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Journal of Health Care for the Poor and Underserved, Volume 32, Number 2, May 2021 Supplement, pp. 62-84 (Article)

Published by Johns Hopkins University Press

DOI: <https://doi.org/10.1353/hpu.2021.0051>

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Designing Digital Tools Capable of Reaching Disadvantaged Adolescents and Improving their Sexual Health: A Mexican Experience

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Abstract: In Mexico, underprivileged adolescents have a higher than average teen pregnancy rate, lower use of contraceptives, and little access to reproductive health services. Yet, few evidence-based attempts to build more equitable, accessible, and available reproductive health services for disadvantaged adolescents than their counterparts have been made. The objective is to describe the design and development process of new content that has been integrated to work in synergy with an existing website to promote sexual and reproductive health among Mexican adolescents. We adopted a user-centered participatory action research approach. We developed a set of nine interactive activities that promote knowledge and skills on self-esteem, gender equity, self-efficacy, and decision-making; a chat with live counseling for healthy sexual and reproductive behavior; and a video with a message that highlights the importance of delaying motherhood. By incorporating this type of constructivist strategy, we seek to meet adolescents' needs more easily and improve the acceptability of interventions.

Key words: Sexual and reproductive health, digital tools, live chat, e-learning, adolescents, Mexico.

Pregnancy and motherhood at an early age are associated with health risks for both mothers and their offspring.^{1,2} The most disadvantaged populations tend to be the most affected by events of this nature, because of lack of timely and adequate informa-

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tion or due to poor access to health services.³ In low- and middle-income countries, 15–19-year-old adolescents from the poorest households experience three times more pregnancies than those living in the 20% of households with the highest incomes.⁴

According to previous studies with adolescents, having basic knowledge concerning sexual and reproductive health (SRH) is conducive to pregnancy prevention and self-care.^{5–7} Knowledge has been associated with postponing the age of sexual initiation,^{8,9} but it also enhances understanding of the immediate and long-term consequences of decisions.¹⁰ Designing strategies that contribute to a comprehensive sexual education for adolescents to broaden their knowledge on SRH is a fundamental step to achieving three of the United Nations (U.N.) 2030 Sustainable Development Goals, adopted in 2015: ensure healthy life styles and promote well-being, ensure inclusive and equitable quality education, and achieve gender equality and empowerment of all women and girls.¹¹

In Mexico, the provision of adolescent health services continues to pose a challenge, as several barriers to the demand, supply, and environment conducive to SRH remain. Low demand has been linked to limited SRH knowledge among adolescents, but also to low self-efficacy to pursue a healthy sexuality.^{12,13} On the supply side, several barriers have been identified, such as highly bureaucratic processes to access the health system, lack of privacy and confidentiality, and low quality of care.¹² Furthermore, the social environment continues to discourage open discussions on the exercise of sexuality as well as on pregnancy prevention among adolescents.¹⁴ As a result, 41% of sexually active female adolescents in Mexico use no contraceptive method,¹⁵ and only 47% of in-school adolescents seek SRH services such as counseling provided in clinics.¹⁶

Mexico has social and economic heterogeneities that pervade sexual and reproductive beliefs and behaviors. Thus, adolescents who live in poverty in rural or marginalized areas and are low-educated or illiterate have higher risk of pregnancy, lower use of contraceptives, and less access to reproductive health services than average.¹⁷ In general terms, more traditional contexts show little regard for gender equality, leading to strongly unbalanced power relationships that favor men over women and perpetuate opportunity gaps for women.^{18,19} In particular, religion has influenced the conformation of the social norm linked to the structure of values around sexuality. This fosters conservative principles that generate gender inequities and hinder informed, free, and healthy sexuality.^{14,20}

Gender inequality is closely associated with women's lack of control over their bodies, their sexuality, and their reproductive health.^{21,22} This is the result of the historical, cultural, and social environment.²³ In Mexico, the social construction of gender has confined women to the role of caregivers entirely responsible for pregnancy and childcare. It is understood that men are subject to different social mandates.^{24,25} Among them, masculinity is asserted by increasing the number of sexual partners and by following high-risk sexual practices.^{25–28} The evidence points to important and complex transformations in the perceptions of the new generations, however, gender inequality continues to be one of the main axes along which to understand the relationships between men and women.^{10,29}

