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REDEVELOPING A DIGITAL SEXUAL HEALTH INTERVENTION FOR ADOLESCENTS TO ALLOW FOR BROADER DISSEMINATION: IMPLICATIONS FOR HIV AND STD PREVENTION

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HIV/STDs and unintended pregnancy persist among adolescents in the United States; thus, effective sexual health interventions that can be broadly disseminated are necessary. Digital health interventions are highly promising because they allow for customization and widespread reach. The current project involved redeveloping and expanding HEART (Health Education and Relationship Training)—a brief, digital sexual health intervention efficacious at improving safer sex knowledge, self-efficacy, and behavior—onto an open-source platform to allow for greater interactivity and accessibility while reducing long-term program costs. The authors describe the process of adapting, reprogramming, and evaluating the new program, which may serve as a guide for investigators seeking to adapt behavioral interventions onto digital platforms. The final product is an open-source intervention that can be easily adapted for new populations. Among 233 adolescents (M_{age} = 15.06; 64% girls), HEART was highly acceptable and generally feasible to administer, with no differences in acceptability by gender or sexual identity.

Keywords: adolescent sexual health, digital health intervention, development, program adaptation, implementation science, evaluation

Dissemination of evidence-based interventions is critical to improving public health (Kerner et al., 2005). However, despite decades of prevention programs and innovative developments in the field of intervention science, there remains a gap between initial program development and evaluation research and what is disseminated into practice (Brownson et al., 2018; Zimmerman et al., 2019). Researchers must address numerous issues and barriers to effectively combat the ongoing challenge

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of translating science into direct service provision. There are technical and financial barriers to timely and effective research implementation, as well as those related to communication, engagement, acceptability, and access (Derman & Jaeger, 2018; Li et al., 2019).

One area that has been the focus of numerous intervention efforts is the reduction of sexual health problems among adolescents. In the United States, alarming rates of sexually transmitted diseases (STDs), including HIV, persist among youth, with young people ages 15–24 years accounting for half of all new STDs (Centers for Disease Control and Prevention [CDC], 2018). Untreated STDs substantially increase adolescents' risk of future HIV transmission and can lead to serious, long-term negative health outcomes (CDC, 2014; Kreisel et al., 2017). Rates of unintended pregnancy are also high among adolescents, with girls ages 15–19 having elevated rates of unintended pregnancy compared to women in any other age group (Guttmacher Institute, 2017; World Health Organization, 2014).

Recently, there has been increased movement toward implementing digital health interventions (also called eHealth, mHealth, or online interventions) to promote adolescent sexual health (Hightow-Weidman et al., 2015; Reynolds et al., 2019). Results of a meta-analysis synthesizing nearly 15 years of research on the development and evaluation of youth-focused digital health interventions highlight the effectiveness of these approaches in improving safer sex behaviors and increasing sexual health knowledge, safer sex attitudes, and positive norms around safer sex among youth (Widman et al., 2018b). Several potential benefits of utilizing digital health interventions include the capabilities to tailor materials to create personalized content, administer programs with high fidelity without requiring extensive facilitator training, and disseminate programs for widespread reach (Hightow-Weidman et al., 2015; Lightfoot, 2012; Rapoff, 2013). In addition, digital health interventions allow for the inclusion of design elements not feasible with interventions delivered in an in-person format (Li et al., 2019). Because adolescents are early adopters of technology and find this method of communication and learning both comfortable and favorable (Moores et al., 2019; Reynolds et al., 2019), there has been a push in the past decade toward these approaches, which have been shown to make youth more open to learning by providing a safe, controlled, and familiar environment to receive sexual health knowledge and skills (Rapoff, 2013; Widman et al., 2018b).

Because of the promise of digital sexual health interventions for the emerging field of implementation science, our goal was to expand the reach of one such digital health intervention that our team developed called HEART (Health Education and Relationship Training; Widman et al., 2016, 2018a, 2020). HEART is a 45-minute digital program grounded in psychological and health behavior change theories. In the program, participants proceed through five modules that each maps onto one of the five theory-based domains of sexual health behavior in the Reasoned Action Model (Fishbein & Ajzen, 2010): (a) safer sex motivation, (b) STD/HIV knowledge, (c) sexual attitudes and norms, (d) safer sex self-efficacy, and (e) sexual communication skills (see Supplemental Material for full list of program objectives). In accordance with fuzzy-trace theory (Reyna, 2008), the information in the intervention was distilled to the essential bottom line, with a tagline appearing on each screen and the most important points emphasized in each activity.

