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Applying ADDIE Model to Develop Multimedia Lessons for Adolescent Reproductive Health Education in Uganda

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Abstract

This study aimed to develop and evaluate a multimedia application intervention for adolescent sexual reproductive health education in secondary schools in Uganda. The lack of access to quality reproductive health education and services, exacerbated by the recent COVID-19 pandemic, contributes to unplanned pregnancies, health complications, and sexual and gender-based violence (SGBV) among adolescents in Uganda. Researchers and teachers collaborated to create multimedia lessons covering topics such as sexual reproductive health and rights (SRHR) and SGBV for adolescents in participating schools. The educational content and format were co-designed to better incorporate the local context and address priority issues by involving end users of the software (adolescents and their teachers) as content contributors during the development phase. The innovative multimedia application was developed using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model. A student manual was also created as a teaching tool, providing educators with lesson introductions and guiding questions for post-lesson group discussions. The manual includes a simplified print version of the educational content, ensuring that students and teachers in schools without ICT resources can benefit from the intervention. Questionnaires were developed and administered to 14 Results indicate that all 14 trained teachers demonstrated improved knowledge about the use of multimedia applications to deliver adolescent-friendly sexual reproductive health (SRH) education. Additionally, all 14 teachers self-reported that the multimedia application is a feasible and acceptable method to deliver adolescent-friendly SRH education.

Keywords: ADDIE model, Adolescent Reproductive Health, Multimedia application, Education
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Introduction

Child and forced marriage constitute a global issue driven by factors such as gender inequality, poverty, social norms, and insecurity. Worldwide, governments have pledged to eradicate child marriage by 2030 as part of the UN's Sustainable Development Goals. Concerns about sexual and reproductive health and rights (SRHR) communication are escalating globally, with recent research by Plan International (2021) proposing that information and communication technology (ICT) tools could play a pivotal role in achieving the goal of ending child marriage by 2030. Given the challenges associated with face-to-face access, there is an increasing imperative to employ new ICT interventions, including mobiles, multimedia applications, and the Internet, to enhance access to SRHR education. These interventions are especially beneficial in reaching hard-to-access groups, such as remote or stigmatized populations, facilitated by the widespread availability of telecommunication infrastructure (WHO, 2019).

While traditional interventions often focus on SRH service provisions through health-related institutions, prior research, including studies by Part et al. (2016) and Moise *et al.*, (2017), recognizes the advantages of freely available, age-appropriate educational materials. In the Global South and within the Ugandan context, interventions have been implemented, primarily prioritizing education as an empowerment tool (e.g., Stambach, 2000; Wamoyi *et al.*, 2015; Pincock, 2018; Perehudoff *et al.*, 2022; Blaak, 2023). The emphasis has been placed on girls, with anticipated benefits including heightened awareness, the ability to make informed decisions about SRHR, and seeking relevant services. However, this approach has faced criticism for its failure to adequately consider non-Western adolescents' needs, highlighting a Western-centric bias in the proposed solutions (e.g., Pincock, 2018).

Rather than dwelling on the various interventions attempted in Uganda and elsewhere (e.g., Renzaho *et al.*, 2022; Blaak, 2023), it is evident that the need for innovative solutions to address the complexity and nuances of adolescent sexual and reproductive health and rights (SRHRs) remains a priority. This is particularly true following the recent COVID-19 pandemic, which exposed weaknesses in existing systems and exacerbated adolescents' vulnerabilities due to the unavailability of SRH services and service providers, orchestrated by the prioritization of COVID-19 prevention (e.g., Mambo *et al.*, 2022). In such contexts, interventions like the one undertaken in the current project on 'Fostering Digital Learning Environment for Adolescent Reproductive Health Education' can provide a much-needed solution to the endemic challenges of adolescents' SRHRs in Uganda.

The strength of the intervention lies in the development and embedding of an ICT solution that utilizes a multimedia content approach to share educational lessons on topics such as contraception, SRHR, and Sexual and Gender-based Violence with adolescents in participating schools in an inclusive way, without discrimination. The educational content and format adopted in the project were consciously co-designed with both the adolescents and their teachers to better incorporate the local context and priority issues, involving the end users of the software (adolescents and their teachers) as content contributors during the development phase.

