Digital Comprehensive Sexuality Education For Young People:

A realist synthesis of what works, for whom and in what circumstances

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Abstract

Background: Young people between the age of 10 and 19 constitute approximately one seventh of the total world population. For them, sexual reproductive health and well-being is an important concern as they transit into adulthood. However, comprehensive, non-biased, and accurate information about sex and sexuality is not always readily available or provided. With the expansion of digital technologies and portable devices providing affordable and easy access to the internet, there is an opportunity to provide sexuality education to these 'digital natives' in a new way. As young people flock online to seek answers about sex, research has been slow in finding out how such an intervention may work. More studies need to be done to better understand the impact of these online interventions and to provide practitioners and policymakers with evidence to facilitate program adaptions or implementations.

Methods: A realist synthesis was conducted to answer the research question 'How does online sexuality education work, in what ways, and under which circumstances'. 5 initial program theories were formulated from a background literature search and were each given a general explanatory theme of either *innovation, interactivity, personal relevance, safe space,* or *empowerment.* A structured database search combined with complementary searches were done iteratively to gather evidence for the testing and refinement of these 5 theories.

Results: In total, 32 documents contributed to the analysis and synthesis of evidence. In explaining how the intervention works for young people, the *motivation* mechanism was most strongly supported by evidence. This was followed by *social learning* where active interactions with others either online or offline came up as the second strongest mechanism. Online learning of this topic also provides opportunities for customized content and learning at one's own pace. Therefore, the mechanism of *aligning needs* was also supported by evidence. Young people, especially those facing stigma and discrimination, found online anonymity and a sense of security to be some of the key reasons why an online program is their preferred way to learn about sex.

Conclusion: This realist synthesis contributes to the knowledge building of how online sexuality education works for young people who have access to digital devices and the Internet. More studies of this kind are needed to further test these theories, look into alternative candidate theories, or evaluate them under different contexts. This study also provides a basic framework for practitioners and policymakers to make sense of this quickly evolving program, and stimulates better future designs and implementation strategies for use with young people.

Keywords: Digital comprehensive sexuality education, Young people, Realist Synthesis, Theory building, Sexual and reproductive health, Online learning

Background

1.2 billion young people between the ages 10-19 make up 16% of the global population (UNICEF, 2019). There is strong evidence that early health in childhood and adolescence has longitudinal impact on adulthood and old age (WHO, 2014). It is therefore important to engage young people and provide them with accurate and accessible sexual and reproductive health (SRH) information, thereby helping them cultivate healthy habits and lifestyles relating to SRH. With the recent adoption of the 2030 Agenda for Sustainable Development, UN Member States confirmed their commitment to sustainable development goal targets 3.7 and 5.6, which call for *universal access to sexual and reproductive health care services and rights by 2030* (WHO Europe, 2016). Positioned within the level of primary health care**,** SRH is a holistic concept as defined by the World health organization (WHO):

> *"Sexual health is an integral part of overall health, well-being and quality of life. It is a state of physical, emotional, mental and social well-being in relation to sexuality, and not merely the absence of disease, dysfunction or infirmity. […] For sexual health to be attained and maintained, the sexual rights of all people must be respected, protected and fulfilled."*

Despite the knowledge that sexual health education contributes to long-term impact on young people's SRH and well-being, the taboo nature of sex and sexuality in many cultures and societies has led to young people being denied basic information about their SRH and rights, resulting in them approaching adulthood with inaccurate, negative, or conflicting messages about sex and sexuality (UN Women, & UNICEF, 2018). This is why evidenced-based comprehensive sexuality education (CSE) plays an important role in bridging this gap. Evidence points to the efficacy of CSE in helping children and young people attain and develop a range of relevant skills and attitudes needed for their SRH wellbeing (Fonner et al., 2014; Constantine et al., 2015; UNESCO, 2015). However, global digital trends are emerging areas that will have a significant influence and impact on the current delivery of CSE.

SRH in the digital age

In the context of this digital revolution and booming information and communication technology (ICT), governments and health authorities are increasingly recognizing the importance of equipping young people with crucial knowledge and skills to help them navigate online spaces safely. As an emerging platform for learning and socialisation, reliable content from trustworthy digital sources is a valuable resource for curious young people. Traditional media such as movies, television, music, and magazines have a longstanding history of influencing young people's sex-related knowledge, attitudes, and behaviours (Lou et al., 2012), with ICT being the latest addition to the list. Since the 2000s, availability of digital technology has soared and now plays a major role in our daily lives. Young people are the most active users of digital technologies, with over 70% of young people being online (O'Sullivan, 2014). With the advent of "Web 2.0", online users have moved from being passive users (Web 1.0) to active content creators. This transition towards social connectivity will have implications for the online delivery of CSE (Manduley et al., 2018).

The Internet offers accessible, personalised, relatively affordable and anonymous sources of information (Cooper, 1998), depending on prevailing national contexts and their ICT policies. Within digital spaces, individuals are able to connect and share knowledge rather than relying on top-down information streams (Manduley et al. 2018). Recognizing the potential of using ICT, WHO has implemented a range of digital health solutions to reach underserved populations. An example of these solutions is the use of mHealth, where mobile devices and technology are used for various health-related purposes (WHO, 2018). Likewise, governments

and health authorities are realising the importance of equipping young people with crucial knowledge and skills to help them navigate online spaces safely.

With the proliferation of SRH-related topics online, young people are increasingly using the Internet to seek information about bodies, sex and relationships, as this information may be lacking at home or at school (UNESCO, 2020). However, it is unclear whether the content of these online sexuality education courses came from reliable knowledge bases. To date, there is limited data about how young people search for SRH-related information online, what they find, how they interpret it, and how it affects their sexual behaviours (Simon & Daneback, 2013). There is also a gap in research investigating the efficacy of existing digital sexuality education platforms available across a range of digital modalities such as mobile apps, social media, and online videos. Furthermore, due to the different methodologies used in researching the topic of online sexuality education, findings and conclusions from meta-analyses and systematic reviews have been inconclusive and at times contradictory. For example, in Holstrom's (2015) literature review on online sexuality education, she found it difficult to draw comparisons across studies because of inconsistent outcome measures, different theories of behaviours change applied, and a general paucity of theoretical foundations underpinning interventions.

Research objective

Digital CSE (d.CSE) is a complex subject intersecting disciplines of primary health, education, and communications technology. Research evidence will help guide decision-making of practitioners and policymakers wanting to apply or promote d.CSE with young people. Anchored in the perspective of global health, this study aims to strengthen and contribute to the knowledge base of this rapidly evolving topic by means of a theory-driven approach – *Realist Synthesis*, which involves sourcing and synthesizing evidence from a broad range of data sources across the above-mentioned disciplines to explain how, why, and in which circumstances complex d.CSE programmes work for young people.

