Open camera or QR reader and
scan code to access this article
and other resources online.

Acceptability of a Game-Based Intervention to Prevent Adolescent Prescription Opioid Misuse

Alison H. Oliveto, PhD,[1,i] Patricia Wright, PhD, MPH, RN,[2] Nihit Kumar, MD,[1]
Srinivasa Gokarakonda, MD, MPH,[1] Ian Fischer-Laycock, MA,[1]
Joseph Williams, PhD,[3] and Ronald G. Thompson, Jr., PhD[1]

Abstract

Objective: This study assessed the initial acceptability of SafeUse, a game-based opioid misuse prevention intervention for delivery via smartphone among adolescents. Evidence-based educational and refusal skills training materials were adapted, and game design elements were applied to clinically and scientifically informed scenarios in which opioids are typically introduced to adolescents using standard product development methods to create the SafeUse prototype.

Materials and Methods: In a mixed-methods study, 14 adolescents were assessed on their knowledge and perceptions of opioids before and following 5–7 days of access to SafeUse. Participants provided feedback in focus groups on the acceptability, relevance, and understandability of SafeUse and made suggestions for its improvement. Feedback was coded and summarized as to playability, acceptability, appropriateness, content development, and knowledge transfer. Pre- and post-access quantitative data were analyzed using Wilcoxon matched pairs signed-rank tests.

Results: Overall, participants liked SafeUse, its characters, graphics, and approach, finding it more appealing than lectures/reading materials and appropriate for school settings. They moderately to extremely "liked the game," "would like to play more game modules," "liked playing through the decisions," thought the game was realistic/relevant and fun, and they learned new information about opioids. Participants reported increased confidence to refuse opioids and decreased likelihood of accepting opioids from someone they know. Knowledge about opioids increased ($P < 0.006$), and adolescent perception that prescription drugs are safer than illegal drugs decreased ($P < 0.003$) after playing SafeUse.

Conclusion: Findings suggest that SafeUse is acceptable and likely educational to adolescents and worthy of further development and research.

Keywords: Adolescents, Prescription opioids, Drug prevention, Gamification, Smartphone

Introduction

ADOLESCENT PRESCRIPTION DRUG MISUSE (PDM), including stimulant, sedative, and opioid misuse (OM), is a significant and underresearched public health problem in the United States. An estimated 16.3 million individuals aged 12+ years reported nonmedical prescription drug (PD) use[1] and 14.6% of 12th graders reported lifetime PDM[2] in 2019. Of PDs used for nonmedical purposes by adolescents, opioids have been among the most prevalent.[3] Moreover, the increase in national opioid prescriptions (e.g., hydrocodone [Vicodin®], oxycodone [OxyContin®, Percocet®],

---

[1]Department of Psychiatry and Behavioral Sciences, College of Medicine, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA.
[2]College of Nursing, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA.
[3]Little Rock Games, Little Rock, Arkansas, USA.
[i]ORCID ID (https://orcid.org/0000-0001-8574-230X).

and oxymorphone [Opana®]) from 2005 to 2010 was associated with an increase in adolescent opioid abuse as well as poison center calls.[4] Initiating PDM during adolescence has also been shown to be associated with a significantly higher risk of developing a subsequent substance-use disorder relative to PDM initiation during young adulthood.[5]

Although PDM prevalence overall has been declining since 2010, drug overdose rates have continued to rise from 1999 through 2017, including among adolescents aged 15–24.[6] Indeed, drug-involved overdose deaths have increased from a rate of 3.5 per 100,000 persons aged 15–24 years in 1999 to 13.0 per 100,000 persons in 2017.[7] In addition, compared with 2002, there was a 37% increase in the probably of having a prescription opioid use disorder in the past year and a fourfold increase over time in the probability of heroin use among emerging adults with PDM in 2014.[8] Deaths from PD overdose among adolescents are increasing, with 4633 adolescents aged 15–24 dying from a drug-related overdose in 2015; 85% of these deaths involved opioids.[9]

These disturbing trends highlight the need to develop and disseminate prescription OM prevention strategies that are easily accessible to and effectively engage and educate adolescents on the risks associated with PDM, particularly OM.

Although it is typically recommended that prevention strategies target all drugs,[10] the epidemiology of PDM has important differences from illicit drug abuse among adolescents. For instance, a high proportion of adolescents perceive that prescription medications are safe, even when used for nonmedical reasons.[11] Motivations to use PDs range widely and include self-medication (e.g., for pain, anxiety, and weight loss),[12,13] getting high, performance enhancement, and experimentation.[14]

Unlike those who abuse illicit drugs, adolescents using PDs for nonmedical reasons are more likely to be female[13,15,16] and to obtain PDs from a friend or relative.[17,18] Adolescents also report that their parents do not talk to them about the risks of PDs as much as they do about other substances of abuse and that, unlike other drugs, there are situations when parents think it is okay to give their children a PD that was not prescribed for them.[19]

Several effective universal substance-use prevention approaches exist for adolescents[20,21]; however, they typically do not cover aspects of PDM that are unique to these classes of agents (see prior paragraph),[12,17,18] particularly opioids, for which self-medication for pain is a common motivation for OM.[12,13] Although at least one PDM-specific program does exist for high school students,[22] its efficacy is unclear. Furthermore, no intervention programs that specifically target PDM/OM among middle school students are generally available, to our knowledge, even though PDM is present among this age group.[2,23]

Given the evidence that younger age of PDM initiation is associated with increased risk of PD use disorder,[5] brief interventions can be effective when targeting a specific issue,[24–27] and the epidemiology of PDM is unique; the development of PDM interventions that are developmentally appropriate for age groups younger than high school students and incorporate innovative strategies to enhance the efficiency, accessibility, and consistency of delivery is vital.

Gamification is the application of game design elements into existing processes and services to engage and motivate players while simultaneously attempting to modify some aspects of their health behavior.[28] It incorporates game design techniques, game thinking, and game mechanics in nongame contexts, such as social situations, to promote attitude and behavior change.[29] Given that 95% of adolescents aged 13–17 have access to a smartphone, 45% use the internet almost constantly, 88% have computer access at home, 90% play computer, web, portable (e.g., cell phone), or console games,[30] and adolescent boys and girls play videogames on an average of ∼120 and 40 min/day, respectively,[31] game-based technology and communication patterns are having a major impact on the way in which risk and protective health-related behaviors are learned and perceived by adolescents.

Research suggests that games may motivate and engage targeted audiences[32,33] by providing feelings of competence, mastery, being in control, achievement, autonomy, choice, and relatedness to others.[34] Electronic games are increasingly recognized as having promise to improve health outcomes[35] as well as potentially being more efficacious and the preferred delivery method to reach today's adolescents.[29] Furthermore, gamification increases the fidelity of prevention delivery by ensuring that prevention content is delivered in a consistent and unbiased manner to all adolescents. Thus, this pilot project aimed to develop "SafeUse," a game-based intervention to prevent adolescent prescription OM, and evaluate its initial acceptability, relatability, and preliminary effectiveness among adolescents.

