes was very low. Most studies in the two reviews were conducted in high-income settings.

One of our studies included in the first review was a cluster-randomized trial of a primary school intervention in Uganda.[17] The intervention helped children to assess the reliability of claims about treatment effects. A follow-up study published after the review showed that children in the intervention arm of the Ugandan trial retained what they learned for at least 1 year.[18] Although the primary school resources were effective, it was hard to scale up use of the resources due to the cost of the intervention, which included a printed textbook that used a comic story.[17] In addition, the primary school lessons were an add-on to the curriculum, rather than being integrated into the curriculum.[19]

Prior to this trial, we conducted a context analysis in Rwanda to explore how we could overcome barriers to wide use of educational resources in secondary schools.[5] Most secondary schools in Rwanda now have "smart classrooms" with computers for students and an Internet connection. Making the resources digital rather than relying on printing could help ensure that they can be widely used at low cost. We therefore developed digital educational resources and planned a cluster-randomized trial to assess the effects of using the resources.

2 | METHODS

2.1 | Design

This was a two-arm cluster-randomized trial conducted in Rwanda. The study was approved by the Rwanda National Ethics Committee (Approval No. 1019/RNEC/2020 and subsequent amendments No. 41/RNEC/2022 and No. 236/RNEC/2022). The trial protocol can be found online.[20] We made no changes to the methods after commencement of the trial. We obtained permission to conduct the trial in schools from the Ministry of Education through Rwanda Basic Education Board. The trial was registered in the Pan African Clinical Trial Registry, trial identifier: PACTR202203880375077.

2.2 | Setting and participants

We conducted our study in lower secondary schools from 10 of the 30 districts in the country. In Rwanda, the basic education system is governed by districts with technical oversight from the Rwanda Basic Education Board (REB) and The National Examination and School Inspection Authority (NESA). Through REB and NESA, we obtained a list of schools with their characteristics and how they categorized them in terms of school performance. We included public, private,

and government aided schools using the national curriculum, which had computers, Internet, over 100 students, and over 10 teachers. We excluded special needs schools, schools that were hard to reach for geographical reasons, and schools that participated in piloting the intervention.

We used multistage sampling to select schools. First, we randomly selected 10 districts, two from each of the five provinces in Rwanda. Then we randomly selected 84 schools from a list of eligible schools in those districts. The schools were stratified by their performance (low versus high performance as defined by NESA) and the sample was proportionate to the number of schools in each district. Participants were students and their science teachers from selected schools. The students were in year 2 of secondary education. We included year 2 students so that we could collect data for this trial and at 1 year follow-up. Students are usually placed in other schools after 3 years. We recruited schools through district authorities after presenting a letter of approval from the Ministry of Education, and school directors selected one senior-two class (normal starting age 14 years) and one teacher. We recruited all students in the class selected by the school director. Before randomization, we obtained consent from school directors and teachers who participated in the study and assent from students.

2.3 | Random allocation and masking

We used a computer-generated sequence to allocate schools in a 1:1 ratio to the intervention or control arm. We used block randomization to balance for school performance, with block sizes of six and four, and equal numbers in each arm. Allocation was conducted by a statistician who was not involved in the recruitment of schools or the analysis of data. We did not change the list after random allocation by the statistician. We did not mask the trial participants or investigators.

2.4 | Procedures

The schools allocated to the intervention arm received the IHC secondary school intervention in addition to the usual curriculum. Teachers in the intervention schools were given access to digital educational resources that included 10 lessons in two versions (blackboard and projector versions) and a teachers' guide.[21] We employed human-centered design with multiple iterations to design the intervention. The lessons focused on nine key concepts that were prioritized by curriculum developers, teachers, and members of the research team (Table 1).[22,23] A detailed description of the intervention is provided using the GREET 2015 checklist in Supplementary File S1.

Teachers in the intervention arm attended a 3-day teacher-training workshop before teaching the lessons. The teacher training was provided by teachers who participated in a pilot study of the IHC secondary school intervention. The teachers in the intervention arm delivered the lessons in a single school term. For each school, the administration planned the timetable based on the free time available. We intended each lesson to last for 40 min (one period). Teachers were free to extend the lesson time or modify the lesson plans.

Teachers in the control arm did not receive any educational resources or training. They were introduced to the trial and its objectives during recruitment meetings. Teachers in both the control and intervention arms of the trial continued with the standard competence-based curriculum. The curriculum includes nine subjects and key generic competences that are taught across subjects, including critical thinking.[24]

At the end of the term in which the intervention was delivered, students and teachers in the intervention and control arms completed the "Critical Thinking about Health" test, Supplementary File S2. We developed this test to measure the ability of students to understand and apply the key concepts covered in trial (Table 1). It includes two multiple-choice questions for each of the nine key concepts. Each question has a scenario including one of the nine concepts, a question about the scenario, and three response options. The questions were taken from the Claim Evaluation Tools item bank.[25]

The test also included questions about English reading proficiency, intended behaviors and self-efficacy, with Likert response options. Prior to the trial, we conducted cognitive interviews and pilot with secondary school students to ensure that the questions and that the format were clear and acceptable. Based on the findings, we modified the questions to clarify some of the terms and to improve formatting. We then conducted a Rasch analysis to assess the validity and reliability of the test.[26] We used a combination of the Nedelsky and Angoff methods to determine the cut off for passing and mastery scores.[27]

The test was administered by trained research assistants within 2 weeks after the intervention was delivered. The research assistants had a questionnaire and answer sheet for each student and teacher, and a unique code was assigned to each participant. The research assistant supervised the test and ensured that students answered the questions independently. After the test, the research assistant scanned the answer sheets.

2.5 | Outcomes

The primary outcome was the proportion of students with a passing score (≥ 9 out of 18 questions answered correctly) on the Critical Thinking about Health Test. Secondary outcomes were the proportion of teachers with a passing score, the proportion of students and teachers with a mastery score (≥14 out of 18), students' and teachers' mean scores (percent correct answers for the 18 multiple-choice questions), the proportion of students that answered both questions correctly for each of the nine concepts, intended behaviors, and self-efficacy.

We assessed the outcomes at the end of the term when the intervention was delivered. After 1 year, we will administer the test again to measure retention of what was learned. We also will compare how well students perform on their national examinations and assess use of what was learned by students in their daily lives and potential adverse effects.

TABLE 1 Learning goals and the prioritized key concepts for the 10 lessons covered in the trial.

	Title of the lesson	Lesson goals	Prioritized key concepts
	Thinking critically about claims		
1	Health actions	- Identify health actions - Explain why it is important to think critically about health actions	1. Health actions can have helpful effects, but they can also have harmful effects and be expensive. 2. The effects of most health actions are not obvious, especially changes that do not occur right after the health action. 3. Usually, personal experience (something that happened to someone after taking a health action) is a weak basis for claims about the effects of health actions. 4. Health actions that have not been evaluated in a reliable comparison but are commonly used or have been used for a long time are often assumed to work. However, they might not work and might be harmful or wasteful. 5. Health actions that have not been evaluated in a reliable comparison but are new, expensive, or technologically impressive are often assumed to work. However, they also might not work and might be harmful or wasteful. 6. Knowledge about the effects of health actions depends on comparisons.
2	Health claims	- Identify claims about the effects of health actions	
3	Unreliable claims	- Identify claims about the effects of health actions that are only based on personal experiences, how commonly used something is, or how new or expensive something is - Explain why most such claims are unreliable	
4	Reliable claims	- Explain why knowledge about the effects of health actions depends on comparisons - Explain why we need researchers to make the comparisons	
5	Using what we learned[1]	- Remember what they learned in Lessons 1 to 4 - Use what they learned in these lessons in their daily lives - Recognize limits to what they have learned	
	Thinking critically about comparisons		
6	Randomly created groups	- Explain why groups of people in a comparison should be similar at the start	7. In a comparison between health actions, important differences (other than the health actions) between comparison groups can be misleading. Randomly creating groups makes sure groups of people are as similar as possible at the start of a comparison and avoids unknown differences. 8. If a comparison between health actions is too small, we cannot be sure that the results reflect a true difference (or lack of difference) between the effects of the different health actions. The results could just be by chance.
7	Large-enough groups	- Explain what it means for comparisons between health actions to be large enough.	
	Making smart choices		
8	Personal choices	- Identify advantages and disadvantages of health actions, for individuals	9. People making a choice about whether to take a health action should consider the potential benefits and potential harms, costs, and other advantages and disadvantages. People making a community choice should also consider who will benefit, who will be harmed, who will achieve savings, and who will bear the costs.
9	Community choices	- Identify advantages and disadvantages of health actions, for communities	
10	Using what we learned[2]	- Remember what they learned in Lessons 1 to 9 - Use what they learned in these lessons in their daily lives - Recognize limits to what they have learned	

2.6 | Statistical analysis

We powered the trial for the primary outcome using the University of Aberdeen Health Services Research Unit's Cluster Sample Size Calculator.[28] We made the following assumptions: 39 students per cluster (one class in each school) based on education statistics,[29] an intraclass correlation at 0.19 and 30% of students achieving a passing score in the control arm based on a previous trial in primary schools,[17] a minimally important difference of 20% based on at least 50% of students in the intervention arm having a passing score, an alpha of 1%, power of 90%, and a maximum 10% loss to follow-up. Based on these assumptions, we calculated a sample size of 84 schools.

In the analysis, we estimated adjusted odds ratios and differences in means for binomial and continuous outcomes, respectively. We estimated adjusted odds ratios using mixed effects logistic regression. Adjusted differences in means were estimated using mixed effects linear regression. For outcomes measured at the level of student, we accounted for the cluster-randomized design using random intercepts at the level of school (the unit of randomization). Because there was a one-to-one relationship between teachers and schools, it was not necessary to account for clustering at the level of teachers. Except where noted below, all analyses were adjusted for the variable used in the stratified random allocation (low versus high school performance). To aid interpretation, we re-expressed odds ratios as adjusted differences,

accounting for uncertainty of the odds in the control arm as well as the odds ratios. Missing test answers were counted as wrong answers. We followed the intention-to-treat principle throughout: all children and teachers who completed the test were included and analyzed in the arms to which they were allocated. We have reported 95% confidence intervals and two-sided *p* values, where appropriate, throughout. All statistical analyses were performed using Stata 16 (StataCorp LLC, College Station, Texas, USA).

Few data were missing so we did not perform the prespecified analyses to explore the risk of bias due to attrition. We estimated adjusted odds ratios comparing students' ability to correctly answer both multiple-choice questions for each of the nine concepts and present these results as a forest plot. For questions about intended behaviors and self-efficacy, we report numbers and percentages of students for each response option and estimates of adjusted odds ratios comparing dichotomized responses (e.g., very unlikely or unlikely, versus very likely or likely).

We performed two planned subgroup analyses as described in our trial protocol.[20] In the first, we estimated treatment effects for the primary outcome in schools with high and low performance as defined by NESA. In the second, we estimated treatment effects for the primary outcome in students whose English reading proficiency was assessed to be advanced, basic, or lacking. Students who correctly answered all four literacy questions in the Critical Thinking about Health Test were categorized as having advanced proficiency. Students who correctly answered both basic questions correctly and one or both of the advanced questions incorrectly were categorized as having basic proficiency. Students who did not correctly answer both basic questions were categorized as lacking basic reading proficiency. For each subgroup analysis, we estimated odds ratios for the interactions between treatment and the variable defining the subgroups and report these alongside *p* values testing hypotheses of no interaction.

Finally, we assessed whether the students who were randomized to the intervention liked the lessons, found them easy, and found them helpful. We report numbers and percentages of students for each response option as well as for dichotomized responses (e.g., liked the lessons a little or very much versus disliked the lessons a little or a lot).

3 | RESULTS

3.1 | Characteristics of trial participants

We recruited participants between February 25, 2022, and March 29, 2022. In total, we recruited 3,128 students in second year of lower secondary and 84 sciences teachers. We randomly assigned 42 schools (1,556 students and 42 teachers) to the control arm and 42 schools (1,572 students and 42 teachers) to the intervention arm. No schools or teachers were lost to follow-up. Thirty-eight students in the intervention arm and 33 in the control arm were absent on the day the test was administered. All participants who were recruited were analyzed for the primary and secondary outcomes. Figure 1 shows the flow of schools, teachers, and students through the study.

Most of the schools in both arms (26 (61.9%) in the control arm and 19 (45.2%) in the intervention arm) were government aided schools, that is, schools mostly owned by faith-based organizations or parents but receiving financial support from the government (Table 2). In both arms 24 schools (57.1%) were categorized as low performing and 18 (42.9%) were categorized as high performing. There were fewer teachers with a bachelor's degree in education in the control arm compared to the intervention arm (22 (52.4%) vs. 31 (73.8%)). The average number of years of teaching experience was similar in the control and intervention arms (9.5 vs. 9.3 years). The median number of students in each class was similar in the control and intervention arms (39 vs. 40). The proportions of female students (53.8% vs. 56.0% and the mean age (15.8 vs. 15.7) were similar in the control and intervention arms.

3.2 | Main findings of the trial

The proportion of students with a passing score in the intervention arm was 915/1572 (58.2%) compared to 302/1556 (19.4%) in the control arm (adjusted odds ratio 10.6 (95% CI: 6.3–17.8), $p < 0.0001$, adjusted difference 37.2% (95% CI: 29.5–45.0)) (Table 3). The proportion of students in the intervention arm with a mastery score was 370/1572 (23.5%) compared to 16/1556 (1.0%) in the control arm (adjusted odds ratio 102.5 (95% CI: 31.9–329.1), $p < 0.0001$, adjusted difference 22.3% (95% CI: 16.6—28.1)). The mean test score for students in the intervention arm was 55.4% (SD 23.1) compared to 33.8% (SD 15.9) in the control arm (adjusted mean difference 20.8% (95% CI: 16.6%—25.0%), $p < 0.0001$).

The proportion of teachers with a passing score in the intervention arm was 41/42 (97%) compared to 20/42 (47.6%) in the control arm (adjusted odds ratio 45.6 (95% CI: 5.7–363.9), $p < 0.0003$, adjusted difference 50.0% (95% CI: 34.2—65.8)). The proportion of teachers with a mastery score was 32/42 (76.2%) in the intervention arm compared to 2/42 (4.8%) in the control arm (odds ratio 64.4 (95% CI: 13.1–315.9), $p < 0.0001$, adjusted difference 71.4% (95% CI: 57.0—85.8)). The mean test score for teachers in the intervention arm was 83.9% (SD 15.2) compared to 47.0% (SD 16.3) in the control arm (adjusted mean difference 36.9% (95% CI: 30.3%—43.5%), $p < 0.0001$).

3.3 | Performance of students on each of the concepts covered in the trial

Students in the intervention arm performed better than those in the control arm on correctly answering both questions for each of the nine key concepts (Figure 2). The largest effect was for the concept "Do not assume that comparisons are not needed," for which 627/1572 (39.9%) students in the intervention arm answered both questions correctly compared to 70/1556 (4.5%) in the control arm (adjusted odds ratio 17.9 (95% CI: 10.9–29.4), $p < 0.0001$, adjusted difference 34.4% (95% CI: 28.3–40.5)). The smallest effect was for the concept "Do not assume that treatments are safe," for which 493/1572 (31.3%) students in the intervention arm answered both questions correctly compared to

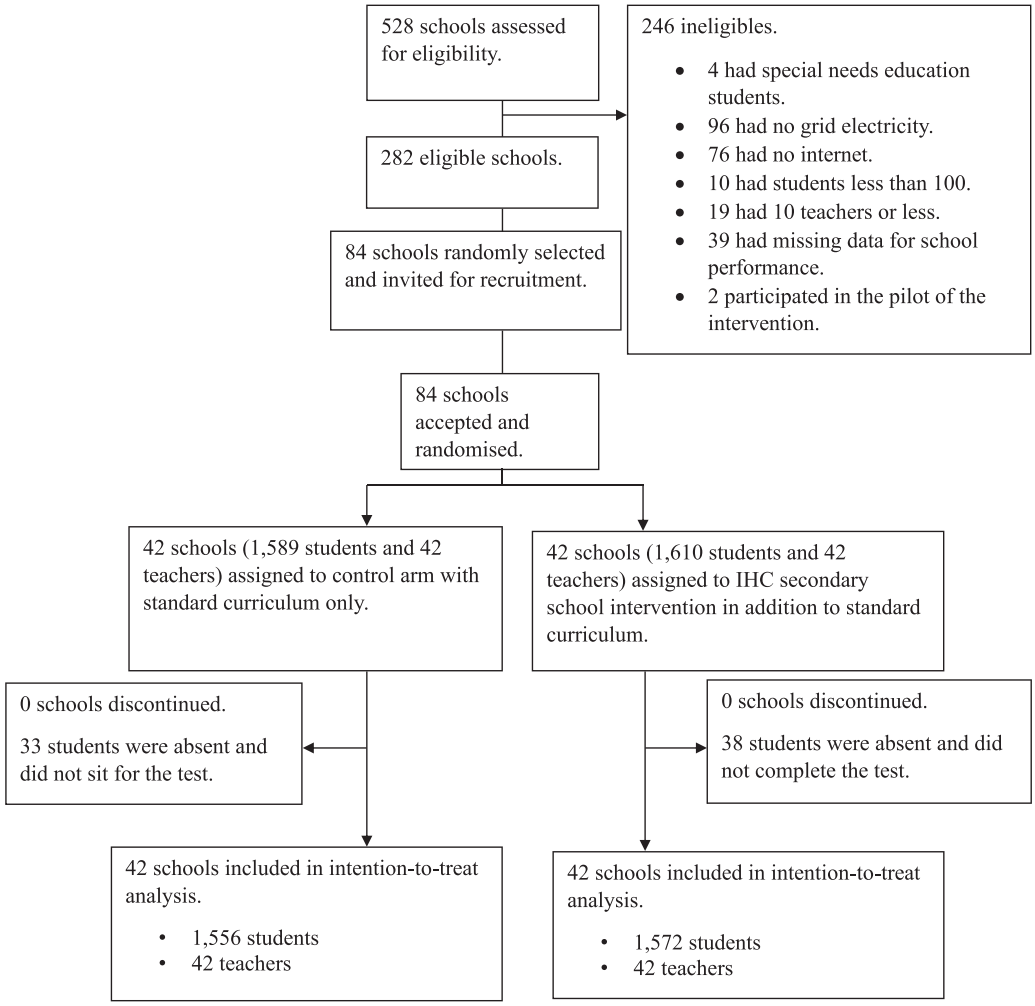

FIGURE 1 Flow diagram of study participants in the trial.

