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Developing Internet-Based eHealth Promotion Programs: The Spiral Technology Action Research (STAR) Model

Harvey A. Skinner, PhD
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Health education and health promotion have a tradition of using information and communication technology (ICT). In recent years, the rapid growth of the Internet has created innovative opportunities for Web-based health education and behavior change applications—termed eHealth promotion. However, many eHealth promotion applications are developed without an explicit model to guide the design, evaluation, and ongoing improvement of the program. The spiral technology action research (STAR) model was developed to address this need. The model comprises five cycles (listen, plan, do, study, act) that weave together technological development, community involvement, and continuous improvement. The model is illustrated by a case study describing the development of the Smoking Zine *(www.SmokingZine.org), a youth smoking prevention and cessation Web site.*

Keywords: *adolescent health; Web site development; Internet health information; eHealth; youth smoking prevention*

Health promotion and information and communication technology (ICT) have a long-standing and productive relationship. New technologies are revolutionizing health promotion by providing timely information to consumers, delivering tailored interventions at a distance, and assisting in mobilizing community groups (Street & Rimal, 1997). In particular, ICT offer much potential for engaging youth in health promotion. Applications that are interactive and involve peer-led components have been shown to be the most effective with youth (Biglan, Mrazek, Carnine, & Flay, 2003; Botvin & Botvin, 1997; Dusenbury & Falco, 1997; Ellickson, 1995; Greenberg et al., 2003; S. B. Johnson & Millstein, 2003; Lynagh, Schofield, & Sanson-Fisher, 1997; Nation et al., 2003; Tobler & Stratton, 1997; Wandersman & Florin, 2003). The Web provides an ideal environment for this interactivity and peer-to-peer interaction.

A systematic review of online behavior change interventions found more than 250 different online resources, and a simple Google search for health promotion and behavior change interventions reveals hundreds of further examples of behavioral eHealth in action (Evers et al., 2003; Norman & Skinner, 2004). Yet a closer examination reveals major gaps and tremendous variation in their evaluation and quality. A review of this literature found fewer than 40 published studies evaluating the impact of the Internet-based interventions for health behavior change and health promotion (Norman & Skinner, 2004).

Despite the early publication of guidelines for evaluating ICT health interventions (Robinson, Patrick, Eng, & Gustafson, 1998), few published studies refer to them. This suggests that these guidelines either are not disseminated properly or there is a lack of knowledge on how to implement guidelines within the context of an intervention development cycle. Guidance is needed for practitioners and researchers interested in developing, evaluating, and sustaining eHealth programs. Unlike the early days of the Internet, the plethora of eHealth resources no longer ensures the adage "if you build it, they will come."

The aim of this article is to present an integrated model for the development, implementation, and evaluation of eHealth promotion programs. The spiral technology action research (STAR) model uses action research to integrate ICT development with health promotion principles, behavior change theories, quality

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improvement, and community mobilization practices. The STAR model evolved and was refined through experiences of the TeenNet Research Program (www.TeenNetProject.org) at the University of Toronto (Skinner, 2002, chap. 17; Skinner, Maley, & Smith, 2001; Skinner et al., 1997). An example of how to use the model is illustrated by a case study of the *Smoking Zine*, a Web-based smoking prevention and cessation resource for youth.

WHY AN INTEGRATIVE MODEL IS NEEDED

ICT has specific advantages and limitations for health promotion. Advantages include interactivity, use of active learning methods, multimedia presentation, temporal flexibility, relative ease of tailoring, and low costs relative to its potential population reach (Rimal & Flora, 1997). However, basic access to the Internet remains a significant issue for many countries worldwide.

As of September 2002, there were 605.6 million Internet users worldwide with great variability by continent (*NUA*, n.d.):

- Africa: 6.31 million
- Asia/Pacific: 187.24 million
- Europe: 190.91 million
- Canada & USA: 182.67 million
- Latin America: 33.35 million.