Materials and Methods

Stage 1: development of SafeUse

Conceptual frameworks. Two stylistically consistent and easily integrated theoretical frameworks guide the development of SafeUse. Social Cognitive Theory (SCT), developed from Social Learning Theory, serves as the overarching explanatory framework for understanding how to prevent adolescent OM.[36–38] SCT proposes that individuals do not simply respond to environmental influences but rather actively seek and interpret information[39]; behavior is viewed as a dynamic reciprocal interaction among the characteristics of a person, the behavior of that person, and the environment in which a behavior is performed. Behavior is influenced by outcome expectations that are acquired through direct experience, vicarious experiences, judgments by others, inferred knowledge from what is already known, and perceived competence to perform the behavior needed to influence outcomes. Behavior is also regulated by its consequences, but only as those consequences interpreted and understood by the individual.

According to the SCT, members of adolescent social networks (e.g., parents, friends, other peers, teachers, and counselors) serve as role models for adolescents and affect expectancies, evaluations, and self-efficacy related to OM. If adolescents see role models misuse opioids or other PDs with positive consequences, they are more likely to develop positive expectations of OM, which increases the likelihood that the adolescent will misuse such drugs.[40] Learning to avoid OM occurs in a similar manner when adolescents who observe negative consequences of misuse expect negative outcomes and are less likely to engage in OM. Self-efficacy to obtain and use or, alternately, to refuse substance use, may also be learned by observing a model and is key to behavior change.

Thus, SafeUse was designed to allow adolescents to engage in social scenarios related to OM and actively construct their own meaning of the new information by relating it to their experiences, attitudes, and beliefs in a safe learning environment that promotes self-exploration and self-evaluation.

The Information-Motivation-Behavioral Skills (IMB) model, which combines the theoretical constructs of the Health Belief Model, Self-Efficacy Model, and the Theory of Planned Behavior, provides the framework to examine causal mechanisms of behavior change.[41,42] The IMB model posits three primary constructs needed to engage in a given health behavior: information (knowledge of preventive behavior); motivation (attitudes toward performing behavior); and behavioral skills (to successfully perform the behavior). Information and motivation interact to activate behavioral skills (e.g., self-efficacy) and, ultimately, enact prevention and risk reduction behaviors.

SafeUse provides information directly relevant to OM, an initial prerequisite of risk behavior changes, in the first scenario (i.e., school assembly on OM) and throughout the game-based intervention (e.g., fun facts and myth busters). SafeUse is designed to motivate adolescents to engage in preventive behaviors by allowing/encouraging them to experience a myriad of outcomes related to OM (or not), evaluate their attitudes toward the performance of OM preventive acts, and the influence of social norms regarding their performance of such acts, and to increase the awareness of their personal vulnerability for OM. Behavioral skills for performing specific OM preventive acts (e.g., opioid refusal skills, accepting but not ingesting opioid, and talking with parents or school counselor) are modeled throughout SafeUse (as are consequences of not performing such) to instill and reinforce self-efficacy and, subsequently, encourage OM preventive behaviors.

Approach. SafeUse is a branching narrative game with weighted randomized outcomes. The prototype takes 3–4 hours to play through all possible content and endings. The majority of gameplay consists of players responding to contextual dialogue choices offered in the fictitious social world of a teenager. These dialogue choices exist in 3D-modeled scenes with a single camera point of view, representing the player's embodied presence in the scene (Fig. 1A, B). Dialogue is also shown through a phone text interface (Fig. 1C). This model of gameplay is represented widely in contemporary videogames.

The specific subgenre used in SafeUse is the "visual novel" game.[43] Using this style, SafeUse incorporates three key elements of game-based engagement: narrative engagement, meaningful choice, and random reinforcement, along with several other secondary elements common to generalized videogame play (Table 1). The game also includes two mechanics that straddle the education/play boundary: fact cards (Fig. 1D) that are triggered by specific events in the narrative, and unlockable endings (Fig. 1E) that allow replay of the game to unlock multiple health outcomes.

The development process for the game began with drafting of a branching script, created in the specialized scripting software Articy Draft.[44] This software is designed for writing branching narrative using a visual editor (Fig. 1F), which allows writers to access various scenes and dialogues quickly, while still affording an overview of the entire branching story. Once the interactive script was drafted, it went through several rounds of revisions, as the research team offered suggestions to game designers about the medical, social, emotional, and behavioral content of the scenes. The research team also helped categorize the various story threads in the game to balance the number and variety of situations that might precipitate OM. Evidence-based materials regarding prescription OM from the BeMedWise website (e.g., https://www.bemedwise.org/prevent-kid-drug-abuse/, https://www.bemedwise.org/prevent-prescription-medicine-abuse-toolkits/not-worth-the-risk-even-if-its-legal/, etc.) and the National Institute on Drug Abuse[45,46] were incorporated during this process.

Once the script was finalized, the game design team constructed 3D-modeled scenes and recorded sound effects and voiceover lines with professional actors to increase the emotional engagement of the experience. The game designers also added game logic to many of the scenes, adding random weighted chances for particular outcomes. This was particularly useful for offering specific chances of overdose, and increasing those chances with each playthrough, so that at some point players are guaranteed to experience one of the "overdose endings" the game includes. The designers also built a user interface (UI) for the game, specifically for use on iOS and Android phones. Once the prototype was complete, it was tested internally, and ongoingly adapted, fixing bugs that arose for users during the pilot study.

All stages of SafeUse's design, from content development and script writing to game and UI design, were based on a collaborative process of exploration between game designers and the research team using agile development procedures.[47,48] Game design elements were applied to the educational content and storylines to engage and motivate players while simultaneously attempting to promote attitude and health behavior change.[28,29]

Stage 2: initial evaluation of SafeUse acceptability and applicability

Overview. A mixed-methods study was conducted to examine the acceptability and applicability of SafeUse among adolescents in the 8th and 11th grades. These grades were targeted with the intent to uncover any potential developmental differences in the game's acceptability and relatedness. Following consent/assent procedures with the adolescents and their parent/caregiver, adolescent participants completed assessments before playing SafeUse; completed postintervention assessments 5–7 days afterward; and participated in a semistructured focus group to provide feedback on SafeUse design (e.g., ease of use, level of engagement, and knowledge transfer). The University of Arkansas Institutional Review Board approved this study protocol under expedited procedures under category 7.