In preliminary studies with HEART, we have shown that the program is feasible to administer in both high school and community-based settings (Kamke et al., 2020; Widman et al., 2017) and highly acceptable among youth. In two randomized controlled trials, HEART was efficacious at promoting safer sex knowledge,

TABLE 1. HEART Reprogramming, Adaptation, and Evaluation Process

Phase	Step	Task
Adaptation Phase	1	Identify areas for improvement in program language, visuals, and content using Heart for Teens acceptability data
	2	Develop an additional module with two activities centered on goal-setting using psychologically wise intervention techniques[a]
Reprogramming Phase	3	Identify online tools for redevelopment
	4	Work with development team to reprogram all online content using inexpensive, user-friendly software
	5	Conduct think-aloud usability testing to obtain feedback on program functionality, content, and style
	6	Iteratively beta test within team to ensure program functionality on both front and back ends
Evaluation Phase	7	Test adapted intervention in randomized controlled trial
	8	Analyze data and disseminate findings

Note. [a]Walton, 2014; Walton & Wilson, 2018.

attitudes, self-efficacy, and sexual communication skills compared to an attention-matched control program (Widman et al., 2018a, 2020), with similar effects shown for boys and girls and for heterosexual and sexual minority youth (Widman et al., 2020). Given HEART's preliminary efficacy, we wanted to expand the program's reach through implementation and evaluation with new populations. However, we faced financial barriers because the original program was developed on a static platform at an outside institution and even minor changes were costly. We also faced technical barriers because HEART was accessible only from a web browser on a computer and could not be accessed from mobile devices or tablets.

The purpose of the current project was to adapt and reprogram a new iteration of HEART using affordable and open-source technologies. We collected data on the acceptability of this updated HEART program in a randomized trial among high school students. This adaptation, reprogramming, and evaluation process occurred in eight steps described below and in Table 1. The description of this process can serve as a model for other investigators who are looking to move from program development to broader implementation. The issues we faced are likely not unique to our project and may contribute to the implementation science literature that seeks to move intervention research toward broader dissemination (Zimmerman et al., 2019).

METHOD AND RESULTS

ADAPTATION PHASE

Step 1: Identifying Areas for Improvement in Original HEART Program. We identified several areas for improvement related to HEART's content and style through a review of the qualitative and quantitative participant feedback provided during our prior administration of the HEART program (Kamke et al., 2020; Widman et al., 2017, 2020), as well as our own thorough review of the program. First, in light of current color trends, we improved the color scheme to be more modern and gender

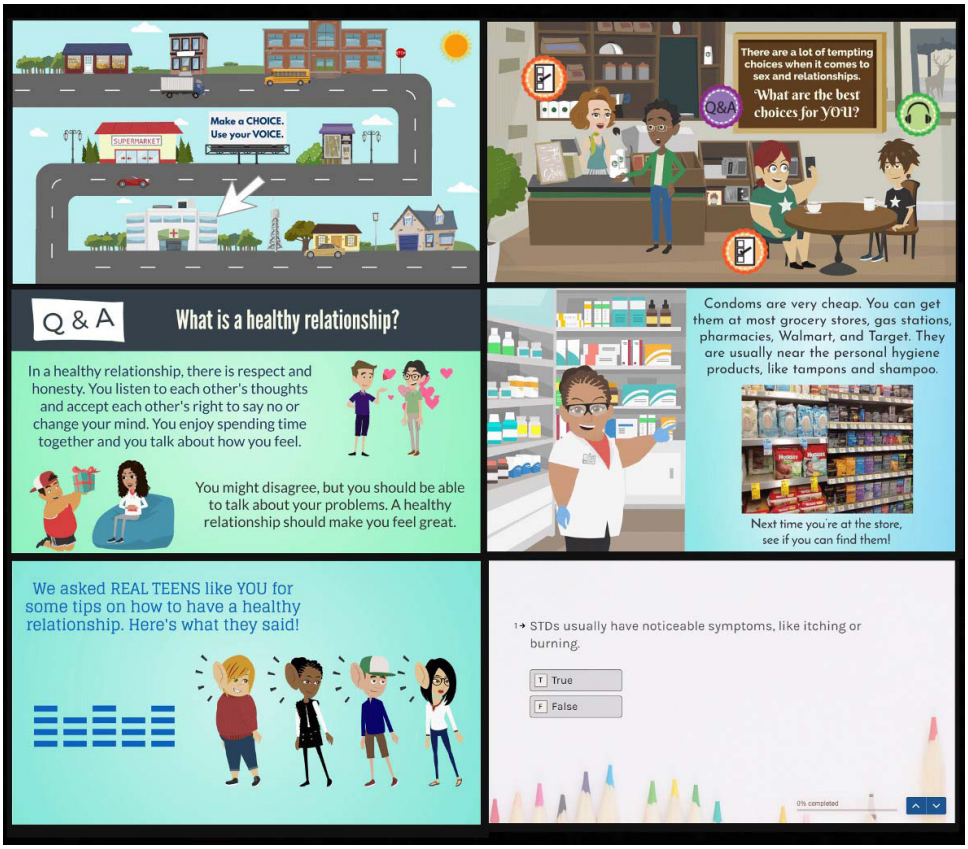

FIGURE 1. Screenshots from the redeveloped HEART program.

neutral. Second, on the basis of prior participant comments where youth suggested that HEART should have more interactive elements to maintain attention (e.g., one 17-year-old girl wrote, "I think more interactive components would keep attention better than the videos and reading"), we incorporated more quizzes, games, and animated characters to make the program more engaging for adolescents.