In the world's first global ICT rankings, the top high-access countries included Sweden, Denmark, Iceland, Korea (Rep.), Norway, Netherlands, Hong Kong, Finland, Taiwan, China, Canada, United States, and United Kingdom, respectively, whereas the low-access countries were mainly in Africa with the lowest five being Guinea-Bissau, Chad, Mali, Burkina Faso, and Niger (*International Telecommunications Union*, 2004). Reducing the gap between high- and low-access countries needs sustained attention as a fundamental determinant of health in the 21st century.

Even in countries with high levels of access, such as Canada and the United States, not all access is equal or of comparable quality (Skinner, Biscope, & Poland, 2003). For example, in Canada, use of the Internet increases with income, level of education, children in the household, and in urban locations (Sciadas, 2002). The use of the Internet in Canada also differs by gender and age with men being the highest users in each age category and Internet use declining with age (Dryburgh, 2001; Sciadas, 2002). This pattern of inequality in access is similar to other health issues where access to the benefits of Internet technology are divided along socioeconomic, geographic, gender, age, and ethnoracial lines (Brodie et al., 2000). Even where access rates appear high, quality of access presents another potential barrier to engaging with eHealth resources. For example, the ability to access sensitive health information can be affected by time limits, the use of Web filters, and a lack of privacy at points of access such as schools (Skinner, Biscope, & Poland, 2003).

Another critical issue related to access pertains to the form and content of Web-based information itself. ICT is often heavily text laden, presenting a barrier for some with low literacy levels. Furthermore, as the amount of disinformation and spam increases on the Internet users require eHealth literacy as well to effectively utilize eHealth. Literacy skills in eHealth include general awareness of Internet resources, the ability to seek and find such resources, and the skills to evaluate them and apply the knowledge gained to a health problem (Norman, 2004). For an eHealth resource to be effective, it must be accessible and relevant to its intended audience, otherwise it is not meeting their needs.

A number of models exist to guide health promotion programming and ICT development separately. Within health promotion, models range in focus from individual behavior change to community mobilization (Bartholomew, Parcel, & Kok, 1998; Glanz, Lewis, & Rimer, 1997; Sorensen et al., 2003); however, none accounts for information technology applications. Theories and models exist to guide ICT development that examine usability and user interface design practices, such as the National Cancer Institute Research-Based Web Design Usability Guidelines (*U.S. Department of Health and Human Services Usability Guidelines* [*USDHHS*], n.d.). However, a theoretically grounded means of bringing these two fields together is needed to ensure that eHealth promotion is user friendly, effective, and accessible. In addition, one needs to address the five coordinated actions of the Ottawa Charter (World Health Organization, 1986): (a) build healthy public policy, (b) create supportive environments, (c) strengthen community action, (d) develop personal skills, and (e) reorient health services. The STAR model is intended to facilitate this integration with respect to eHealth promotion.

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THE STAR MODEL

The STAR model combines health promotion theory with ICT systems design approaches using rapid-cycle change strategies adapted from the organizational improvement literature (Langley, Nolan, Nolan, Norman, & Provest, 1996; Skinner, 2002). A visual representation of the model is provided in Figure 1.

The STAR model incorporates multilevel concepts and behavior change strategies from a number of social science perspectives. The approach to health promotion is guided by self-determination theory (Ryan & Deci, 2000) that encourages using strategies that build on intrinsic motivations to take action ("I want to change") as opposed to extrinsic motivations for change ("I have to change"). Another key perspective is social cognitive theory (Bandura, 1997) that seeks to build skills and confidence for change while modeling successful change processes noted in others. Change is most likely to happen if an individual or organization is ready to change. The transtheoretical model, especially the stages of change concept (Prochaska, DiClemente, & Norcross, 1992), is useful in assessing how prepared and willing people are to engage in the change process. This means working where people are in their readiness to change rather than where we might want them to be. A harm reduction approach (Erickson, Riley, Cheung, & O'Hare, 1997) is also fostered, recognizing the benefits of small gains and improvements on the way to more complete transformations. The STAR model not only supports change but also emphasizes the need to organize and build capacity for action and well-being: perspectives associated with community organization and development approaches to health (Kretzmann & McKnight, 1993; McBeth & Schweer, 2000; Minkler & Wallerstein, 2002). Finally, action research (Argyris, Putnam, & Smith, 1985) methods are used to continuously build and feedback knowledge to encourage improvement, learning, and capacity building. Together, these combined theoretical tools work within the STAR model to facilitate a process that is centered on the user and grounded in the everyday realities of the target population and organizations that work with such populations.