292/1556 (18.8%) in the control arm (adjusted odds ratio 2.2 (95% CI: 1.5–3.2), $p < 0.0001$, adjusted difference 11.8% (95% CI: 6.1–17.4)).

3.4 | Subgroup analysis on school performance and English proficiency of participants

The effect of the intervention was similar in high and low performing schools (adjusted odds ratio for an interaction between the intervention and school performance (low vs. high) 0.8 (95% CI: 0.3–2.3, $p = 0.72$) (Table 4). The effect also was similar for students with advanced and basic English reading proficiency (odds ratio for an interaction between the intervention and English reading proficiency (basic vs. advanced) 0.9 (95% CI: 0.5–1.4, $p = 0.57$). The intervention was effective for students lacking English reading proficiency (adjusted odds ratio 5.6 (95% CI: 3.2–9.9), $p < 0.0001$, adjusted difference 22.9% (15.4–30.4%)). However, the effect was less for students lacking English reading proficiency compared to students with advanced proficiency (adjusted odds ratio for an interaction between the intervention and English reading proficiency (lacking vs. advanced), 0.3 (95% CI: 0.2–0.6), $p < 0.0001$).

3.5 | Self-efficacy and intended behaviors of students participated in the trial

There was little difference in the proportions of students in the intervention arm compared to the control arm who found it easy or very easy to know if a claim about treatments is based on research studies comparing treatments (4.0% (95% CI: −2.3 to 10.2)), to find information about treatments that is based on research (0.5% (95% CI: −4.9 to 5.9)), to judge the trustworthiness of the results of a research study comparing treatments (4.0% (95% CI: −0.8 to 8.8)), or to judge the relevance of a research study comparing treatments (2.7% (95% CI: −1.8 to 7.2)) compared to students in the control arm (Table S5).

More students in the intervention schools compared to the control schools said they were likely or very likely to find out if a claim was based on a research study (adjusted odds ratio 1.4 (95% CI: 1.2–1.8),

TABLE 2 Characteristics of participants in the trial.

		Control schools	Intervention schools
School characteristics			
Schools	*N*	42	42
Province			
Eastern	*N* (%)	14 (33.3%)	12 (28.6%)
Kigali City	*N* (%)	5 (11.9%)	1 (2.4%)
Northern	*N* (%)	9 (21.4%)	10 (23.8%)
Southern	*N* (%)	9 (21.4%)	7 (16.7%)
Western	*N* (%)	5 (11.9%)	12 (28.6%)
School type			
Boarding	*N* (%)	15 (35.7%)	14 (33.3%)
Day schools	*N* (%)	27 (64.3%)	28 (66.7%)
School ownership			
Government aided	*N* (%)	19 (45.2%)	26 (61.9%)
Private	*N* (%)	8 (19.0%)	5 (11.9%)
Public	*N* (%)	15 (35.7%)	11 (26.2%)
School performance			
Low	*N* (%)	24 (57.1%)	24 (57.1%)
High	*N* (%)	18 (42.9%)	18 (42.9%)
Teacher characteristics			
Teachers	*N*	42	42
Completed test	*N* (%)	42 (100.0%)	42 (100.0%)
Education level			
Advanced diploma	*N* (%)	19 (45.2%)	11 (26.2%)
Bachelor's degree	*N* (%)	22 (52.4%)	31 (73.8%)
Masters	*N* (%)	1 (2.4%)	0 (0.0%)
Experience (years)	Mean (SD)	9.5 (6.0)	9.3 (6.4)
Students' characteristics			
Recruited in the study	*N*	1589	1610
Completed test	*N*	1556	1572
Completed test per class	Median (IQR)	39 (33 to 46)	40 (33 to 46)
Gender			
Female	*N* (%)	837 (53.8%)	881 (56.0%)
Male	*N* (%)	719 (46.2%)	691 (44.0%)
Age	Mean (SD)	15.8 (1.4)	15.7 (1.4)

adjusted difference 8.8% (95% CI: 3.5%−14.1%)). There was little difference in how likely they were to find out what a claim is based on (adjusted difference −1.5% (95% CI: −6.1 to 3.1)) or how likely they were to participate in a research study if asked (adjusted difference 3.3% (95% CI: −8.2 to 1.7)) (Table S6).

Most students in the intervention arm liked the lessons a little or very much (85.8%), found the lessons easy or very easy to understand (71.7%), and found what they learned helpful or very helpful (86.7%) (Table S7).

4 | DISCUSSION

The IHC secondary school intervention was effective in helping students to think critically about health claims and choices compared to the usual curriculum. More than half (58%) of the students in the intervention schools had a passing score on the Critical Thinking about Health Test compared to just under 20% of students in the control schools. About 23% of the students in intervention schools mastered the nine key concepts compared to 1% in the control schools. The intervention was effective in both low and high performing schools. The effect was less for students lacking English reading proficiency than for students with advanced proficiency. This may, in part, be because the test was written. The intervention itself required very little reading.

Teachers also benefitted from the intervention. All but one of the teachers in the intervention arm ($n = 42$) had a passing score compared to less than half (48%) of the control teachers ($n = 42$). About three quarters (76%) of them mastered the nine key concepts compared to 5% of the control teachers.

Randomized trials of the IHC secondary school intervention were conducted in Kenya and Uganda in parallel with this trial (unpublished work). The intervention had large effects in all three countries. The proportion of students with a passing score in Kenya was 61.7% (adjusted difference 27.3% (95% CI: 19.6–34.9), $p < 0.0001$). The proportion of students with a passing score in Uganda was 55.1% (adjusted difference 32.6% (95% CI: 26.0–39.2), $p < 0.0001$).

A previous randomized trial of the IHC primary school intervention in Uganda also found a large effect.[17] The proportion of students with a passing score, was 69% and the adjusted difference was 50% (95% CI: 44—55). In that trial, the intervention included a printed textbook that used a comic book story, a printed teachers' guide, and other printed materials. Twelve key concepts were taught, and the intervention included double periods (80 min) for each of the nine lessons. In contrast, our secondary school intervention utilized substantially less time (40 min for each of the ten lessons) and did not include printed materials for the students or the teachers, and only the teachers had access to the digital resources. In addition, the intervention was delivered in a time that was extra stressful for teachers and students. This was because the intervention took place in the last school term following prolonged school closures due to the COVID-19 pandemic.

Other studies have shown that educational interventions can improve people's ability to think critically about the effects of health interventions.[15,16] However, previously there were only two other small, randomized trials in schools and none using digital educational resources.

Critical thinking is among the key competences regarded as essential in the new Rwandan competence-based curriculum, which was implemented in 2016.[5] This trial shows that it is possible to teach such

TABLE 3 Main results of the primary and secondary outcomes of the trial.

	Control schools	Intervention schools	Adjusted difference	Adjusted odds ratio	*p* Value	ICC
Primary outcome[a]						
Students with a passing score (≥9/18)[b]	302 (19.4%)	915 (58.2%)	37.2% (29.5–45.0)	10.6 (6.3–17.8)	<0.0001	0.26
Secondary outcomes[a]						
Students with a mastery score (≥14/18)[b]	16 (1.0%)	370 (23.5%)	22.3% (16.6–28.1)	102.5 (31.9–329.1)	<0.0001	0.37
Mean score for students[c]	33.8% (15.9%)	55.4% (23.1%)	20.8% (16.6–25.0)		<0.0001	0.28
Teachers[d]						
Teachers with a passing score (≥9/18)[b]	20 (47.6%)	41 (97.6%)	50.0% (34.2–65.8)	45.6 (5.7–363.9)	0.0003	
Teachers with a mastery score (≥14/18)[b]	2 (4.8%)	32 (76.2%)	71.4% (57.0–85.8)	64.4 (13.1–315.9)	<0.0001	
Mean score for teachers[c]	47.0% (16.3%)	83.9% (15.2%)	36.9% (30.3–43.5)		<0.0001	

Data are % (SD), % (95% CI), or *n* (%).

Abbreviation: ICC = intraclass correlation coefficient.

[a]The cluster design was accounted for using random intercepts at the level of school.

[b]Logistic regression was used to estimate an adjusted odds ratio, which is re-expressed as an adjusted risk difference.

[c]Linear regression was used to estimate an adjusted difference in means.

[d]Teachers were treated as equivalent to the units of randomization (schools), so these models did not include random intercepts. The stratification variable was modeled as a fixed effect in all analyses. Wald-type confidence intervals and two-sided normal *p* values were computed in all analyses.

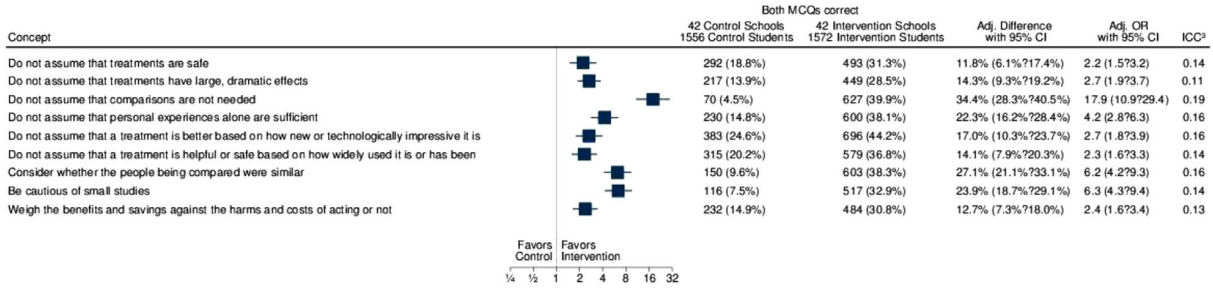

FIGURE 2 Results for each key concept covered in the trial. $p < 0.0001$ for all comparisons. *Number (%) of students answering both MCQs correctly. †Adjusted odds ratios are re-expressed as adjusted risk differences. ‡Intraclass correlation coefficient.

skills in a classroom setting with Internet access and a projector and few other resources. However, the teacher training we provided was probably essential. Findings of the pilot study we conducted prior to the trial, feedback from teachers, and findings of our context analysis all indicated that teachers lacked skills in teaching critical thinking generally and specifically critical thinking about health.[5]

The teacher training was consistent with usual practice in Rwanda, where teachers are trained prior to the introduction of new teaching methods or the implementation of new curricular changes. The workshop was taught by teachers using resources that we provided and could easily be scaled up. In addition to the workshop, the projector version of the lessons, which includes a presentation for each lesson, provided scaffolding for the teachers. An inclusion criterion for schools in this trial was that they had Internet access and projectors. Most public schools in Rwanda have computers, projectors, Internet access, and electricity. However, use of ICT by students is still limited, due in part to low computer-to-student ratios.[5]

School health education in Rwanda includes comprehensive sexuality education, prevention and control of sexually transmitted infections, neglected tropical diseases, hygiene and sanitation.[30] These programs differ from our intervention in two ways. First, they focus on teaching students what to do and not how to assess what to believe and do. Second, they are disease specific, whereas this intervention applies to any disease or health intervention. Teaching critical thinking about health could potentially improve the effectiveness of other school health programs and could potentially be integrated with those programs.

This study has several strengths. Importantly, it was a large, randomized trial carried out in a random sample of schools in Rwanda. In addition, there was very little loss to follow-up of study participants, most likely because the outcomes were assessed at the end of the school term when all students were ready to sit for exams. The Critical Thinking about Health Test was validated,[26] and neither the teachers nor students were exposed to the similar multiple-choice questions before it was administered.

However, the limitation is that responses to the questions about self-efficacy, intended behaviors, and students' perceptions of the lessons may have been biased to some extent by social desirability.

TABLE 4 Subgroup analyses on school performance and English proficiency.

	Control schools ($n = 42$)	Intervention schools ($n = 42$)	Adjusted difference	Adjusted odds ratio	*p* Value	ICC
Low and high performing schools						
Low performing schools	874 students	862 students				
	24 schools	24 schools				
Students with a passing score (≥9/18)	65 (7.4%)	362 (41.9%)	33.0% (23.8–42.3)	11.3 (5.8–21.9)	<0.0001	0.23
High Performing Schools	682 students 18 schools	710 students 18 schools				
Students with a passing score (≥9/18)	237 (34.8%)	553 (77.9%)	41.6% (28.1–55.2)	9.8 (4.3–22.0)	<0.0001	0.29
Interaction						
Intervention × High Performance				0.8 (0.3–2.3)	0.7242	
Students with advanced, basic, and lacking English reading proficiency						
Advanced Proficiency	416 students	481 students				
	37 schools	39 schools				
Students with a passing score (≥9/18)	143 (34.4%)	395 (82.1%)	45.8% (34.8–56.8)	15.2 (7.3–31.7)	<0.0001	0.30
Basic Proficiency	432 students	443 students				
	41 schools	41 schools				
Students with a passing score (≥9/18)	90 (20.8%)	306 (69.1%)	47.2% (38.0–56.3)	17.1 (8.8–33.2)	<0.0001	0.25
Lacking Proficiency	708 students	648 students				
	41 schools	42 schools				
Students with a passing score (≥9/18)	69 (9.7%)	214 (33.0%)	22.9% (15.4–30.4)	5.6 (3.2–9.9)	<0.0001	0.22
Interactions with Reading Proficiency						
Intervention × Basic Proficiency			0.9 (0.5–1.4)	0.5700		
Intervention × Lacking Proficiency			0.3 (0.2–0.6)	<0.0001		
Joint test of no interaction					<0.0001	

Data are *n* (%) and % (95% CI). Logistic regression was used to estimate adjusted odds ratios, which are re-expressed as adjusted risk differences. The cluster design was accounted for using random intercepts at the level of school. Wald-type confidence intervals and two-sided normal *p* values were computed in all analyses. Low school performance was used as the reference and Advanced English reading proficiency was used as the reference. ICC = intraclass correlation coefficient.

Other limitations of the study include uncertainty about retention of what was learned, the extent to which students use what they learned in their daily lives, and potential adverse effects. We will measure the extent to which students have retained what they learned after 1 year, using the same Critical Thinking about Health Test. We are exploring use of what was learned (transfer), other potential benefits, and potential adverse effects in a process evaluation and will explore these further in the 1-year follow-up study.

Inequities, both in the effects of the intervention and their sustainability over time, are an important concern for this intervention. Many of the students in the intervention schools did not achieve a passing score on the test. The subgroup analysis evaluating the impact of English reading proficiency on the effectiveness of the intervention suggests that students who otherwise do less well in school may also benefit less from the intervention.

The Critical Thinking about Health Test was a treatment-inherent outcome measure. That is, it measured content taught in the intervention schools and not in the control schools. Treatment-inherent outcome measures are associated with larger effect sizes than treatment-independent measures of content taught equally in intervention and control schools.[31] Thus, it is inappropriate to compare the effect of our intervention to treatment-independent outcome measures, such as reading or math tests.

Notwithstanding these limitations, the intervention has been more rigorously evaluated than most of what is taught in schools, and we have shown that it improves the ability of some students, as well as their teachers, to think critically about health claims and choices. Future research should focus on developing and evaluating ways of expanding the lessons across multiple school terms to reinforce the nine key concepts taught in the 10 lessons. They should also introduce additional concepts in a spiral curriculum that is integrated into secondary school curricula,[23] ensuring that students who did not achieve a passing score are provided additional support and implementing the intervention nationally.

In summary, this study shows that it is possible to teach critical thinking about health to secondary school students in a low-income setting without a costly intervention. This can potentially reduce the risk of being misled by claims about treatment effects, increase trust in

evidence-based information, and help to improve the extent to which decisions about health interventions are well informed.

AUTHOR CONTRIBUTIONS

MM was the principal investigator for this trial. He conceptualized the study, planned data collection, managed trial process, and wrote the manuscript. LN and ADO were the supervisors and oversaw the trial implementation and were members of the trial steering committee together with NKS and MK. CMCS supported the coordination of field work activities. All authors contributed to the protocol development, review, and approval of this manuscript and had final responsibility for the decision to submit for publication. SER, ADO, JM, and MO led the development of the intervention. AD led the development and validation of the outcome measure. All authors except CJR and AD contributed to the development, review, and approval of the intervention. CJR provided statistical advice and conducted the statistical analyses. All authors had full access to all the data and final responsibility for the decision to submit for publication.

CONFLICT OF INTEREST STATEMENT

MM, LN, CMCS, FC, RS, MO, AN, DS, JM, MK, SL, NKS, SER, and ADO both developed and evaluated the intervention.