To strengthen the demand for SRH services, developed countries have advanced effective and easily available information through digital media;^{30,31} however, efforts in middle-income countries have been modest and understudied.³² Adolescents often

encounter difficulties in accessing evidence-based information and quality health services.³³ It is essential to undertake innovative strategies that appeal to this age group, provide them with up-to-date information in line with their needs, and address their sexual and reproductive rights. Evidence has clearly shown that adolescents have a strong affinity for information and communication technologies (ICTs), and that these resources offer an effective tool for social inclusion and development.³⁴

Mexican adolescents have ample access to and frequently use the Internet, often on a smartphone.³⁵ This provides an opportunity to reach this group at relatively low costs, with improved fidelity during intervention delivery, and greater privacy and comfort to learn about SRH. Efforts to use digital resources for addressing SRH themes have been successful for promoting safer-sex attitudes and positive norms related to safe-sex practices.³⁶ They have also been found to reinforce the use of and adherence to contraceptive methods,^{37,38} broaden SRH knowledge,^{31,39} delay sexual initiation,⁴⁰ prevent high-risk sexual practices, and boost self-efficacy.⁴¹

In Mexico, as of 2015, different governmental institutional efforts (health, education, and population) and by the civil society were linked through the National Strategy for the Prevention of Adolescent Pregnancy (ENAPEA, its Spanish acronym). However, it is still necessary to continue promoting different digital actions to get closer to the adolescent population, since these tools are scarce. Part of this effort is the *comolehago.org* ("How do I do it") website, an open-access, sustainable web page for the adolescent population. The site aims to increase the knowledge, self-efficacy, and skills of adolescents concerning the exercise of a healthy sexuality and pregnancy prevention, and presents available scientific evidence on early pregnancy prevention, using tailored language and attractive learning resources for this age group. This website features two virtual courses on contraception and life planning as well as didactic resources such as a map of contraceptive methods, information on sexually transmitted infections (STIs), and a map to easily identify SRH services. It also contains videos, tutorials, and blogs where users can formulate questions and clarify doubts.

In 2017, seeking to improve the contents of *comolehago*, we conducted a qualitative study to understand the digital learning needs that could be fulfilled with the website and to compare those to the experience provided by *comolehago*. The results revealed that adolescents liked the page, identified with the language used, and considered it to be a safe and reliable site.⁴² Pending needs included an online chat with specialized personnel where users could ask questions in real time, information for adolescents planning to have a child as part of their life plan, and material on self-efficacy and empowerment. Based on these results, a plan to create new components of the website was developed, focusing on the provision of two new types of contents, an encompassing message to promote waiting to have children until early adulthood and the provision of *e-learning*s aimed at improving self-efficacy and empowerment, and one new capability, an online chat to solve the most pressing questions on SRH as defined by adolescents.

The objective of this article is to describe the design and development process for the new content that has been integrated to work in synergy with the *comolehago.org* web page to promote the development of knowledge, attitudes, and skills for preventing/postponing pregnancy and motherhood during adolescence.

Methods

We adopted a user-centered participatory action research approach,⁴³ placing the user at the heart of product design and development. Information was gathered from marginalized urban communities in the states of Mexico and Morelos, located in central Mexico. We divided the study into three digital strategy processes: first, designing and programming nine electronic learning (*e-learning*s) on key themes for a comprehensive sexual education with a focus on self-efficacy and empowerment; second, designing an online chat to clarify SRH doubts in an immediate and individualized way; and third, developing a framing study to elaborate a message for disseminating the importance of postponing pregnancy until early adulthood. To assess the effectiveness of the information reinforced through these three digital resources, we planned an evaluation, specifically a pragmatic trial, to measure the changes in knowledge, attitudes, and skills among the female and male adolescents exposed to the *comolehago.org* web page. Since it is still in progress, the evaluation will not be discussed in the following pages.

All procedures conducted as part of this project were approved by the Ethics and Research Committees of the National Institute of Public Health in 2018 (CI: 1543). We obtained the informed consent of the parents (in the case of minor children), the assent of adolescents under 18 years of age, and the consent of adolescents 18 years of age and older. Each of the strategies followed a specific methodology, described below.

E-learnings. The term *e-learning* refers to an online teaching-learning process that encourages the user to adopt an interactive stance towards knowledge. The methodology we followed in constructing e-learning s consisted of three phases. In the process of creating the materials, we considered the scientific evidence and the opinions of adolescents, youth in general, and experts in SRH; we also included input from instructional designers of virtual educational strategies (Figure 1).