In addition, in light of prior participant comments that the program could go further to be inclusive of lesbian, gay, bisexual, transgender, and queer (LGBTQ+) youth (e.g., one 15-year-old girl suggested that we should "include more forms of protection and ways to be safe during sex for the LGBTQ+ community"), we edited and added terminology, content, and animations to make the program more inclusive. For example, one major consideration was ensuring that all language was gender-neutral (e.g., using the word *partner* instead of *boy/girlfriend*). We also expanded the animated characters throughout the program to include more same-gender couples, as well as multiracial couples, individuals of different body types, and individuals with varying levels of physical ability, such as including a character in a wheelchair (see Figure 1).

Step 2: Expanding Program to Include New Goal-Setting Module. Although most of the program content remained the same, one of our goals for reprogramming was

TABLE 2. Descriptions of Software and Services Used in the Development Process

Name	Web Address	Description	Capabilities (in regard to HEART)
Twine (Tweego, SugarCube)	twinery.org motoslave.net/tweego motoslave.net/sugarcube	Free, open-source tools for telling interactive, nonlinear stories	Framework of program Condom game
MySQL	mysql.com	Open-source database management system	Backend data
Vyond	vyond.com	Cloud-based, animated video creation platform	Street scene Fact/Myths Q+As in each module
Typeform	typeform.com	Online software that specializes in form building and online surveys	Pre-module screener quizzes Healthy communication practice exercise STD knowledge quiz Values clarification activity Backend data
Video clips	bedsider.org plannedparenthood.org howcast.com	Short, animated video clips from multiple sources (with permission)	Debunking myths Condom demonstration Consent explanation
Slack	slack.com	Proprietary business communication platform with chat rooms, private groups, and direct messaging	Daily within-team communication

to add content that would improve the long-term efficacy of the program. Thus, we added a sixth module to HEART, grounded in psychologically wise theory (Walton, 2014), to help people draw adaptive meanings, set goals, and improve health outcomes. This sixth module included two interactive activities that centered on goal-setting and employed wise intervention techniques (e.g., prompting new meanings, active reflection, and "saying-is-believing" exercises that prompted youth to use their own experiences to advocate for the ideas conveyed in the intervention to others). Studies of existing programs specifically for adolescents that employ these techniques have shown evidence of sustained psychological change in participants over time (Bryan et al., 2016; Okonofua et al., 2016; Walton & Wilson, 2018); thus, our added "wise" module demonstrates promise for extending HEART's long-term effects.

REPROGRAMMING PHASE

Step 3: Identifying Online Tools. Once we identified the program content that needed to be changed or added, our next step was to identify free or inexpensive online tools to successfully reprogram HEART using the skills of our in-house team of behavioral scientists and computer scientists. We acquired and used numerous tools throughout redevelopment (see Table 2) that allowed the interactive program to be developed at minimal cost and easily accessible on a variety of hardware platforms (e.g., desktop computers, mobile devices). This included text display, animations, data entry through interactive forms, and a visualization of the narrative spaces that can be navigated by users.

Step 4: Redeveloping All Content Onto an Open-Source Platform. We used a popular open-source tool called Twine with its associated formats, Tweego and Sugarcube, to allow dynamic text boxes to pop up, as well as to allow participants to

choose their movement on the screen. Twine provides a graphical interface for authoring game worlds with interactive spaces. Within each space, animated objects and characters were developed using the Vyond animation software. Then, to assess learning objectives, we used Typeform, a quiz-building software. This provided a more immersive experience to participants as they switched between learning activities and assessment activities. The data collected through Typeform were stored on a secure MySQL database and accessible with the Bluehost service. The Bluehost service (a) protects participant data through security measures that make data accessible only through unique participant ID numbers, and (b) allows interactive data (e.g., time spent on module, clicks per page) to be recorded securely on the server.

Step 5: Usability Testing. Once a complete version of the web-based program was developed, we recruited 14 adolescents to participate in a single usability testing session. We obtained written parental consent and adolescent assent prior to participation. During a 60-minute session in our lab, adolescents completed the entire program using a "think-aloud" protocol, whereby they were asked to verbalize thoughts, observations, and questions about material they were viewing (Jääskeläinen, 2010). They also answered a short survey immediately after the program and provided feedback regarding anything they thought might improve the program. The first author conducted the think-aloud protocol, taking detailed notes and interacting with participants. We used these responses to assess design and functionality, as well as comprehension of the content and the program's potential usefulness.