Approach. Adolescents were initially recruited via e-mail announcements and flyers to 8th and 11th grade students from a superintendent-selected middle and high school in central Arkansas; however, due to lower than anticipated response rates, students were also recruited from around the state via advertisements on social media and flyer distribution. To be included in the study, adolescents were required to be enrolled in the 8th or 11th grade; identify as female or male gender; and have access to a smartphone with headphones.
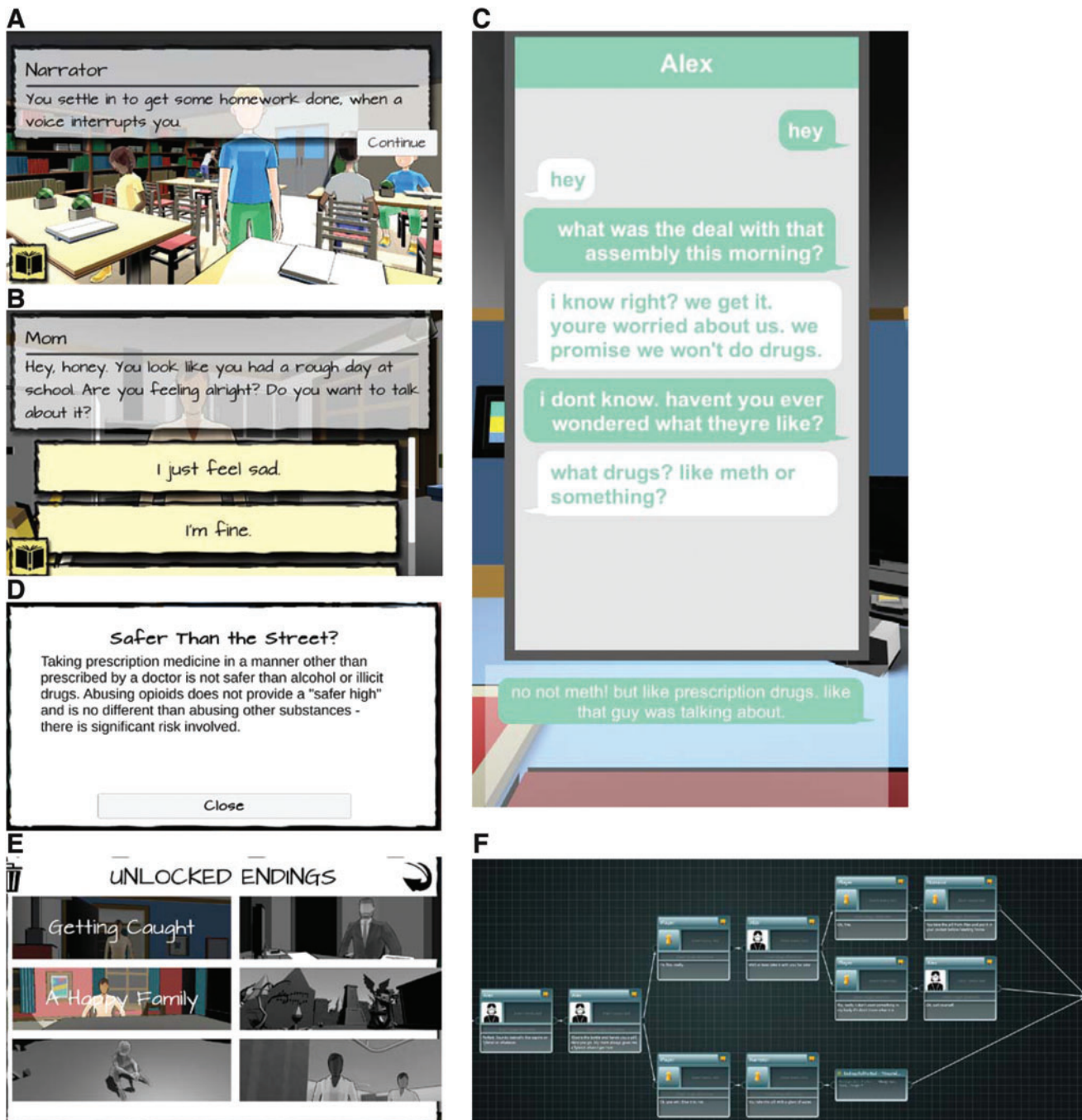
FIG. 1. Examples of screenshots of the game and game flow with player choice points: **(A)** library scene in which a schoolmate offers to share medication; **(B)** scene at home where mothers ask players if they are okay, allowing a choice point to share with mothers or not; **(C)** a texting scene in which player is discussing prescription drug information with a friend (a ''fun fact'' box pops up after each inaccurate response); **(D)** one of the ''fun fact'' boxes that pop up at relevant points in the game; **(E)** which endings have been unlocked thus far are shown in color with a title; and **(F)** an example of game flow with player choice points, such that ''Alex'' offers the player some pain pills and the player chooses how to respond, which determines the game path at each decision point. Every time the player chooses to take pills, a random generator increases the odds of overdose and, potentially, death. Color images are available online.

Parents were asked to call a recruitment line and a member of the research team discussed the study with them and their child. If they and their child were interested in participating, they were given a link to access the consent/assent forms in REDCap and the research staff member performed informed consent and assent over the telephone.

Once consent and assent forms were electronically signed, printouts of the signed forms were mailed to the participant's home. Typically, once at least two to five students in a particular grade signed informed consent, focus groups were scheduled. About 5–7 days before the scheduled session, participants completed the preassessment forms and were

Table 1. A Brief Overview of Major Design Concepts (and Key Sources That Analyze Them)
That Were Used to Inform Game Elements in *SafeUse*

Design concept	Description of use	Reference source(s)
Narrative engagement	Narrative is a broad complicated concept, and its use and role in games are contested. For SafeUse, story was leveraged as a primary mode of engagement and learning, creating a sense of presence and embodiment for players.	Juul[59] Murray[60]
Meaningful choice	Players engaging with interactive systems want to feel that their actions have an impact. In SafeUse, this idea was central to the branching stories players experience.	Murray[60]
Random reinforcement	Chance engages players with both unpredictability and the assessment of risk/reward. SafeUse focused on unpredictability and opioids, since that is a primary learning goal of the project, weighting the chance of an overdose in multiple storylines.	Schell[61]
Usability	Like any digital experience, games should be designed following established usability principles. SafeUse was designed and tested using established standards for interface usability.	Cooper et al.[62]
Skill atoms	Skill atoms are the core feedback loop of all digital games: action, simulation, feedback, and modeling. These were used as the basic element of every player-initiated interaction in SafeUse.	Cook[63]
Simulation	Modeling reality in a productively abstract way is one important way that games engage people. SafeUse simulated (in a limited way) the unpredictability of human response to opioids, to teach the dangers inherent in that modeled system.	Aldrich[64] Salen and Zimmer-man[65]
Pattern matching	Humans love to identify and match patterns, and many games leverage this. This concept was used in the narrative structure of SafeUse, e.g., repeating character relationships across multiple storylines.	Koster[66]
Rhetoric	There is extensive research and theory on the value and role of so-called serious games, which use game design to teach socially meaningful content or argue for a particular worldview. While not a game element per se, this concept was an important justification for the creation of SafeUse itself.	Bogost[67] Salen and Zimmer-man[65]
Affordances	Well-designed games should present intuitive elements to users, offering indications about the appropriate use of those elements. SafeUse uses multiple affordances, primarily in the design of the user interface (e.g., button design).	Norman[68]

instructed to download the SafeUse from the app store and interact with the game for about 1 h/day. Twenty-five participants signed informed consent, of which 10 (mostly 11th graders) did not enter the study due to school workload and/or extracurricular activities (Fig. 3). One participant did not show up to the scheduled focus group session and was lost to follow-up.