In the first phase, we conducted a literature review of educational interventions to identify key topics for a comprehensive sexual education. Simultaneously, we reviewed existing recreational and educational activities to identify the interactive elements and tools that could appeal to adolescents. Then, we selected a public middle school and a public high school in the state of Morelos, where we developed three exploratory workshops to present the identified topics and tools to the participants, asking them to help us identify the best ways to present those topics using creative and interactive scenarios that could be used in a digital environment. We subsequently organized four workshops with adolescent students to refine their contributions, particularly with regard to the interactive mechanisms and the definition of the scenarios. Based on all of this, we crafted the first version of the descriptive cards for the preliminary design of the e-learning s.

In phase two, we selected two additional schools in the same state (one private middle school and one public high school), along with three health-care facilities with groups of adolescent health promoters (GAPS, by the initials in Spanish). Together with these participants, we piloted each preliminary version of the e-learning programs with slides. We conducted pre-/post-tests with adolescents in order to measure changes derived from the contents presented in the e-learning s. We then gathered their opinions to

Figure 1. Sequence of e-learning methodology
Source: Prepared by the authors

finetune the materials. Similarly, we consulted eight SRH experts to advise us on a brief presentation of each preliminary version of the e-learning programs. We sought their opinions on the contents and interactive elements of the e-learning and descriptive cards; further adjustments were made based on the expert opinion.

Phase three focused on the digital production of the e-learning and the pilot testing of its functionality. Using the Shareable Content Object Reference Model (SCORM) (CAE: Formato SCORM: 7 principios para contenidos e-learning [Internet]. [place unknown]: Innovative Learning Solutions; Blog CAE, Contenidos interactivos, E-learning [cited 7 August 2020]. Available from: <https://www.cae.net/es/principios-formato-scorm-elearning/#>), we described in detail the dynamics of the e-learning, as well as their graphic design and interactive features. By means of a dynamic dialog between researchers and the design team, we made adjustments to the preliminary versions. Once we had completed the production of interactive dynamics in a digital format (HTML5), we performed an optimization, or web-hosting, test of the e-learning with 18 adolescents (10 female and eight male). We presented each participant with at least one e-learning, after which we administered a brief questionnaire. The questions were designed not only to identify technical failures that prevented or hindered carrying out the activities, but also to assess whether the cognitive and behavioral objectives had been achieved. Finally, the programmers made the definitive transfer to the web-hosting service to integrate the Platform/Interactive HUB.

Online chat. We conducted four focus groups (FGs) with 45 participants (23 women and girls and 22 men and boys) aged 12 to 19 residing in the States of Mexico and Morelos; two FGs comprised adolescents aged 12 to 14 and two comprised adolescents 15- to 19-years old; each age group was divided by sex. The topics explored, categories analyzed, and the specific objectives of the sessions are shown in Box 1.

In addition, we organized two meetings with 21 participants including thematic and academic experts, public officials, members of civil society, and health personnel involved in SRH for adolescents. The guide for leading the meeting with experts addressed the following categories: experience working with adolescents, similar national and international experiences, guidelines for interactions between health system personnel and adolescents and, finally, ethical considerations of the system.

With the information obtained, we developed matrices that systematized the main findings, and then carried out a thematic analysis using an inductive analytical process.

Framing study. We implemented this study in two stages (Figure 2). An initial benchmark analysis consisted of a literature review that sought to identify sources of information for ascertaining the discursive elements that have dominated the debates on the topic and for identifying successful practices. Based on these results, we created guides for the FGs and semi-structured interviews in order to understand the cognitive framework used by the public to conceptualize adolescent pregnancy as part of a young women's life plan, as well as to elicit the opinions of health care providers and experts in the field. In the final part of this stage, we defined potential metaphors that could convey the message.

During the second, or prescriptive, stage of the framing study, we tested three metaphors from the previous stage with the FGs and selected the one with which participants most identified. Subsequently, we conducted a persistence trial that consisted

Box 1.

EXPLORED TOPICS, ANALYZED CATEGORIES, AND SPECIFIC OBJECTIVES RAISED IN THE FOCUS GROUPS WITH ADOLESCENTS.