Overall, participants provided positive feedback on the program's inclusivity, accessibility, level of engagement, and design. Generally, they described the program as fun, informative, and aesthetically pleasing. They particularly enjoyed the bright color scheme, mix of diverse characters, brevity of text, communication practice activities, and anecdotes from real teens their age. Participants also suggested valuable areas for improvement: (a) adding more audio voiceovers to increase attention; (b) adjusting the color of the text against the program background to improve readability; (c) including the option to go back and see activities that they had already completed; and (d) improving the clarity of some concepts. After all users provided feedback, salient quotes were discussed among our team members and were used to inform one last round of changes to arrive at our final product.

Step 6: Beta Testing Within Programming Team. After finalizing the program content and design, our development team went through many iterations of beta testing; in addition, we tested the program with our graduate and undergraduate research assistants. We communicated daily over Slack and met biweekly by phone, using Zoom, or in person. Each team member completed the entire program many times to ensure that all aspects were functional and ran smoothly. This collaboration also allowed us to communicate specific desires about backend data we wanted to obtain.

EVALUATION PHASE

Step 7: Collecting Feasibility and Acceptability Data From Adolescents. The process of adaptation and reprogramming lasted 5 months (May to September, 2019). Then, in October 2019 we began evaluating the updated HEART program in a randomized controlled trial (clinical trial registration number NCT04156516). All 9th and

11th grade students from a school district in the southeastern United States were invited to participate in the study. The final sample consisted of students whose parents granted consent (n = 457). Students were randomized into one of two study conditions: the HEART intervention or a control intervention focused on cultivating growth mindsets (adapted from Schleider & Weisz, 2018), which was relatively matched with HEART in terms of time and interactive features. All participants completed a computerized pretest assessment, then the intervention or control program, and then a computerized posttest assessment in a 90-minute class period. In this article, we focus on results related to the feasibility and acceptability of HEART obtained from the posttest assessment for the 233 students assigned to the HEART intervention. All study procedures were approved by North Carolina University's Institutional Review Board.

Step 8: Data Analysis and Evaluation. Of the 233 students who took the HEART intervention, 150 (64%) were girls, 79 (34%) were boys, and 4 (2%) identified as transgender or another gender identity. All participants were between the ages of 14 and 17, with the exception of one participant who was 18 (M = 15.06; SD = 1.10). Regarding race/ethnicity, 34% of participants identified as Hispanic, 32% as White, 25% as Black, and 9% as another race/ethnicity. Furthermore, 177 students (76%) identified as exclusively heterosexual, 18 (8%) as mostly heterosexual, 17 (7%) as bisexual, 4 (2%) as mostly gay or lesbian, 8 (3%) as gay or lesbian, and 9 (5%) as unsure, questioning, or another sexual identity. Finally, 42 (18%) youth reported having had sex (defined as vaginal or anal intercourse).

In general, the redeveloped HEART program was feasible to administer, although we did encounter a few issues. All procedures were completed during the school day within one 90-minute academic period. Within this period, 45 minutes were reserved to obtain consent from students and collect pretest and posttest data. The remaining 45 minutes were reserved to complete the HEART program: Two thirds (67%) of the participants completed the full HEART program in the time allotted, and the remaining students had to be stopped prior to full program completion. Nearly all (90%) of the participants received all but the final module, and even more (95%) received all but the final two modules. In the future, HEART should be shortened or a minimum of 1 hour should be allotted to allow for program completion for all students. Furthermore, some students encountered technical issues, including a school-wide WiFi outage that prevented many students in one session from getting the full 45 minutes for completion.

Program acceptability was assessed at immediate posttest with four items rated on a 4-point scale: 1 = *Not at all,* 2 = *A little,* 3 = *Some,* and 4 = *A lot* (adapted from Widman et al., 2020). Responses of "some" or "a lot" were considered indicators of acceptability. Each item is presented in Table 3, along with item descriptives for the full sample and separately for boys and girls and for heterosexual and sexual minority youth. Overall, participants found HEART highly acceptable: 85% liked the program, 89% learned new things, 85% said it kept their attention, and 90% said that they would use information from the program in the future. Participants also answered two questions regarding the likability and usefulness of the new goal-setting module that we added to the reprogrammed version of HEART. Of the 156 students who completed this module, 79% indicated that they liked the new goal-setting module, and 86% indicated that they found the activities in this module to be at least somewhat helpful. We found no significant differences in any of the program acceptability findings by gender or sexual activity status (see Table 3).