DATA AVAILABILITY STATEMENT

All de-identifiable individual-participant data and the data dictionary will be made available on Zenodo. The study protocol with the detailed analysis plan can be found online at https://doi.org/10.5281/zenodo.6562788.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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III

III

Supplementary file 1 – intervention description

GREET checklist.

Guideline for reporting evidence-based practice educational interventions and teaching (GREET) checklist[1]

BRIEF NAME

1. **Intervention:** Informed Health Choices (IHC) secondary school intervention

The intervention was compared to routine practice (teaching according to the national lower-secondary school curriculum without intervening).

WHY this educational process

2. **Theory:** The IHC secondary school resources are based on the *IHC Key Concepts* framework. The framework includes concepts (principles) that people should understand and apply when deciding whether to believe a claim about the effects of health actions (things that people do to care for their health or the health of others) and what to do.[2,3] The framework is based on evidence of the importance of the included concepts,[4,5] logic, feedback, other relevant frameworks, [6] and adaptation of the IHC Key Concepts to other types of interventions such as educational, environmental, and policing interventions.[7]

The resources were developed by the investigators between 2020 and 2022 using human-centred design methods.[8] This included cycles of idea generation and prototyping, piloting with observation, user-testing with teachers and students, and feedback from teachers, students, and curriculum developers in Kenya, Rwanda, and Uganda, and an international advisory group. The aim of the design process was to ensure that teachers and students find the resources to be engaging, useful, and easy to use.

The teaching strategies used in the resources were based in part on an overview of systematic reviews of teaching strategies, [9] and draw on several educational theories. These include social constructivist theory (which postulates that learning can be maximized through well-designed, intentional social interaction with other learners), [10] the theory of active

student response (which postulates that learning is enhanced by high levels of active student response), [11] and the elaborative retrieval hypothesis (which postulates that the search for correct answers on practice tests or quizzes results in multiple retrieval routes which aid later recall). [12]

3. **Learning objectives:** The primary learning goal is for students to have a basic ability to think critically about health actions and understand why this is important. They should be able to recognise claims about the effects of health actions and assess some of those claims. They should understand why it is important for them that researchers study the effects of health actions and recognise two key features of reliable comparisons of health actions. They should recognise that health actions can have both advantages and disadvantages and the importance of weighing the benefits and savings against the harms and costs when deciding what to do.

4. **Evidence-based practice content:** The resources focus on nine IHC Key Concepts that were prioritised by curriculum developers, teachers, and researchers in Kenya, Rwanda, and Uganda. [13]

WHAT

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5. **Materials:** The IHC secondary school resources (*Be smart about your health*) are open access digital resources for lower-secondary school teachers. The 10 lessons are provided as lesson plans in two formats: for teachers who are using either a blackboard and or a projector in the classroom. The aim is for students to learn to think critically about health claims and choices. The resources were made available to schools in the intervention group. Teachers in those schools downloaded the resources to a computer or smartphone and delivered the lessons. Schools in both the control and intervention group continued teaching the national curriculum, which did not include teaching critical thinking about health. No additional materials were provided to the control schools.

Each Lesson includes an introduction, an activity, and a wrap-up. The introduction includes the key messages from the previous lesson, a question about the previous lesson, and what this lesson is about. The activity is designed to help students achieve the learning goals. The wrap-up includes a question about what was learned, the key messages for the lesson, a homework assignment, if there is one, and what the next lesson is

about. Lessons 5 and 10 include quizzes and discussions of application of what students learned in their daily lives.

For each of the 10 lessons there is an overview and background for teachers. The overview includes learning goals, key terms introduced in the lesson, and the main teaching strategies used in the lesson. The background includes a description of what the lesson is about and if relevant, common misunderstandings and closely related content that is not covered in the lesson.

In addition, there is a teachers' guide, materials for teacher training workshops, information about how to use the resources (help), optional printouts (PDFs) for teachers and students, and a glossary. Teachers were provided with binders with printouts at the training workshops.

6. **Educational strategies:** Key strategies used across lessons included guided note taking, small group discussion, use of response cards, [11] homework, use of a standard lesson structure, setting objectives and providing feedback, and multimedia design. Other strategies used in some of the lessons include concept cartoons, inquiry-based instruction, and role play.

7. **Incentives:** The incentive for teachers and students was the value they perceived in learning to think critically about health actions. Teachers at schools without Internet access were reimbursed for the cost of downloading the resources and any other costs related to participation in the trial. They were not paid for participating in the trial and there were no other financial incentives for the schools, head teachers, teachers, or students. The evaluation administered at the end of the school term did not count towards the students' school marks or assessment of the teachers or schools.

WHO PROVIDED

8. **Instructors**: The head teacher at each participating school selected a teacher of a relevant subject (e.g., biology) for year-1 or year-2 of lower-secondary school. The teachers were invited to a 2-3-day workshop to introduce them to the resources and the learning content. The training was facilitated by other teachers who had participated in one of the teacher networks that helped to develop the resources or who piloted use of the

resources. The facilitators were provided with presentations and other materials for the workshops, and they reviewed the material and plans for the workshops with the research teams prior to the workshops.

HOW

9. **Delivery:** The 10 lessons were delivered by the teachers during regular classroom time or, if necessary, outside of regular classroom time. They could use a computer, smartphone, or printouts when delivering the lessons. Depending on what equipment was available to the teachers, they delivered the lessons to students using only a blackboard or using a projector and slide presentations that are included in the digital resources. The number of students in a class varied.

WHERE

10. **Environment:** Representative samples of schools were recruited, including rural and urban schools. The conditions in the schools varied. Details of the context can be found in report of the context analysis undertaken prior to developing the resources. [14]

WHEN and HOW MUCH

11. **Schedule:** The 10 lessons were taught in a single school term. Each school decided how to fit the lessons into the schedule for that term.

12. **Amount of time**: Each lesson was designed to be delivered in a single period (40 minutes). The students were encouraged to collect and assess claims about the effects of health actions outside of class and to discuss claims with their families and friends. The teachers needed up to 30 minutes to prepare for each lesson.

PLANNED CHANGES

13. **Adaptation**: No specific adaptation was required, but teachers were able to adapt the lessons, for example by using different or additional examples or editing the presentations.

UNPLANNED CHANGES

14. **Modifications**: As part of the process evaluations, teachers were asked to complete an evaluation form after each lesson, including information about changes they made to the lesson plan, and some teachers were observed for one to two lessons. No feedback was given to the teachers during the trial.

HOW WELL

15. **Attendance:** The teachers were asked to record attendance for each lesson. Students were encouraged to attend all lessons by telling them when the next lesson would be and its learning goals. The lessons were designed to appeal to students and to make clear the relevance and importance of the learning goals.

16. **Fidelity**: We will explore the extent to which the lessons were delivered as planned in the process evaluation, based on the evaluation forms completed by teachers after each lesson, observations of their teaching a lesson, and interviews with teachers and students.

17. **Delivery schedule**: The teachers were asked to record when each lesson was taught, the duration of each lesson, and whether all the lesson were completed as planned.

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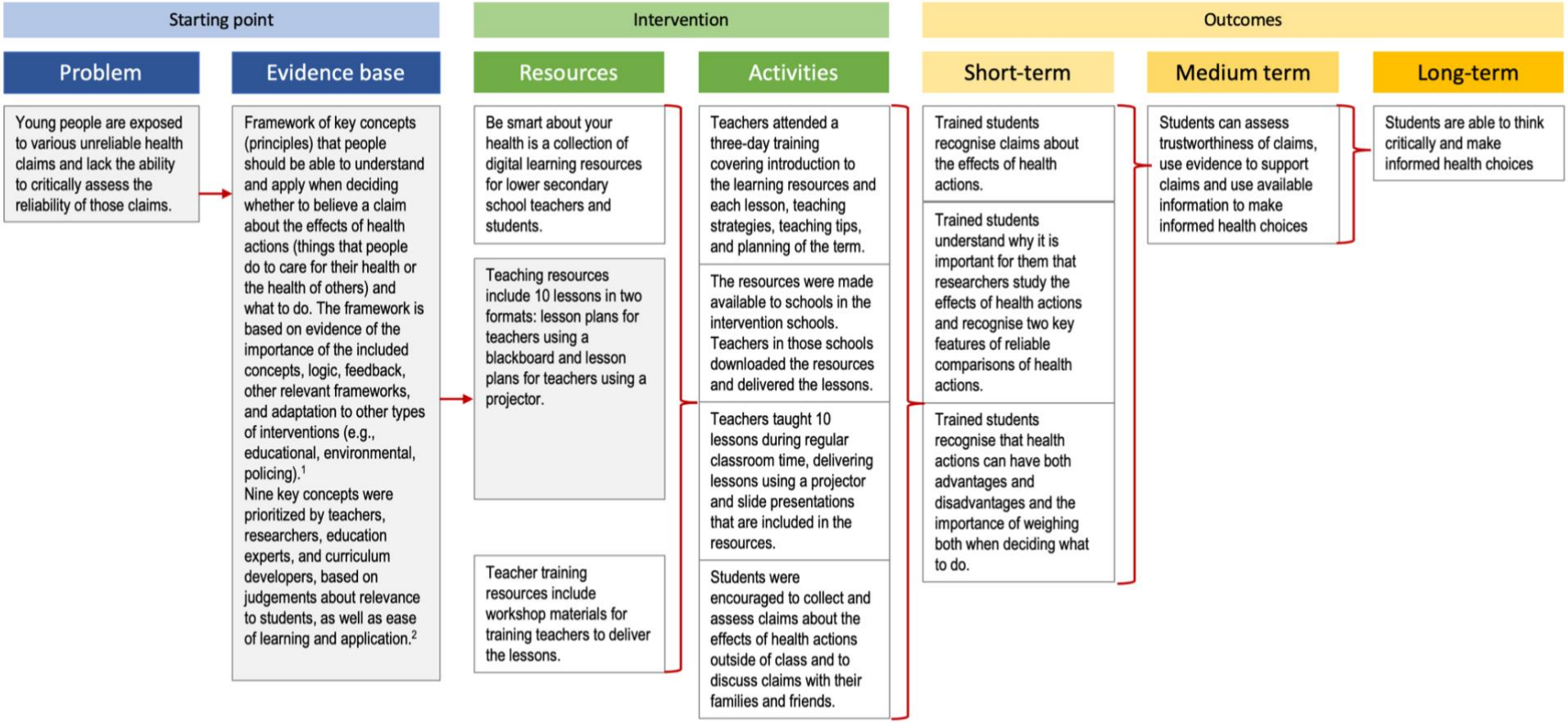
Supplementary file 2 – Logic model

Logic model of the implementation of the IHC secondary school intervention in Rwanda



1. Oxman AD, Chalmers I, Austvoll-Dahlgren A, et al. Key Concepts for assessing claims about treatment effects and making well-informed treatment choices. F1000Research 2019; 7. DOI:10.12688/F1000RESEARCH.16771.2/DOI.
2. Agaba JJ, Chesire F, Mugisha M, et al. Prioritisation of Informed Health Choices (IHC) key concepts to be included in lower secondary school resources: A consensus study. PLoS One 2023; 18: e0267422.

Table 2. Logic model assumptions and external factors affecting the intervention.

ASSUMPTIONS	EXTERNAL/CONTEXTUAL FACTORS
1. Lessons developed are useful and fit for the context. 2. Teacher training enables them to deliver the intervention as intended. 3. Teachers can teach lessons with support of the lesson plan. 4. Students participate fully in learning the resources. 5. Schools are willing to dedicate time and resources for learning the content.	1. ICT factors (computers, projectors, internet) and their use for teaching and learning 2. School administration support (avail class, dedicate time, support teacher in lesson delivery) 3. National curriculum and demand for the teaching critical thinking skills 4. Educational leaders at the district and national level support the intervention delivery. 5. Parents and home members discuss the content of the intervention with students.

SUPPLEMENTARY FILE 3: CERQUAL ASSESSMENT OF THE MAIN FINDING

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
	Implementation of the intervention			
1	Most of the teachers agreed that the teacher training was essential and gave them knowledge and skills to deliver the intervention as planned.	Key informant interviews, lesson and training evaluation forms	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
2	Some teachers said that they took time to prepare and plan well to deliver the intervention.	Key informant interviews, lesson observations, lesson evaluation forms	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
3	Most teachers said that there was not enough time to prepare due to competing activities.	Key informant interviews, lesson observations, lesson evaluation forms	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
4	All schools taught all the lessons and most of the students attended the lessons with few absent.	Lesson evaluation forms, lesson observations, key informant interviews	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
5	Most of the teachers followed the lesson plans with minimal adaptation.	Lesson evaluation forms, lesson observations, key informant interviews	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
6	For some lessons that teachers felt were too long, they increased the time spent if that was possible, or they rescheduled the lesson and repeat the content if there was not enough time to cover the lesson objectives	Lesson observations, key informant interviews	Moderate	The study finding is limited to our few observations and some reports from teachers.

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
7	Most of the teachers noted that students were motivated and participated actively, and that this contributed to students understanding the lesson and achieving the lesson objectives.	Lesson evaluation forms, key informant interviews, lesson observations	Moderate	There were concerns regarding coherence of data underlying a finding. Although teachers reported having achieved lesson gioals, Some of our observations indicated that some lesson goals were not met.
	Perceived desirable effects of the intervention			
	Understanding of the key concepts			
8	Students explained what a claim is and indicated an understanding of some weak bases for health claims, reflecting on what they learnt in class. Their understanding was further illustrated by examples of claims from their daily lives.	Focus group discussions, lesson observations	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
9	Students said that they understood concepts related to critical thinking about evidence (the need for comparisons, for large studies, and for random allocation) but some could not apply the concept in an appropriate way.	Focus group discussions, lesson observations	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
10	Students also indicated an understanding of the concept of weighing the benefits and harms of treatments when deciding what to do.	Focus group discussions swith students, lesson observations	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
	Application of lessons in health context			
11	Students indicated that what they had learnt was useful, and they showed interest in applying this to health claims and practices they encountered in their day-to-day lives	Focus group discussions with students and parents	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
	Use of what learned in other decisions/choices			
12	Some students reported using what they learned in contexts other than health. The concept that students transferred most easily was weighing the benefits and harms of doing something.	Focus group discussions with students and parents	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
13	Teachers and parents said that students who participated in the intervention arm more thoughtful, questioning, and open minded.	Key informant interviews with teachers, focus group discussions with parents	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
	Teachers views on how the intervention impacted them			
14	Some teachers said that these lessons helped them to apply what they taught in real life through 'thinking out of the box', not believing everything, and applying critical thinking skills.	Key informant interviews with teachers	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
	Factors facilitating impact of the intervention			
15	Most of students found the lessons to be interesting and easy to understand because these related to everyday life.	Focus group discussions with students.	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
16	Students, teachers, and school leaders all said that the digital format of the lessons helped and engaged students.	Key informant interviews with teachers and school administrators, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
17	Students felt that the teachers created room for friendly discussions about the lessons and linked what they learned in class to what they faced outside the class.	Focus group discussions with students.	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
18	Techers and school leaders said that a key factor that contributed to the effectiveness of the intervention was that teachers were motivated to deliver the lessons.	Key informant interviews with teachers and school administrators, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
19	Teachers and students found the lessons easy to understand. Teachers, students, and parents found them useful. Teachers and school administrators valued the lessons.	Key informant interviews with teachers and school administrators, focus group discussions with students and with parents	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding.
20	Students were motivated to learn and attended the lessons.	Key informant interviews with teachers, focus group discussions with students, lesson observations, and lesson evaluation forms	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
21	School administration and management supported the delivery of the lessons by providing the necessary resources and time.	Key informant interviews with teachers and school leaders	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
22	Parents' support and home environments helped students to understand the lessons.	Focus group discussions with parents and students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
	Barriers to effective delivery			
23	A barrier related to the lessons was that the concepts and some terms were hard for the students to understand.	Focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
24	The fact that the educational resources were digital was viewed as a barrier by students and teachers because students could not access them outside class.	Key informant interviews with teachers, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
25	Some of the concepts taught in the lessons were difficult and some lessons were hard to understand.	Key informant interview with teachers, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
26	The main barrier expressed by students was that the lessons were not examinable.	Key informant interviews with teachers and school leaders, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
27	Teachers felt that teaching the lessons was an additional workload that was hard to manage.	Key informant interviews with teachers and school leaders	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
28	Competition for use of computers and projectors by other classes was a barrier to implementation of the intervention.	Key informant interviews with teachers and school leaders, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
29	The allocated time (40 minutes) was inadequate for teaching some lessons and competing priorities and time constraints were a major barrier to effective delivery of the intervention.	Key informant interviews with teachers and school leaders, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
	Factors facilitating scale-up of the intervention			
30	The resources addressed skills that are important for students, teachers, and the public.	Key informant interviews with teachers, school leaders, and policymakers, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
31	The lessons are compatible with the curriculum and integrating the lessons in specific subjects could facilitate scale-up of the intervention.	Key informant interviews with teachers, school leaders, and policymakers, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding

No	**Main findings**	**Methods and data sources underlying a finding**	***Overall CERQual assessment***	***Comment on the study finding***
32	Making the content examinable would facilitate scale-up of the intervention.	Key informant interviews with teachers and school leaders, focus group discussions with students	High	No concerns related to methodology, relevance, coherence and adequate of data underlying the finding
33	Policy makers, teachers and students suggested the use of school clubs, printing of IHC resources and use of social media to scale up the IHC lessons.	Key informant interviews with teachers, school leaders, and policymakers, focus group discussions with students.	Low	There were concerns related to coherence and adequate of data underlying the finding

Supplementary file 4 – Team reflexivity considerations

Team reflexivity considerations

By considering and communicating reflexivity considerations, researchers are able to explore and express how their *a priori* values, views, experiences and beliefs about the topic of interest, as well as their context, may influence the research being undertaken (1, 2). While reflexivity considerations are often undertaken individually, there are multiple benefits to also considering how the dynamics, structure and expectations of the research team may influence the research (3). In a team reflexivity process, all relevant members of the research team can discuss how their individual and collective perspectives, beliefs and experiences could have influenced the design and or conduct of the process evaluation, and/or their interpretation of the findings.