Methods

Introduction to realist synthesis

Developed by Pawson and Tilley (1997), realist synthesis (RS) is based on 'Realism' – a broad logic of inquiry grounded in the philosophy of science and social science (Pawson, 2006). With the assumptions that reality can be experienced and understood by direct observations as well as interpreted indirectly through human perceptions, philosophical realism positions itself between positivism and constructivism (Wong et al., 2013a) when it comes to claiming what is true. Further, by acknowledging the "existence of an external social reality and the influence of that reality on human behaviour" (Wong et al., 2013a, p.5), realism is poised to help us understand the social world by using the concepts of *'context'* and '*mechanism*'.

Mechanism, context and C-M-O configuration

In realist philosophy, mechanisms are causal forces generating outcomes under specific contexts. Unlike mechanisms as known in natural science (e.g., gravity), mechanisms in realism could be *underlying processes* (e.g., psychological processes leading to specific human behaviour), *entities* (e.g., social norm) or *social structures* (e.g., class systems). Yet they share common features of being 'invisible' (i.e., can only be inferred from observable data) and being context sensitive (Wong et al., 2013a). Mechanisms are therefore contingent on contexts to be activated or inhibited. Contexts can take many forms, such as conditions

affecting interventions (e.g., staff training), broader social or geographical features (e.g., educational level of target population; school vs clinic), and individual characteristics of participants (e.g., health status). Finally, using a heuristic known as the context-mechanism-outcome (C-M-O) configuration, RS creates realist explanations for how an intervention works, for whom it does so, and under what circumstances.

Realist synthesis versus other review methods

The utility of realist syntheses (RS) for complex interventions becomes apparent when compared to other forms of reviews. The aim of any RS is to develop, test and refine program theories that explain how, why and in which contexts complex interventions work. To do so, RS uses a theory-driven approach to synthesize existing evidence, where 'theories' explaining 'interventions' become the focus of analysis (Pawson et al., 2004). In contrast, systematic reviews try to answer a well-defined research question by collating all empirical evidence conforming to strict eligibility criteria within a linear search procedure (Chandler et al., 2019). A meta-analysis, on the other hand, is a statistical procedure used to combine quantitative results of multiple studies to come to a precise estimate of particular effects or outcomes (Hanratty, 2018). These latter two methods are useful when generalizing results from a large number of interventions where variables and outcomes are controlled and not subjected to large heterogeneity (e.g., clinical experiments). However, as practitioners and policymakers are recognizing the need for literature reviews capable of drawing lessons from complex social and health interventions where contextual variations are present (Pawson et al., 2004), RS is better suited to answer this call.

Rationale

This synthesis was conceptualised and conducted between April 2020 and May 2021 following the RAMESES publication standards for RS (Wong et al., 2013b). Health behaviour research has shown that theory-based interventions produce greater effects on behaviour than interventions without a theoretical basis (Bartholomew & Mullen, 2011). Educational programs such as CSE are designed with an underlying theory of how learners will learn and transfer knowledge into skills to address their SRH needs or behaviours. The combination of complexity, contingency of the social world and evidence inconsistency of CSE makes it difficult for systematic reviews to make meaningful claims about the effectiveness of an intervention. This is why a RS with its above-described features was chosen as the method to investigate the research question in this study.

Detailed methods and steps

In this section, techniques used for this synthesis will be described in detail according to the following 5 steps: scoping literature and identifying IPTs; searching for empirical evidence; selecting documents; extracting data; and synthesising evidence for program theory refinement. Figure 1 shows a diagram of this search and refine process.

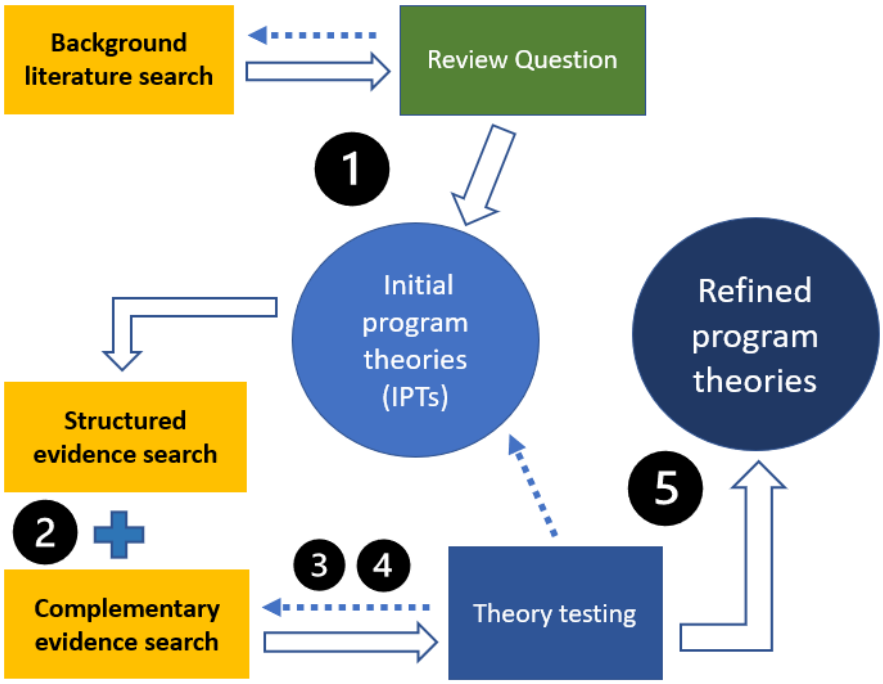
Step 1: Scoping literature and identifying IPTs

This synthesis began by developing initial program theories (IPTs) explaining how d.CSE works. This was done primarily via an exploratory search, document review and consulting of an expert in adolescent SRH. Grey literature within the broader area of CSE was scoped by using Google Scholar with the terms "comprehensive sexuality education + online/digital". Additional information was also sought via a 'berry picking' method (Bates, 1989) which included relevant citation searches and information gathering from other sources of interest. Useful information harvested included guidelines and papers about CSE published by

international non-governmental organisations (NGOs) such as WHO, UNESCO, UNICEF and UNFPA, National health or educational authorities, and NGOs such as Rutgers. Additionally, the co-promoter of this study, Kristien Michelsen, is an expert in adolescent SRH research and has pointed the reviewer to several highly relevant papers such as *The Opportunity for Digital Sexuality Education in East Asia and the Pacific* (UNICEF, 2019) and *Switched On: Sexuality Education in the Digital Space* (UNESCO, 2020). As part of the global CSE partnership, she also gave advice on prioritization of IPTs in order to focus the scope of this study for completion within a limited timeframe.