Program relevance and participation are achieved through authentic engagement of community members in the development process. Authentic engagement is achieved through participatory action research (PAR) methods (Wandersman & Florin, 2003; Whyte, 1991) and action science (Argyris et al., 1985). This approach allows community members to develop technical capacity and facilitates a sense of ownership of the final product. Friere's (1970) critical pedagogy provides a central guiding framework for this process of engagement:

Listening, precedes
Dialogue, precedes
Action.

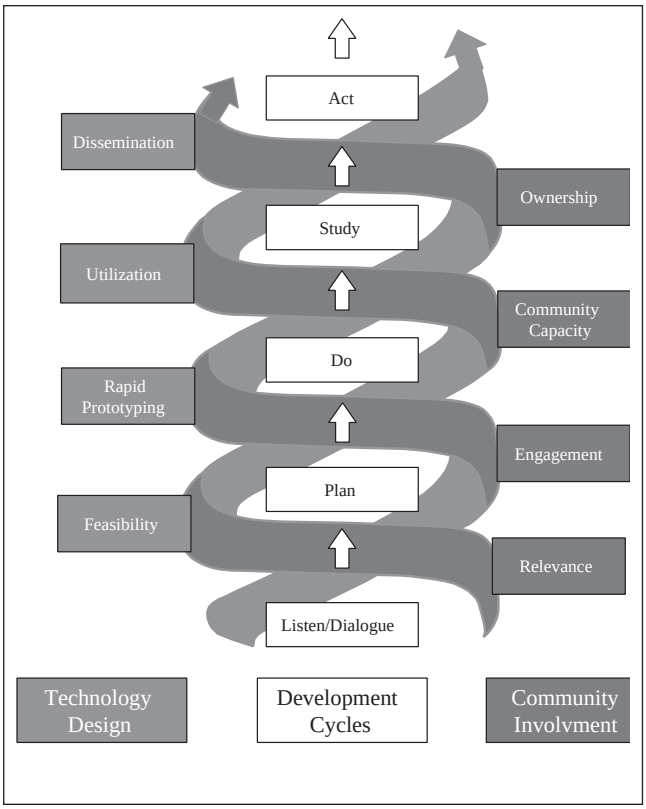

FIGURE 1 Spiral Technology Action Research (STAR) Model Showing the Interplay Among Technology and Community Involvement Through Successive Developmental Cycles

Care is taken to first listen to the target population and understand their perspectives and needs. These are then clarified and negotiated through ongoing and open dialogue, before any specific action plans are initiated.

With respect to the technological component of the model (Figure 1), the goal is to ensure that the intended users of an ICT system find the system easy to learn and use. As such, it is critical the final product fits the accessibility needs of the intended community. In addition to issues of literacy and levels of access, it is important to understand how technology is used by community members. For example, for youth access to Web sites may be limited by bandwidth or by limits on computer time (Skinner, Biscope, & Poland, 2003). To ensure the final product is accessible, relevant issues related to technology and literacy must be identified and integrated into the development specifications. Rapid prototyping and usability testing of interventions are undertaken involving members of the community to ensure the final product meets their needs (*USDHHS*, n.d.). Throughout this development process, user feedback and suggestions are combined with observational and quantitative assessment data to determine the utility of any intervention prior to deployment.