Explored Topics in Focus Groups with Adolescents	Analyzed Categories	Objective
1 Sexual and reproductive health (SRH) education	SRH education	Explore exposure to sexuality education and identify information and counseling needs on SRH issues among adolescents in the State of Mexico and Morelos.
2 Experiences with the use of information and communication technologies (ICTs)	ICTs use	Describe preferences and experiences using digital strategies to obtain information and counseling on SRH issues among adolescent participants.
3 Perception of alternative digital media to meet information needs	ICTs mentioned at focus groups Perception on digital media	
4 Digital information on sexual and reproductive health issues (Planificatel and comolehago.org)	Planificatel ^a and comolehago.org	Define an initial thematic proposal for the operation of the online counseling system.
5 Sexuality, perceptions of adolescent pregnancy, contraception and myths related to pregnancy and contraceptive use	Topics mentioned in the FG Sexuality, pregnancy, contraception, myths	

Source: Prepared by the authors

^aPlanificatel is a family planning telephone service.

Figure 2. Framing methodology

Source: Prepared by the authors

in communicating the message to one participant and observing how it was relayed to the others.

Results

E-learning. This strategy consisted of three stages. In stage one, we defined the themes of the e-learning, which were self-esteem, gender equality, decision-making, and self-efficacy. For each topic, we elaborated a monographic review that synthesized its definition and essential characteristics. We searched for examples of application of these topics to the field of SRH, particularly those of interest to adolescents.

The digital tools that were identified to generate interaction were actions such as dragging, transforming elements, puzzles in general, crossword puzzles, wordsearch puzzles, sentence completion, and graphic panels. Using these tools, we defined educational strategies that could help adolescents acquire or expand their knowledge by identifying useful tips and examples in favor of SRH.

In addition, the workshops provided information for designing and selecting interactive elements for the initial conformation of the e-learning. We identified the importance of selecting youthful and colorful images as well as characters attractive to adolescents such as avatars, emoticons, and zombies. We also decided to employ everyday-life examples and use simple and colloquial language, and for audios we decided to use voices from adolescents or young adults. We also assessed the possibility of incorporating music and varied sounds such as applause or buzzers.

We defined a scenario for each activity. These settings were intended to simulate common environments for adolescents, such as classrooms, parks, WhatsApp conversations, or fictional scenarios such as TV quizzes, solving riddles using a crystal ball, a haunted house, trivia games, and arcade machines. In order to provide an adequate setting, we conceptualized different types of graphic resources and animations such as

signs with varied fonts, various ways of handling colors and visual effects, and movement of elements or characters. Moreover, we identified the advantage of including a stopwatch that would set time limits as well as a scoring or goal achievement system.

From that moment on, we determined that an interactive and reflexive approach was the most effective way to present the contents of each e-learning, incorporating practical elements that adolescents could apply in their daily lives. In this way, users would play an active role instead of only receiving information. Additionally, we decided not to focus on the theoretical description of the topics. Each one was organized in the ways described below.

For the subject of *self-esteem*, we set up two complementary e-learning. These prioritized basic concepts based on the idea that self-esteem is built daily through multiple actions that people do for themselves. In particular, the e-learning emphasized the importance of tenacity and practice. Similarly, they pointed out the ways in which emotions affect the body and vice versa, and pointed out that sedentary behavior and isolation negatively affect the construction of self-esteem.

For *gender equality*, we constructed two e-learning. The first focused on differentiating the terms *sex* and *gender*, and the second defined *equality* and *inequality*. By means of examples, we illustrated the current unequal distribution of tasks and opportunities between men and women and explained that this distribution could be modified to the advantage of both sexes.

In relation to the theme of *decision-making*, we developed three e-learning. The first showed adolescents that they have potential to make decisions regarding when to have sex and how to avoid pregnancy and/or STIs. The second focused on the possibility of being informed in order to make better decisions about their sexual practices. The third focused on choices and sacrifices in decision-making. The intention of these contents was to underscore the fact that life is built on decisions that are made, actions taken, and the consequences that emerge from the process. They also emphasize that each individual is responsible for his/her decisions, and that reflection is a useful tool for identifying the advantages and disadvantages of the chosen options.

For *self-efficacy*, we constructed two e-learning. One focused on helping adolescents identify the basic steps for developing self-efficacy, and the other, on using daily-life situations to illustrate where these e-learning can be applied. We emphasized two main ideas: first, that self-efficacy is built through the personal development of a series of skills, and second, that by putting these skills into practice, adolescents can gain confidence regarding certain behaviors.