Figure 1

The Realist Synthesis Iterative Search and Theory Refinement Process

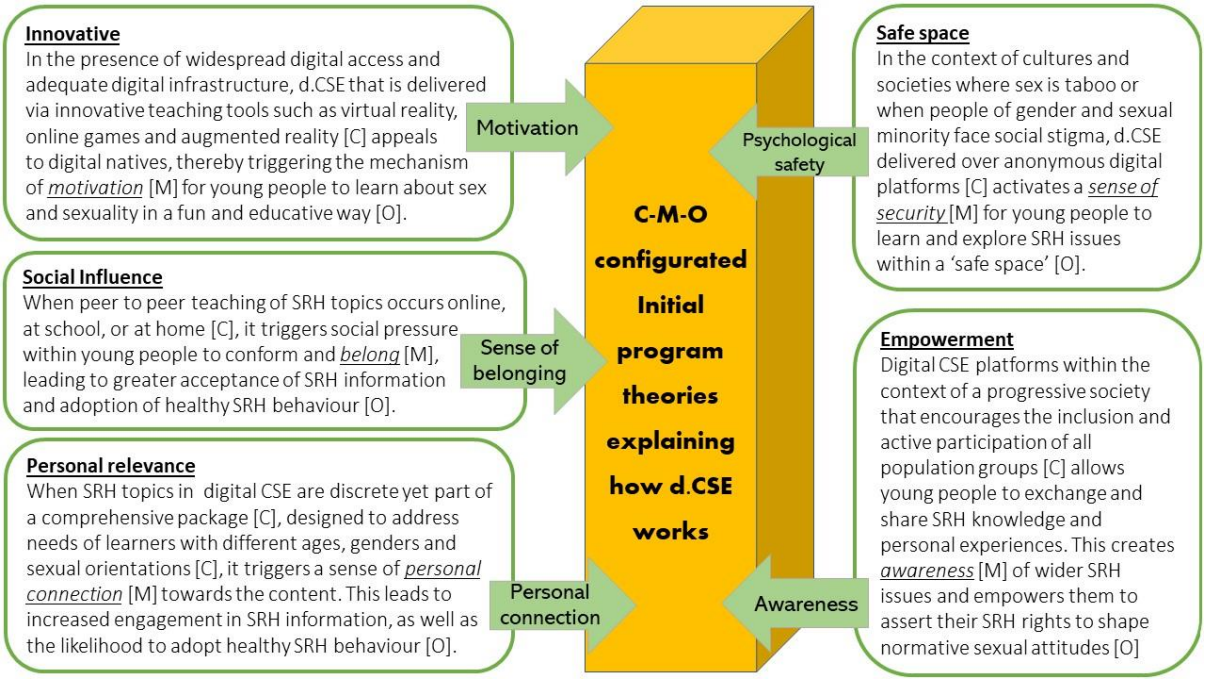


Note. Details of steps 1-5 are described in the following sections, with subheadings corresponding to the numbered icons in the figure. Dotted backward arrows indicate the iterative nature of the search and refining process.

From this scoping exercise, a knowledge gap regarding the effectiveness of d.CSE was confirmed (Simon & Daneback, 2013; DeSmet et al., 2015; Guse et al., 2012). IPTs were elicited by 'digging through' literature and piecing together clues in texts implying contexts, mechanisms and outcomes. Very often these were not described in the above sequence, nor were they always complete. As expected, mechanisms were the least explicitly named and had to be inferred in many instances. A group of around 8 to 10 IPTs formed the basis of the theory eliciting and were all described as C-M-O configurations. These IPTs underwent at least another 2 rounds of refining in order to determine the logical placements of context and mechanism constructs. Finally, the refining process yielded 8 IPTs where 5 were prioritized, each given a theme: *innovative, social influence, personal relevance, safe space,* or *empowerment.* Figure 2 details these 5 IPTs as a collective diagram.

Figure 2

The Five Initial Program Theories (IPTs) as Candidate Theories for Further Testing



IPTs informed by behavioural change model

Barak & Fisher (2001) assert that sex education should ideally be based upon well-developed and well-validated behavioural science theory. To link the 5 IPTs to an approximate existing explanatory model, the Information-Motivation-Behavioural (IMB) skills model (Fisher et al., 2003) was chosen during the scoping exercise and later tested together with the 5 IPTs. The IMB skills model is a general social psychological model for understanding and promoting health-related behaviour. The concepts of personal and social motivation in this model find resonance with the IPT of innovation and personal relevance where motivation and engagement in learning is key. Furthermore, this model is also useful for translating behavioural interventions that can be empirically evaluated in *terms of motivation, information and behavioural skills*, and for viewing these 3 concepts as having linked causal relationships instead of being isolated from one another (Fisher et al., 2003). Applied to the scope of this study, the IMB model asserts that SRH-related information, motivation, and behavioural skills are fundamental determinants of performance of sexual health behaviours. When young people are well informed of SRH issues online, are motivated to act, and possess the required behavioural skills for effective action, they will be likely to initiate and maintain healthy sexual behaviours and attain positive SRH and relationships outcomes (Fisher et al., 2003).

Step 2: Searching for evidence

Evidence search in a realist synthesis is a blend of sampling and search techniques and does not require comprehensiveness like systematic reviews do (Pawson, 2006). The search technique used here is iteratively conducted throughout the study so that information gets updated, and new explanations were sought as program theories underwent refinement and testing (Booth et al., 2018).

For this review, 5 academic databases encompassing themes of healthcare, social science, and education were searched – Embase, Web of Science, Scopus, ERIC and PubPsych. The search syntax was developed around the key concepts of sexuality education, SRH, online/digital format and young people as target group. A complete search strategy and search log can be found in (*Appendix 1: Database Search Strategy)*. Given the limited available evidence, 'young people' and 'SRH outcomes' were at times omitted in the search terms to gather a larger set of relevant data for review. Where appropriate, these searches were also limited from year 1990 onwards, which coincides with the invention of the World Wide Web and the beginning of widespread Internet use (Greenemeier, 2009). Additionally, snowballing and citation tracking techniques using the free software *Publish or Perish* were used to find related articles and identify impactful studies. Lastly, limited complementary searches were also conducted for emerging theories and concepts in order to enable theory testing.

Step 3: Selecting Documents

Titles from the searched databases were downloaded and collated on Microsoft Excel, where duplicates were removed. Titles and abstracts screening was conducted using the free online software tool Rayyan. A list of exclusion criteria was applied to screened documents in order to focus on the most relevant data (See Table 1). These exclusions however did not apply to complementary theory searches, as relevant information could be located in broader literature. After the exclusions were applied, full-text articles were downloaded for a detailed review.