In Uganda, access to adolescent health-friendly services is low, and limited disease surveillance results in a high rate of teenage pregnancies at 25%, of which 34% come from the lowest wealth quintile compared to 15% from the highest quintile. HIV prevalence increases rapidly with age in this age group, especially among adolescent girls, where it rises from 0.5% at 15 years to 5.1% by 20 years (MLGSD, 2021). Sexual and other forms of violence against children remain

prevalent, with one in four girls (25%) and one in ten boys (11%) reporting sexual violence in the previous year (MLGSD, 2021). Exposure to domestic hindrances limits adolescents' ability to grow and develop to their full potential (National Planning Authority, (NPA), 2020). Various factors, including age, cultural views, political, societal, religious, and personal aspects, contribute to reproductive health issues among the youth (Mehta & Seeley 2020; Sunarsih et al., 2020; Kirungi Kasozi *et al.,* 2019).

During the COVID-19 pandemic lockdown in Uganda, over 650,000 adolescent students became pregnant when schools were closed (Olukya, 2021). This alarming pregnancy rate resulted from the absence of sexual reproductive health and life skills education in schools, emphasizing the necessity for the development of educational interventions to address this issue. It reflects the fact that young people's sexual and reproductive health remains a significant challenge in Uganda. To effectively tackle these challenges, there is an urgent need for a comprehensive and harmonized sexual and reproductive health system that is youth-friendly and considers local socio-cultural contexts (Renzaho *et al.,* 2017). The utilization of ICT for health services across Uganda is still very limited, primarily due to inadequate ICT knowledge and skills, as well as limited innovation capacity (NPA, 2020). Furthermore, Uganda faces a skills gap in multimedia and animation application development (NPA, 2020). The project aimed to foster a teenage reproductive health digital learning environment ecosystem by developing and evaluating new multimedia lessons, digital stories, and student manuals for teaching and learning in secondary schools. The following are the specific objectives: to sensitize and introduce a select sample of 14 teachers from 7 schools to develop multimedia lessons and digital stories for teenage reproductive health education; to facilitate and expand teachers' knowledge and skills in the use of digital stories and multimedia lessons as pedagogical tools.
To implement and evaluate multimedia lessons to document good practices of using multimedia applications for adolescent reproductive health education.

Project Rationale and Outcomes

The project's focus was to design multimedia lessons based on stories for communicating SRH information to adolescents. This was aimed at empowering adolescents with knowledge in SRH for behavioral change and to reduce child and forced marriages in Uganda. This aim was achieved by teachers and researchers developing educational materials for adolescent reproductive health education, transforming the educational materials into multimedia stories for teaching and learning, implementing the multimedia package in classroom teaching, and finally, evaluating the lessons.

The target audience for this communication was adolescents between the ages of 13 to 19 years. The potential benefits if adolescents received reproductive health education included gaining knowledge in reproductive health, avoiding child and forced marriages, completing studies to enable them to have knowledge and skills to earn a living, taking responsibility to make marriage decisions at the right time and when ready, having a stable future family, and having a stable future income. The potential risks if adolescents did not receive reproductive health education were maternal and infant health risks, increased rates of abortion, domestic and sexual violence, school dropouts, an increase in the number of street children, an increased rate of divorce, and a financial burden on parents.

A total of 10 out of 14 trained teachers demonstrated improved knowledge about the use of multimedia applications to deliver youth-friendly SRH education. Also, 12 out of 14 teachers self-reported that the multimedia application was a feasible and acceptable method to deliver youth-friendly SRH education. The project developed content in a multimedia package, which, altogether, was useful for teachers and the target audience of the adolescent population.

Review of Related Literature

Digital solutions offer an opportunity to deliver relevant sexuality education materials without being constrained by personal discomfort and socio-cultural restrictions (UNCF, 2019). ICT provides scope for targeted interventions for specific populations and the potential to reach adolescent populations at scale, anytime, anywhere (UNCF, 2019). Currently, there is no system in place to assist digital sexuality educators and creators in developing quality solutions with evidence-based, comprehensive content and for users to identify trustworthy platforms (UNCF, 2019). The use of digital games for supporting adolescent reproductive health education has become an important area of research in sub-Saharan Africa. Digital games for sexual health education increase engagement and create an interactive learning environment (Chu et al., 2015). Games also offer practical skills through hands-on learning activities (Hieftje, *et al.,* 2016).