Team reflexivity process methods

Written reflections from the team

All members of the research team (FC, RS, SL, AN, DS, SR, JM, AO, AF, NS, MM, MO, MK, AF) were asked to write their responses to the following questions:

- What findings do I expect to come out of the process evaluations?
- How do I anticipate that the findings will contribute to the CHOICE project overall?
- How might I shape the process evaluations or my views of them, based on my beliefs (e.g., about the impacts of the intervention); background and previous research experiences (e.g., my disciplinary training); or hopes or concerns related to the CHOICE project?
- What are my concerns related to the CHOICE project, if any?

The written responses were coded and analyzed using thematic analysis methods by one member of the research team (AN).

Team discussions

We conducted two team discussions with all members of the research team (AF, CH, MK, SL, JM, MM, AN, AO, MO, SR, DS, NS). The team reflexivity discussions took place in January and April 2023. This was after data collection for the process evaluations took place, but before the team started data analysis. Each discussion lasted one to two hours. We used findings from the analysis of the written reflections to guide the discussion. The first team discussion focused on the first three questions in the list above. Based on the topics covered in the first team discussion, we organized the second discussion around the following themes:

- What are other concerns aside from implementation and sustainability (covered during first discussion)?
- Where do these concerns come from?
- What are the relationships between the project team members and how does that impact the research?

Parts of the first team discussion were recorded. The second team discussion was recorded, but the recording was destroyed before transcription. Two people observed and took notes for each discussion.

Analysing our reflections

AN used thematic analysis to identify themes from the written reflections shared by research team members. HMK used framework analysis to identify themes from the team discussions. HMK used thematic analysis to combine the analyses from the written reflections and the group discussions.

Team reflexivity considerations

Ten members of the research team submitted written reflections. 15 researchers participated in the first team discussion and ten researchers participated in the second team discussion. The main reflexivity considerations that emerged were: expectations of the findings from the process evaluations, concerns related to the CHOICE project, and team dynamics.

Background of researchers

The research team consists of 16 researchers who represent a wide array of methodological experience, experience with Informed Health Choices educational resources, and geographic and cultural backgrounds. Most of the researchers (SL, AN, DS, SR, JM, AO, AF, NS, MM, MO, MK, AF) were involved in the development of Informed Health Choices educational resources in an earlier project exploring the effect of these resources among to teach primary school children to assess claims about treatment effects (4). Four of the researchers are leading various components of the CHOICE project as part of their doctoral work. None of the researchers are teachers, educational specialists, curriculum developers, or otherwise involved with the development or implementation of school curricula.

Expectations regarding the process evaluation findings

All members of the research team indicated that they expected findings from the process evaluation to be mostly positive (e.g., students and teachers using what they learned and viewing the learning resources as being well-structured and suitable for student; the resources being relevant for daily life; and leading to improvements in teachers' skills). In addition, some researchers expected there to be clear examples of students and teachers applying what they learned in real life settings (called transfer or far transfer by team members). However, all members of the team also noted (to varying degrees) that they expected important challenges to emerge from the process evaluation (e.g., lack of time, teachers not feeling prepared, infrastructure issues, supervision gaps, resource constraints).

The researchers were almost unanimous in their view that the findings from the process evaluations would inform decisions about scaling up implementation of the intervention, and also inform future research on developing and evaluating the learning resources. Other team members also mentioned that they hoped the findings could be used to apply for future funding to continue development and evaluation of IHC resources.

Reflections on the process evaluation

Given the variety of backgrounds represented in this research project, and different perspectives on how to interpret the emerging process evaluation findings, it is perhaps unsurprising that different concerns regarding the project emerged. The concerns can be divided into the following categories: effects of intervention, project sustainability, wider perspective, and the researchers' relationship to participants.

Considerations regarding the effects of the intervention

Some team members were concerned that a substantial proportion of children receiving the intervention did poorly on the evaluation tests used in the trial, and that both the trial and process evaluation findings suggested that there were some misunderstandings of the key concepts among students and teachers. Others mentioned the potential disadvantages of measuring treatment-inherent outcomes and only near transfer (rather than far transfer). Some team members raised concerns that the research team was not focused enough on assessing the real-world importance of the benefits or how to interpret the effects of the intervention (e.g., what does it mean that students pass a test on key concepts?). Furthermore, many team members expressed concerns about the challenges of assessing the impacts of the resources on decision making in participants' daily lives (transfer).

Considerations regarding the project sustainability and scaling up

Some team members discussed the sustainability of the intervention and issues related to how to scale up implementation of the resources to other settings. Team members' views fell broadly into two groups: firstly, concerns about how to scale up the project and identify innovative methods to improve uptake of the educational resources outside of a research context. Secondly, a view that the team should take a step back and consider whether the project should be scaled up at all. The latter opinion was informed by uncertainties regarding the benefits of the intervention for the day-to-day lives of students, and whether it is worth investing resources in scaling up.

Considerations regarding the scope of the evaluation

Some members of the research team were concerned that the research team has potentially viewed the findings in a limited way (i.e., only within the scope of the project) and has not sufficiently explored how this project fits in with, or could be enhanced by, other research in the field. However, others noted that the project used a very practical approach and focused on identifying issues that could be addressed and improved upon in further research.

Considerations regarding the researchers' relationship to the project and to the participants

Two members were concerned that the research team was both responsible for implementing the intervention and undertaking the process evaluation. They noted that this could have hindered honest and/or critical feedback from the research participants (e.g., teachers).

Considerations regarding dynamics within the research team

The research team had considerable discussion about team dynamics, particularly about the researchers' backgrounds and roles in the project, and hierarchy.

The team generally saw it as advantageous that researchers from contexts of the evaluations were responsible for implementing the research in those contexts. They thought that the design of the educational resources and the conduct of the studies had been improved by input from researchers with an in-depth understanding of each context.

Some members of the team expressed concerns that the team consisted mostly of individuals with health-related backgrounds. It may have been advantageous to have included researchers with educational research and curriculum development when designing the study and interpreting the findings. In the discussions, it was noted that the research team attempted to mitigate this potential weakness by involving stakeholders (e.g., teachers, curriculum developers) at all stages of the research process.

Some members of the team also highlighted that the roles of particular researchers in the project may influence their interpretation of the findings from the trial and the process evaluation. They suggested that those members of the team who had been involved in developing and evaluating the IHC educational resources in a previous project may lean toward over overstating positive findings and may pay less attention to potential harms or negative findings. In contrast, those who have responsibility for exploring adverse effects may focus on negative findings and downplay positive findings.

The role of the researcher also emerged as a theme during discussions of team dynamics. Some of the more junior researchers noted that having a very senior researcher leading the project could have been a barrier to sharing critical opinions. However, they felt that in this project there were opportunities for sharing opinions freely, including disagreeing about methods and interpretation, and a general openness.

Finally, given that the study took place largely during the COVID-19 pandemic, there were few opportunities in the earlier phases of the project for face-to-face meetings or team-building events. Some team members noted that this may have impacted on the way in which the team worked together. During the last phase of the project (data analysis and planning the 1-year follow up) many of the project team members met regularly face-to-face.

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Study tools

Study tools - Paper I

1. Interview guide
2. Interview guide for stakeholders
3. Interview guide ICT use – stakeholders
4. Interview guide – teachers
5. Observation checklist

Study tools – Paper II

The Critical Thinking about Health Test

Study tools – Paper III

1. Lesson evaluation form
2. Lesson observation form
3. Teachers interview guide
4. Guide for focus group discussion
5. Guide for parents focus group discussion
6. Training Evaluation Form
7. Descriptive data for schools
8. Descriptive data for Teachers
9. School authorities interview guide

Study tools – Paper I

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1. INTERVIEW GUIDE FOR STUDENTS

A. HEALTH IN SUBJECTS TAUGHT

1. Describe or mention subjects that you learn about health or health concepts

Probe:

- What subjects in your curriculum you learn about health?
- What topics are health related

2. Share your opinion regarding health content in the curriculum or mentioned above

Probe:

- Benefits (how helpful is it in their lives)
- Application in their daily lives
- Ease of understanding

B. TREATMENT CLAIMS

1. Can you think of examples of things that people say you should do to protect or improve health – for example, things that you have heard on the radio or television, seen on the internet, or heard friends or family say?

Probe:

- Different health conditions and treatments

2. Do you hear lots of claims like those or not so many?

3. How do you decide whether to believe what someone says you should do?

C. HEALTH INFORMATION

1. If you wanted health information where would you look for it? For example, if you were sick and wanted information about what you should do, or if you had a question about what you should do to stay healthy or avoid getting sick?

2. How do you decide what information to believe and what to do?

D. COMPARISONS AND CHOICES

Imagine you heard a story on the radio or the internet about health research – a study – that found that a health intervention (something that people can do to protect or

improve health) worked – for example, something that people can do to protect them against COVID-19.

1. How would you decide whether to believe what the study found?

Probe:

- What would you want to know about the study?

2. How would you decide whether to use that health intervention?

Probes:

- What things would you think about when deciding?
- What other information would you want?

E. LEARNING CRITICAL THINKING ABOUT HEALTH

1. Critical thinking is identified as an important competence in the national curriculum.
   What does critical thinking mean to you?
   Do you think it is important to be able to think critically?
   Can you think of examples where critical thinking was taught in any of your subjects?
   How was it taught?

Probe:

- One definition of critical thinking is "thinking carefully about what to believe or do"

2. Health is not a subject, but it is taught in several different subjects.
   Can you think of examples where health is taught in any of your subjects?
   How was it taught?
   What did you learn?
   Do you think it is important to learn about health was taught in any of your subjects?

3. Do you think there is a need for students like you to learn how to think carefully about what to believe or do to protect or improve health?
   Can you think of any examples where critical thinking about health?

F. USE OF ICT FOR LEARNING IN SCHOOL AND AT HOME

1. Can you think of examples where computers, the internet, a projector, printers, or other ICT has been used to teach lessons in a subject other than ICT (i.e. learning how to use computers)?
   What did or would you like about using ICT in different subjects in school?
   What did or would you not like about using ICT in different subjects in school?

2. How have you been studying at home during the pandemic, while schools are closed? For example, have you listened to lessons on radio or television, have you used textbooks at home (printed or digital), other printed material (things that your teachers printed for you and your classmates) have you used a computer or smart

phone? Have you studied together with friends or with your parents? How have you communicated with your teachers?
What did or would you like about studying at home while schools are closed?
What did or would you not like about studying at home while schools are closed?

2. INTERVIEW GUIDE FOR STAKEHOLDERS

INTRODUCTION

Role:…….

TEACHING AND LEARNING IN GENERAL

1. In a few words, describe the current (Competence-based) curriculum and how it compares to the previous curriculum.
2. How is teaching and learning conducted in Rwanda in line to the current curriculum (Competence Based Curriculum)

Probe:

- Main characteristics
- Main differences

3. What teaching methods are used for teaching and learning in Rwanda

Probe:

- Small group discussion etc

4. How are cross-cutting subjects taught and managed in school;

Probe:

- Cross cutting issues such as comprehensive sexuality education
- Coordination team for cross-cutting (e.g comprehensive sexuality education)

TEACHING CRITICAL THINKING

5. Is critical thinking about health taught today in Rwanda, and if so, how? (Critical thinking about health is *reasonable reflective thinking focused on deciding what to believe or do for your health)*

6. Do you think there is a need to teach critical thinking about health? If so, where in the curriculum can they fit

7. Do you think there are challenges existing to teach critical thinking about health?

Probe:

a. Students
b. Teachers

G. NEW RESOURSES IMPLEMENTATION

8. Describe how decisions are made involving which new resources will be used to teach in schools.
    - Prompt: who is involved, who makes the final decision, what is a typical process, what criteria are used to decide

9. When would it be possible to test new resources in secondary schools?

Probe:

a. Which subjects;
b. During class hours or out of class hours

H. TEACHER TRAINING AND DEVELOPMENT

10. Describe how in-service teacher training is conducted especially when introducing new curricula or resources

I. SCALING UP AND SUSTAINING USE

11. Are there important considerations or guidance that we should be aware of when designing the learning resources to ensure that they can be made available through REB's gateway?

12. How can we partner with REB to ensure sustainability of the resources after the end of the project and are there other partners with whom we should collaborate?

Probe:

a. Are there specific people or departments at REB
b. Are there specific people or groups with responsibility for or interest in teaching critical thinking
c. Are there specific people or groups with responsibility for competences or learning goals related to health

3. INTERVIEW GUIDE ICT USE – STAKEHOLDERS

Topic 3: Information and Communication Technology (ICT)

1. Describe technologies used in secondary schools today for teaching and learning purposes?

    - What type(s) of devices *(e.g. computer, tablet, smartphone)* and how old are they?
    - Ratio of students/teachers to device?
    - When and how much can students/teachers use devices?
    - Do students use devices individually and/or in groups?
    - What operating system(s) *(e.g. Windows, OS or Linux on desktop/laptop computers; iOS, Android, Chrome OS on tablets/smartphones)*? What version(s)?
    - What type/version of browsers *(e.g. Internet Explorer 9)?*
    - Is there capacity to change/update operating systems or browsers?
    - How are resources downloaded?
    - How is information uploaded?
    - How are learning resources distributed to students? *(e.g. downloaded directly, or downloaded to a local network and distributed from there)p*
    - Ability of teachers to ineract with students digitally
    - Firewalls / security systems

2. What are the main challenges using ICT in teaching, and what are the work-arounds to these issues?
    a. Probe: maintenance, connectivity, *power supply, support, computers per student, etc*

3. What are existing digital learning resources and how are they developed?

4. What plans are there for introducing or improving technologies in the future?

Topic 4: Opportunities and challenges for using digital resources

5. What opportunities are there for using digital learning resources?

6. What challenges are there to using digital learning resources?

7. Are there any standards or guidelines for developers of digital learning resources for Rwandan schools?

4. INTERVIEW GUIDE – TEACHERS

IHC CHOICE – Context analysis interviews	
Country	
Interview no.:	
Date:	
Interviewer/Observer:	
Audio recording?	

BEFORE THE INTERVIEW: INTRODUCTION AND CONSENT

Introduce yourself and your role in the project, briefly.
Refer to the information that the participant should have received via email beforehand.
Inform the participant about their rights and our responsibilities.

- Data will be handled anonymously.
- Sensitive personal information will not be saved.
- They are free to end the interview at any time, without giving a reason.

Describe and explain the project, briefly, using plain language.

- There are many claims about what is good for our health.
- Many of those claims are unreliable (we cannot be sure that they are correct).
- To make good choices for our health, we must be able to separate reliable from unreliable health claims.
- Many people have not learned how to do this.
- [Your university] together with partners in other countries, are developing resources for secondary schools, to help students think critically (carefully) about health choices.

Explain the purpose of the interview, briefly:

- We want to learn from your experience, so the resources we develop are appropriate.
- You are not being tested, and there are no wrong answers.

Request written consent to participation and to being recorded
Begin recording if given written consent to do so

INTERVIEW

Ask the participant to introduce themselves (without revealing their identity)

Prompts for teachers

- Subjects taught, in what grades
- Type of school
- Class sizes

Topic 1*:* Teaching critical thinking, health, and critical thinking about health

Prompts

- How is critical thinking taught today?
- How is health taught today?
- How is critical thinking about health being taught today?
- What need is there for teaching critical thinking about health?
- Where in the curriculum can it fit in?
- How much time could potentially be made available to teach critical thinking about health and how/where? (What could it replace?)
- What plans are there for developing the national curriculum with respect to critical thinking, health, and critical thinking about health?
- What are challenges to teaching students critical thinking about health?

Topic 2: Learning resources for teaching critical thinking, health and critical thinking about health

Prompts

- What resources are currently used to teach these subjects?
- Who makes decisions about which learning resources to use and how?
- Where are learning resources typically found or accessed by teachers?

Topic 3: Information and Communication Technology (ICT)

Prompts

- What technologies are used in secondary schools today for teaching and learning purposes? *(For teachers and head teachers, answer about conditions in your school. Teachers may not have all the answers to these questions – they can refer you to their ICT manager.)*
    - What type(s) of devices *(e.g. computer, tablet, smartphone)* and how old are they?
    - Ratio of students/teachers to device?
    - When and how much can students/teachers use devices?
    - Do students use devices individually and/or in groups?
    - What operating system(s) *(e.g. Windows, OS or Linux on desktop/laptop computers; iOS, Android, Chrome OS on tablets/smartphones)*? What version(s)?
    - What type/version of browsers *(e.g. Internet Explorer 9)?*

- Is there capacity to change/update operating systems or browsers?
- How are resources downloaded?
- How is information uploaded?
- How are learning resources distributed to students? *(e.g. downloaded directly, or downloaded to a local network and distributed from there)p*
- Ability of teachers to interact with students digitally
- Firewalls / security systems

- What are the main challenges using ICT in teaching *(e.g. maintenance, connectivity, power supply, support, computers per student, etc)*, and what are the work-arounds to these issues?
- What plans are there for introducing or improving technologies in the future?
- How does your school compare with other schools that you are familiar with (regarding ICT)?