The quality improvement plan, do, study, act (PDSA) approach for rapid-cycle change (Baker, 2002) forms a

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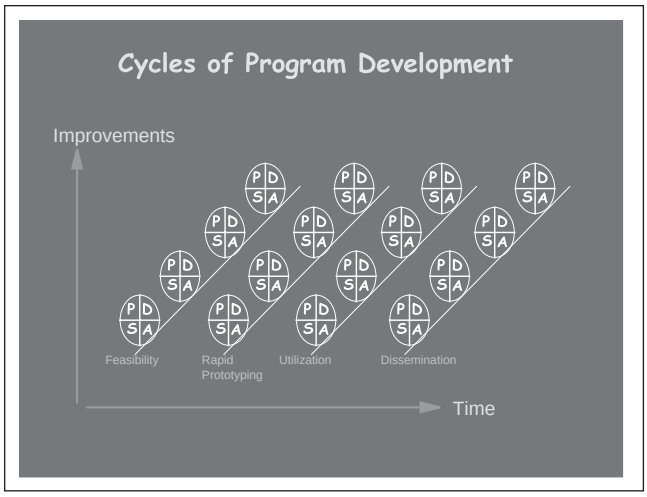

FIGURE 2 Display of How a Series of Linked Plan, Do, Study, Act (PDSA) Cycles Are Used to Design, Test, and Disseminate the eHealth Promotion Program.

core process for implementing the STAR model. Figure 2 displays how a series of linked PDSA cycles are used to design, test, and disseminate the eHealth promotion program. This approach divides the technical development process into a series of smaller decisions and developments, each subject to improvement, evaluation, and reflection. Within each cycle, information is continually gathered so that modifications can be made without extensive redevelopment.

As depicted in Figure 1, the STAR model groups the technical and community development processes into five iterative cycles. These five cycles of the model are now discussed and supported with examples from our work with the TeenNet Research Program (www.teennetproject.org), a youth health promotion initiative based at the University of Toronto.

Cycle I: Listen

Goal: interact with the target community and population(s), identify their needs and wants, and understand how the community relates to the technology

Systems design begins by understanding the task of the system to be developed, the intended users, and how the users interact with any existing system (Baecker & Buxton, 1987; Schneiderman, 1998). Using participatory and action research techniques (Argyris et al., 1985; Whyte, 1991), and drawing on the work of Friere's (1970) critical pedagogy, this process of understanding and needs analysis takes place within an environment of open dialogue and active listening with the community. The goal is to ensure that what guides the development of the system from the outset comes from the community itself, and that a climate of respect and collaboration is created between the community members and the development team. This initial Listen component is vital to overall success by ensuring that the eHealth promotion product meets priority needs of the target users.

For example, in a large-scale qualitative study, 27 focus groups were conducted with 210 youth to identify adolescent health information needs, their use of information technologies, and emerging roles for health professionals (Skinner, Biscope, Poland, & Goldberg, 2003). Study participants most frequently sought or distributed information related to school (89%), interacting with friends (85%), social concerns (85%), specific medical conditions (67%), body image and nutrition (63%), violence and personal safety (59%), and sexual health (56%). However, finding personally relevant, high-quality health information was a pivotal challenge. In a related study, Skinner, Biscope, and Poland (2003) found that the quality of Internet access is a major issue and that it greatly influenced young people's ability to obtain health information and resources. Internet use statistics do not reflect this characteristic.

Cycle II: Plan

Goal: develop a plan for addressing identified community needs using technology and specify technical and organizational requirements for the project. Methods to ensure authentic involvement by the target community are also identified.

Before any technical programming begins, a high-level design of the system is developed based on the user requirements, organizational guidelines, and policies such as accessibility and literacy criteria (Schneiderman, 1998). Such guidelines encourage user-centered designs that build systems to human wants, needs, and behaviors as opposed to technologically centered designs that assume individuals or organizations will adapt to the system. Organizational guidelines and policies are critical for ensuring the final program is responsive to not just user requirements but also broader issues affecting a community such as types and levels of access to technology. For example, at the organizational level, the TeenNet Project uses five guiding principles (Table 1) with each project it undertakes (participatory, relevant, active learning, autonomy supportive, and accessible—PRAAA). The PRAAA approach is especially important for engaging high-risk communities and marginalized populations (e.g., street-involved youth) as their perspective is frequently ignored in program planning exercises.