Storytelling is an ancient human activity (Miller, 2008). In many cultures, people use stories to make sense of their world and to pass knowledge on to future generations. Making use of stories in education usually starts during early childhood, when parents teach their children values and understanding of the world using language and metaphors that can be easily understood by the child. Educational stories are typically told by educators to convey certain values or information to the learners. In many African cultures, oral traditions that are current and promote the growth of African narratives have been proposed to support literacy (Chinweizu & Madubuike 1983). This study demonstrates how technology can renew the use of storytelling in education, and more relevantly in the African context.

The use of stories in education is most useful in language learning (e.g. Huang, 2023) with emotionally laden subjects, and for encouraging students to share personal experiences. Woodhouse (2008) listed several advantages and disadvantages of storytelling (Table 1).

Table 1: Advantages and Disadvantages of storytelling (modified from Woodhouse, 2008).

Advantage of storytelling	*Disadvantage of story telling*
Students can use storytelling to share stories of success and develop a sense of community	Preparation for storytelling takes time
Students can use stories to explore personal roles and make sense of their lives	Students require a safe environment and may feel uncomfortable to share their stories
Storytelling enhances creativity, and imagination and concentrates the mind	Topics may challenge personal values and therefore threatening
The use of imagination enables stories to be remembered	Students may need directions and guidance at various stages of story telling
Storytelling enhances critical thinking and listening skills	The student's response depends on their earlier exposure to storytelling
Storytelling maintains the oral tradition	Storytelling requires visualization skills and may not suit everyone's learning style

Source: (Woodhouse, 2008)

Woodhouse (2008) listed six disadvantages of storytelling in education (Table 2). First, he argued that storytelling is time-consuming. This also holds true for digital storytelling, where digitizing the story requires even more time, especially if students need to learn new IT tools and applications. Secondly, Woodhouse (2008) argued that students require a safe environment and may feel uncomfortable sharing their stories. When sharing stories, especially personal ones, it is crucial that students feel safe. In this context, computers function as a neutral platform, as students can express their thoughts more easily to a machine than to a human, given that the machine does not judge or ridicule them. It is essential to ensure, however, that if the stories are shared over the Internet, the students' identities must be kept confidential.

Table 2: Traditional Storytelling and Digital Storytelling: Disadvantages

Traditional storytelling	*Digital Storytelling*
A lot of time is needed in preparation	Initially, more time was spent learning new digital tools. Recording and editing add time. Can save time in the reuse of material and presentation
Students require a safe environment and may feel uncomfortable to share their stories	Neutral platform
Topics may challenge personal values and therefore be threatening	Impersonal conduit for sensitive topics
Students may need directions and guidance at various stages of storytelling	New digital tools require additional guidance
The response may depend on the previous exposure	Like traditional storytelling
Requires visualization skills and may not suit everyone's learning style	Offers more variety for different talents in visualization

Source: (Woodhouse, 2008)

Digital Storytelling

Digital storytelling is defined as a modern expression of the ancient art of storytelling (The Digital Storytelling Association, 2011). In digital storytelling, a combination of multimedia tools is used for communication, including text, graphics, audio narration, video, and animations (Robin, 2016; Huang, 2023). A group of still images combined with narrated audio constitutes a digital story as long as they are coherent (Kajder *et al.*, 2005). Digital storytelling is an innovative pedagogical approach that engages students in deep and meaningful learning (Smeda et al., 2014). A digital story is seen as a merger between traditional storytelling and the use of multimedia technology (Normann, 2011; Robin, 2016; Huang, 2023). Digital storytelling enables students to develop their creativity to solve important problems in innovative ways (Ohler, 2008). The power of storytelling as a pedagogical tool has existed since the beginning of humanity, and at present, storytelling is an important component of e-learning (Neal, 2001).

Amer *et al.,* (2014) emphasize that educational content for multimedia lessons should be relevant to the storyline, appropriate for the predetermined learning objectives, correct, accurate, real/believable, valid, reliable, balanced, free of bias, of good quality, and provide interactive feedback. These attributes of multimedia story lessons help make the lessons more active and attractive, hence the student derives pleasure to reach the lesson goals easily. However, if the educational content does not contain these attributes, it can cause emotions of rejection in the student, reducing the students' motivation to detect the educational use of the lesson.