Topic 4: Opportunities and challenges for using digital resources

Prompts

- Examples of good and bad digital resources used today
- What opportunities are there for using digital learning resources?
- What challenges are there to using digital learning resources?
- Are there any standards or guidelines for developers of digital learning resources for [Rwandan] schools?

Other people we should talk to

- Do you have suggestions of people we should talk to?
- If yes, do you give your consent for us to identify you as the person who recommended we contact them?

Other comments

- Is there anything you want to add?

Thank the participant for their time and insight.

5. OBSERVATION CHECKLIST

Observation school visits (seeing ICT in use, in addition to interviews)

IHC CHOICE – Context analysis interviews	
Date	
School Name	
School ownership(Private/ public)	
School geographical location (Rural/Urban)	
Location	**Country……..** **District ……** **sector……**
Observer Name:	
Serial Number	

1. School organisation/setting (classess, computer lab, students, teachers)

2. Description of what technologies you see in use

3. Description of how these technologies are being used by teachers and by students and how they do some tasks . Describe the environment, the objects, the people, their interactions with eachother and with the technology,, their observable experiences including barriers and work-arounds, your thoughts and comments. (Use more paper to write or draw).

What to do with notes:

- Spend an hour at the end of each day discussing what you found
- Build on what you have found to focus next on areas that need more fleshing out
- Write up your notes at the end of that day (you lose so much if you wait too long)

Study tools – Paper II

The Critical Thinking about Health Test

Instructions

Before you start, please note that some words in this questionnaire may not be familiar to you. Please read through the following explanations:

A **TREATMENT** is anything done to care for yourself, so you stay well or, if you are sick or injured, so you get better and not worse. For example, skin cream.

A **TREATMENT CLAIM** is something someone says about whether a treatment causes something to happen or to change. A claim can be true or can be false. For example, if a friend says "Using skin cream will help your skin rash".

A **RESEARCH STUDY** is a way to answer a question by carefully collecting information. For example, a study might be done to answer the question: Does skin cream help people with skin rash?

RESULTS of a study are what the study found. For example, whether people who use skin cream had less skin rash.

When something happens by **CHANCE**, it is not possible to tell in advance what will happen. For example, if you flip a coin, you cannot tell in advance if it will land on one side or the other side.

First, read the text above the questions and then answer each question on **the SCORE sheet,** using one of the provided answers.

For each question, choose what you think is the best answer and **fill in the circle** for that answer in the score sheet, like this.

If you want to change your answer, carefully erase the first circle that you filled in.

Do not fill in more than one circle for each question.

The examples below show you the one correct way and some wrong ways to mark your answers.

Be sure to fill in the circles the correct way.

Part 1.
Questions about you

1. **District code** ☐

2. **School code** ☐

3 **Student code** ☐

4 **Your age** ☐

5. **Your gender** ☐ M

☐ F

Part 2. Reading ability questions

A doctor did a research study to find out if drinking tea keeps people from getting sick. He flipped a coin to decide who should get the tea and who should not. People who got tea went to the doctor's office every day to drink their tea. At the end of the study, people who got the tea were less likely to be sick than those who got no tea.

Based on the text above, please answer the following questions:

6. *Question*: Who went to the doctor's office every day?

Options:

A) People who did not get tea

B) People who got tea

C) Everyone

D) People who got sick

7. *Question*: How did the doctor decide who should get tea?

Options:

A) By flipping a coin

B) By asking people if they would like tea

C) The doctor gave tea to those who were more likely to be sick

D) The doctor asked people who came to his office

A doctor did a research study to find out if drinking tea keeps people from getting sick. He flipped a coin to decide who should get the tea and who should not. People who got tea went to the doctor's office every day to drink their tea. At the end of the study, people who got the tea were less likely to be sick than those who got no tea.

Based on the text above, please answer the following questions:

8. *Question*: **What was the treatment?**

Options:

A) Tea

B) Sleep

C) The study

D) The doctor

9. *Question*: **What was the result of the study?**

Options:

A) Drinking tea can help people from getting sick

B) Doctors should toss coins when doing studies

C) People should go to the doctor if they are sick

D) Not drinking tea can help people from getting sick

Part 3.
Questions about claims

10. *Question***:**

Anne has pain in her ear, and she asks her brother Hassan what to do about it. He says that once, when he had a pain like that, he cleaned his ear with hot water. The next day, his ear pain was gone. Based on his experience, he says rinsing with hot water is helpful for ear pain.

Question: **Do you agree with Hassan?**

Options:

A) Yes. Because this is Hassan's experience, it is likely to be true

B) No, Hassan's experience is not enough to be sure

C) Yes, Hassan rinsed his ear with hot water and the next day his ear pain was gone

11. *Question***:**

Sarah says that medicines from well-known companies, costing more money, are not necessarily the best. Medicines from less known companies, costing less money, may be just as good or even better.

Question: **Is Sarah right?**

Options:

A) No, medicines costing less money are more likely to be harmful than expensive medicines

B) Yes, just because the medicine is expensive does not mean that it will work better than other medicines

C) No, expensive medicines made by well-known companies are better than less expensive medicines made by lesser-known companies

12. *Question***:**

Edith has stomach pain. Edith's mother says that fruit juice is a good treatment for stomach pain. She learnt about this treatment from Edith's grandmother. Over many years, other families she knows have also used fruit juice to treat stomach pain.

Question: **Based on this, how sure can we be that fruit juice is a good treatment for stomach pain?**

Options:

A) Not very sure. Even though people have used fruit juice over many years, that does not mean that it helps stomach pain

B) Very sure. If it has worked for Edith's mother and other people who have tried it, it will probably work for her too

C) Not very sure. Edith should ask more families if they use fruit juice to treat stomach pain

13. *Question***:**

John has a skin rash on his leg. A shop sells several skin creams to treat skin rashes. John chooses a skin cream from a well-known company, even though it is more expensive than the other creams. John thinks this skin cream is more likely to heal his rash than the other skin creams because it is more expensive.

Question: **Is John right?**

Options:

A) No, just because the skin cream is expensive does not mean that it will work better than other creams

B) It is not possible to say. However, expensive skin creams are likely to be better because the companies spend more time making them

C) No, the skin cream is probably not as good as the other skin creams. People just like well-known companies more

14. *Question***:**

Sarah has a sickness. There is a medicine for it, but she is not sure if she should try it. A research study comparing the medicine with no medicine found that the medicine was helpful but also that it could be harmful. Three of Sarah's friends are telling her what to do.

Question: **Which of the following things said by her friends is more correct?**

Options:

A) She should only take the medicine if many people have tried the medicine before

B) She should only take the medicine if she thinks it will help her more than it will harm her

C) If Sarah has enough money to buy the medicine, it could not hurt to try it

15. *Question***:**

Imagine you and your friends have formed a team to take part in a local running competition. People on the other teams all had bananas for breakfast. You and your friends did not have bananas for breakfast and lost the race. Some people say that this was because your team had bread for breakfast and that made them run slower.

Question: **If you did a research study comparing people who eat bananas for breakfast with people who don't eat bananas for breakfast, how would you decide who should have bananas for breakfast?**

Options:

A) By chance (like flipping a coin) to make sure the two groups are as similar as possible

B) By having the teams decide, to make it as fair as possible

C) By having the teachers decide, because they know who would benefit best from eating bananas

16. *Question*:

Regina has a sickness that makes it difficult for her to breathe. She hears on the radio about a medicine that has helped many people with breathing problems.

Question: **How sure can Regina be that the medicine does not have any harms?**

Options:

A) It is not possible to say, it depends on how much hope Regina has in the medicine

B) Very sure, since the medicine has helped many people, it is unlikely that it also harms people

C) Not very sure, because all medicines may harm people as well as help them

17. *Question*:

Outside the city where Paul lives there are many farms. The farmers often get coughs. For many years, the farmers have used strong tea to treat their coughs. They say that the tea is good for them and that it protects them from becoming more sick.

Paul says that the farmers may not be right, and that the strong tea may not help coughs.

Question: **Do you agree with Paul?**

Options:

A) Yes, Paul should try drinking strong tea himself to know for sure. The strong tea may work differently on him

B) Yes, we can only know for sure if the strong tea works if it has been compared with other treatments in studies

C) No, the farmers would not have used strong tea for all those years if it did not work

18. *Question***:**

Jane often has headaches. Her doctor tells her that there is a medicine that may help her, but it may harm her. The medicine is also very expensive.

Question: **What does Jane need to think about before using the medicine?**

Options:

A) If the medicine will help her more than it will hurt her, and if she thinks it is worth paying so much money for it

B) If anybody she knows has tried the medicine so that she can ask them what they thought about it

C) If she should ask another doctor, since the doctor must be wrong. A medicine which is helpful cannot be harmful

19. *Question***:**

Mercy wanted to know if eating bananas makes you run faster. To find out, she invited her six best friends to take part in a research study. Three friends each got bananas, and three friends did not get bananas. At the end of the study, the friends who did not get bananas ran a lot faster.

Question: **How sure can Mercy be about her study's results?**

Options:

A) More sure, because Mercy found a difference between the groups in how fast they ran. This means that the study included enough people.

B) Less sure, because the difference between the two groups could have occurred by chance

C) More sure, if she repeats the study with six more friends

20. *Question*:

Doctors studied people with stomach pain before and after they took a new medicine. After taking the new medicine, many people felt less pain.

Question: **Can we be sure that the new medicine is good for treating stomach pain?**

Options:

A) No, taking the new medicine should have been compared either with not taking the medicine, or with taking an older medicine

B) Yes, people were asked how much pain they felt before and after they took the new medicine

C) Yes, the study was done by doctors

21. *Question*:

A new and an old mosquito spray (insecticide) were compared in a research study. In the study, two houses were sprayed with the new spray, and two houses were sprayed with the old spray. Based on this study, the new spray was better for protecting against mosquito bites than the old spray. Neither of the sprays was found to be harmful to people.

Question: **How sure can you be about what the study found?**

Options:

A) Less sure, because only four houses were studied and the differences between sprays may have happened by chance

B) More sure, because the new spray was better for protecting against mosquito bites and it was not harmful

C) More sure, because the new spray was found to be better, and the differences between sprays is unlikely to have happened by chance

22. *Question*:

On the radio, there is someone selling a treatment - a new juice. The seller says that if you drink one glass of it every day, you will not get sick.

Question: **How sure can you be that the new juice will keep you from getting sick?**

Options:

A) It is not possible to say. I would have to try the new juice myself to be sure

B) Very sure, otherwise this news would not be on the radio

C) Not very sure. Very few treatments work so well

23. *Question*:

Dr. Javier has done a research study giving a new medicine to people who were vomiting. Some of the people stopped vomiting after they got the new medicine. Dr. Javier says that this means that the medicine works.

Question: **Is Dr. Javier right?**

Options:

A) No. The people who used the medicine were not compared with similar people who did not use the medicine

B) Yes, some of the people stopped vomiting

C) No, since not all the people stopped vomiting

24. *Question***:**

George has stomach pain. The last time George had a stomach pain was two months ago. That time, he drank some hot milk and after an hour, his stomach pain was gone. Therefore, George says hot milk cures stomach pain.

Question: **Is George right?**

Options:

A) It is not possible to say. His stomach pain might have gone away without the hot milk

B) It is not possible to say, but it is likely to be true based on the fact that George had this experience

C) Yes, George's experience is enough to show that hot milk makes stomach pain go away

25. *Question***:**

Esther recommends a new treatment – a medicine - for pain. She says that everyone who has tried it felt better.

Question: **How sure can you be that what Esther says about the new medicine is true?**

Options:

A) Not very sure. Very large benefits, where everyone or nearly everyone gets better because of a treatment are rare

B) It is not possible to say. To be sure I would have to try the medicine for myself

C) Very sure. The medicine must be very good since everyone who has tried it got better

26. *Question*:

A doctor wanted to know which of two treatments was best for headaches. In a study to find out, he asked people to choose which treatment they would like to get. He compared the people who took each of the two treatments.

Question: **How sure can we be about the results of this comparison of the two treatments?**

Options:

A) More sure, because the doctor asked people to choose which treatment they wanted

B) Less sure, because the doctor should have decided who got which treatment

C) Less sure, because the doctor should have given people one of the two treatments by chance (like flipping a coin)

27. *Question*:

Mary wanted to find out which plants were best for treating people with headaches, so she did a research study to compare green plants with yellow plants. The people who used the green plants had fewer headaches compared to the people who used the yellow plants.

Question: **How sure can we be that green plants are better than yellow plants?**

Options:

A) It is not possible to say. Mary did not study possible harms of the plants

B) Very sure, since people who used the green plants had fewer headaches

C) Not very sure, it depends on how much people believe the green plants will work

Part 4. Questions about your views

Below are some questions about what you think. **There are not right or wrong answers to these questions.**

Below are some actions. Please read each one carefully and give the answer that comes closest to how difficult or easy you find each of the actions to be. There are not right or wrong answers to these questions.

28. *Question:* How difficult or easy do you find knowing if a claim about a treatment is based on a research study comparing treatments?

Options:

A) Very difficult
B) Difficult
C) Easy
D) Very easy
E) I don't know

29. *Question:* How difficult or easy do you think it is to find information about treatments that is based on research studies comparing treatments?

Options:

A) Very difficult
B) Difficult
C) Easy
D) Very easy

Below are some actions. Please read each one carefully and give the answer that comes closest to how difficult or easy you find each of the actions to be. There are not right or wrong answers to these questions.

30. *Question:* **How difficult or easy do you find judging the trustworthiness of the results of a research study comparing treatments?**

Options:

A) Very difficult
B) Difficult
C) Easy
D) Very easy
E) I don't know

31. *Question:* **How difficult or easy do you find knowing if the results of a research study comparing treatments are relevant to you?**

Options:

A) Very difficult
B) Difficult
C) Easy
D) Very easy

Think about a sickness that you might get. Imagine someone claiming (saying) that a treatment might help you get better.

32. *Question:* **How likely are you to find out what the claim was based on (for example by asking the person making the claim)?**

Options:

A) Very unlikely
B) Unlikely
C) Likely
D) Very likely
E) I don't know

33. *Question:* **How likely are you to find out if the claim was based on a research study comparing the treatment to no treatment?**

Options:

A) Very unlikely
B) Unlikely
C) Likely
D) Very likely
E) I don't know

34. *Question:* **How likely are you to say "yes" if you are asked to participate in a research study comparing two treatments for your sickness?**

Options:

A) Very unlikely
B) Unlikely
C) Likely
D) Very likely
E) I don't know

Part 5.
Questions about your experience with the Be Smart about Your Health lessons

Below are some questions about what you think. **There are not right or wrong answers to these questions.**

35. *Question:* **How much did you <u>like or dislike</u> the lessons?**

Options:

A) I liked the lessons very much
B) I liked the lessons a little
C) I disliked the lessons a little
D) I disliked the lessons very much

36. *Question:* **How <u>easy or difficult</u> were these lessons to understand?**

Options:

A) Very difficult to understand
B) Difficult to understand
C) Easy to understand
D) Very easy to understand

37. *Question:* **How <u>helpful or unhelpful</u> has what you have learned been to you?**

Options:

A) Very helpful to me
B) Helpful to me
C) Unhelpful to me
D) Very unhelpful to me

Study tools – Paper III

1. Lesson evaluation form

	Lesson evaluation questionnaire	
	1. SCHOOL GENERAL INFORMATION	**Expected answer**
1.1	District	Burera
		Kicukiro
		Muhanga
		Musanze
		Ngororero
		Nyagatare
		Ruhango
		Rusizi
		Rwamagana
1.2	School code	School name
1.3	Lesson	Test session
		Lesson 1: Health actions
		Lesson 2: Health claims
		Lesson 3: Unreliable claims
		Lesson 4: Reliable claims
		Lesson 5: Using what we learned (1)
		Lesson 6: Randomly created groups
		Lesson 7: Large-enough groups
		Lesson 8: Personal choices
		Lesson 9: Community choices
		Lesson 10: Using what we learned (2)
	2. Lesson preparation	
2.1	How long did it take you to prepare the lesson (minutes)	Number
2.2	How would you rate the level of preparedness	Very unprepared, Unprepared, Prepared, Very prepared
2.3	What made the preparation easy or difficult for you	text
	3. Lesson Delivery	

3.1	Planned date of lesson delivery	Date
3.2	Actual date of lesson delivery	Date
3.3	Was there a change to the planned date of delivery	yes/no
3.4	If yes explain what happened	text
3.5	Mode of delivery	blackboard/projector
3.6	Was there a change to the mode of delivery	yes/no
3.7	If yes explain what happened	text
3.8	Number of students attended the lesson	number
3.9	Time used in lesson delivery (minutes)	number
3.10	Overall, how easy or difficult was it to teach the lesson	Very difficult, difficult, easy, Very easy
3.11	What made this lesson easy or diffcult to teach	text
	4. Overall objective of the lesson	
4.1	How would you rate the extent to which lesson objectives were achieved	Too little achieved, Unachieved, Achieved, very much achieved
4.2	Why do you think the lesson objectives were/were not achieved	text

2. Lesson Observation form

Lesson # Title:	
Version:	☐ Blackboard ☐ Projector

Date:	
School:	
School type:	1. ☐ Public ☐ Private ☐ Government-aided 2. ☐ Low performing school ☐ High performing school
Observer(s):	

Scheduled start/end time of lesson	
Number of students attending	
Number of teachers in class	
Type of technology teacher uses	☐ laptop ☐ smart phone ☐ pad ☐ projector

See Instruction page: '**Instructions before the observation starts'** and **'Observation materials'**

Pre-lesson

Record what the teacher has done before the lesson, including: **For the blackboard version**: Note if anything is written on the blackboard. **For the projector version:** Note whether the projector is set up and ready for use, has the lesson set up and is ready for use	

Equipment/technology used during lesson

Note the type of equipment/technology used. **For the blackboard and projector version**: Note if the students have response cards. **For the projector version:** Note whether the projector is set up and ready for use, has the lesson set up and is ready for use. Note the type of audio-visual equipment used: (smart phone/projector). Note if there are any power outages or loss of Internet connection during the lesson and how these are managed.	