Semistructured focus groups (Fig. 2) were facilitated with a sample of 14 adolescents (aged 13–17 years; eleven 8th graders and three 11th graders) to receive feedback on the design and development of SafeUse, including whether it is usable, engaging, and effective. Before and following access to SafeUse, adolescents completed a questionnaire about their perceptions about opioids. They also completed a postaccess questionnaire about their demographics and experience with the game. Qualitative data obtained during the focus groups explored the norms, phenomenological life-worlds (i.e., the world as immediately or directly experienced in the subjectivity of everyday life) and experiences of

adolescents at each grade level determined the actual range of behaviors and ideas that were valid indicators of feasibility.[49]

Focus group questions centered on adolescents' context-specific experiences, risk behaviors, normative pressures, and barriers related to opioid use and gaming. Specific questions included the following: ''Do you think you would play SafeUse (or a game like it), why? Tell me more''; ''What do you think about the current name of the game: Safe Use? What do you like or not like about it? What would you call it?'' ''What do you think we need to consider when further developing Safe Use?'' ''How effective do you think SafeUse would be if made available for students, why?'' ''What would motivate you to continue playing Safe Use, if it were made available?'' ''What would discourage you from playing SafeUse, if it were made available?'' ''What specific recommendations do you have for further developing SafeUse, in terms of instructions, opening graphics, choice of scenarios, types of decisions offered; number of decisions
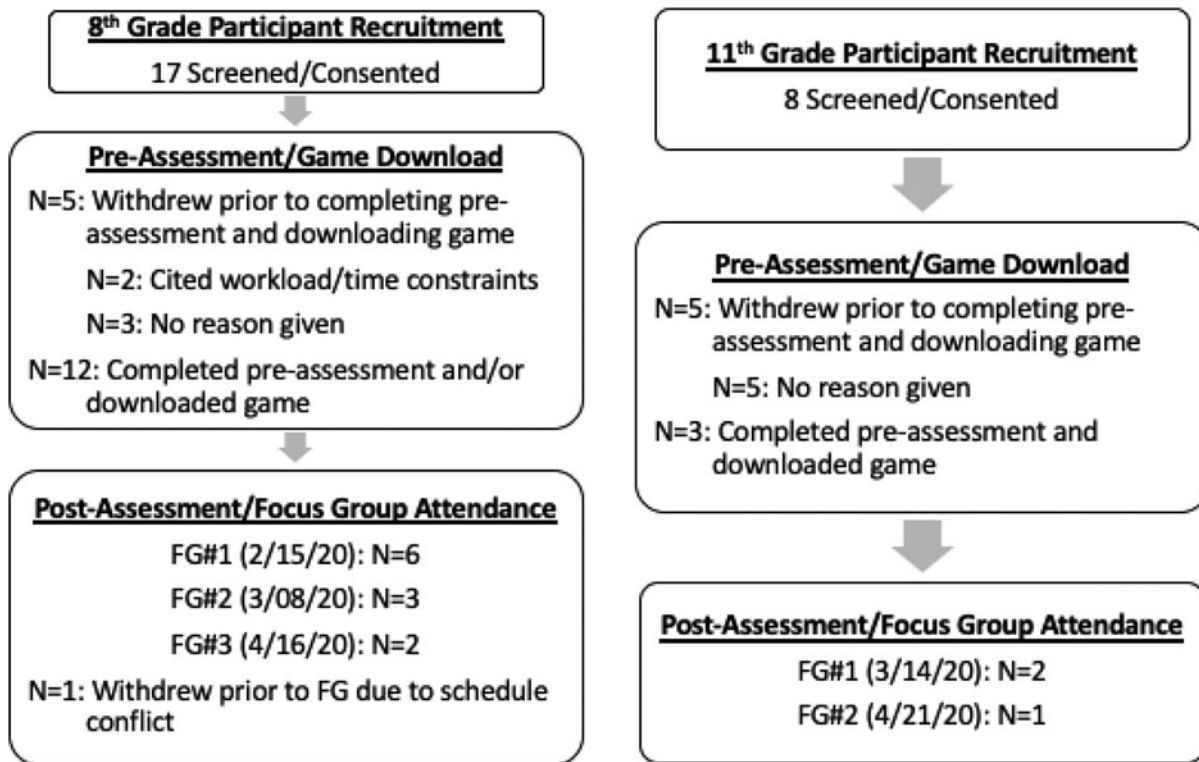
FIG. 2. Subject flow during the course of the study. FG, focus group.

offered; realistic outcomes of use; adequate information provided; and playability?'' ''Is there anything else about what we have discussed that you would like to add?''

Focus groups were segmented by grade,[50] lasted 1–1.5 hours and initially conducted in-person at a time convenient for adolescents and their parents; however, due to the rise of COVID-19, focus groups were shifted to a virtual format using the Zoom platform. Parents were not present in focus groups to enhance adolescent willingness to share personal experiences. Before participating in the focus group, adolescents signed a confidentiality agreement stating that they pledged to maintain the confidential nature of the group.

For in-person focus groups, adolescents were gathered in a conference room to start the focus group session after a quick snack. If focus groups were conducted via Zoom, study staff instructed participants to ensure they were in a private space behind a closed door where the conversations could not be overheard (as was the case for study staff). For both Zoom and in-person groups, the recorder was turned on and participants were asked a series of questions regarding the intervention (see second paragraph above, starting ''Focus group questions''). At the end of the focus group, participants were given or mailed (for those participating virtual groups) $50 gift cards for their time. Two in-person focus groups were held at the University of Arkansas for Medical Sciences and three virtual focus groups were conducted online.

Focus groups were digitally recorded, deidentified, and transcribed. Conventional content analyses were conducted to create preliminary themes by which to sort adolescent quotes.[51] A preliminary codebook consisting of top and sublevel codes were developed after reading one to two transcripts.[52] The first transcript was independently coded by all members of the study team and results were compared to define and refine the codebook as well as ensure inter-rater reliability.

Two coders independently coded the remaining transcripts to enhance rigor in analysis, and findings were discussed to determine the final themes. The rigorous and accelerated data reduction (RADaR) technique was used[53] to code and summarize focus group feedback under five major domains (playability, acceptability, appropriateness, content development, and knowledge transfer). These terms and definitions for program fit were obtained from the California Evidenced-Based Clearinghouse (CEBC) for Child Welfare website (https://www.cebc4cw.org) and Weiner et al.[54] Additional game-related terms and definitions (e.g., for screenplay/scenarios, technical/knowledge transmission, gameplay/playability, music and sound) were selected from Ak.[55]

Pre-and post-access questionnaires were designed to measure adolescent knowledge and perceptions about prescription opioid use and misuse, including legality, safety, and side effects. Adolescents indicated the degree to which they agreed with each statement on a 6-point scale from strongly agree to strongly disagree. The post-access questionnaire included visual analog questions about SafeUse rated on a scale from 0 (not at all) to 10 (extremely), including the degree to which the adolescent understood the material; liked the game; learned something new about prescription pain killers; was likely to refuse an opioid if offered; was confident in being able to refuse a prescription pain killer if offered; and would like to play another module of the game.