Table 1

Exclusion Criteria Applied in Database Search

Exclusion criteria applied to structured evidence search
Review protocols
Digital features without online connectivity
Study not targeting young people
Interventions focused on sexual behaviours, not sexuality education
No full-text available
Non-English texts

Step 4: Data extraction and organization

The aim of extraction was to populate the IPTs with evidence and ready them for analysis. Every included document was added to *NVivo*© and read through, with relevant words or passages highlighted and added to one of the following codes:

- Intervention type (e.g., game / web module / iPad / mobile)
- Actors (e.g., boys, girls, LGBTQ+, parents, educators)
- C-M-O configuration (articulated contexts leading to specific outcomes because of particular mechanisms)
- Individual context, mechanism and outcome code (if not directly linked by author)
- Any underpinning theories mentioned

A separate word document was created where coded information was transferred to and tabulated under the headings *reference, intervention, actors*, *C-M-O identified* and IPT theme corresponding to either innovation, social influence, personal relevance, safe space, or empowerment (Example shown in Table 2).

Table 2

Data Extraction Table

Reference	Intervention	Actors	C-M-Os identified in text	IPT themes: Innovative / Safe space / Personal relevance / Social influence / Empowerment Explicit / inferred mechanisms
Barak & Fisher (2001) *Toward an internet-driven, theoretically based, innovative approach to sex education*	Internet for delivery of sex education	Unspecified group	• An Internet sex-education website is able to communicate actively, reciprocally, and continuously with the learner and with others [C], therefore sex-related learning becomes a dynamic two-way process [O]. At the same time that it is controlled by the learner [M] and is as private and protected [M] as he or she requires. • Privacy, portability, uniformity of quality [C]. An Internet sex-education website provides an intervention channel that is completely private, portable in the sense that it can be accessed from multiple locations, and of uniform quality, without being subject to the influence of individual differences in teachers' skill or enthusiasm, which are especially critical in the sex education domain.	Social influence Safe space M: Motivation (intrinsic & extrinsic) Reinforcement learning Control/agency
Holstrom (2015) *Sexuality Education Goes Viral: What We Know About Online Sexual Health Information*	Internet based SRH information	Young people 13-24 USA, Australia, Europe	• Anonymity [C] is a major concern for young people [A]. They do not want others to know that they are searching for sexual health information, most often because they fear stigma or embarrassment [M]. • Teens' willingness to go into explicit detail is important because it highlights that teenagers are willing to open up [O] when they feel safe [M]. The anonymity of the Internet [C] offers this safe space [O].	Safe space M: Sense of security

Step 5: Analysing and synthesizing evidence

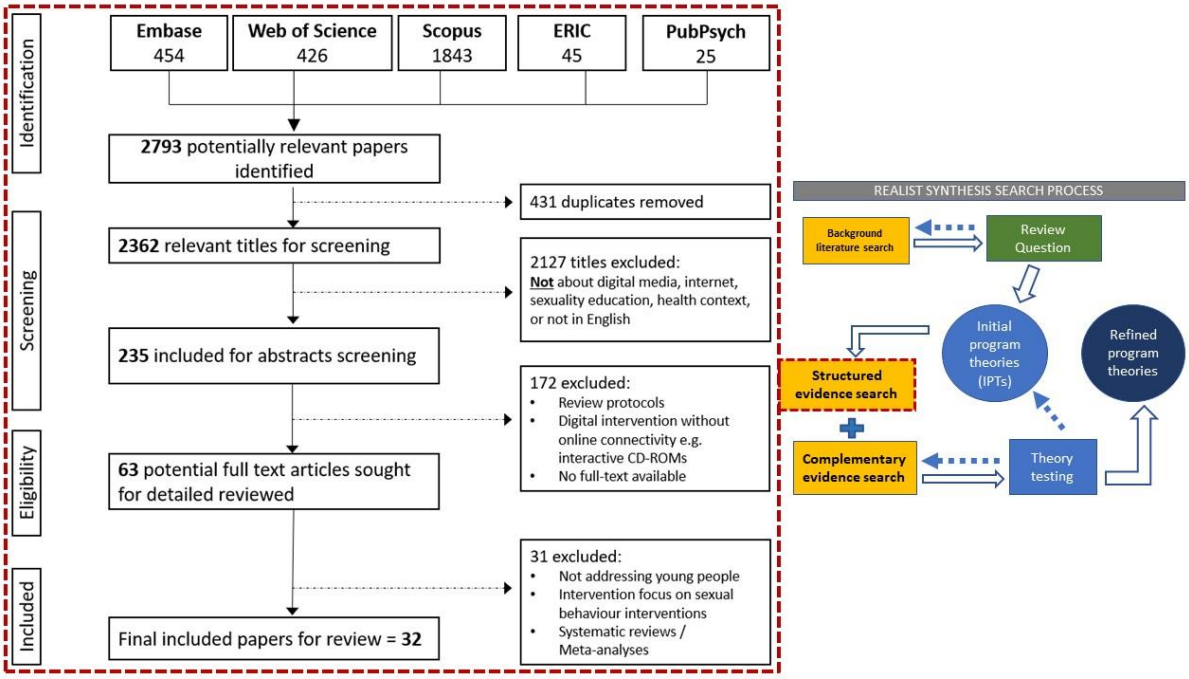
Refining IPTs is about comparing the hypotheses of IPTs with the empirical evidence drawn from documents. To identify the connections between C-M-Os and the IPTs, text segments containing C-M-O explanations from the extraction table were reviewed in depth. As expected for complex issues, C-M-O explanations from different documents were not always aligned. To counteract this, evidence had to be further treated using techniques of *juxtaposing, reconciling/adjudicating, consolidating, or situating* (Pawson, 2006) so as to arrive at an explanation which best fits the context to outcome patterns. The next step of the synthesis was to link the C-M-Os with relevant middle-range or substantive theories from fields of health promotion or educational pedagogy, in order to produce a final refined program theory, which is presented under the results section.

Results

Figure 3 shows the document flow of the structured evidence search, where 5 online databases resulted in 2793 potentially relevant papers after removing duplicates. During the title and abstract screening stage we excluded papers that were clearly unrelated to online/digital technology or sexuality education, were not within a health context, were review protocols, described digital strategies not based online, or had no full text available, 63 papers were selected for the next stage of full text screening. After applying the remaining exclusion criteria, a total of 32 papers were included for data extraction and analysis.