Start of the lesson/timing

Planned start time of the lesson:	

Actual start time of lesson: [Do not let teacher or students know you are timing lesson.]		
If there is a substantial gap between the planned start time and when the lesson started, note what happened during that time.		
Keep track of whether more or less time is used for the review of the previous lesson, the activity, and the wrap-up.	Review	Actual time spent:
	Activity	Actual time spent:
	Wrap up	Actual time spent:

See observer instructions: "During the lesson"

Review of previous lesson

Start time of the review:	
Did all the students respond to review questions? Did the teacher explain the answers?	
Did the teacher review the key messages from the previous lesson and check to see if there were any questions or misunderstandings?	

Lesson activity

Start time of the lesson activity:	
Did all the students participate (small groups, individual)? Were the activities clear after teacher explanations? Did you observe any adverse outcomes, or were there observations that might indicate an adverse outcome? • A student or teacher misunderstanding an explanation or example • Conflict between students, students and teachers, or others • Distraction due to irrelevant, excessive, or difficult questions from students • Any other adverse outcome Did you observe any transfer of learning, or were there observations that might indicate transfer of learning? • Transfer of learning to other fields, besides health • Transfer of learning to practical choices about what to believe or do, in daily life • Any other transfer of learning	

Wrap up

Start time Wrap up	
Did all the students respond to wrap up question(s)? Did the teacher explain the answers?	
Did the teacher repeat the key messages and ask the students to make sure they have them in their notes?	
Did she give the assignment and information about the next lesson?	
Did she check whether the students had questions or misunderstandings?	
Other	
End time Wrap up	

Post lesson

Overall, teachers: how did the teacher appear to respond to the lesson?	

(Did they seem to enjoy it? Did the teacher get frustrated or bored? Did they say anything about the lesson?)	
Overall, students: how did the students appear to respond to the lesson? (Did they seem to enjoy it? Did they seem engaged? Did they get frustrated or bored? Did you hear them saying anything about the lesson to eachother?)	
Overall, School environment: how did the school environment appear to facilitate the lesson delivery?	
Did you observe any adverse outcomes, or were there observations that might indicate an adverse outcome?	
Did you observe any transfer of learning, or were there observations that might indicate transfer of learning?	

Summarize the main findings here

Instructions for observers

Instructions before the observation starts:

- Review the lesson before the lesson and bring a copy with you to follow along while observing the lesson.
- Share the study objectives. (Remind them that we are observing how the students and teachers interact with the materials)
- Explain the data collection methods we are using for the observation (non-participatory observation).
- Sit in the back of the class to ensure that there is no class distraction

Observation materials:

- Observation Guide (printed)
- Notebooks
- Pens/pencils
- Identification card (mandatory- if visiting study participant for the first time)
- Covid-19 PPE (masks, sanitizer etc)
- Voice recorder/camera

During the lesson

Follow along in the lesson plan, so you can note how the teacher uses and understands it, e.g., whether the teacher misunderstands or skips steps. Note things like:

- What seems to work well, or not well from the teacher's side
- What the students and teacher seem to like or dislike
- What the students and teacher seem to misunderstand
- Anything else that you think is important for the effective use of the resources

3. Teacher's interview guide

This guide is divided in three main parts: first impressions, Achieving lesson objectives, Intended and unintended outcomes, adaptations to the lesson delivery and questions covering the factors affecting delivery and scale up of the intervention.

Instructions for inteviewer (moderator)

- Review the lesson plan before the interview
- Share the interview objectives. Remind them that we are exploring the how they have achieved teaching the lessons, effects of the lessons, and factors that might have affected teaching the lessons.
- Clarify that the purpose of the interview is to evaluate the lessons and the resources, NOT to evaluate the teacher. There are no wrong or right answers.
- Remind them that their answers will be kept confidential, and they should not hesitate to be open about their experience teaching the lessons, whether positive or negative.

Instructions for Notetaker

- Make the recorder ready for discussions
- The teacher may refer to any lesson. Notetakers should be diligent about noting which lesson(s) the teacher is referring to, whenever relevant.

User test materials:

- Interview Guide
- Notebooks
- Pens/pencils
- Identification card (mandatory- if visiting study participant for the first time)
- Covid-19 PPE (masks, sanitizer, etc.)
- Voice recorder/camera

Inteview session details

Date:	
School:	
School type:	1. ☐ Public ☐ Private ☐ Government-aided 1. ☐ Low performing ☐ High performing
Facilitator/moderator	
Observer/note taker(s)	

Teacher details (Refer to the teacher details for received)

Teachers study ID	
Teaches which subjects	

Teacher's age and sex	Sex: Age (years):
Type of technology teacher used	☐ laptop ☐ smart phone ☐ pad ☐ projector

Section A. TEACHER FACTORS

Question	**Observer notes**	**Barriers and facilitators framework**
A1. Having been one of the teachers that participated in teaching the "Be smart about your health" lessons at your school, what are your general thoughts about the lessons?		Begin with an open question (also listen especially for new themes that aren't covered below)
A2. The content in the "Be smart about your health" resources" might have initially felt new and unfamiliar to many teachers. How did the content feel to you? Probe: - If the content felt new and unfamiliar, why? - For the new elements in the content, were they hard to convey to students?		To put teacher at ease "Remember, we are not evaluating you. Please don't hesitate to be open about how you felt. It is important to understand how you and other teachers perceived your own understanding of the material."
A3. What sort of skills or competencies do you feel helped you teach this content in an effective way? Probe: How did those skills help to teach the content? What skills or competencies did you feel you lacked?		TEACHER Skills and competencies.
A4. What are your thoughts on the training you received in the delivery of the lessons? Probe: What was useful What was less useful or not useful What can be improved? Suggestions		TEACHER Sufficient training

A5. Tell me a bit about how you felt teaching this material to your class. Prompt! Name any feelings you had or have now.		TEACHER Emotions
A6. Did you feel confident about teaching these lessons?		TEACHER
Example: Can you give me an example of a situation when you felt confident? Probe: What aspects of the lesson did you feel less confident or unsure to teach		Self-efficacy
A7. How motivated did you feel to teach these lessons to your class – very motivated or not so motivated? Explanation: Can you tell me a bit about why? Prompt: Did you look forward to teaching these lessons? Or did you feel they were a burden somehow? (Please be honest with us!)		TEACHER Motivation
A8. Did you experience any strong differences between the lesson content and your own beliefs about treatments, or about what children or others should be encouraged to do? Example: Can you give an example of content that was different from your beliefs? Probe: How did these differences impact on your teaching		TEACHER Beliefs, attitudes
A9. Did you feel that you managed to engage the students during the lessons and get them thinking and discussing - or was this difficult to do with these lessons? Probe: What helped to engage students and / or what made it difficult to engage students.		TEACHER Positive learning environment

Section B. FEEDBCK ON THE BE SMART ABOUT YOUR HEALTH SECONDARY SCHOOL RESOURCES

Question(s)	Observer notes	Barriers and facilitators framework
B1. How was teaching the "Be smart about your health" lessons similar to how you teach other lessons? **How was teaching these lessons different from how you teach other lessons?**		TEACHER Fit to teacher's teaching style and context

B2. Could you give an example of how you <u>typically prepared</u> a lesson? (Recall a specific lesson and explain how you went about it in detail.)		Fidelity evaluation
B3. How did you typically deliver the lessons in relation to how it was planned? - What helped you deliver the lessons as planned? - What made it difficult to deliver the lessons as planned? - Were there specific parts of the lessons that you could not implement in the classroom, or that were difficult to implement? If so, why? - What might help teachers deliver these lessons as planned?		Fidelity evaluation
B4. Do you think that the "Be smart about your health" resources are <u>appropriate</u> for students in your class?'. **To the extent appropriate: W**hat made them appropriate?		TEACHING MATERIALS Appropriateness of material
To the extent not appropriate: What do you think should be changed to make them more appropriate?		

B5. To what extent did you trust the content in the CHOICE materials: To the extent trustworthy: What made the materials trustworthy? To the extent untrustworthy: What made them untrustworthy?		TEACHING MATERIALS Credibility of material
B6. How valuable were the "Be smart about your health" resources for you as a teacher to use in your class and your school? To the extent valuable: What made the materials valuable? To the extent unvaluable: What made them unvaluable?		TEACHING MATERIALS Value of material
B7. Do you think these resources should be a part of the curriculum for this age group in your school? Do you have any thoughts about where they might fit or how they would need to be adapted to fit?		
B8. Taking into consideration your experience in teaching these lessons at your school, what should be in place to enable more schools like yours to introduce the "Be smart about your health" lessons into their schools?		Scale up

Section C. FEEDBACK REGARDING STUDENTS

Question(s)	**Observer notes**	**Barriers and facilitators framework**
C1. Can you tell us briefly how the students in your class responded to being taught these lessons? **Prompt:** Either positively or negatively**.** **Can you give us examples of anything you remember in particular?**		Open question
C2. Which kinds of students benefitted most from **the "Be smart about your health"** **Prompt: high, average, and low performers?**		STUDENTS Differentiated instruction

C3. How motivated were the student in your class to learn the lessons? **To the extent motivated:** What seemed to motivate them most? **To the extent unmotivated:** Why do you think they were unmotivated?		STUDENTS Motivation to learn new materials
C4. Do you think students were able to read and understand the "Be smart about your health" resources **Probe:** What was hard for them What was easy for them		Students ability to read and understand the material.
C5. Could you describe how students attended "Be smart about your health" lessons **Probe:** - Reasons for attending less frequent/more frequent - Attendance of **"Be smart about your health" lessons** compared to other lessons at school		Pupils' attendance or reasons for poor attendance (eg, long distance to school or inability to pay school fees).
C6. Could you describe the students attitudes when learning the resources: - Attitudes towards learning, towards authorities, towards science, towards critical thinking		Pupils' attitudes towards learning, towards authorities, towards science, towards critical thinking
C7. To what extent students believed the content of the **"Be smart about your health"**		Pupils' beliefs about the content
C8. In your opinion, how did home environment affect learning the **"Be smart about your health"**		The extent to which the pupil's home environment encourages or discourages learning from the lessons.

C9. How did other students (peers) affect learning the **"Be smart about your health"** lessons.		Positive or negative attitudes of other pupils towards the material.

Section D. School system and environment

Question(s)	Observer notes	Barriers and facilitators framework
D1. How <u>easy or difficult was it for you to take on and to teach</u> the "Be smart about your health" lessons in addition to all your other responsibilities at the school? **Prompt:** Did you have sufficient resources to carry out the teaching effectively? Did you have sufficient time in your schedule? Were these lessons competing for time that you feel might have been spent better doing other things? Was it a burden to prepare for lessons?		SCHOOL ENVIRONMENT Time constraints Competing priorities School resources Competing
D2. Besides time constraints, were there <u>other factors that made it difficult</u> to teach these lessons in your school, such as: · lack of support/interest from your leaders · lack of support/interest from your peers · lack of support/interest from parents or community · School resources (human, equipment, etc) · Political environment · Bureaucracy · Incentives and disincentives		SCHOOL ENVIRONMENT

Section E. Intended effects, unintended effect and transfer

Question(s)	Observer notes	Adverse effect and transfer
E1. Have you experienced or observed the lessons having <u>any advantages</u> to students? If so, please tell us about it. **Probe** · **Assertiveness** (students asking more questions and not taking things for granted) · ***Improved decision--making (****students making more thoughtful and informed decisions)* ***Creativity (****Thinking outside the box)*		**intended effects**
E2. Have you experienced or observed the lessons having <u>any disadvantages</u> to students? If so, please tell us about it. Prompt: · Misunderstanding · Conflict (students and teachers, parents, or other authorities) · Distraction · Stress, or other uncomfortable thoughts or feeling · Wasted time or resources		**unintended effects**
E3. Have your students <u>used anything they learned</u> in the lessons at home with family/ when they are with friends? If so, please tell us about it. **Prompt:** -Have they **<u>taken something learned</u>** in the lessons **<u>and used it in a different subject or field</u>**?		Transfer of learning

E6. Do you have any suggestions of other possible good or bad impacts that "Be smart about your health" resources or learning these concepts might have on people?		Intended and unintended effects

Section F. Other

F1. Do you have <u>any other feedback</u> you'd like to share with us, either positive or negative about these resources or your involvement in this project?		Open question

Section G. Feedback on our session.

Question(s)	Observer notes	Barriers and facilitators framework
G1. How has this <u>interview</u> been conducted? **Prompt!** What can we make better?		

Section H. Immediate discussion after the session

Observer notes

4. Guide for student focus group discussion

Students in intervention arm

This guide is for discussing with students who participated in the intervention of the secondary school resources ***Be Smart About Your Health***, in the CHOICE Project. The goal of the discussion is:

- to explore the potential intended effect of the intervention "***Be Smart About Your Health***" among students.
- to explore unintended effect of the intervention "***Be Smart About Your Health***" among students

Country										
Date										
FGD facilitator										
Note taker										
Which 'mode(s)'?	☐ blackboard ☐ projector									
Type of data collection (mark all that apply)	☐ focus group students ☐ other (specify) ……									
Mode of data collection (notes, recording)										
Number of students										
School year/s										
Gender/s										
Ages										

SECTION A: Introduction

Briefly introduce yourself.

Purpose of the focus group: to hear about students' experiences of the lessons – students' own thoughts and opinions.

No right or wrong answers. We are evaluating the lessons, not the students. We are interested in hearing both things that they liked and things that they did not like about the lessons.

They may not agree with each other about somethings. That's not a problem. But sometimes we may ask them if they agree with something that someone said, just to get a sense of whether everyone had the same experience.

Tell students how long the session will last (at least an hour).

Tell students that:

- *We want to record the session so we can be sure of what you said.*
- *We will not attach names to the notes or recording.*

Ask if students have any questions.

Start recording if given consent.

SECTION B: Intended effects, unintended effect, and transfer

1. First impressions of the lessons (for opening up)

Think back to when you started these lessons, what were your first impressions?

Notes

2. Intended and unintended effect

2.1 What are the most important things you have learnt from the "Be smart about your health" lessons?

Narrative summary, with quotes

2.2 Please tell us about **any disadvantages of the lessons**, in your experience.

Probe only if none has mentioned any of these:

- Misunderstanding
- Conflict (students and teachers, parents, or other authorities)
- Distraction
- Stress, or other uncomfortable thoughts or feeling
- Wasted time or resources

Narrative summary, with quotes

3. Transfer of learning

3.1 Have you used anything you learned in the lessons in your home / when you are with your friends / when you are with your family? **If so, please tell us about it.**
Prompt: Have you **taken something learned** in the lessons **and used it in a different subject or field**?

4. Barriers and facilitators for learning the resources

Question(s)	Observer notes	Barriers and facilitators framework
4.1. Which kinds of students benefitted most from the "Be smart about your health" **Prompt: high, average, and low performers?**		STUDENTS Differentiated instruction
4.2. How were you/your fellows student motivated to learn the lessons? **To the extent motivated:** What seemed to motivate you? **To the extent unmotivated:** Why do you think made you unmotivated?		STUDENTS Motivation to learn new materials
4.3. Do you think you and your fellow students were able to read and understand the "Be smart about your health" resources **Probe:** What was hard for you e.g lesson # or words What was easy for you e.g lesson # or words		Students' ability to read and understand the material.
4.4. Could you describe how you attended "Be smart about your health" lessons **Probe:** - Reasons for attending less frequent/more frequent - Attendance of "**Be smart about your health" lessons** compared to other lessons at school		Students' attendance or reasons for poor attendance (eg, long distance to school or inability to pay school fees).
4.5. Could you describe your attitudes when learning the resources? - Attitudes towards learning, towards authorities, towards science, towards critical thinking		Students' attitudes towards learning, towards authorities, towards science, towards critical thinking

4.6. Do you believe the content of the "Be smart about your health" lessons? **If so, why?** **If not, why not?**		Students' beliefs about the content
4.7. In your opinion, how did home environment affect you regarding learning the "Be smart about your health"		The extent to which the students' home environment encourages or discourages learning from the lessons.
4.8. How did other students (your peers) affect the learning "Be smart about your health" lessons?		Positive or negative attitudes of other Students towards the material.

5. Wrap-up

Is there anything else you would like to discuss about these lessons?

Narrative summary, with quotes

Stop recording and thank them.