Descriptive statistics were used to describe subject characteristics. Selected data from the postaccess questionnaire were graphed to show distribution of feedback regarding

SafeUse. Data for each continuous measure from the pre- and postaccess questionnaires were entered into Wilcoxon matched pairs signed-rank tests and means and standard deviations were calculated. For all analyses, a P-value of ≤ 0.05 was used to infer statistical significance.

Results

Participants were 14.1 ± 1.1 years on average, 57.1% female, 57.1% white, 35.7% black, 7.1% Asian, and 14.2% Hispanic. Adolescents reported being an A or A/B (64.3%), B or B/C (14.3%), or C (21.4%) student. About 71% of participants reported having experience playing electronic games, including smartphones (50%), computers (21.4%), and/or televisions (42.9%).

Participants reported playing SafeUse for 4.7 ± 0.9 days and 42.7 ± 20.6 min/day on average. They also reported unlocking a mean of 3.0 ± 1.71 out of six endings. The two endings with the lowest completion rate (21.4% of participants) were (i) attending the funeral of a friend who died of an opioid overdose and (ii) dying from an opioid overdose. Otherwise, more than half of the participants completed the other four endings (57.1%–71.4%). After access to SafeUse, adolescents reported that they moderately to extremely "liked the game," "would like to play more game modules," "liked

playing through the decisions," thought the game was realistic/relevant, that the game was fun, and they learned new information about opioids (Fig. 3). Adolescents showed high levels of agreement that the material increased confidence to refuse opioids and low likelihood of taking an opioid from someone they knew. They did report low to moderate agreement that the game was boring (Fig. 3).

A summary of focus group feedback is shown in Table 2. Adolescents generally liked SafeUse, its characters, graphics, and approach. They stated that the game was a more appealing way to learn than lectures/reading materials and that they learned a lot. They also reported technical glitches they would like addressed. They saw SafeUse as appropriate for school settings, but not having mass appeal, and suggested a wider targeted age range, inclusion of other substances, and plainer language. Many suggestions for building out content, including relevant scenarios and additional information regarding fun facts, resources, and longer term effects of OM, were also provided.

Before access to SafeUse, respondents indicated strong agreement about being knowledgeable about opioids, their dangers, and physical effects, and comfortable refusing opioids if offered (Table 3). The extent to which participants agreed that they were knowledgeable about opioids significantly increased and that PDs are safer than illegal drugs
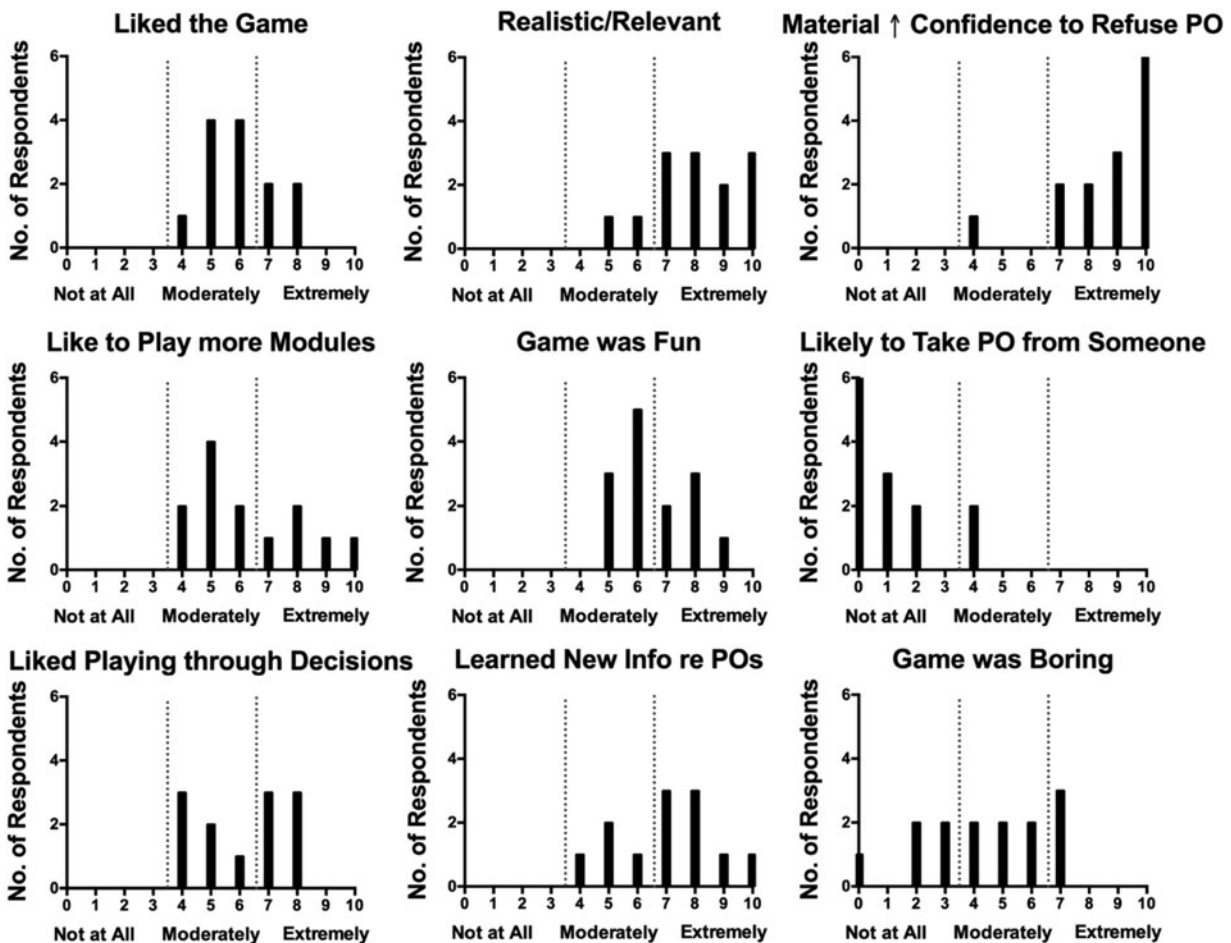

FIG. 3. Degree of respondent agreement with selected statements on the post-SafeUse access questionnaire on a scale from not at all (0) to extremely (10). The number of respondents is plotted as a function of score.