In stage two of the e-learning strategy, we performed pre-/post-testing of the pre-designed e-learning to evaluate the adolescents' comprehension of their contents. These results helped us recognize the need to make adjustments concerning the best ways of transmitting certain messages.

With respect to *self-esteem*, we identified the need to reinforce in both e-learning the messages about attitudes and actions for achieving a change of behavior. In the case of *gender equality*, no adaptation of content was necessary for the first e-learning. However, for the second, an activity that presented statements about gender stereotypes, we identified that two of the statements were confusing and had the opposite effect, making those who initially showed an equitable attitude show a more traditional one

after reading them. We modified the wording of these two statements to avoid any confusion. With respect to *decision-making*, we observed that the main problem needing correction was in the synthesis of the contents presented by one of the e-learning, particularly as it pertained to becoming aware that each decision in life entails both gains and losses.

Finally, with respect to *self-efficacy*, we observed that the e-learning adequately transmitted the contents designed for this topic.

With regard to the information gathered in the workshops with adolescents, GAPS, and the presentation with experts, we obtained new suggestions for refining some of the proposed messages and interactions. Most were around the need to make adjustments in the presentation such as (1) enhancing activity names and cover colors to make them more eye-catching, (2) making the messages or dialogs shorter, (3) using more colloquial language, (4) including more competition or overcoming of challenges, (5) adding and improving sound effects, (6) including more images and celebration or animation audios, (7) designing random content with different paths and outcomes, (8) reviewing some definitions and specific examples, and (9) redesigning some images or scenarios to make them more youthful. With the information collected, we conducted a thorough review and modified the descriptive card for each e-learning.

In stage three, the research team presented the e-learning proposal for discussion and digitalization to a group of instructional designers and digital graphic programmers. Again, this entailed a joint and continuous process of improvement. The designers and programmers reviewed and improved the mechanics, dynamics, and production design of each e-learning.

Once the proposal was developed and agreed upon, we carried out an optimization test in digital format with adolescents. Most participants interacted with the activities without any setbacks. However, those who had a slow Internet service experienced technical problems in using the interactive resources effectively; problems included frozen images, audio lag, frequent interruptions, and slow e-learning transitions.

We identified other problems not necessarily related to bandwidth; for instance, the links for the sequences took a long time to appear on the screen, and in the case of e-learning in which a character (avatar) was requested, several attempts were needed for the system to recognize the selection. We also noted the lack of buttons to pause some e-learning. Problems unrelated to Internet quality were corrected.

Finally, concerning content, participants reported that they had learned something new about the topics illustrated, and stated that they liked the way these were addressed because the approach was simple and enjoyable.

Online chat. *Focus groups with adolescents.* Participants all stated that the first talks on sexuality took place in school, although the contents were not the same. Some adolescents had received this information in elementary school, mainly focused on anatomy, while others had not received any until middle school. We found that both the approach and the depth in which the subjects were covered varied greatly.

The four FGs agreed that the topics most frequently addressed in schools were adolescent pregnancy, contraceptive methods, sexual orientation, and STIs. However, in a few cases, the classes covered additional topics such as reproductive anatomy and physiology, puberty, and interpersonal relations.

The mobile phone (owned or borrowed from a family member) was the most widely used device for surfing the Internet and accessing social networks. Both male and female adolescents mentioned that the sites they visited most were social networks (Facebook, Instagram, YouTube, and WhatsApp). Google was the platform most frequently used to search for information on SRH. However, none of the participants mentioned the specific name of any search web page; it was common practice to browse and search for information on multiple pages. The adolescents indicated that to determine the reliability of the information, they compared several pages that Google itself suggested and corroborated that the information was similar among them. They did not mention pages related to any particular institution and, as far as knowledge of the *comolehago.org* web page was concerned, five female adolescents and one male aged 15–19, as well as one female adolescent in the group aged 12–14 had heard about it, although they had not visited the site.

Most participants reported never seeking information on SRH or contraception from a health-service facility. One young man in the 15–19 age group stated he had gone twice and had different experiences each time. The first time was positive because the health staff not only gave him the condoms he needed but they also provided him with information on other contraceptive methods and how to use them; however, on his second visit the health staff did not respond to his health concern and even left the consultation, alluding to being called to attend an emergency. This situation discouraged him from returning to the health center. The other experiences of contact with health services were related to pre- and post-natal care in the case of the two adolescents with pregnancy experiences.