Content components are evaluated to test whether lessons provide feedback, good content, and proper learning materials (Senapa & Ibrahima, 2019). This includes aspects related to the educational material. It tests if the content from the manual is easy to understand, if the content provides enough background to understand the lesson, if the content should be learned alongside the story, and if the content is well-organized, interesting, and engaging (Marciano, Leonardo & Erica, 2014).

Theoretical Framework

The theories that guided this study were the Cognitive Load Theory, Elaboration Theory, and ADDIE model. The Cognitive Load Theory (Sweller, 1999) posits that learning occurs under conditions aligned with human cognitive structure. It distinguishes between knowledge that can be acquired unconsciously (e.g., general problem solving) and that which requires conscious effort and teaching as seen in formal schooling (Geary, 2012; Geary & Berch, 2016). This theory guides instructional designers, urging them to reduce redundant cognitive load resulting from poor course design or learning materials. Information is initially processed in working memory before moving to long-term memory. Course designers must be mindful of the working memory's limited capacity to ensure course effectiveness. Recommendations based on the Cognitive Load Theory for multimedia course design included breaking down the course into smaller topics, simplifying course content presented digitally and physically, utilizing audio-visual software with cartoon stories, incorporating real-world problems and solution presentations, and ensuring uniqueness and diversity in each topic and corresponding story to eliminate redundancy in content.

The Elaboration Theory by Reigeluth (1999) emphasizes organizing instruction in increasing order of complexity for optimal learning. The design should progress from simple to complex and from the known to the unknown (e.g. Reigeluth et al 2017). In designing stories for multimedia lessons, each story started with a simple problem, escalating in difficulty over time. Interventions were developed to address the problems, leading to the identification of solutions.
The ADDIE instructional design model is a generic process used by instructional designers and training developers, comprising five major phases: analysis, design, development, implementation, and evaluation. The ADDIE model was employed to develop multimedia lessons for adolescent reproductive health and rights education.

Research Procedure

Analysis Phase

During the analysis phase, we conducted workshops for secondary school headteachers and teachers to discuss educational content and stories for inclusion in multimedia software for classroom teaching and learning. Four topics were identified for content development. A total of 14 teachers participated in content development, working in groups of 3 or 4 teachers for every identified topic. The topics for designing multimedia lessons were child and forced marriage, sexual and gender-based violence: adolescent sexual violence, teenage unplanned pregnancies and health complications in communities, and a story on teenage pregnancy and marriage: a shattered dream.

Design and Development Phase

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The lesson content was designed based on the format recommended by the National Curriculum Development Centre of Uganda. Each lesson had objectives, learning outcomes, educational stories (content), and questions for discussions. The stories were programmed into multimedia cartoon stories using Scratch 3.0 software. Four cartoon stories were developed based on the topics identified during the analysis phase. The student manual for the course was also developed.

Logical Design of the Course

Pedagogical Considerations for Lesson Design

The learning management system should be designed to support learning principles and online teachers' tasks. The design features for an online course should take into consideration the following phases or activities: Planning and identifying goals, objectives, standards, and content for the course; conducting learner and audience analysis; identifying technology requirements; reviewing other similar courses; facilitating the content analysis; reviewing samples of evaluation activities to match objectives and content; examining templates for syllabus design for various levels; and selecting appropriate activities and choosing the right media attributes to support the objectives of the learning experience.

Instructional Design

Instructional design is a discipline that describes the entire development process from learning requirements analysis to the implementation of the product (developed learning environment) satisfying those requirements. It is pedagogically focused on learning environment requirements that originate from the considered learning theories. Instructional design is the practice of creating instructional tools to facilitate learning. The process involves establishing the current state and needs of the learner, finding out the end goal of the instruction, and creating an intervention to assist in the transformation process. The instructional design process specifies all the tasks involved in a particular learning environment about learning objectives, content organization, assessment strategies, learner motivation strategies, media for content delivery, and learning outcomes.