TABLE 2. SUMMARY OF FOCUS GROUP FEEDBACK AMONG STUDENTS ACROSS FIVE MAJOR DOMAINS: PLAYABILITY, ACCEPTABILITY, APPROPRIATENESS, CONTENT DEVELOPMENT, AND KNOWLEDGE TRANSFER

	Playability	Acceptability	Appropriateness	Content development	Knowledge transfer
Positive comments and/or what worked	Clear instructions Intuitive to use Flows well Fun to try to unlock all endings Mystery keeps it fun Deliverable through social media	Great game, good as a school assignment Better than a school assembly/lecture Really great, would play without $$ incentive Really good for entry-level game More likely to want to learn about information in a game Liked several scenarios Good approach Unique Interesting Liked the pop-up bubbles of information Fun to talk about with peers Liked character design/graphics/voices Liked first person Liked different decision points	More effective than a presentation Should be offered in schools as a school assignment Realistic Relevant to geographic population Perfect for high schoolers Dog dying scenario was relatable	Clear instructions Interesting Mystery keeps it fun Liked several scenarios Realistic Relevant to geographic population Perfect for high schoolers Dog dying scenario was relatable Questions good even for 11th graders as gateway to information Good to experience situations vicariously without actual danger	Informative Gave new knowledge Good information about short-term outcomes Good refusal skills learned Learned more about opioids Questions good even for 11th graders as gateway to information Good to experience situations vicariously without actual danger

(continued)

111

TABLE 2. (CONTINUED)

	Playability	Acceptability	Appropriateness	Content development	Knowledge transfer
Negative comments and/or suggested improvements	Technical problems need to be fixed Not long enough Text messages were perpendicular to phone view during texting scenario More user controls and instructions Optional tutorial Plainer language More change in facial expressions Increase level/amount of graphics More sound effects Less narrative, more action	Unappealing to play "just for fun" Redundant/tedious storylines (technical glitches) Need more realism More character development Be able to see drug effects and consequences occur More flexibility with choosing path More comedy	Wider age range (6–9th grade) Different levels of the game depending on age Too advanced for 5th graders Add points/incentives Alternate name: "The Choice is Yours" Include other substances	Have multiple levels Version for young children with parent using more "real-life" scenarios Have harsher consequences, such as loss of friends/more social backlash More "real-life" situations such as party scenes, social media More social interactions with friends Witnessing others using and consequences, drug effects Add more levels, other substances Add minigames within scenarios More flexibility with choosing path More variety of answers in text conversations Have a flat-out NO More storyline development More endings, variety Include father as caregiver Add friend or family with drug problems	Add pre/post test Add resources (e.g., phone #'s to call) Add more "fun facts," statements, and long-term effect information Add more substances Add friend or family with drug problems Break up information more

TABLE 3. SUMMARY OF RESPONSES TO GENERAL KNOWLEDGE ABOUT OPIOIDS BEFORE (PRE)
AND AFTER (POST) ACCESS TO THE GAMIFIED INTERVENTION

Item[a]	Pre[b]	Post[b]	P[c]
I know what opioids are.	2.29 (1.27)	1.07 (0.27)	**0.004**
Unlike underage drinking and marijuana use, using and sharing prescription medications are legal.	3.50 (2.21)	4.78 (1.97)	0.12
Prescription drugs are safer to use than illegal substances because doctors prescribe them.	2.86 (1.70)	5.00 (1.41)	**0.005**
It is very easy for students to obtain prescription drugs.	2.85 (1.34)	2.54 (1.51)	0.69
Taking prescription drugs that were not prescribed for you is fine ''every once and a while.''	5.36 (1.34)	5.64 (0.63)	>0.99
Mixing different prescription drugs together or with alcohol can have deadly consequences.	1.00 (0.00)	1.71 (1.82)	0.50
Opioid use has physical side effects.	1.79 (0.58)	1.71 (1.38)	0.64
Most students who use prescription medications that were not prescribed for them get the drugs from friends or relatives.	2.21 (0.89)	1.93 (1.07)	0.31
If offered opioids by my friends, I am comfortable telling them that I don't want to take drugs.	1.29 (0.61)	1.21 (0.43)	>0.99
Narcan (naloxone) will reverse the effect of an opioid overdose.	3.31 (1.38)	3.38 (1.85)	0.81
All overdoses are fatal (deadly).	3.07 (1.33)	3.07 (1.49)	>0.99
Students in my grade are using opioids that were not prescribed for them.	4.36 (1.50)	4.07 (1.73)	0.76
I know an adult that I can talk to about opioid use.	2.00 (1.75)	1.29 (0.47)	0.34

Bold indicates a statistically significant change.
[a]Participants rated the degree to which they agreed with each question on a scale of 1 (strongly agree) to 6 (strongly disagree).
[b]Mean (standard deviation of the sample).
[c]Wilcoxon matched pairs signed-rank test statistic.

significantly decreased after access to SafeUse. In contrast, their knowledge about Narcan or overdoses showed minimal, if any, changes.

Discussion

This article describes the development of SafeUse, a new game-based prescription opioid prevention intervention for adolescents. The methods used to develop this intervention were to (i) incorporate evidence-based materials into the creation of SafeUse, using standard development processes, allowing players to experience the consequences of different choices regarding prescription opioid use, learn the facts that dispel myths about PDs, and offer examples of how to easily refuse drugs when offered; and (ii) to obtain stakeholder feedback on its initial acceptability through a mixed-methods study.

SafeUse was generally acceptable to participants, with postaccess questionnaires and/or focus group feedback indicating that the game was fun to play, was educational, and increased confidence in refusal skills. Although the approach, design, and graphics were also liked as a rule, there was moderate agreement that the game was boring. However, this seemed tied mainly to technical glitches that created redundancies, not allowing participants to complete certain endings, and the inflexibility in having to repeat certain parts of the game multiple times. At the same time, adolescents did generally report that they were unlikely to play the game if accessible outside of the school setting, suggesting that the game would not have mass appeal outside the school setting in its present form.

Participants did offer many suggestions for improving the game (Table 2), such as targeting a wider age range (potentially with different developmentally appropriate levels of

the game), inclusion of other substances beyond just opioids, having more flexibility in skipping parts that they had already experienced, more user controls, and plainer language. Many suggestions for building out content were also provided. For instance, participants suggested adding other scenarios, including being at a party, socializing with friends on school grounds outside the building, more social media interactions, having a family member with a drug problem, physical abuse in the home, watching the drug effects experienced by another user, and adding a father (not just mother) character.

Participants wanted to see additional information regarding ''fun facts,'' resources, and longer term effects. They also suggested having more minigames within scenarios to engage and entertain players and some sort of incentive (e.g., points, grade, and credit) to motivate players. These suggestions are quite feasible and likely would enhance the effectiveness of SafeUse in preventing PDM.

The few studies that have assessed the fidelity of school-based drug prevention programs implemented by teachers under real-world conditions have revealed that there is a noticeable deficit in the fidelity of program delivery that is achieved.[56] Rigorous field trials of drug abuse prevention curricula have been done where considerable effort is made to get teachers and others to deliver the curriculum exactly as intended. However, even under these circumstances, there is tremendous variability in how consistently various teachers present program material.[56,57] Thus, SafeUse would likely be appropriate and effective for delivery with high fidelity in school settings.

Interestingly, before accessing the game, participants already appeared to perceive a strong knowledge of opioids, but this perception still significantly increased after access to the game. In addition, the perception that prescription

opioids are relatively safe compared with illegal substances significantly decreased after game access. This, along with postgame ratings showing increased confidence to refuse drugs if offered as well as low likelihood of taking PDs from someone if offered, suggests that the game may have some initial efficacy to enhance certain protective factors and reduce particular risk factors. Meanwhile, the lack of change in knowledge about opioid overdoses may be due to the fact that, because of technical glitches that were not caught initially, many adolescents could not access the overdose scenario and so did not access the material on this topic.