TABLE 3. Acceptability of HEART in Full Sample and Compared by Gender and Sexual Orientation

	Full Sample (n = 233)	Boys (n = 79)	Girls (n = 150)	Between-Group Comparison[a,c]		Heterosexual (n = 177)	Sexual Minority (n = 55)	Between-Group Comparison[c]	
	% (n)	% (n)	% (n)	χ^2	p	% (n)	% (n)	χ^2	p
Liked program	84.5 (196)	76.9 (60)	88.0 (132)	4.74	.03	85.3 (151)	81.8 (45)	7.49	.06
Learned new things	89.2 (207)	85.9 (67)	90.7 (136)	1.20	.27	89.8 (159)	87.3 (48)	4.78	.19
Program kept attention	85.0 (198)	79.7 (63)	87.3 (131)	2.30	.13	86.4 (153)	80.3 (45)	7.46	.06
Will use information in future	90.5 (209)	84.4 (65)	93.3 (140)	4.62	.03	91.5 (161)	87.3 (48)	6.86	.08
Helpfulness of goal-setting activities[b]	85.9 (134)	77.4 (41)	91.0 (91)	5.70	.13	88.4 (107)	77.1 (134)	4.98	.17
Liked goal-setting activities[b]	78.7 (122)	71.2 (37)	83.0 (86)	3.03	.39	82.0 (98)	68.6 (24)	8.27	.04

Note. For each group, the % (n) refers to the number of students who reported "some" or "a lot" to that item. One student did not complete the intervention acceptability survey and was therefore excluded from all analyses. [a]Data from the four transgender/gender nonbinary students who completed HEART were removed from the chi-square analyses testing gender differences between boys and girls. These students were included with the full sample data in the first column of this table. [b]Because not all youth completed the final goal-setting module of HEART, data for these items come from the 156 youth who completed the module. [c]We applied a Bonferroni correction (0.5/12 = .004) to account for multiple comparisons. None of the tests that we conducted met this test of statistical significance.

Participants also completed a free-response item that asked how we could improve HEART. Eighty-one participants provided an answer to this item; of these, 44% of comments were only positive. For example, one 14-year-old girl wrote, "There is really nothing you can do to improve the program because I really learned a lot & I have a rough time understanding a lot of things half the time. So I know if I learned something, a lot of other people can too!" The majority of the remaining comments were mostly positive. Participants seemed to find HEART to be an informative and engaging program, and critical feedback was generally minor and constructive (e.g., "I think that the students should have the option at the end to select a topic they want to learn a little more about"; "Talk more about statistics").

DISCUSSION

The emergence of new technologies that facilitate easier redevelopment and evaluation of health interventions yields promise for the rapidly moving field of implementation science. This article describes the three-phase redevelopment of HEART (Widman et al., 2016, 2018a, 2020), an online sexual health program for adolescents, onto an open-source, easily accessible platform. We also report on the feasibility and acceptability of the redeveloped HEART program. In line with the goal of implementation science to move effective programs beyond research studies and out into the world (Zimmerman et al., 2019), our goal was to make it possible for HEART to be disseminated more broadly. Major considerations of our project involved utilizing innovative and affordable technology, making the program more inclusive, and adding a goal-setting module to extend the efficacy of program effects. This study complements recent research showing that evidence-based, in-person interventions can be translated to online delivery and disseminated on a large scale in a timely manner (e.g., Saunders et al., 2019).

DISCUSSION OF ADAPTATION PHASE

In the adaptation phase, a top priority was editing HEART content and visuals for inclusivity, because this was mentioned in qualitative feedback on prior versions of the program. Although the current program is a general sexual health intervention for youth and does not target specific adolescent populations, our accessible, open-source software allows us further opportunities for customization and tailoring to the needs of specific populations facing health disparities. One such population is LGBTQ+ youth, who are at increased risk for HIV and sexual health problems compared to heterosexual youth and often lack access to inclusive sexual health programming (Kubicek et al., 2010; Mustanski et al., 2014). In addition, LGBTQ+ youth experience sexual prejudice (Herek & McLemore, 2013) and disproportionate rates of sexual violence (CDC, 2017). While we found no significant differences in the acceptability of HEART between heterosexual and LGBTQ+ youth, many students indicated in their qualitative feedback that they would appreciate more information specific to the needs of LGBTQ+ youth. With the opportunities provided by our new technology and ease of adaptation moving forward, future versions of the program can include information targeting the unique needs of this group and potentially allow users to customize avatars and pronouns for further inclusivity. In line with recommendations regarding program adaptation, the majority of changes we made were focused on updating style and language or adding relevant evidence-based content, while retaining fidelity to the

original program. A key takeaway for other researchers is that adaptations to programs should not alter theory, internal logic, or potential efficacy (e.g., substantially reducing the length of the intervention, eliminating key messages or skills trainings; Rural Health Information Hub, 2020).

DISCUSSION OF REPROGRAMMING PHASE

The second phase of redevelopment focused on reprogramming HEART. Over the course of 5 months, using free or inexpensive open-source tools, we recreated all program content, created a backend database, and tested the program within our multidisciplinary team as well as with individuals in our target population.

Some important takeaways from the reprogramming phase include (a) understanding the importance of establishing processes for ongoing collaboration with interdisciplinary partners, and (b) maintaining patience and flexibility during the highly iterative process of usability testing. An important recommendation for researchers is to form an efficient and multidisciplinary team, because ensuring sufficient expertise in behavioral science and computer science contributed to the success of this project. Our team included behavioral scientists and computer scientists, the latter group largely college students recruited from work-based learning co-ops. Over the course of the programming phase, we adjusted our team makeup as we identified which work-based learning students had the most experience and expertise with the programming software.