Participatory Design (PD)

Population

This is an educational content development and testing innovation project targeting 400 teenagers to be equipped with skills in reproductive health, and life skills using digital lessons, multimedia educational content, digital stories, and other course materials locally developed by the researchers and teachers. The study covered students in O-level and A-level classes; these age categories range from 13 to 23 years. An assent form was given to them for signing before participation in the research. The stakeholders in the digital game design, development of digital stories, and multimedia educational materials were teachers, researchers, and students. A participatory design approach was used to involve teachers in the technology innovation development process. Teachers participated in analysis, design, implementation, and evaluation. Participatory design was directed by the action research method. The methods were clear: The

digital content was developed by teachers under the guidance of researchers through participatory residential workshops for content development. Action research drove the entire process from problem formulation to artifact development, implementation, and evaluation. The educational material was recommended by head teachers developed by the teachers and modeled by the researchers into cartoon lessons.

Development of Multimedia Teaching Software

The cartoon interface below in Figure 1 is for the story of a young girl called Asiomizu who went through hard times during her education because she had little support from home after the death of her father and ended up making mistakes that put her in a lot of pain. She ended up losing her brilliant dream of becoming a health worker. In the end, she realized her mistakes and reformed to go back to school and continue with her studies.

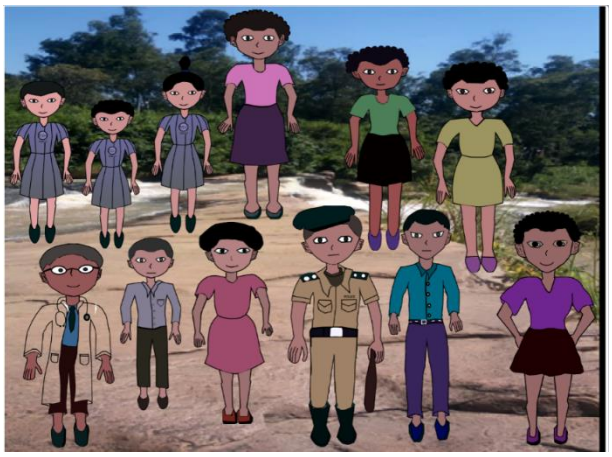

Figure 1: Cartoon Story Interface

Implementation Phase

During the implementation phase, adolescent sexual reproductive health and rights education was conducted in the seven schools that participated in the project. Students watched the cartoon stories and studied the student manual for the course.

Evaluation

Finally, we asked the teachers to share with us their experiences of participating in multimedia educational content design and its implementation in classroom teaching. We used questionnaires with a Likert scale to gather the opinions of the teachers. The scale ranged from strongly disagree (1), disagree (2), Neutral (3), agree (4), and strongly agree (5). Data were captured and analyzed using SPSS version 21. All 14 project teachers participated in multimedia lesson evaluation. The evaluation results are presented in the next section.

Results

Demographic Information

Fourteen secondary school teachers participated in the project. Seven (50%) were female teachers, and seven (50%) were male teachers. Two (14%) of the teachers had master's degrees, nine (64%) had bachelor's degrees, and three (22%) were diploma holders in education. The tables in the next section present quantitative results using means (Mean) and standard deviations (SD) of the theoretical constructs in the questionnaire.

Table 3: Story Development

No.	Item	Number	Mean	SD
1	I learned and I can apply the logic of developing educational stories from the workshop I attended.	14	4.93	0.267
2	I can develop logical conversations between actors when building educational stories for adolescent reproductive health and right education.	14	4.93	0.267
3	I can set logical questions to enhance discussions and learning during story-based lessons.	14	4.64	0.497
4	After the residential workshop, I was able to develop story-based lessons with students at my school.	14	4.79	0.426

In story development, 98.6% of the teachers (Mean = 4.93, SD = 0.267) expressed that they learned and could apply logic for story development for classroom teaching; 98.6% (Mean = 4.93, SD = 0.267) also acknowledged that they gained skills in cartoon story development. 92.8% of the teachers (Mean = 4.64, SD = 0.497) said that they could set logical questions to support cartoon-based learning.

Table 4: Multimedia Teaching

No.	Item	Number	Mean	SD
1	The multimedia lessons (cartoons) were well understood by the students.	14	4.71	0.469
2	The students were able to connect the cartoon stories to the corresponding story documentation in the student manual.	14	4.43	0.514
3	Multimedia lessons demonstrate real world problems and solutions to learners in exact settings.	14	4.71	0.469
4	Multimedia lessons are good for teaching and learning about adolescent reproductive health and rights in schools.	14	4.86	0.363

For multimedia-based lessons for classroom teaching, 94.2% of the teachers (Mean = 4.71, SD = 0.469) expressed that multimedia lessons were well understood by students; 88.6% of the teachers (Mean = 4.43, SD = 0.514) also mentioned that students perfectly connected the cartoon stories to the student manual; and 94.2% of the teachers (Mean = 4.71, SD = 0.469) expressed that multimedia lessons demonstrated solutions to real world problems in exact settings.