Thus, whether the material enhances adolescent understanding of opioid overdoses is unclear at this time. Otherwise, ratings generally shifted in the desired direction after game access, even though the changes were not statistically significant, suggesting that this approach may be effective in altering knowledge and attitudes about OM.

Several limitations of the study need to be noted. First, although the prototype was developed by content experts and game developers experienced in producing serious games, students and other stakeholders did not provide initial input into the game. Reasons for not involving stakeholders in initial decision-making included a very limited amount of pilot funds, a 1-year duration of award, the expertise of collaborators, including child and adolescent psychiatrists, the intended focus on opioids with an already available evidence base to draw from, and the desire to produce a prototype with which students could provide feedback. That some participants likened the prototype to the "Oregon Trail" (see Charsky and Barbour[58]) educational game suggests that our approach was built on similar proven successful designs.

Second, although our intention was to examine potential developmental differences between 8th and 11th graders, we were unable to recruit and retain enough 11th grade participants to make formal comparisons of their feedback with that of the 8th graders. Third, our sample size of 14 overall was small. Thus, whether the lack of significant differences in pre- and postgame access scores was due to the lack of power or due to the lack of efficacy is unclear. Fourth, players nevertheless, the findings of this study overall suggest that further development and evaluation of this prototype are warranted.

Future plans include obtaining stakeholder (parent and school staff) feedback on proposed changes to the game based the findings of this study, findings from a subsequent usability evaluation of the revised game among middle school students (6th–8th grade), and optimal strategies for evaluating the efficacy of this product in school settings, all in preparation for a school-based prevention trial of SafeUse. Ultimately, this intervention has the potential to fill a developmental gap in PD prevention efforts that could help delay and/or reduce PDM and the subsequent development of substance-use disorder among middle school students.

Conclusions

SafeUse is acceptable and likely educational to adolescents and has the potential to reduce risk and strengthen protective factors related to OM, thus warranting further research and development.

References

1. Substance Abuse and Mental Health Services Administration. Key substance use and mental health indicators in the United States: Results from the 2019 National Survey on Drug Use and Health. HHS Publication No. PEP20-07-01-001, NSDUH Series H-55. Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration; 2020.
2. Johnston LD, Miech RA, O'Malley PM, et al. *Monitoring the Future National Survey Results on Drug Use 1975–2019: Overview, Key Findings on Adolescent Drug Use.* Ann Arbor, MI: Institute for Social Research, University of Michigan; 2020.
3. Young AM, Glover N, Havens JR. Nonmedical use of prescription medications among adolescents in the United States: A systematic review. J Adolesc Health 2012;51: 6–17.
4. Sheridan DC, Laurie A, Hendrickson RG, et al. Association of overall opioid prescriptions on adolescent opioid abuse. J Emerg Med 2016;51:485–490.
5. Volkow ND, Han B, Einstein EB, Compton WM. Prevalence of substance use disorders by time since first substance use among young people in the US. JAMA Pediatr 2021;175:640–643.
6. Hedegaard H, Miniño AM, Warner M. *Drug Overdose Deaths in the United States, 1999–2019.* NCHS Data Brief, No. 394. National Center for Health Statistics; 2020.
7. Centers for Disease Control and Prevention. *Underlying Cause of Death 1999–2019 on CDC WONDER Online Database, Released in 2020.* Vol. 2021. Atlana, GA: CDC; 2020.

8. Martins SS, Segura LE, Santaella-Tenorio J, et al. Prescription opioid use disorder and heroin use among 12–34 year-olds in the United States from 2002 to 2014. Addict Behav 2017;65:236–241.

9. National Institute on Drug Abuse. Drug Overdoses in Youth. February 4, 2021. In: Services NIoDANIoHUSDoHaH, ed. Vol. 2021: National Institute on Drug Abuse; National Institutes of Health; U.S. Department of Health and Human Services; 2020. https://teens.drugabuse.gov/drug-facts/drug-overdoses-youth on 2021

10. Robertson EB, David SL, Rao SA. *Preventing Drug Use Among Children and Adolescents: A Research-Based Guide for Parents, Educators and Community Leaders*, 2nd ed. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Institute on Drug Abuse; 2003.

11. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. *Monitoring the Future National Survey Results on Drug Use. 1975–2008. Volume I: Secondary School Students*. Bethseda, MD: National Institute on Drug Abuse; 2009.

12. Upadhyaya HP, Kroutil LA, Deas D, et al. Stimulant formulation and motivation for nonmedical use of prescription attention-deficit/hyperactivity disorder medications in a college-aged opulation. Am J Addict 2010;19:569–577.

13. Alemagno S, Stephens P, Shaffer-King P, Teasdale B. Prescription drug abuse among adolescent arrestees: Correlates and implications. J Correct Health Care 2009;15:35–46.

14. Stone AM, Merlo LJ. Attitudes of college students toward mental illness stigma and the misuse of psychiatric medications. J Clin Psychiatry 2011;72:134–139.

15. Boyd CJ, Teter CJ, West BT, et al. Non-medical use of prescription analgesics: A three-year national longitudinal study. J Addict Dis 2009;28:232–242.

16. McCabe SE, West BT, Morales M, et al. Does early onset of non-medical use of prescription drugs predict subsequent prescription drug abuse and dependence? Results from a national study. Addiction 2007;102:1920–1930.

17. Rogers PD, Copley L. The nonmedical use of prescription drugs by adolescents. Adolesc Med State Art Rev 2009;20:1–8, vii.

18. Tourinho FSV, Bucaretchi F, Stephan C, Cordeiro R. Home medicine chests and their relationship with self-medication in children and adolescents. J Pediatr 2008;84:416–422.

19. Partnership for Drug-Free Kids. *The Partnership Attitude Tracking Study: Teens & Parents*. 2013. https://drugfree.org/wp-content/uploads/2014/07/PATS-2013-FULL-REPORT.pdf

20. Morris MC, Cline RJ, Weiler RM, Broadway SC. Prescription drug abuse information in D.A.R.E. J Drug Educ 2006;36:33–45.

21. Spoth R, Trudeau L, Shin C, Redmond C. Long-term effects of universal preventive interventions on prescription drug misuse. Addiction 2008;103:1160–1168.

22. Office of the Arkansas Attorney General. Prescription for Life: A Digital Approach to Prescription Drug Abuse Prevention. https://arkansasag.gov/programs/prescription-abuse/prescription-for-life/ (accessed August 1, 2020).

23. International Survey Associates LLC. *Arkansas Prevention Needs Assessment (APNA) Student Survey: State Report 2019*. Little Rock, AR: University of Arkansas at Little Rock MidSOUTH Center for Prevention and Training Funded by Arkansas Department of Human Services Division of Aging, Adult, and Behavioral Health Services; 2020.

24. Embry DD, Biglan A. Evidence-based kernels: Fundamental units of behavioral influence. Clin Child Fam Psychol Rev 2008;11:75–113.