Because the redevelopment phase was the lengthiest part of our project, we encourage other researchers to carefully determine the time needed to undertake development. We also recommend that researchers take time at the start of the process to ensure that each part of the intervention can be reprogrammed. Researchers should determine if the software they plan to use in redevelopment will be able to sustain key program components (e.g., if interactive quizzes are essential to intervention effectiveness, will the new software be able to integrate this feature?). Utilizing innovative, open-source software and forming a multidisciplinary team, including computer science experts, help make this possible.

DISCUSSION OF EVALUATION PHASE

The third phase of redeveloping HEART was the evaluation phase. Specifically, once we had adapted the program content and reprogrammed HEART into an open-source platform, we needed to ensure that the program would remain feasible and acceptable for broader dissemination.

A strength of the current HEART program is its use of an online platform. Digital health interventions can increase standardization and fidelity of program delivery (Bailey et al., 2015; Eaton et al., 2011). However, despite these feasibility benefits, we encountered barriers during delivery. The school-wide WiFi outage, our largest technical issue, prevented many students from completing the program in a single session. This is an issue for researchers to consider when implementing digital health programs, even in non-school-based settings, because internet connectivity issues could interfere with access to programs from participants' smartphones or personal computers. There were also more minor technical issues (e.g., mouse batteries and computers losing power) that may have held up students and resulted in slightly longer completion times, but did not result in loss of data because our team resolved these issues quickly when they arose. In addition, due to time constraints,

not all participants received the full intervention in the current study. A critical takeaway is to initially budget more time than anticipated for program completion to account for technological problems and participants who take longer than expected on activities, which is typical of school-based research.

In our sample of more than 230 high school students, we found that participants generally enjoyed the updated HEART program, learned new things from the program, and found it to be highly useful. Levels of acceptability were generally the same or greater in the redeveloped program compared to our earlier assessments of the original HEART program; for example, 85% of teens who participated in the current study said that the program maintained their attention, compared to 78% of participants in the previous evaluation of HEART (Widman et al., 2020).

LIMITATIONS AND FUTURE DIRECTIONS

One limitation of a brief online program such as HEART is that not all topics can be covered in depth. A significant sexual health problem that impacts adolescents and emerging adults is sexual violence (Kann et al., 2018). While a clear understanding of consent is crucial to sexual violence prevention and especially relevant in adolescence, very few adolescents receive adequate information about consent during this time (Naide & Guttmacher Institute, 2020; Weissbourd et al., 2017). In addition, HEART does not have a specific focus on consent or sexual violence, but rather one short video explaining consent near the end of the program. On the basis of feedback from teens, our team plans to employ development methods used in the current project to develop a stand-alone digital intervention for adolescents that specifically focuses on affirmative consent. This program will build from other projects that cover adolescent sexual consent (e.g., Scull, Kupersmidt, Malik, & Morgan-Lopez, 2018).

Because HEART has only been tested in efficacy trials thus far, a larger study is still needed to assess longer term program effectiveness and move toward real-world implementation outside of a controlled research environment. While we have previously administered HEART in supervised school and community settings, our open-source, online format provides flexibility for teens to take the program in a setting of their choice, including at home or on-the-go by smartphone. This transition to self-directed program implementation will allow teens to complete the program comfortably without time-related barriers, although it may raise other concerns about attrition, because this format may decrease teens' motivation to begin or complete the program (Bawa, 2016). Other common barriers, including technology issues, distraction, and lack of motivation to continue participation in research, must be considered when delivering this program in a standalone format (Mason & Suri, 2012). Although feasibility studies show that adolescents generally welcome interventions delivered using technology they already use (Lattie et al., 2017), further research is needed to determine concrete ways to ensure that adolescents remain engaged in online interventions if they are not receiving the content in a supervised setting.

CONCLUSION

This study demonstrates the feasibility and acceptability of the redeveloped HEART program and the value of implementing digital health interventions for youth. Over the course of 5 months, our team redeveloped an existing and efficacious sexual health program for adolescents using current, widely available, and open-source

technologies. The program was highly acceptable among adolescents, with no significant differences by gender or sexual orientation. Our three-phase redevelopment process may serve as a model for future developers and emerging implementation scientists to consider when looking to translate interventions into digital platforms that can be widely used.

REFERENCES

Bailey, J., Mann, S., Wayal, S., Abraham, C., & Murray, E. (2015). Digital media interventions for sexual health promotion—Opportunities and challenges. *BMJ, 350*, h1099.

Bawa, P. (2016). Retention in online courses. *SAGE Open, 6*, 215824401562177.