Table 5: Student Learning

No.	Item	Number	Mean	SD
1	Multimedia lessons promote student-centered learning in the classroom.	14	4.79	0.426
2	Multimedia cartoons motivate students to learn in the classroom.	14	4.79	0.426
3	Multimedia lessons enhance students' concentration in learning new things.	14	4.71	0.469
4	Multimedia lessons enable students to get information and knowledge which can	14	4.93	0.267

be translated into real life skills for problem-solving.

For the case of student learnings, 95.8% of the teachers (Mean = 4.79, SD = 0.426) expressed that multimedia lessons promoted student-centered learning; 95.8% of the teachers (Mean = 4.79, SD = 0.426) acknowledged that multimedia cartoon motivated students to learn; 94.2% of the teachers (Mean = 4.71, SD = 0.469) expressed that multimedia lessons enabled students to concentrate and learn new things; and 98.6% of the teachers (Mean = 4.93, SD = 0.267) acknowledged that multimedia lessons enabled students to get information and acquire knowledge which could be translated into real life skills for problem-solving.

Table 6: Opportunities in multimedia approaches to teaching and learning

No.	Item	Number	Mean	SD
1	If I am given a chance, I can train other teachers in story development for multimedia content.	14	4.50	0.519
2	If I am given a chance, I can independently develop educational materials for teenage reproductive health and right education with other teachers and students.	14	4.21	0.802
3	Future projects should involve web-based cartoons for easy accessibility by students.	14	4.86	0.363
4	Future project should involve cartoons that can be accessed from mobile phones.	14	5.00	0.000

When asked about the opportunity to use multimedia applications for classroom teaching, 90% of the teachers(Mean = 4.50, SD = 0.519) reported that they were ready to be trained in multimedia application development; 84.2% of the teachers (Mean = 4.21, SD = 0.802) reported that they could independently develop multimedia stories for translation into lessons; 97.2% of the teachers (Mean = 4.86, SD = 0.363) reported that future projects should involve web-based cartoons for easy accessibility to students; and 100% of the teachers (Mean = 5.00, SD = 0.000) reported that mobile-based cartoons stories should be developed because mobile phones are ubiquitous.

We also asked one open question to the teachers as follows:

Please give any other comment you feel can improve on future projects on adolescent reproductive health and wellbeing.
The following were the responses:
"I request the same program be extended to other schools after successfully piloting in the few schools."
"I wish the boy child too should be actively involved in this as drug abuse is on the high among the boys in schools."
"Disseminating the materials produced to all schools and involving the schools in the next program."

"For me, the stories should be allocated by the professor and sent to various schools both on a hard and soft copy early enough so that students can begin narrating them which will give ample time for teachers to read and edit the stories before submitting them for publication.
Secondly, the web cartoon content needs to be developed using the most suitable software so that it portrays the real motion of a life situation. And the interview videos should be on the web or phones for easy accessibility to adolescent people."

"I propose that next time the learners in various schools could do a focus group discussion on matters related to adolescent reproduction to reach out to their fellow youths."
"Students be involved fully in developing cartons to enhance their understanding of reproductive health and wellbeing better and the language used in the cartoon should be local language so that this can be presented to adolescents in primary schools and the local community."
"Animation and motions to be highly emphasized in Cartoon development."
"I think it could also be a good idea if these contents are acted by the adolescents in drama or film form."

Discussions

Adolescent sexual reproductive health education has not been formalized for teaching in Ugandan schools, and the country has no national curriculum for it. This study was conducted to develop and evaluate a multimedia application intervention for adolescent sexual reproductive health education in secondary schools in Uganda. The multimedia application for teaching and learning was jointly developed by a team of researchers, teachers, and students. This clearly demonstrates the development of educational solutions by the local people to solve local problems affecting them. This is in line with Pincock (2008), who stated that sexual reproductive health and right educational interventions are normally Western-centric and do not sufficiently address the needs of non-Western adolescents, and hence contextualized solutions are preferred.