Figure 3

Document Flow of Structured Evidence Search from 5 databases



The majority of the papers (n=19) addressed online sex education interventions in the Global North, while 7 targeted young people in the Global South. The remaining 6 papers had unspecified geographic focus and maintained a global view. A small encouraging trend is the appearance of studies from 2015 onwards which addressed the sex education needs of young people who belong to sexual and gender minorities. Approximately a third of the included papers (n=10) were qualitative studies seeking to understanding young users' and providers' perspectives about how digital sexuality education interventions work. Mixed methods studies (n=5) with similar goals were also conducted and provided more methods of inquiry to evaluate their digital interventions. Commentaries (n=5) were a source of expert opinions about how online sexuality education could work and improve. Content analyses (n=5) of online websites and mobile phone applications for sexuality education also provided an overview of the features and characteristics of the intervention types that were available at the time of research. Effectiveness studies (n=4) looked into variable outcomes such as SRH knowledge, healthy sexual behaviour and sexual attitudes (See *Appendix 2: Document Characteristics* for full details). Finally, a total of 15 different theories and approaches were mentioned in the documents (See Table 3). Notably, the IMB model only appeared in 2 documents, prompting a rethink and complementary search for another theory which could further support the IPTs.

In the complementary search, Connectivism theory from the field of education became a potential candidate theory.

Connectivism as a learning theory for the digital age

Theories of learning provide frameworks for effective teaching and also apply to CSE in general. Learning in a digital age occurs in social, networked, and technological landscapes where learners engage with diverse information sources. Connectivism evolved from the constructivist school of thought which posits that (Anderson, 2004) learners are active participants in their learning journey, constructing knowledge based on their experiences. In Connectivism, learners control their learning agenda and contextualise information (Dunaway, 2011). However connectivism goes further than the constructivist social learning because of the inclusion of technology and digital networks. In this paradigm, learning is viewed as a network phenomenon influenced by both technology and socialization (Goldie, 2016). Based on the framework of distributed knowledge, one of the key ideas consists of learners connecting to and participating in a learning community via self-created personal learning environments (Goldie, 2016) such as an online learning environment.

Table 3

List of Theories and Approaches Found in Documents Reviewed

Theory / Approach	Source articles
Scenario-based Risk information	(Mevissen et al., 2018)
Social Cognitive Theory	(Coyle et al., 2019)
Theory of Planned Behaviour	(Coyle et al., 2019)
Community Engagement	(Chu et al., 2019) (Haruna et al., 2018)
Health literacy principles	(Kalke et al., 2018) (Manduley et al., 2018)
Integrative model of behaviour	(Coyle et al., 2019) (Carswell et al., 2012)
Theory of Situated Learning	(Coyle et al., 2019)
Information-Motivation-Behavioural (IMB) skills model	(Mustanski et al., 2015) (Barak & Fisher, 2001)
Peer-led approach	(Chen & Barrington, 2017)
Anticipated affect	(Carswell et al., 2012)
Intervention Mapping	(Mevissen et al., 2018)
Game based approach	(Chu et al., 2019) (Haruna et al., 2018)
Community of Inquiry Model	(Green et al., 2015)
Activity Theory	(Haruna et al., 2018)
Connectivism	(Goldman, 2016)

Main findings

This section presents results obtained from testing the IPTs across evidence found. By bringing the 5 IPTs together, we arrived at the hypothesis that a combination of mechanisms of *motivation, psychological safety, sense of belonging, engagement*, and

awareness act as main drivers for positive outcomes when different formats of d.CSE were implemented. Through the synthesis process, these theories gained support from the gathered evidence but underwent slight refinement when it comes to the themes *social influence* and *personal relevance*. We also found weightings indicating strength of influence across these 5 IPTs. Table 4 presents selected evidence contributing to the IPT refinement as well as problems using online sexuality education interventions.

Table 4

Selected Text Examples from Documents Reviewed

Theme	**Selected examples of supporting evidence** (For full list see *Appendix 3: Supporting Evidence)*
INNOVATIVE	• The game mechanics (leaderboards, levels, and points) noted as extrinsic motivational factors may have played a role in driving students to be motivated in the learning process by gaining points, increasing levels, and reaching a rank on the leader boards (Haruna et al., 2018). • An Internet sex-education website will be able to access text, sound, still pictures, animation, videos, and other graphic channels, exploiting and engaging human beings' multi-sense capabilities (Barak & Fisher, 2001). • Many students said that they liked receiving sex education online because they could drive their own learning independent of their teacher and their peers. Students could pace themselves (e.g., students in one classroom would be working on different activities or even different lessons at the same time) and could access the online intervention from any device connected to the Internet (Chen & Barrington, 2017). • In addition, using appropriate tools, the website will determine when the individual reaches criterion levels of behaviour change that reflect his or her personal needs and priorities (Barak & Fisher, 2001). • Sexual health education through games enables adolescents to easily absorb, transfer, and retain the intended information. The learner is engaged to act in various challenging learning activities (thinking tasks, quizzes, competitions) that foster cognitive functioning and development skills including critical thinking, decision-making, remembering, evaluating, reasoning, and problem-solving (Haruna et al., 2018).
INTERACTIVITY	• Online sex education could provide a more interactive space where young people could anonymously discuss experiences and questions about sexuality and relationships that they face in real life (Müller et al., 2017). • Interaction is an important part of the learning process. It enables learners to ask for clarification of learning material, raise doubts and discuss issues with other students (Weerakoon, 2003). • An Internet sex-education website is able to communicate actively, reciprocally, and continuously with the learner and with others (e.g.,

	instructors or other users), making sex-related learning a dynamic two-way process, at the same time that it is controlled by the learner and is as private and protected as he or she requires (Barak & Fisher, 2001) • Keeping online sexuality education private does not mean that young people need or even want to stay isolated from one another. In focus groups and interviews with 16–22-year-olds, respondents expressed that it was important to them to be able to remain anonymous but that they would like some type of social interaction included in a sexual health website. Respecting privacy and confidentiality while maintaining a rich discussion of sexual health topics is often the goal (Holstrom, 2015).
SAFE SPACE	• Overall the participants agreed that a substantial benefit of such an approach was privacy and confidentiality. They liked being able to get information and explore these topics in private (Bull et al., 2010). • Learning through games is confidential by nature, hence encouraging adolescents to discuss sexual health matters freely. Therefore, it is applicable even in cultural contexts such as Africa, where talking about sex matters in public is taboo (Haruna et al., 2018). • Teens' willingness to go into explicit detail is important because it highlights that teenagers are willing to open up when they feel safe. The anonymity of the Internet offers this safe space. (Holstrom, 2015). • Online formats offer a safe place where people can maintain their privacy and/or anonymity. The combination of anonymity and ease of access can help those who fear discrimination or rejection to connect with similar individuals and become part of a larger community (Mckee, Green, & Hamarman, 2012).
PERSONAL RELEVANCE	• The language used on the site aimed to be gender and sexuality neutral to allow engagement with the website content regardless of gender, sexuality, or sexual preference (Carswell et al., 2012). • Young people might feel drawn to sex education because YouTube producers are able to create narratives that relate to their viewers' present preoccupations with sex and sexuality. In addition, narratives can amplify the influence of participation and mediate between the fulfilment of personal needs and a shared emotional connection (Johnston, 2017). • Based on elicitation research carried out with a specific individual, the website's executive functions will create an empirically targeted and completely individualized sex education curriculum (Barak & Fisher, 2001).
EMPOWERMENT	• The website emphasized equality and sexual rights, informed by the connection between gender power imbalances and sexual health risk (Carswell et al., 2012). • Virtual sexual education programs radically shift the dynamics of sexual knowledge and power, offering young people options other than those dictated by parental norms or religious doctrine (Manduley et al., 2018). • Online spaces allow LGBTQ+ people to have voice, and to engage with each other and take control of their environment (Manduley et al., 2018).