Upon exploring the perceptions of adolescents on the possibility of installing an online chat in the *comolehago.org* web page, we obtained a positive response. Women were enthusiastic about being able to consult information anonymously and in an immediate and interactive way. They also emphasized that the information should be accurate and straightforward, regardless of the format. Respondents preferred the use of formal language, without euphemisms or diminutives.

Participants indicated that for an online chat to inspire trust it must be associated with a recognized institution, and the information must be provided by qualified professionals. The fact that the online chat forms part of the *comolehago.org* web page and is managed by the National Institute of Public Health could be key to gaining the confidence of users in the quality and safety of the information offered.

Doubts aired by adolescents on use of the online chat concerned privacy and confidentiality. Participants pointed out that users would not know who is at the other end of the conversation, and would run the risk of sharing personal information or engaging in conversations that could later be made public. In the group of male adolescents aged 12 to 14 years, it was proposed that users have the possibility of erasing their conversations after a certain time to ensure that the information is not disclosed. Participants were also concerned about the safety of users, adducing that they could interact with people who might harm or expose them to dangers such as kidnapping, abuse, or other perils.

Meetings with experts. All the experts consulted had knowledge of applications, platforms, and non-official media dealing in SRH information. They unanimously

recognized the vital importance of having qualified health professionals deliver the services on these media.

The experts also identified the following challenges and risks in designing and implementing an interactive system with on-call response service through the Internet: (1) achieving the capacity to provide information on cross-sectional issues, regardless of the topic consulted; (2) offering the necessary sensitivity to clearly identify what users are attempting to express; (3) ensuring that operators are competent to resolve doubts concerning daily urgent circumstances (e.g., violence) and to orient users towards a solution; (4) implementing a response protocol for inappropriate use of the service; (5) providing suitable information and guidance on controversial issues; and (6) ensuring that operators undergo continuous training.

The experts identified a series of elements that must be considered when designing interventions of this nature. In particular, they recommended using appropriate language; requesting basic data from users, which would later serve as feedback on the service (namely location [state], sex, age, and source of initial contact with the *como le hago.org* web page); and offering users the possibility of receiving their communications by email to enable them to examine the material carefully. The experts also suggested that the online chat application be operated by young health professionals, since adolescent users would feel more confident to openly express their concerns to them. Finally, they indicated that systematizing the information would facilitate responding to the most frequently asked questions.

While exploring the subjects that could and should be addressed in depth through media of this type, the experts specified the following: sterilization for those who have experienced maternity, errors in contraceptive use, sexual violence, and self-esteem. Regarding the effectiveness of natural contraceptive methods, they indicated that it was important to emphasize sexual hygiene and to mention to pregnant users of the online chat—even if they do not directly broach the subject—that legally interrupting pregnancy is an option for adolescents.

The experts alerted us to limits in the reach of the online chat; among them were circumstances that could jeopardize the adolescents and require immediate action. For instance, when faced with reports of violence, operators must refer users to an emergency telephone number or an institution competent to resolve the problem. Alternatives including civil organizations should also be provided. Finally, the experts unanimously established that autonomy and confidentiality were the most important ethical dimensions that must be guaranteed to users. They emphasized that every concern raised by the adolescents must be viewed as legitimate. In light of the foregoing, we developed a library of contents that served as input for programming the online chat.

Framing study. We found in the benchmark analysis that the themes we should explore with our male and female participants were goals in adolescence, pregnancy and parenthood, pregnancy during adolescence, aspirations for the future, and exposure to sexual health information and pregnancy.

Figure 3 presents all the themes and subthemes included in the guides for the FGs and semi-structured interviews. Based on the responses, we selected three metaphors. The first conceived of pregnancy as an anchor.

Figure 3. Themes and subthemes for the descriptive stage focus groups derived from the benchmark analysis
Source: Prepared by the authors

- Maternity as an anchor: we pondered the idea that while an anchor normally offers stability, it impedes moving forward to the desired harbor when it is cast before reaching the intended port (a metaphor for goals).