The innovative multimedia application lessons were developed for use in school computer labs (desktop computers), with plans to extend their usage on tablets and mobile phones, making them even more accessible to a wide range of adolescents in different contexts. A manual was also developed (in print and softcopy) to support and guide educators' use of the multimedia application. This manual is intended to be used as a teaching tool, providing educators with lesson introductions and guiding questions for post-lesson group discussions. The manual also includes a simplified print version of the educational content; this ensures that students and teachers in schools without ICT resources can benefit from the intervention. The researchers worked with educators to deploy learning assessments and evaluation tools to assess the impact of the intervention at various points throughout the intervention period.

In teachers' evaluation of the multimedia lessons based on cartoon stories for teaching adolescent sexual reproductive health education in schools, teachers expressed that they learned the development of cartoon stories and techniques for setting questions for students' discussions after watching the cartoon stories. The teachers also acknowledged that students understood the cartoon stories very well and were able to relate the cartoon stories to the student manual textbook; hence, the cartoon stories and the books were good tools for teaching sexual reproductive health in secondary schools. This research is in line with findings from Dakich (2008) that storytelling facilitates integrated approaches to curriculum development and engages learners in higher-order thinking and deep learning. Digital storytelling is a powerful model that creates constructivist e-learning environments. Digital storytelling engages learners in integrated approaches to learning with digital media, enhances learners' motivation, and enables teachers to build constructivist learning environments (Smeda *et al.,* 2014).

Conclusion

The project was implemented in the West Nile Sub-region of Northern Uganda, involving seven schools selected from three of the 12 districts. These schools were purposively chosen to ensure a mix of rural and urban settings, including both girls-only and mixed schools. Three girls' schools and four mixed schools participated, with three from rural areas and four from urban areas. The project commenced with the training of teachers in residential workshops to develop educational materials translated into multimedia applications, specifically cartoon stories.

Given that all 14 trained teachers demonstrated improved knowledge about using multimedia applications to deliver adolescent friendly SRH education, all schools successfully implemented the multimedia project, albeit with varying levels of achievement. This underscores the effectiveness of multimedia applications as valuable pedagogical tools for teaching and learning adolescent reproductive health education in schools. The Ugandan government is urged to formally adopt multimedia pedagogy for adolescent reproductive health education, as evidenced by the unanimous self-report from all 14 teachers that the multimedia application is a feasible and acceptable method for delivering adolescent friendly SRH education. The evaluation results of the innovative multimedia application demonstrate the suitability of using cartoon stories and student manuals for teaching and learning adolescent sexual reproductive health in schools.

Recommendations

In the section below, we provide recommendations for policymakers and education practitioners to consider when developing and implementing adolescent reproductive health education in schools.

Practitioners:

1. Educational content development for adolescent sexual reproductive health education should be a collaborative effort involving teachers, researchers, and student representatives, tailored to the specific needs of the students.
2. Reproductive health education should be integrated into life skills training for students, empowering them to care for themselves and avoid early child marriages, sexually transmitted diseases, and teenage pregnancies.
3. Reproductive health education should be inclusive, reaching all students in secondary schools, rather than being limited to a small fraction.
4. The educational content for reproductive health education should be youth-friendly, fostering open sessions for discussions where students can express their challenges and receive appropriate responses.
5. Teachers should undergo training to proficiently use computer applications such as multimedia lessons, digital games, and animations for teaching sexual reproductive health, both face-to-face in classrooms and online.
6. The National Curriculum Development Centre (NCDC) should be actively involved in content evaluation to facilitate the adoption of project-developed content by schools nationwide.

Government Policies:

1. The Ministry of Education should design a curriculum for teaching and learning sexual reproductive health education in secondary schools and teacher colleges.
2. The government should allocate funds for the development of sexual reproductive health education resources for schools and teacher colleges.
3. Translate the English educational content into other languages spoken in the country to ensure accessibility for out-of-school youth.
4. Promote the use of ICT for teaching and learning reproductive health education in schools.
5. Provide training for teachers to develop multimedia lessons from teaching materials.
6. Engage parents through the Parents Teachers Association (PTA) to ensure children receive guidance at home.

The government should actively support the project and adolescent reproductive health, particularly through dissemination to relevant stakeholders, encouraging their active participation in the project and garnering goodwill for its success.

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