Innovative methods enabling motivation and engagement

Evidence supports d.CSE as an innovative method of delivering CSE. It is positioned as an accessible, affordable, and acceptable teaching and learning method among young people and educators (Barak & Fisher, 2001; Nik Farid et al., 2018). It also facilitates the finding of information, connects young people to peer experiences, and is highly convenient if accessed with mobile devices (Rogers et al., 2020). Standardizing content and ensuring regular content updates are also easier with a digital format. Given their familiarity with digital technology for learning, playing, and socialising, young people surveyed were especially motivated to learn about sexual health matters on platforms that uses novel formats such as gamification and avatars (Chen & Barrington, 2017; Mckee et al., 2012). For example in the game-based approach, online quizzes and gamification of learning tasks create an atmosphere of competition via visual scoreboards, thus driving extrinsic motivation for learning and increasing SRH knowledge (Haruna et al., 2018). Online platforms which appeal to the senses of young learners were also more effective in capturing their attention and boost engagement with the content (van Lieshout et al., 2017). Digital platforms also offer hyperconnectivity to other relevant resources such as SRH services and online educators who facilitate their learning (Barak & Fisher, 2001). Lastly, digital tools such as learning analytics can be used for monitoring learners' progress, while also functioning as calibrators of difficulty levels catering to individual learning ability and progress (Barak & Fisher, 2001).

Despite all the described advantages, it is important to contextualise these findings. D.CSE was found to benefit young users who live in remote places and have difficulty accessing physical classes. Learners who have physical disability or medical conditions limiting their mobility will also benefit from that (Mckee et al., 2012). Lastly, reasonable digital infrastructure and access to ICT devices are needed to achieve desired SRH outcomes from d.CSE (Aventin et al., 2020).

Online safe space affording psychological safety

Anonymity is another major feature of the Internet that has been frequently mentioned as the reason why d.CSE is successful among young people (Bull et al., 2010). It offers a safe place where privacy can be maintained while young people explore sensitive topics in a discreet and independent manner (Yoost et al., 2021). Online discussions could go more in depth as students put in more thought into their questions and comments (Holstrom, 2015). Not having a teacher standing in front of the class also helped to reduce students' assumptions and biases that a teacher may bring with him or her.

The psychological sense of safety afforded by online anonymity encourages young people to discuss sexual health matters with minimal reservations (Mckee et al., 2012), making it a useful tool for use in cultural contexts such as Africa and Asia, where openly talking about sex matters is considered taboo (Haruna et al., 2018). Furthermore, it not only provides a valuable information platform for users from sexual and gender minority communities who fear discrimination, but also provides a place to connect with other similar individuals and form a supportive online community (Holstrom, 2015). Therefore, a safe space is appreciated by young people in all contexts, but especially by those of the LGBTQ+ community (McCarthy et al., 2012).

Interactivity as part of learning in online social environments

Evidence stressed the importance of dynamic interactive processes for learning about SRH, which include getting reciprocal feedback, having questions and doubts clarified, friendly competition in games, and having honest discussions not only with peers but with adults who possess the relevant SRH background (Chen & Barrington, 2017; Barak & Fisher, 2001). Interactive Learning (IL) is a pedagogical approach incorporating social networking into

teaching and has evolved out of the hyper-growth of digital technology and virtual communication (Fahy, 2008). To apply IL effectively, computers and associated technology becomes an essential part of the learner, while teachers fall into the role of 'facilitators' (Parker, 2008). Online interaction has many forms, such as discussion boards and chatrooms, and have an engaging effect on young people (van Lieshout et al., 2017; Haruna et al., 2018).

The interactivity feature has helped bridge the gap for talking about sex, and enhanced communication between young people and adults who want to facilitate their learning about sex and sexuality. Interestingly, while young people reflected upon the value of being anonymous online to discuss experiences and questions about sexuality and relationships that they face in real life, they still prefer some form of social interaction on a sexual health learning online platform (Holstrom, 2015; Chen & Barrington, 2017). The goal therefore is to respect privacy and confidentiality while retaining a rich discussion of sexual health matters.

Personal relevance for deeper engagement with SRH content

For a learner to engage and immerse into educational content such as CSE, a certain personal relatedness towards the shared experiences and personal relevance to the mind's preoccupation have to be present. CSE which adheres to the UNESCO International Guidelines comes close to addressing age appropriate SRH issues and delivering it to groups of young people at calculated stages. An online delivery format goes further than just topical content (e.g., video snippets, blogs), and gives the learners freedom to choose their topics of interest. Furthermore, websites with the capability of delivering individualised educational experiences will be able to target the learner's specific needs, level of motivation, and any behavioural-skills deficits related to the SRH issue of concern (Barak & Fisher, 2001). As mentioned before, the online environment also allows interactivity, where young people could share and hear personal narratives of others, be it peers or adults, thus providing insights into their own problems and doubts.

Evidence has also shown that online CSE which uses age-appropriate gender-neutral language fares better for engagement and acceptance of young users, especially for sexual and gender minority youths (Andrzejewski et al., 2020; Carswell et al., 2012). This reinforces and broadens the relevance to reach as many youths as possible without putting them off with difficult medical jargon, while also creating an inclusive environment where the content they explore does not make them feel judged or pigeon-holed. Finally, online sexuality education promotes active learning, where online learners are able to learn at their own pace and explore topics of their immediate interest (Kalke et al., 2018). This departs from conventional methods of CSE education in classrooms where a teacher is often in control of teaching the syllabus and often does so according to a prescribed sequence.

Empowerment from awareness enabling voice and agency

Within the evidence gathered, the concept of empowerment was raised as both a means and outcome such that young people are enabled to exercise their SRH rights and demand comprehensive and non-discriminatory sexuality education (Roffman et al., 1997). Although traditional CSE also has components for addressing SRH rights, ICT and its hyper-connectivity to the wider world more readily reaches young people in raising awareness for SRH issues. Of the included papers, only 4 mentioned the concept of empowerment via their intervention. This could be due to the lower importance placed on sexual rights as compared to other more concrete goals of improving sexual health and promoting healthy sexual behaviours. Nonetheless, online spaces for learning about SRH remain a potential means to challenge normative ideas via knowledge sharing and online activism (Manduley et al., 2018). Sexual and gender minorities greatly benefit from such a space to have a voice and engage within like-minded communities (Manduley et al., 2018).