Furthermore, as the notion of being or not being ready to be a father or mother was broached recurrently across all groups, we conceived two possible metaphors:

- Baking a cake: Preparing a cake requires certain ingredients and timing. Without all the necessary ingredients (a metaphor for schooling, work, and maturity), or if the cake is removed from the oven ahead of time, the result may not be what is expected.
- Farmland: we discussed the idea that arable land must be prepared as a prerequisite to yielding a good harvest.

During the FGs in the prescriptive stage, we noted that the participating adolescents perceived the last two metaphors unfavorably. Most male adolescents failed to understand the cake metaphor, while female adolescents felt that it was cruel to think that a raw cake might suggest an ugly baby. The anchor metaphor, the one best understood, was accepted by most participants, although it posed a risk in that some participants interpreted the anchor as a baby and felt that this was negative.

Having selected the anchor metaphor, we organized two groups of eight adolescents each and conducted a persistence trial. In the first group, the original message was repeated three times to the first participant. We interrupted the exercise when reaching the fourth participant, however, because the message had been distorted, incorporating the element of “social decomposition,” an element that could be interpreted as a negative value judgment against adolescents. The second sequence included all participants; however, the message had been completely distorted by the end of the exercise, and we decided to find another metaphor. To this end, we analyzed the FG information once again, being particularly mindful of the age group in question. Given that the participating adolescents had repeatedly asked to be spoken to clearly and in a straightforward manner, we consulted an expert in communication and advertising for adolescents who reviewed the information and recommended exploring two new ideas:

- Getting on the bus?: This scenario shows a couple waiting at a bus station and watching buses with different destinations such as “work” and “university” go by. Another couple including a pregnant woman approaches them. They chat for a while, and when the “maternity/paternity” bus arrives at the station, the couple with the pregnant woman asks the other whether they’re getting on. The latter reply that they will wait for another bus.
- Ready?: individuals are involved in difficult situations such as fighting in a boxing match, diving off a board, and skydiving. A group of adolescents are told that it is their turn to undertake those activities. Startled, they respond that they are not prepared. The message at the end affirms that to give the best version of themselves they must be prepared.

While testing these ideas together with the anchor metaphor in adolescent FGs, the latter obtained a neutral assessment, the one with buses was rejected by most participants

because they felt they were being judged unfavorably, and the one about being “prepared” was very well received, with the majority of adolescents expressing the opinion that it was a good idea to wait and prepare in order to offer the best of themselves. They declared that they did not consider the sketch judgmental or feel that they were being told what to do. We therefore decided to use the direct message on being “prepared.” The www.comolehago.org web page contains all the strategies described above.

Discussion

Adopting a user-centered and participatory action-research approach to design digital strategies facilitated our understanding of the needs of potential users regarding the provision of SRH skills through digital media. It also allowed us to incorporate the ideas of key actors who work with adolescents, instructional and graphic designers, as well as communication experts. Finally, the participation of adolescents in the design process was highly relevant, with their perspective contributing elements that adults alone would have been unlikely to envision. The outcome was a design and contents that proved appealing and interesting to this age group. Blending ideas through a continuous and iterative process allowed us to develop digital tools on the basis of robust and efficient evidence.

The development of diversified digital strategies for the *comolehago.org* web page was rooted in the vision of the World Health Organization (WHO) on sexual health. We consider sexual health a state of physical, mental, and social wellbeing in relation to sexuality, entailing a respectful approach to the sexual and reproductive rights of adolescents.⁴⁴ This includes the promotion of an environment and educational content that favor the exercise of sexuality based on knowledge, attitudes, and skills that provide adolescents that capacity to achieve an informed, freely chosen, and pleasurable experience.

As with previous studies, our investigation identified the relevance of using information and communication technologies (ICTs) in health promotion as a highly attractive resource for adolescents.^{45,46} It has been demonstrated that ICTs offer an effective vehicle for delivering health—and specifically sexual health—education.^{31,36,37,39} The use of digital tools for adolescent education on sexual and reproductive health (SRH) has been growing and has obtained positive results.³⁶ It has also been observed that appealing and easy-to-access designs not only enhance the potential of these tools, but are also associated with improved SRH-related knowledge and behavior.³⁷ This is particularly the case for youths who become sexually active at an early age and whose parents have little education, possess limited SRH knowledge, and offer their children minimal support in this regard.⁴⁵