25. Miller KS, Maxwell KD, Fasula AM, et al. Pre-risk HIV-prevention paradigm shift: The feasibility and acceptability of the parents matter! Program in HIV risk communities. Public Health Rep 2010;125(Suppl 1):38–46.

26. Zahradnik A, Otto C, Crackau B, et al. Randomized controlled trial of a brief intervention for problematic prescription drug use in non-treatment-seeking patients. Addiction 2009;104:109–117.

27. Werch CE, Moore MM, DiClemente CC, et al. Single vs. multiple drug prevention: Is more always better?: A pilot study. Subst Use Misuse 2005;40:1085–1101.

28. Baranowski T, Buday R, Thompson DI, Baranowski J. Playing for real: Video games and stories for health-related behavior change. Am J Prev Med 2008;34:74–82.

29. Schoech D, Boyas JF, Black BM, Elias-Lambert N. Gamification for behavior change: Lessons from developing a social, multiuser, web-tablet based prevention game for youths. J Technol Hum Serv 2013;31:197–217.

30. Anderson M, Jiang JJ. *Teens, Social Media & Technology 2018*. Washington, DC: Pew Research Center; 2018.

31. Clement J. *Daily Time Spent on Video Games Among Children in the U.S. 2019, by Gender*. New York, NY: Statista; 2021.

32. Raasch C, Hippel E. Amplifying user and producer innovation: The power of participation motives. SSRN Electron J 2012. DOI: 10.2139/ssrn.2167948.

33. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000;55:68–78.

34. Bozarth J. An interview with Sebastian Deterding. eLearn 2011. DOI: 10.1145/2001333.2008214.

35. Primack BA, Carroll MV, McNamara M, et al. Role of video games in improving health-related outcomes. Am J Prev Med 2012;42:630–638.

36. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. Health Educ Q 1988;15:175–183.

37. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Hoboken, New Jersey: Prentice-Hall; 1986.

38. Bandura A. Moral disengagement in the perpetration of inhumanities. Pers Soc Psychol Rev 1999;3:193–209.

39. Nevid JS. *Psychology: Concepts and Applications,* 3rd ed. Boston, MA: Houghton Mifflin Company; 2009.

40. Ford JA. Social learning theory and nonmedical prescription drug use among adolescents. Sociol Spectr. 2008;28:299–316.

41. Fisher JD, Fisher WA. Changing AIDS-risk behavior. Psychol Bull 1992;111:455–474.

42. Fisher JD, Fisher WA, Misovich SJ, et al. Changing AIDS risk behavior: Effects of an intervention emphasizing AIDS risk reduction information, motivation, and behavioral skills in a college student population. Health Psychol 1996;15:114–123.

43. Wikipedia. Visual Novel. https://en.wikipedia.org/wiki/Visual_novel (accessed November 10, 2021).

44. Articy Software. *Articy Draft 3*. 2021. https://www.articy.com/en/ (accessed November 10, 2021).

45. NIDA Blog Team. 6 Tactful Tips for Resisting Peer Pressure To Use Drugs and Alcohol. https://archives.drugabuse.gov/blog/post/6-tactful-tips-resisting-peer-pressure-to-use-drugs-and-alcohol (accessed February 2, 2021).

46. National Institute on Drug Abuse. Opioid Facts for Teens. NIH Pub. No. 18-DA-8054. National Institute on Drug

Abuse; National Institutes of Health; U.S. Department of Health and Human Services; 2018.

47. Cass J. Mandatory Stages for Perfect Design: Wireframes, Mockups, Prototypes. JUST*Creative Blog. 2017. https://justcreative.com/2017/03/20/mandatory-stages-for-perfect-design-wireframes-mockups-prototypes/ (accessed April 1, 2021).

48. Mesibov M. How to Work with a Busy Subject Matter Expert. Adventures in Content Strategy. 2016. http://marli.us/how-to-work-with-an-sme/ (accessed April 21, 2021).

49. Strauss AL, Corbin J. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 3rd ed. Thousand Oaks, California: Sage Publications; 2007.

50. Morgan DL. *Focus Groups as Qualitative Research*. Thousand Oaks, California: Sage Publications; 1988.

51. Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res 2005;15:1277–1288.

52. Crabtree BF, Miller WL. A template approach to text analysis: developing and using codebooks. In: Crabtree BF, Miller, W.L., eds. *Doing Qualitative Research*, vol. 3. Thousand Oaks, California: Sage Press; 1992:93–109.

53. Watkins DC. Rapid and rigorous qualitative data analysis: The ''RADaR'' technique for applied research. Int J Qual Methods 2017;16:1–9.

54. Weiner BJ, Lewis CC, Stanick C, et al. Psychometric assessment of three newly developed implementation outcome measures. Implement Sci 2017;12:108.

55. Ak O. A game scale to evaluate educational computer games. Proc Soc Behav Sci 2012;46:2477–2481.

56. Tortu S, Botvin GJ. School-based smoking prevention: The teacher training process. Prev Med 1989;18:280–289.

57. Botvin GJ, Baker E, Dusenbury L, et al. Preventing adolescent drug abuse through a multimodal cognitive-behavioral approach: Results of a 3-year study. J Consult Clin Psychol 1990;58:437–446.

58. Charsky D, Barbour MK. From Oregon Trail to Peacemaker: Providing a framework for effective integration of video games into the social studies classroom. In: *Proceedings of SITE 2010—Society for Information Technology & Teacher Education International Conference Association for the Advancement of Computing in Education (AACE)*. San Diego, CA: 2010.

59. Juul J. *Half-Real: Video Games Between Real Rules and Fictional Worlds*. Cambridge, MA: MIT Press; 2011.

60. Murray JH. *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. MIT Press; 2017.

61. Schell J. *The Art of Game Design: A Book of Lenses,* 3rd ed. CRC Press; 2019.

62. Cooper A, Reimann R, Cronin D, Noessel C. *About Face: The Essentials of Interaction Design*. Wiley; 2014.

63. Cook D. The Chemistry of Game Design. Gamasutra: The Art and Business of Game Design. 2018. https://www.gamasutra.com/view/feature/129948/the_chemistry_of_game_design.php (accessed June 18, 2021).

64. Aldrich C. *The Complete Guide to Simulations and Serious Games: How the Most Valuable Content Will be Created in the Age Beyond Gutenberg to Google*. Hoboken, New Jersey: Pfeiffer; 2009.

65. Salen K, Zimmerman E. *Rules of Play: Game Design Fundamentals*. Cambridge, MA: MIT Press; 2003.

66. Koster R. *Theory of Fun for Game Design*. Sebastopol, California: O'Reilly Media; 2013.

67. Bogost I. *Persuasive Games. The Expressive Power of Video Games*. Cambridge, MA: MIT Press; 2007.

68. Norman DA. *The Design of Everyday Things: Revised and Expanded Edition*. New York, NY: Basic Books; 2013.

Address correspondence to:
Alison H. Oliveto, PhD
Department of Psychiatry and Behavioral Sciences
College of Medicine
University of Arkansas for Medical Sciences
4301 West Markham Street
Slot 843
Little Rock, AR 72205
USA

E-mail: olivetoalison@uams.edu