Problems with d.CSE

Evidence presented above has largely supported the IPTs of how a d.CSE intervention works. However, there were also issues raised that diminish the efficacy of this intervention. Nonetheless, these issues are unlikely to override the overall advantage of d.CSE, but decision-makers and practitioners need to be aware of them and consider any implementation carefully. Firstly, when evidence supported the motivating factor of an online intervention, there is a general assumption that learners already have prior success and familiarity with online learning. However, there are several underlying prerequisite capabilities, such as writing skills, communication, managing one's time online and independence in learning (Chen & Barrington, 2017). The issues of digital literacy and access to internet were often described as a 'digital divide', which forms a learning barrier for girls and young people from socio-economically disadvantaged backgrounds (Manduley et al., 2018; McKee et al., 2012). Furthermore, it is well known that the online environment is highly distracting, meaning that d.CSE content may not capture the attention of young people if it was not designed to be engaging for them.

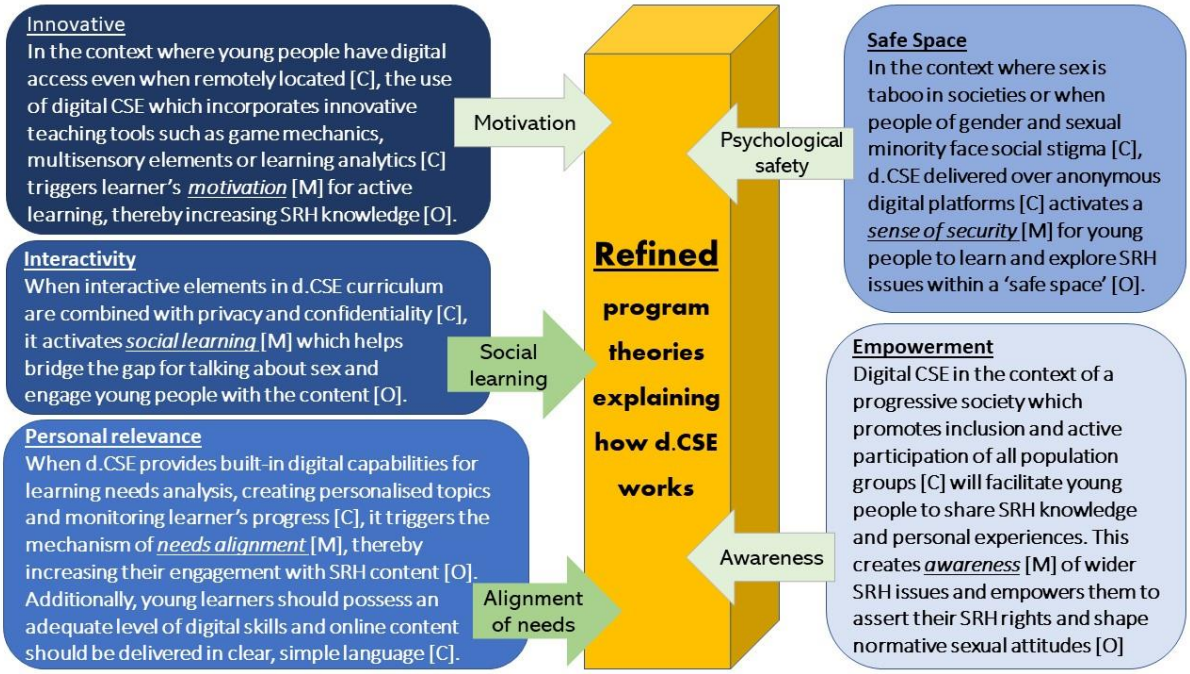
The online medium also presents challenges of capturing the complexities of discussion and debate that occur during face-to-face conversations (Kop & Hill, 2008), leading to concerns about the lack of critical engagement online (Norris 2001). Critical engagement is missing if educators were reduced to the role of facilitators, which is often the case for online learning (Salmon, 2004). Well-trained teachers who are able to spot students with negative beliefs and attitudes can directly address the issue in a face-to-face class, but the same issues can easily go unnoticed in an online teaching format. Other pragmatic issues pertain to a lack of human or physical resources. Such is often the case for rural schools (Chen & Barrington, 2017). which would prioritise the scarce resources for teaching mainstream subjects, and relegate sexuality education to an 'extra-curricular' subject. Internet laws and regulations of each country affect what can be taught online and what information can be found. It is difficult to regulate the online space in such a way as to provide accurate educational content while restricting explicit content, especially given that the sets of search terms often overlap (Bay-Cheng, 2001). Finally, traditional opposition from conservative gatekeepers continues to have power to restrict young people's access to materials and content for online CSE (Müller et al., 2017).

Refined program theories

At the final stage of this synthesis, refinements were made to the 5 IPTs as shown in Figure 4 where the weighting of influence was colour coded from the strongest (deepest blue) to least strong (lightest blue). For the IPT themed 'Interactivity', evidence around the IPTs found *social learning* (learning *with* and through others) to be the underlying mechanism rather than *social influence* (a more passive concept of diffused learning *from* others). Next, the mechanism of *personal connection* under the theme of personal relevance was refined to reflect *alignment of needs* as the driver for higher engagement in SRH content online. Finally, the emphasis on empowerment was also lessened as it was not necessarily an explanation of why online sexuality education would work, but rather an important by-product which feeds back into CSE and changes how CSE may be best delivered to young people, namely through advocacy and voicing of young people's needs with respect to their SRH and wellbeing. Implications of these refined program theories will be discussed in the next chapter.

Figure 4

Refined Program Theories



Note. Colour gradient indicates frequency of evidence reported for the specific program theory, with darkest being the most evidence found. Underlying mechanisms that were adapted are indicated by darker green arrows.

Discussion

Summary of findings

Although CSE strives to be universal for every young person, the importance of contexts was known and confirmed by this synthesis. One example pertains to physical contexts, such as direct access to a technological device including computer, mobile phone or tablet. Although developing countries are rapidly catching up with ownership and use of digital devices, a gap still exists between high- and low-income countries. Therefore d.CSE may still for a time be out of reach for young people in rural communities.