5. Guide for parents focus group discussion

Parents of students in intervention arm

This guide is for discussing with parents of students who participated in the intervention of the secondary school resources ***Be Smart About Your Health***, in the CHOICE Project. The goal of the discussion is:

- to explore the potential intended effect of the intervention "***Be Smart About Your Health***" among students.
- to explore unintended effect of the intervention "***Be Smart About Your Health***" among students
- to explore the context factors that might facilitate or hinder effective delivery and scale up of the "***Be Smart About Your Health***"

Country										
Date										
FGD facilitator										
Note taker										
Which 'mode(s)'?	☐ blackboard ☐ projector									
Type of data collection (mark all that apply)	☐ focus group students ☐ other (specify) ……									
Mode of data collection (notes, recording)										
Number of parents										
Gender/s										
Ages										

SECTION A: Introduction

Briefly introduce yourself.

Introduction to the parents

We would like to thank you for having accepted our invitation to discuss with you. You were invited because your child has participated in the "Be smart about your health" lessons. The purpose of those lessons was to help young people learn to think critically about "health actions" things that people do to care for their health or the health of others.

The purpose of this discussion is to explore with you as a parent some of the factors that might have affected what your children got out of these lessons and their ability to use what they learned. These factors could be related to the home environment, interaction with your child regarding what they learnt and anything else you think might be important.

We would like to know about things that might have contributed to good (effective) teaching or learning experiences for the students, but also about things that you felt were problematic.

There is no right or wrong answer.

The information you give us will help us to understand what students learned, whether they have been able to use what they learned, and how "the be smart about your health" lessons could be integrated in the curriculum and be scaled up country wide and elsewhere.

Please remember that whatever information we get from you will be kept confidential.

Tell parents how long the session will last (at least an hour).

Tell parents that:

- *We want to record the session so we can be sure of what you said.*
- *We will not attach names to the notes or recording.*

Ask if parents have any questions.

Start recording if given consent.

SECTION B: Focus group questions

Home Learning Environment

1. Have you heard about the "Be smart about your health" lessons that your children attended this term?

Prompts:

- **What have you heard?**
- **From whom?**
- **Have you talked about the lessons with your child?**
    - **If so, what did you discuss?**

Notes

2. Did your child ever talk with you about their "homework"?

Prompts:

- **If YES, what did you think about the homework?**
- **Did you help your child how with the homework?**
- **If so, how did you help your child?**

Narrative summary, with quotes

3. Have you recently talked with your child about what people, or the radio or other media say about health – for example, things one can do to improve one's health?

Narrative summary, with quotes

Intended and unintended effect

6a. Given what you know about the "Be smart about your health" lessons, how do you think your child benefitted from these lessons?

Prompts:

- Have you observed or experienced any of those benefits or advantages?
- **If yes**: Can you tell us about what you observed or experienced?

Narrative summary, with quotes

6b. Do you think there are any disadvantages of your child's participation in the lessons?

Prompts:

- Have you observed or experienced any of those disadvantages?
- **If yes**: Can you tell us about what you observed or experienced?

Do not mention this but check the tendance to mention these below:

- **Conflict between children and teachers**
- ***Distrust of health professionals***
- ***Conflict due to undermining of religious beliefs***

Narrative summary, with quotes

7. Do you think what students learn would cause conflict between you and your child

Narrative summary, with quotes

Transfer

8. Did your child <u>use anything they learned</u> in the lessons at home/ with family/ when they are with friends? If so, please tell us about it.

Prompt:

-Has he/she **<u>taken something learned</u>** in the lessons **<u>and used it in a different subject or field</u>**?

Narrative summary, with quotes

9. Wrap-up

Is there anything else you would like to discuss?

Narrative summary, with quotes

Stop recording and thank them.

6. Training Evaluation Form

District…… School code ……. Teacher code …….

Please indicate your impressions of the items listed below.

Training components	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The training gave me general understanding of the critical thinking about health.	❍	❍	❍	❍	❍
2. The training gave me a clear overview and flow of all lessons.	❍	❍	❍	❍	❍
3. I can navigate through the resources, and I know where I can find all that I need on the website	❍	❍	❍	❍	❍
4. Now I understand all teaching strategies relevant for teaching critical thinking about health	❍	❍	❍	❍	❍
5. The training gave me teaching tips that I need to consider while teaching CHOICE lessons	❍	❍	❍	❍	❍
6. I am confident that I understand and can teach all 10 lessons	❍	❍	❍	❍	❍
Competences					
7. The training met my expectations.	❍	❍	❍	❍	❍
8. I will be able to apply the knowledge learned.	❍	❍	❍	❍	❍
9. The training objectives for each topic were identified and followed.	❍	❍	❍	❍	❍
Training materials					
10. The content was organized and easy to follow.	❍	❍	❍	❍	❍
11. The materials distributed were pertinent and useful.	❍	❍	❍	❍	❍

Trainers

12. The trainer was knowledgeable.	❍	❍	❍	❍	❍
13. The quality of instruction was good.	❍	❍	❍	❍	❍
14. The trainer met the training objectives.	❍	❍	❍	❍	❍
15. Class participation and interaction were encouraged.	❍	❍	❍	❍	❍
16. Adequate time was provided for questions and discussion.	❍	❍	❍	❍	❍

17. How do you rate the training overall?

Excellent	Good	Average	Poor	Very poor
❍	❍	❍	❍	❍

18. What aspects of the training could be improved?

19. What was most useful?

20. What was least useful?

21. Other comments?

THANK YOU FOR YOUR PARTICIPATION!

7. Descriptive data for schools

No	District	
1	School name	
2	School location (urban, rural, semi-urban)	
3	Ownership (public, government aided)	
4	Number of students at school (secondary)	
5	Number of teachers at school (secondary)	
6	School performance	

8. Descriptive data for Teachers

Date: _____

School_____

district_____

No	How old are you? (Age)	
1	Gender? (Male/Female)	
2	What is your level of Education? (Masters, bachelor's degree (A0), Advanced diploma (A1), advanced level Certificate (A2), or other…….)	
3	How long have you worked as a secondary school teacher? (No. of years in teaching profession)	
4	What main subjects do you teach at school?	
5	How many periods (lessons) do you teach per week?	
6	What is your average class size (how many students are in your class on an average day?)	

9. School authorities interview guide

This guide is divided in three main parts: first impressions, Achieving lesson objectives, Intended and unintended effects, adaptations to the lesson delivery and factors affecting delivery and scale up of the intervention.

Instructions for interviewer (moderator)

- Review the lesson plan before the interview
- Share the interview objectives. (Remind them that we are exploring the how he has achieved teaching the lessons, effect of the intervention to students and external factors that might have affected the teaching the lesson)

Instructions for Note taker

- Make the recorder ready for discussions
- The teacher may be referring on any lesson in an interview. Note takers should be diligent about noting which lesson the teacher is referring to.

User test materials:

- Interview Guide
- Notebooks
- Pens/pencils
- Identification card (mandatory- if visiting study participant for the first time)
- Covid-19 PPE (masks, sanitizer etc)
- Voice recorder/camera

Inteview session details

Date:	
School:	
School type:	1. ☐ Public ☐ Private ☐ Government-aided 1. ☐ Low performing ☐ High performing
Facilitator/moderator	
Observer/note taker(s)	

Head teacher/Director of studies details (Refer to the teacher details for received)

participant study ID	
Role of the participant at school	
Type of technology teacher used	☐ laptop ☐ smart phone ☐ pad ☐ projector

Introduction to the school authority (headmaster/director of studies)

We would like to extend our sincere appreciation for having completed teaching the "Be smart about your health" lessons during this term.

The purpose of this discussion is to explore with you as a leader at your school some of the factors that might have affected teaching and learning from the lessons.

We would like to know about things that might have contributed to good (effective) teaching, and positive learning experiences for the students, but also about things that you felt were problematic.

There is no right or wrong answer.

The information you give us will help us to understand the advantages and disadvantages of the "Be smart about your health" lessons and how they could be integrated in the curriculuum and be scaled up country wide and elsewhere.

Please remember that whatever information we get from you will be kept confidential.

Section A. SCHOOL SYSTEM AND ENVIRONMENT

Question	Observer notes	Barriers and facilitators framework
1. What were your first thoughts about the "Be smart about your health" lessons teaching them in your school?		Begin with an open question (also listen especially for new themes that aren't covered below)
2. Based on both your current position as the school head, and your school's recent participation in teaching the lessons, what were your main challenges when introducing lessons into your school timetable? **Prompts:** Is the timetable flexible enough to accommodate the introduction of new material, such as these lessons? Was the ICT equipment (computer and projector) always available when needed?		- School organizationand management - Competing priorities

3. What policies or regulations if any by the Ministry of Education or REB do you think may have affected the way the "be smart about your health" lessons were delivered at your school? **Prompt:** Remember the lessons were to be delivered in English, twice a week, for five weeks, using a projector.		- Policies/Regulations
4. Taking into consideration your experience as the school head, what should be in place to enable more schools like yours to introduce the "Be smart about your health" lessons into their timetable?		- Scaling up

Section B. FEEDBACK ON CHOICE MATERIALS AND THE TEACHER

5. Based on the information you have about the "Be smart about your health" resources and your interaction with the resources: **Do you think the material is appropriate for Senior two students in your school?**		- Appropriateness of thematerial
6. In your opinion, to what extent are the "Be smart about your health" lessons compatible with the current school curriculum? **Prompt:** What would need to change for the lessons to fit into the current curriculum?		Compatibility with the curriculum
7. In your opinion, do you think you teacher was motivated to teach the lessons? **Why? Or why not**		motivation
8. Do you think the teacher was able to deliver the lessons as planned? ▪ What helped you deliver the lessons as planned? ▪ What made it difficult to deliver the lessons as planned? ▪ Were there specific parts of the lessons that you could not implement in the classroom, or that were difficult to implement? Then probe as to why ▪ What might help teachers deliver these lessons well?		

Section C. Intended effects, unintended effect and transfer

Question(s)	Observer notes	Adverse effect and transfer
9. Have you experienced or observed the lessons having <u>any advantages</u> to students? If so, please tell us about it. **Probe** • **Assertiveness** (students asking more questions and not taking things for granted) • ***Improved decision---making (****students making more thoughtful and informed decisions)* ***Creativity (****Thinking outside the box)*		**intended effects**
10. Have you experienced or observed the lessons having <u>any disadvantages</u> to students? If so, please tell us about it. Prompt: • Misunderstanding • Conflict (students and teachers, parents, or other authorities) • Distraction • Stress, or other uncomfortable thoughts or feeling • Wasted time or resources		**unintended effects**
11. Have your students <u>used anything they learned</u> in the lessons at home with family/ when they are with friends? If so, please tell us about it. **Prompt:** -Have they **<u>taken something learned</u>** in the lessons **<u>and used it in a different subject or field</u>**?		Transfer of learning

12. Do you have any suggestions of other possible good or bad impacts that "Be smart about your health" resources or learning these concepts might have on people?		Intended and unintended effects

Section D. Immediate discussion after the session

Observer notes

Approvals

1. UR Letter of request for collaboration to Rwanda Biomedical Center (RBC).
2. RBC response letter accepting collaboration and nominating advisory team.
3. UR Letter of request for collaboration to Rwanda Basic Education (REB).
4. REB response letter accepting collaboration and nominating advisory team.
5. Rwanda National Ethics Committee (RNEC) approval letter of 2019.
6. RNEC annual renewal and ammendment letter of 2020.
7. RNEC annual renewal letter of 2022.
8. RNEC annual renewal and ammendment letter of 2022.
9. REB letter of introduction to 84 schools participated in the trial.

UNIVERSITY of RWANDA

OFFICE OF THE VICE CHANCELLOR

Kigali, 25/09/2019
Ref. VC/1553/2019

Director General
Rwanda Biomedical Centre (RBC)
Kigali, Rwanda

Dear DG,

RE: Request for collaboration and appointment of senior staff to be part of the National Advisory Council for CHOICE Project in Rwanda

The University of Rwanda is part of a Consortium led by Norwegian Institute of Public Health that received from the Research Council of Norway a research grant (under the acronym of "CHOICE project") aiming at improving health literacy among teenagers through development and testing of learning resources for informed personal health choices and participation in dialogues about health in East African countries (Kenya, Rwanda and Uganda).

In Rwanda the research is implemented by University of Rwanda's School of Public Health, with research team of Professor Nyirazinyoye Laetitia and Mr. Mugisha Michael (PhD fellow at the Faculty of Medicine, University of Oslo, Norway).

It is in this background that we are requesting collaboration in this project. We request you to kindly identify two senior staff (one in Community Health and one in Adolescent health) who will join the research team to work on the above project as well as being part of the National Advisory Council.

Attached, please find the concept note for the project. For further information please contact Prof. Nyirazinyoye Laetitia on phone 0788683209 and email lnyirazi@nursph.org with cc to mmugisha@nursph.org.

We are grateful for your continued collaboration in developing research capacity in Rwanda.

Sincerely,

UNIVERSITY OF RWANDA - UR

Prof Philip Cotton
Vice Chancellor

Cc:

- Deputy Vice Chancellor, UR (AR)
- Principal, CMHS, UR
- Coordinator, SPIU, UR

P.O Box 4285 Kigali, Rwanda | vc@ur.ac.rw | www.ur.ac.rw

RWANDA BIOMEDICAL CENTER

A Healthy People. A Wealthy Nation

Kigali on, 14 OCT 2019
Ref: No...../RBC/2019
983

Director General's Office

Vice Chancellor
University of Rwanda
KIGALI

UNIVERSITY OF RWANDA
Central Secretariat
Item received on 14/10/2019
Signature.....

Re: Appointment of staff

Dear Vice Chancellor,

Reference made to your letter dated 25th September 2019 requesting for collaboration and appointment of senior staff to be part of the National Advisory Counsel for CHOICE Project in Rwanda,

First of all I would like to thank you for the project which will help to tackle the issues related to adolescent health especially the prevention of teenagers' pregnancies.

Therefore I would like to inform you that we appointed Mrs MUKAMANA Beatrice, Community Health Senior Officer and Mr KARAMAGE Eliphaz, Adolescent Health Officer.
We believe that by their expertise, they will contribute a lot for the success of the project.

We thank you for your usual collaboration.

RWANDA BIOMEDICAL CENTER
10/10/2019

Dr Sabin NSANZIMANA
Director General

CC:

- **Head of Institute of HIV/AIDS, Diseases Prevention and Control Department, RBC**
- **Division Manager of Maternal, Child and Community Health Division, RBC**

www.rbc.gov.rw / Info@rbc.gov.rw / KG 17 Ave, PO Box : 7162 , Kigali - Rwanda

UNIVERSITY of RWANDA

OFFICE OF THE VICE CHANCELLOR

Kigali, 25/09/2019
Ref. VC/1554/2019

Dr. Irénée NDAYAMBAJE
Director General
Rwanda Education Board (REB)
P.O. BOX 3817, Kigali,

Dear DG,

RE: Request for collaboration and appointment of senior staff to be part of the National Advisory Council for CHOICE Project in Rwanda

The University of Rwanda is part of a Consortium led by Norwegian Institute of Public Health that received from the Research Council of Norway a research grant (under the acronym of "CHOICE project") aiming at improving health literacy among teenagers through development and testing of learning resources for informed personal health choices and participation in dialogues about health in East African countries (Kenya, Rwanda and Uganda).

In Rwanda the research is implemented by University of Rwanda's School of Public, with research team of Professor Nyirazinyoye Laetitia and Mr. Mugisha Michael (PhD fellow at the Faculty of Medicine, University of Oslo, Norway).

It is in this background that we are requesting collaboration in this project. We request you to kindly identify two senior staff (one in curriculum and resources development and one in ICT for education) who will join the research team to work on the above project as well as being part of the National Advisory Council.

Attached, please find the concept note for the project. For further information please contact Prof. Nyirazinyoye Laetitia on phone 0788683209 and email lnyirazi@nursph.org with cc to mmugisha@nursph.org.

We are grateful for your continued collaboration in developing research capacity in Rwanda.