It has been documented that traditional teaching practices center almost exclusively on the cognitive dimension of learners, while interactive educational activities also incorporate their curiosity, feelings, thoughts, and knowledge into the instructional process.⁴⁷ Relevant as well is the fact that digital strategies allow adolescents to learn and to resolve doubts without the risk of being stigmatized.^{36,48} Web pages with sexual education contents also give users the opportunity to select the information they wish to incorporate based on their needs, which favorably affects their levels of user

satisfaction.^{36,45,46} Finally, digitally-driven educational interventions are able to reach populations in areas marked by scarce resources owing to the rapidly expanding access to mobile phones and Internet technologies, even in rural areas.^{36,49,50}

Apart from the proven appeal of digital resources among youth, our strategies incorporate key elements such as accurate information, privacy, confidentiality, and relevance, motivating adolescents to use them.⁵¹ The option presented here is attractive, effective, and innovative in that it offers different possibilities from those of traditional face-to-face interventions. Consistent with previous studies, we contribute evidence that tools of this nature favor dynamic and playful teaching, engaging the interest of adolescents.³⁶

Overall, scientific evidence has demonstrated that adolescent interventions within the comprehensive sexual education framework are more effective than alternate methods.⁵² While other interventions also cover non-cognitive skills and include the themes addressed in our study, the majority employ face-to-face communication.^{53–55} Our strategies are innovative in that, apart from cultivating non-cognitive skills, they offer the possibility of on-call SRH counseling. This can help male and female adolescents change their traditional ways of thinking⁵⁶ through the chats and embrace a new paradigm that will help them to easily recognize that they are in charge of their sexuality and can exercise it in a healthy manner. When adolescents decide to embark upon a sexual experience, they will thus be better equipped to make choices that reduce the risk,⁵⁷ for instance, of unintended pregnancies.¹⁷

Notwithstanding the undeniable advantages of using the above strategies to design and provide information, a number of challenges and limitations prevent them from achieving their full impact. It is important to bear in mind that the transmission of SRH information is plagued by fear, ignorance, and myths that influence parents, educators, and health care providers, rendering the delivery of SRH education to adolescents a complex endeavor, regardless of the means.⁵⁸ In addition, having sufficiently broad bandwidth to interact efficiently is a key requirement for optimizing the e-learning. With regard to the online chat application specifically, the participants in our study expressed concern about the difficulty of managing sensitive topics such as violence and abortion. Various other authors have reported similar findings and highlighted the dangers of sustaining interactions on these subjects. It has been noted that, in using digital tools for transmitting SRH information to adolescents, the connection among certain themes might not be perceived by a population group whose members are still maturing and whose perceptions are still evolving. These themes must therefore be handled carefully, soberly, and with the utmost sensitivity.^{59,60} Finally, greater dissemination efforts must be undertaken to ensure that a larger number of adolescents learn of and use the *comolehago.org* resources. As part of the efforts, in 2021, we will seek to explore the feasibility of disseminating *comolehago.org* resources among disadvantaged rural and urban communities in a southern state in Mexico.

Our study suffered from some limitations. First, the digital strategies developed were geared towards a marginalized urban population with Internet access, thus excluding population groups without such access. Second, we included only two states in central Mexico; therefore, our findings cannot be generalized to different contexts in other states. Finally, financial restrictions prevented us from considering designs that are more

competitive in the market and derive their popularity from offering more entertaining contents; our tools were centered on educational purposes.

Despite the limitations, our study broadens the information on the use of ICT in middle-income contexts, where a digital divide remains more marked in terms of access and use of technology. Therefore, this study covers the gap in the ICT's adolescent pregnancy prevention literature in which the majority of studies have been conducted in high-income countries.^{38–41} Similarly, using the perspective of comprehensive sexuality education for designing our materials also contributes to expanding the topics addressed in digital interventions for prevention of adolescent pregnancy, since most interventions mainly focused on improving knowledge of use of contraceptive methods.

Expanding and investing in digital interventions to improve SRH is a cost-effective pursuit given that their replicability and scalability potentially broadens their capacity for attracting an increasingly large number of adolescents of different age ranges and needs. Establishing multidisciplinary and inter-institutional synergies among the health and educational sectors, among others, would maximize the benefits of SRH interventions in achieving a healthy sexuality and preventing unintended pregnancies among adolescents.

Acknowledgments

This project was supported by The Gonzalo Rio Arronte Foundation (SALUD-2017-S583) and the National Institute of Public Health Mexico (Anexo-13-E022-630).

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