Brownson, R. C., Colditz, G. A., & Proctor, E. K. (2018). *Dissemination and implementation research in health: Translating science to practice*. Oxford University Press.

Bryan, C. J., Yeager, D. S., Hinojosa, C. P., Chabot, A., Bergen, H., Kawamura, M., & Steubing, F. (2016). Harnessing adolescent values to motivate healthier eating. *Proceedings of the National Academy of Sciences of the United States of America, 113,* 10830–10835.

Centers for Disease Control and Prevention. (2014). *Adolescents and STDs*. Retrieved from https://www.cdc.gov/std/life-stages-populations/stdfact-teens.htm

Centers for Disease Control and Prevention. (2017). *LGBT youth*. Retrieved from https://www.cdc.gov/lgbthealth/youth.htm

Centers for Disease Control and Prevention. (2018). *STDs in adolescents and young adults*. Retrieved from https://www.cdc.gov/std/stats17/adolescents.htm

Cooper, B., Toskin, I., Kulier, R., Allen, T., & Hawkes, S. (2014). Brief sexuality communication—A behavioural intervention to advance sexually transmitted infection/HIV prevention: A systematic review. *BJOG: An International Journal of Obstetrics & Gynaecology, 121*, 92–103.

Derman, R. J., & Jaeger, F. J. (2018). Overcoming challenges to dissemination and implementation of research findings in under-resourced countries. *Reproductive Health, 15*(Suppl 1), 86.

Eaton, L. H., Doorenbos, A. Z., Schmitz, K. L., Carpenter, K. M., & McGregor, B. A. (2011). Establishing treatment fidelity in a web-based behavioral intention study. *Nursing Research, 60,* 430–435.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Psychology Press.

Guttmacher Institute. (2017). *Adding it up: Investing in contraception and maternal and newborn health*. Available at: https://www.guttmacher.org/sites/default/files/factsheet/adding-it-up-contraception-mnh-2017.pdf

Herek, G. M., & McLemore, K. A. (2013). Sexual prejudice. *Annual Review of Psychology, 64*, 309–333.

Hightow-Weidman, L. B., Muessig, K. E., Bauermeister, J., Zhang, C., & Legrand, S. (2015). Youth, technology, and HIV: Recent advances and future directions. *Current HIV/AIDS Reports, 12*, 500–515.

Jääskeläinen, R. (2010). Think-aloud protocol. In Y. Gambier & L. Van Doorslaer (Eds.), *Handbook of translation studies* (pp. xxx–xxx). John Benjamins Publishing Company.

Kamke, K., Widman, L., & Desmarais, S. L. (2020). Evaluation of an online sexual health program among adolescent girls with emotional and behavioral difficulties. *Journal of Child and Family Studies*, *29*, 1044–1054.

Kann, L., McManus, T., Harris, W. A., Shanklin, S. L., Flint, K. H., Queen, B., . . . Ethier, K. A. (2018). Youth Risk Behavior Surveillance—United States, 2017. *Morbidity and Mortality Weekly Report, 67*(8), 1–114. https://doi.org/10.15585/mmwr.ss6708a1

Kerner, J., Rimer, B., & Emmons, K. (2005). Introduction to the special section on dissemination: Dissemination research and research dissemination: How can we close the gap? *Health Psychology, 24*, 443–446.

Kreisel, K., Torrone, E., Bernstein, K., Hong, J., & Gorwitz, R. (2017). Prevalence of pelvic inflammatory disease in sexually experienced women of reproductive age—United States, 2013–2014. *Morbidity and Mortality Weekly Report, 66*, 80–83.

Kubicek, K., Beyer, W. J., Weiss, G., Iverson, E., & Kipke, M. D. (2010). In the dark: Young men's stories of sexual initiation in the absence of relevant sexual health information. *Health Education and Behavior*, *37*, 243–263.

Lattie, E. G., Ho, J., Sargent, E., Tomasino, K. N., Smith, J., Brown, C. H., & Mohr, D. C. (2017). Teens engaged in collaborative

health: The feasibility and acceptability of an online skill-building intervention for adolescents at risk for depression. *Internet Interventions, 8*, 15–26.

Li, D. H., Brown, C. H., Gallo, C., Morgan, E., Sullivan, P. S., Young, S. D., & Mustanski, B. (2019). Design considerations for implementing ehealth behavioral interventions for HIV prevention in evolving sociotechnical landscapes. *Current HIV/AIDS Reports*, *16*, 335–348.

Lightfoot, M. (2012). HIV prevention for adolescents: Where do we go from here? *American Psychologist, 67*, 661–671.

Mason, W. & Suri, S. (2012). Conducting behavioral research on Amazon's Mechanical Turk. *Behavior Research Methods, 44,* 1–23.

Moores, C. J., Maeder, A., Miller, J., Prichard, I., Lewis, L. K., Bell, L. K., Macousta, A., & Miller, M. D. (2019). A digital intervention for Australian adolescents above a healthy weight (Health Online for Teens): Protocol for an implementation and user experience study. *JMIR Research Protocols, 8*(10), e13340.