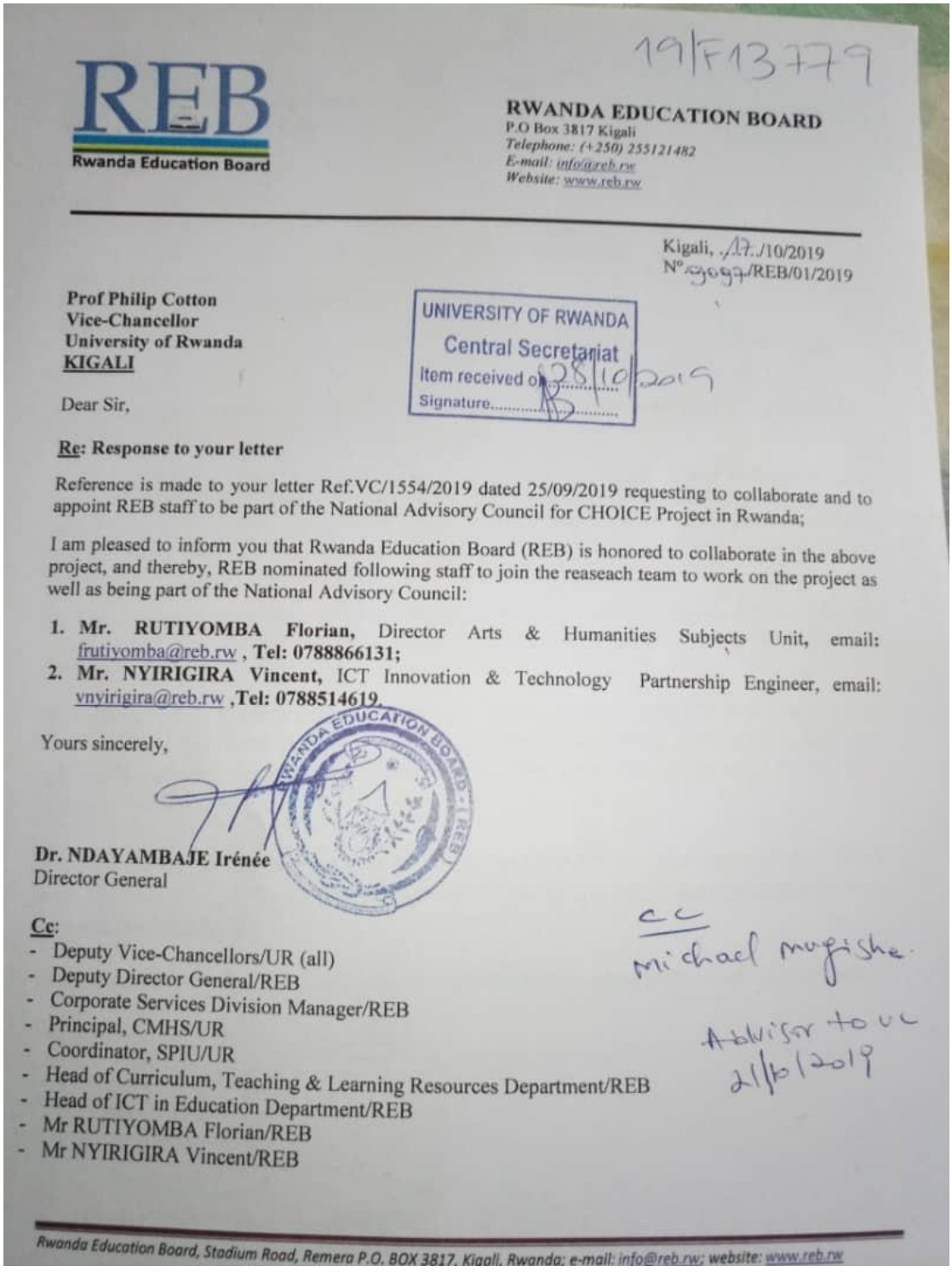
Sincerely,

Prof Philip Cotton
Vice Chancellor

UNIVERSITY OF RWANDA - UR

Cc:
- Deputy Vice Chancellor, UR (All)
- Principal, CMHS, UR
- Coordinator, SPIU, UR

P.O Box 4285 Kigali, Rwanda | vc@ur.ac.rw | www.ur.ac.rw



19/F13779

REB
Rwanda Education Board

RWANDA EDUCATION BOARD
P.O Box 3817 Kigali
Telephone: (+250) 25512482
E-mail: info@reb.rw
Website: www.reb.rw

Kigali, 17/10/2019
N° 5097/REB/01/2019

Prof Philip Cotton
Vice-Chancellor
University of Rwanda
KIGALI

UNIVERSITY OF RWANDA
Central Secretariat
Item received on 28/10/2019
Signature

Dear Sir,

Re: Response to your letter

Reference is made to your letter Ref.VC/1554/2019 dated 25/09/2019 requesting to collaborate and to appoint REB staff to be part of the National Advisory Council for CHOICE Project in Rwanda;

I am pleased to inform you that Rwanda Education Board (REB) is honored to collaborate in the above project, and thereby, REB nominated following staff to join the reaseach team to work on the project as well as being part of the National Advisory Council:

1. **Mr. RUTIYOMBA Florian,** Director Arts & Humanities Subjects Unit, email: frutiyomba@reb.rw , **Tel: 0788866131;**
2. **Mr. NYIRIGIRA Vincent,** ICT Innovation & Technology Partnership Engineer, email: vnyirigira@reb.rw ,**Tel: 0788514619.**

Yours sincerely,

RWANDA EDUCATION BOARD - REB

Dr. NDAYAMBAJE Irénée
Director General

cc
Michael Mugisha.
Advisor to VC
21/10/2019

Cc:
- Deputy Vice-Chancellors/UR (all)
- Deputy Director General/REB
- Corporate Services Division Manager/REB
- Principal, CMHS/UR
- Coordinator, SPIU/UR
- Head of Curriculum, Teaching & Learning Resources Department/REB
- Head of ICT in Education Department/REB
- Mr RUTIYOMBA Florian/REB
- Mr NYIRIGIRA Vincent/REB

Rwanda Education Board, Stadium Road, Remera P.O. BOX 3817, Kigali, Rwanda; e-mail: info@reb.rw; website: www.reb.rw

REPUBLIC OF RWANDA/REPUBLIQUE DU RWANDA

NATIONAL ETHICS COMMITTEE / COMITE NATIONAL D'ETHIQUE
Telephone: (250) 2 55 10 78 84
E-mail: info@rnecrwanda.org
Web site: www.rnecrwanda.org

Ministry of Health
P.O. Box. 84
Kigali, Rwanda.

FWA Assurance No. 00001973
IRB 00001497 of IORG0001100

November 21, 2019
No.916/RNEC/2019

Investigators: Prof. Nyirazinyoye Laetitia, UR CMHS SPH,
Mr. Mugisha Michael, UR CMHS, Dr. Andrew David Oxman, Norwegian Institute of Public Health, Prof. Atle Fretheim, Norwegian Institute of Public Health

Your research project: **"DEVELOPMENT AND TESTING OF DIGITAL LEARNING RESOURCES FOR INFORMED HEALTH CHOICES AND PARTICIPATION IN INFORMED DIALOGUES ABOUT HEALTH IN RWANDA"** has been evaluated by the Rwanda National Ethics committee.

Name	Institute	Involved in the decision		
		Yes	No (Reason)	
			Absent	Withdrawn from the proceeding
Dr.Jean-Baptiste MAZARATI	Biomedical Services (BIOS)	X		
Prof. Jean Paul RWABIHAMA	Kigali Teaching Hospital		X	
Prof.Laetitia NYIRAZINYOYE	University of Rwanda			X
Ass .prof. Egide KAYITARE	University of Rwanda	X		
Mr. Spencer BUGINGO	Lawyer	X		
Dr. David K. TUMUSIIME	University of Rwanda	X		
Ass. Prof. Lisine TUYISENGE	Kigali Teaching Hospital	X		
Dr. Darius GISHOMA	University of Rwanda	X		

RWANDA NATIONAL ETHICS COMMITTEE R.N.E.C P.O BOX:84 KIGALI

Sr Epiphanie MUKABARANGA	Rwamagana Nursing and Midwife school		X	
Dr. Vedaste NDAHINDWA	University of Rwanda	X		
Prof. Claude MUVUNYI	Biomedical Services (BIOS)	X		

After review of the protocol and consent forms, during the RNEC meeting of August 17,2019 where quorum was met, and revisions made on the advice of the RNEC submitted on November 21, 2019, **we hereby provide approval for the above-mentioned protocol**.

Please note that approval of the protocol and consent form both English and Kinyarwanda version is valid for **12 months**.

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.
2. Only approved consent forms are to be used in the enrollment of participants
3. All consent forms signed by subjects should be retained on file. The RNEC may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the RNEC in a timely fashion and before expiry of this approval.
5. Failure to submit a continuing review application will result in termination of the study.
6. Notify the Rwanda National Ethics committee once the study is finished.

Sincerely, P.O Dr Vedaste Ndahindwa

Date of Approval: November21,2019
Expiration date: November 20,2020

Dr. Jean- Baptiste MAZARATI
Chairperson, Rwanda National Ethics Committee.

RWANDA NATIONAL ETHICS COMMITTEE R.N.E.C P.O BOX:84 KIGALI

C.C.
- Hon. Minister of Health.
- The Permanent Secretary, Ministry of Health.

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Kigali, Rwanda.

FWA Assurance No. 00001973
IRB 00001497 of IORG0001100

December 22nd ,2020
No.1019/RNEC/2020

Principal Investigator: Professor Nyirazinyoye Laetitia, MSc, PhD
CHOICE Project.

Your research project: **"Annual Renewal and Amendment: DEVELOPMENT AND TESTING OF DIGITAL LEARNING RESOURCES FOR INFORMED HEALTH CHOICES AND PARTICIPATION IN INFORMED DIALOGUES ABOUT HEALTH IN RWANDA"** has been evaluated by the Rwanda National Ethics committee.

Name	Institute	Involved in the decision		
		Yes	No (Reason)	
			Absent	Withdrawn from the proceeding
Dr. Jean-Baptiste MAZARATI	Biomedical Services (BIOS)		X	
Prof. Jean Paul RWABIHAMA	University of Rwanda	X		
Prof.Laetitia NYIRAZINYOYE	University of Rwanda			X
Ass .Prof. Egide KAYITARE	University of Rwanda	X		
Mr. Spencer BUGINGO	Lawyer	X		
Ass. Prof. David K. TUMUSIIME	University of Rwanda	X		
Ass. Prof. Lisine TUYISENGE	Kigali Teaching Hospital	X		
Dr. Darius GISHOMA	University of Rwanda	X		
Sr.Epiphanie MUKABARANGA	Rwamagana Nursing and Midwife school		X	
Dr. Vedaste NDAHINDWA	University of Rwanda	X		
Prof. Claude MUVUNYI	Biomedical Services (BIOS)		X	

After review of the protocol, progress report and the requested amendments, during the RNEC meeting of 12 December 2020 where quorum was met, the requested **annual and amendments were approved.**

Please note that approval of the protocol and consent form both English and Kinyarwanda version is valid for **12 months.**

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.
2. Only approved consent forms are to be used in the enrollment of participants
3. All consent forms signed by subjects should be retained on file. The RNEC may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the RNEC in a timely fashion and before expiry of this approval.
5. Failure to submit a continuing review application will result in termination of the study.
6. Notify the Rwanda National Ethics committee once the study is completed.

Sincerely, P.O Dr Vedaste Ndahindwa Vice chair.

RWANDA NATIONAL ETHICS COMMITTEE P.O BOX:84 KIGALI

Date of Approval: December 12 ,2020
Expiration date: December 11 ,2021

Dr. Jean- Baptiste MAZARATI
Chairperson, Rwanda National Ethics Committee.

C.C.
- Hon. Minister of Health.
- The Permanent Secretary, Ministry of Health

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IRB 00001497 of IORG0001100

25 February 2022
No.41/RNEC/2022

Investigators:

- **Prof. Nyirazinyoye Laetitia, UR CMHS SPH**
- **Mr. Mugisha Michael, UR CMHS**
- **Dr. Andrew David Oxman, Norwegian Institute of Public Health**
- **Prof. Atle Fretheim, Norwegian Institute of Public Health**

Your research project: "**Annual Renewal: DEVELOPMENT AND TESTING OF DIGITAL LEARNING RESOURCES FOR INFORMED HEALTH CHOICES IN RWANDA**." has been evaluated by the Rwanda National Ethics committee.

Name	Institute	Involved in the decision		
		Yes	No (Reason)	
			Absent	Withdrawn from the proceeding
Dr. Jean-Baptiste MAZARATI	Chairperson of the RNEC	X		
Prof. Jean Paul RWABIHAMA	University of Rwanda	X		
Prof.Laetitia NYIRAZINYOYE	University of Rwanda	X		
Ass .Prof. Egide KAYITARE	University of Rwanda	X		
Mr. Spencer BUGINGO	Lawyer	X		
Ass. Prof. David K. TUMUSIIME	University of Rwanda	X		
Ass. Prof. Lisine TUYISENGE	Kigali Teaching Hospital	X		
Prof. Darius GISHOMA	University of Rwanda	X		
Sr.Epiphanie MUKABARANGA	Rwamagana Nursing and Midwife school	X		
Dr. Vedaste NDAHINDWA	University of Rwanda	X		
Prof. Claude MUVUNYI	Biomedical Services (BIOS)	X		

After review of the protocol and progress report during the RNEC meeting of 12 February 2022 where quorum was met **Continuation of approval has been granted to the above -mentioned study**.

RWANDA NATIONAL ETHICS COMMITTEE
R.N.E.C
P.O BOX: 84 KIGALI

Please note that approval of the protocol and consent form both English and Kinyarwanda version is valid for **12 months**.

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.

2. Only approved consent forms are to be used in the enrollment of participant

3. All consent forms signed by subjects should be retained on file. The RNEC may conduct audits of all study records, and consent documentation may be part of such audits.

4. A continuing review application must be submitted to the RNEC in a timely fashion and before expiry of this approval.

5. Failure to submit a continuing review application will result in termination of the study.

6. Notify the Rwanda National Ethics committee once the study is completed.

Sincerely,

Date of Approval: 12 February 2022
Expiration date: 11 February 2023

Dr. Jean- Baptiste MAZARATI
Chairperson, Rwanda National Ethics Committee.

C.C.
- Hon. Minister of Health.

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FWA Assurance No. 00001973
IRB 00001497 of IORG0001100

22 August 2022
No.236/RNEC/2022

Name of Principle Investigator: Prof Laetitia Nyirazinyoye

Your research project: **"Annual renewal and Amendment: Development and testing of digital learning resources for informed health choices in Rwanda"** has been evaluated by the Rwanda National Ethics committee.

Name	Institute	Involved in the decision		
		Yes	No (Reason)	
			Absent	Withdrawn from the proceeding
Dr. Jean-Baptiste MAZARATI	Chairperson of the RNEC		X	
Prof. Jean Paul RWABIHAMA	University of Rwanda		X	
Prof.Laetitia NYIRAZINYOYE	University of Rwanda			X
Ass .Prof. Egide KAYITARE	University of Rwanda	X		
Mr. Spencer BUGINGO	Lawyer	X		
Ass. Prof. David K. TUMUSIIME	University of Rwanda	X		
Ass. Prof. Lisine TUYISENGE	Kigali Teaching Hospital		X	
Ass. Prof. Darius GISHOMA	University of Rwanda	X		
Sr.Epiphanie MUKABARANGA	Rwamagana Nursing and Midwife school	X		
Dr. Vedaste NDAHINDWA	University of Rwanda	X		

RWANDA NATIONAL ETHICS COMMITTEE R.N.E.C P.O BOX:84 KIGALI

After review of the protocol, progress report and amendment during the RNEC meeting of 13 August 2022 where quorum was met the **requested annual renewal and amendments were approved.**
Please note that approval of the protocol and consent form both English and Kinyarwanda version is valid for **12 months**.

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.

2. Only approved consent forms are to be used in the enrollment of participant

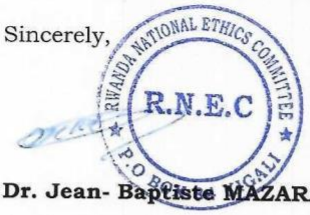
3. All consent forms signed by subjects should be retained on file. The RNEC may conduct audits of all study records, and consent documentation may be part of such audits.

4. A continuing review application must be submitted to the RNEC in a timely fashion and before expiry of this approval.

5. Failure to submit a continuing review application will result in termination of the study.

6. Notify the Rwanda National Ethics committee once the study is completed.

Sincerely,



Date of Approval: 13 August 2022

Expiration date: 12 August 2023

Dr. Jean- Baptiste MAZARATI

Chairperson, Rwanda National Ethics Committee.

C.C.

- Hon. Minister of Health.
- The Permanent Secretary, Ministry of Health

REB | RWANDA BASIC EDUCATION BOARD

Kigali,. on 13/04/2022
N°: 2215/REB/ICTE/2022

The Mayor of District: Rwamagana, Nyagatare, Musanze, Burera, Muhanga, Ruhango, Rusizi and Ngororero;

Through: Ministry of Local Government

DUSENGIYUMVA Samuel
P.S - MINALOC

Dear Sir/Madam,

Re: Invitation of schools to facilitate the CHOICE Project research team in testing of digital secondary school resources among 84 selected schools in Rwanda.

Young people are often exposed to claims about what they can do to improve and protect their health. They lack competences to assess various information they get. To respond to this problem, Rwanda Basic Education Board (REB) in collaboration with the University of Rwanda are conducting research with aim to test secondary school learning resources to help young people learn critical thinking about health skills.

In line with the above activity, the developed learning resources will be tested in 84 selected schools in third term between 18th April to 15th July 2022. In this testing, 42 selected schools were assigned to teach students the content for a period of five weeks and other 42 will not. After teaching the content in 42 schools, all 84 schools will answer a questionnaire to assess the effect of learning the content. Prior to testing of resources, teachers of selected schools assigned to teach the lessons will be trained from 22nd to 24th April 2022 in Kayonza District. Venue and other logistics will be catered for by the University of Rwanda and communicated to the participants in an email.

I would therefore request your facilitation to the above-mentioned activities in selected schools from your district. For more information, please contact a team from the University of Rwanda led by Prof. Laetitia Nyirazinyoye (Tel: 0788683209 or email: lnyirazi@nursph.org), Mr. Michael Mugisha (Tel: 0788596947 or email: mmugisha@nursph.org) and REB team led by Mr. Florian Rutiyomba (Tel: 0788866131 or email: frutiyomba@reb.rw) and Jeannine Usabuwera (Tel: 0788734348 or email: jusabuwera@reb.rw)

Please find here attached a list of 84 selected schools to participate in the testing of the learning resources.

Yours sincerely,

RWANDA BASIC EDUCATION BOARD (REB)

Dr. MBARUSHIMANA Nelson
Director General

Cc:
- Hon. Minister of Education
- Hon. Minister of state in charge of primary and secondary Education
- Hon. Minister of State in charge of ICT and TVET
- Permanent Secretary, MINEDUC
- Vice Chancellor, University of Rwanda
- Director General, NESA
- Head of CTLR Department/REB
- Head of ICTE Department/REB

Rwanda Basic Education Board
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