On the societal level, certain normative attitudes and beliefs about sex and sexuality need to change in order for young people to have a safe space for questions and to generally have better access to SRH information. For example, research found that formal sexuality education and health promotion content often do not match up to what young people want to learn. While stakeholders acknowledge the fact that they are not giving young people what they want, many remain uncomfortable discussing sexual pleasure, or find themselves limited within institutional and policy frameworks that require them to avoid controversial topics of sex (Albury & Byron, 2015; Leahy & McCuaig, 2013). Next, issues of gender divide in use of technology (Banaji et al., 2018) and young people belonging to sexual and gender minority groups being ignored in sexuality education are still problematic. There is evidence from this synthesis that d.CSE benefits young people belonging to these groups (Andrzejewski et al.,

2020; Carswell et al., 2012; Manduley et al., 2018). Therefore, future d.CSE can be better designed and implemented for these target groups. With greater adoption of d.CSE, roles of trusted adults need not be diminished as there is still much value in sharing practical knowledge and experiences with young people by being online "experts".

On the individual level, the promotion of d.CSE needs to happen in tandem with the development of young people's digital literacy and general health literacy. Sexual health literacy gives young people the ability to understand preventive sexual health information and to make informed sexual behavioural choices (Wong et al, 2021; Manduley et al., 2018). Digital literacy provides young people with the skills to critically reason about what they come across online and exercise better judgment when faced with inaccurate information. Furthermore, digital literacy can also be used to provide knowledge and promote safe online behaviours (Park, 2019). Young people will always be ahead with emerging technology and adults need to be able to anticipate future needs. Consulting and involving young people from very early on into every design of d.CSE is imperative, and gives value and importance to the knowledge possessed by young people, who will eventually be the main beneficiaries of such an intervention and would be highly invested into making d.CSE a fun and educative learning experience for themselves.

Theory building

The purpose of this synthesis was to build a framework which could explain how d.CSE works with young people and in which contexts. From a global health perspective, findings from this synthesis contribute to the theoretical knowledge of d.CSE and go towards creating better intervention programs that could impact young people on a global scale. Given the interdisciplinary and complex nature of d.CSE, it is necessary to build a context-sensitive theory to explain how, for whom and under which contexts it works. In this study we have adopted the theory-driven realist approach to do so. As d.CSE is an emerging intervention, primary studies relating to sexuality education taught online or via digital technology were scarce. Acknowledging this limitation, this study was conducted based on the realist paradigm which argues that nuggets of explanations and insights for understanding a complex social intervention such as d.CSE can be mined from diverse forms of evidence. In total, 5 IPTs were elicited from a background literature search and were then further refined after being compared against existing evidence. The C-M-O configurations that made up the IPTs remained largely stable, and evidence supported the initial hypotheses. Minor refinements were made to some of the IPTs to reflect what evidence has shown, thereby nuancing the C-M-O configurations. This synthesis exercise validated the explanatory power of the program theories and brought together some of the key mechanisms for understanding how a d.CSE intervention works for young people under different contexts.

To the best of our knowledge, there was no other study done to build a theory around this topic, even though some studies (Mustanski et al., 2015; Barak & Fisher, 2001) attempted to introduce theory into its program design or evaluation. These include health promotion theories such as the health belief model, which is suited for predicting behavioural changes. However, such models do not serve the purpose of building explanations of why an intervention works. Connectivity theory, on the other hand, has potential for being included for theory building or refinement for our intervention in question. As part of a group of learning theories, connectivism provides a theoretical framework for understanding the process of learning in a digital age and therefore puts the digital context upfront in its explanation. There is nonetheless still utility for adapting theories from the fields of health promotion and education into implementation and policymaking, where underlying theories as well as practical applications of an intervention are both needed. Integrating these frameworks will however be the scope of future research, and *Appendix 4: Application Model* presents one such possibility of an application framework of d.CSE for further research.

Limitations and future directions

Conducting this synthesis presented some methodological roadblocks. Firstly, as this method is a less established form of literature review, more detailed descriptions about the exact steps taken were needed to allow a wider audience to understand the purpose and reasonings behind the process. An extended methods section may allow the reader to follow the work more easily but limits the amount of insight into the actual topic that can be discussed. The breadth of the research question necessitated program theories that are broad enough to cover all subdomains within the context of d.CSE. As a result, program theories that mostly work well for specific subdomains (such as d.CSE for gender and sexuality minorities, or d.CSE solely through mobile phones) can be potential areas for further research. To address these limitations, care was taken to be meticulous in documenting every step of the process and to be transparent in the reporting, so that the method can both stand up against scrutiny and allow future improvements.

RS pursues rigour much like other qualitative methods would (Wong et al., 2010), following and documenting the steps as recommended by the RAMESES publication standard for realist syntheses. However, interpretation remains at the core of such quests and inevitably adds subjectivity into the synthesis of findings. This means that other reviewers conducting a synthesis on the same topic may come up with different theories to make sense of the intervention. A typical review should ideally comprise of a small team where reflections, triangulation of ideas, and robust discussions could occur before conclusions are made. Even though some effort was done to discuss the theories with other people informally, there is admittedly a lack of regular and intensive discussions in this study, thereby risking some interpretations to be overly biased or subjective. Another step that could reduce subjectivity of the study is to conduct stakeholder discussions at various stages of the study, from eliciting candidate IPTs from practitioners first-hand at the beginning of the study, to cross-checking with young people in the middle or at the end of the syntheses whether the explanations provided by the theories resonate with their own experiences. Steps like these take time, coordination and effort to reach out to groups of people but will eventually create theories that have more persuasive power.

Finally, even though the inclusion of heterogenous evidence on d.CSE or other forms of online sexuality education allowed for a large area to mine an array of C-M-O configurations, it remained challenging as they were often described without sufficient depth or out of sequence. This increased the need for us to make inferences which may or may not be fully in line with what actually occurred. Realist studies such as this can help bridge this understanding and serve as precursors for future studies that further strengthen the theoretical base of this intervention.

Conclusion

Sexuality education is a complex intervention that navigates between the fields of primary health and education. This realist synthesis was conducted to test and build theories about how an online form of comprehensive sexuality education works, and under which circumstances it works (or does not work). 5 key mechanisms were tested and refined, leading to explanations on how motivation, a sense of psychological safety, aligned needs, awareness and interactive social learning can be triggered to achieve outcomes such as increased engagement with online SRH information, knowledge about sex and sexuality, as well as overall empowerment.

The findings of this synthesis combine theoretical thinking with the broad evidence gathered around this relatively recent intervention. It provides practitioners and policymakers with a framework for making sense of how d.CSE works, which stimulates better future designs and

implementation strategies. Finally, this study contributes to the knowledge base of online sexuality education programs by making their theories more apparent and available for further fine-tuning. However, it is recommended that more similar reviews are taken up to further test the theories (presented or not presented in this study), as well as to investigate this intervention under different contexts. D.CSE programs supported by well-evidenced theories will positively impact the sexual and reproductive heath and well-being of many young people who increasingly seek to learn about sex and sexuality online.

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