Mustanski, B., Greene, G. J., Ryan, D., & Whitton, S. W. (2014). Feasibility, acceptability, and initial efficacy of an online sexual health promotion program for LGBT youth: The Queer Sex Ed Intervention. *Journal of Sex Research, 52*, 220–230.

Naide, S., & Guttmacher Institute. (2020, January 15). *State lawmakers say yes to consent education*. Guttmacher Institute. https://www.guttmacher.org/article/2020/01/state-lawmakers-say-yes-consent-education

Okonofua, J. A., Paunesku, D., & Walton, G. M. (2016). Brief intervention to encourage empathic discipline cuts suspension rates in half among adolescents. *Proceedings of the National Academy of Sciences of the United States of America, 113,* 5221–5226.

Rapoff, M. A. (2013). E-health interventions in pediatrics. *Clinical Practice in Pediatric Psychology, 1*(4), 309–313.

Reyna, V. F. (2008). A theory of medical decision making and health: Fuzzy trace theory. *Medical Decision Making, 28,* 850–865.

Reynolds, C., Sutherland, M. A., & Palacios, I. (2019). Exploring the use of technology for sexual health risk-reduction among Ecuadorean adolescents. *Annals of Global Health, 85*(1), 57.

Rural Health Information Hub. (2020). *Adapting interventions*. https://www.ruralhealthinfo.org/toolkits/rural-toolkit/2/adapting-interventions

Saunders, R. P., Schenkelberg, M. A., Moyer, C., Howie, E. K., Brown, W. H., & Pate, R. R. (2019). The translation of an evidence-based preschool physical activity intervention from in-person to online delivery of professional development to preschool teachers. *Translational Behavioral Medicine, 9*, 1186–1196.

Schleider, J., & Weisz, J. (2018). A single-session growth mindset intervention for adolescent anxiety and depression: 9-month outcomes of a randomized trial. *Journal of Child Psychology and Psychiatry, 59,* 160–170.

Scull, T. M., Kupersmidt, J. B., Malik, C. V., & Morgan-Lopez, A. A. (2018). Using media literacy education for adolescent sexual health promotion in middle school: Randomized control trial of Media Aware. *Journal of Health Communication, 23*, 1051–1063.

Walton, G. M. (2014). The new science of wise psychological interventions. *Current Directions in Psychological Science, 23*(1), 73–82.

Walton, G. M., & Wilson, T. D. (2018). Wise interventions: Psychological remedies for social and personal problems. *Psychological Review, 125*, 617–655.

Weissbourd, R., Anderson, T. R., Cashin, A., & McIntyre, J. (2017). *The Talk: How adults can promote young people's healthy relationships and prevent misogyny and sexual harassment*. Harvard Making Caring Common Project. Retrieved from https://mcc.gse.harvard.edu/files/gse-mcc/files/mcc_the_talk_final.pdf

Widman, L., Golin, C. E., Kamke, K., Burnette, J. L., & Prinstein, M. J. (2018a). Sexual assertiveness skills and sexual decision-making in adolescent girls: Randomized controlled trial of an online program. *American Journal of Public Health, 108*, 96–102.

Widman, L., Golin, C. E., Kamke, K., Massey, J., & Prinstein, M. J. (2017). Feasibility and acceptability of a web-based HIV/STD prevention program for adolescent girls targeting sexual communication skills. *Health Education Research*, *32*, 343–352.

Widman, L., Golin, C. E., Noar, S. M., Massey, J., & Prinstein, M. J. (2016). ProjectHeartforGirls.com: Development of a web-based HIV/STD prevention program for adolescent girls emphasizing sexual communication skills. *AIDS Education and Prevention, 28*, 365–377.

Widman, L., Kamke, K., Evans, R., Stewart, J. L., Choukas-Bradley, S., & Golin, C. E. (2020). Feasibility, acceptability, and preliminary efficacy of a brief online sexual health program for adolescents. *Journal of Sex Research, 57*, 145–154.

Widman, L., Nesi, J., Kamke, K., Choukas-Bradley, S., & Stewart, J. (2018b).

Technology-based interventions to reduce sexually transmitted infections and unintended pregnancy among youth. *Journal of Adolescent Health, 62*, 651–660.

Wight, D., Wimbush, E., Jepson, R., & Doi, L. (2015). Six steps in quality intervention development (6SQuID). *Journal of Epidemiology and Community Health, 70*, 520–525.

World Health Organization. (2014). *Adolescent pregnancy*. Available at: http://www.who.int/mediacentre/factsheets/fs364/en/

Zimmerman, L., Strompolis, M., Emshoff, J., & Mooss, A. (2019). Dissemination and implementation. *Introduction to community psychology*. Retrieved from https://press.rebus.community/introductiontocommunitypsychology/chapter/dissemination-and-implementation/