Cycle III: Do

Goal: implement the plan by developing the graphical layout, navigation, and Web site components. An incremental approach is used where each new component is reviewed with community members to ensure relevance and engagement. A parallel check of financial and technical feasibility is conducted.

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TABLE 1
TeenNet's Five Guiding Principles (PRAAA)

Participatory: key involvement (ownership) at all stages by youth
Relevance: focus on personal, health, and social issues identified by youth
Active Learning, Fun: engaging, flexible and highly interactive, stimulates self-directed learning
Autonomy Supporting: respects individual choice and exploration of options regarding health behavior
Access: designed and adapted to be accessible and relevant to diverse groups and settings, especially marginalized populations

NOTE: The principles are implemented through participatory action research, involving young people from diverse backgrounds in all stages of program development, evaluation, and dissemination.

When system development is initiated, an iterative process is recommended to minimize design errors and prevent the need for extensive and costly reprogramming. Using this technique, prototypes of increasing complexity are developed for review by the community and developers with each new enhancement or version. Prototypes can be nonfunctioning such as a paper sketch outline, computer screen images, and/or early versions of the final system (P. Johnson, 1992). The number of community participants required to provide feedback on the prototypes can be as few as six (*USDHHS*, n.d.). What is critical is to use methods that ensure the broadest range of participation in the feedback process. For example, TeenNet has conducted drop-in feedback sessions with youth who are high risk recognizing they have many concerns that may prohibit committing to structured activities.

Cycle IV: Study

Goal: review the graphical layout, navigation, and Web site components with community members. Prototypes are evaluated before they are converted to Web format, images are reviewed before interactivity is added, and partial functionality is examined before full implementation.

A series of mini studies are undertaken to test aspects of the new system when a working version is established using rapid-cycle prototyping (Baker, 2002). Using a rapid-cycle approach, development of the full program is done in small incremental stages rather than in one step. At each stage, prototypes are evaluated with users to allow for further refinements and ensure the system, as it is being developed, meets the articulated requirements. This approach can avoid costly reprogramming by catching design and requirement errors in the early stages. Review of the developed system by experts in systems design is also encouraged to provide added depth to prototype reviews (Schneiderman, 1998). Systematic evaluation is a key step to informing the next actions and activities.

Cycle V: Act

Goal: launch the Web site after addressing feedback obtained during the study phase. In addition, ensure that mechanisms are in place for ongoing feedback ("listening"), periodic updates, and site sustainability.

Building on the lessons learned from the previous steps, intervention prototypes are modified further, and the final system is constructed in iterative stages. When the intervention is built, it is implemented and disseminated with the participating community. An important aspect of this stage is the creation of mechanisms for ongoing feedback to enable system corrections and refinement (Schneiderman, 1998). This could include cycling back to any part of the listen, plan, do, and study cycles (Figure 1). In addition, attention is given to maintaining positive change and renewal of the system (Skinner, 2002). Through a process of continuous learning and improvement, mechanisms are created to enhance knowledge translation to various interested communities (consumers, health practitioners, funders, and policy makers).

The STAR model was initially developed through experiences of the TeenNet Project in creating a youth health promotion Web site called *CyberIsle* (www.cyberisle.org). Launched in 1996, *CyberIsle* takes a holistic approach to teen health focusing on social, emotional and educational needs regarding health issues (Skinner, 2002; Skinner et al., 1997; Skinner et al., 2001). The concept of *CyberIsle* is based on a teens-only island (Figure 3) and is the product of a series of collaborations between TeenNet and youth. Flowing from the ongoing dialogue with youth and TeenNet's community partners came the idea of establishing a smoking-specific Web site using *CyberIsle* as a model for development. The following case study illustrates how the STAR model was used to create this new Web-based smoking prevention and cessation resource.

CASE STUDY: THE *SMOKING ZINE* WEB SITE

The *Smoking Zine* (Figure 4) is a five-phase program that offers information, self-assessment tools, guided self-change, and opportunities to connect to other youth for providing and receiving support around smoking and teaches coping skills and action planning for resisting cigarette use. The program aims to prevent nonsmokers from starting to smoke (resistance self-efficacy) and to assist smokers to quit or cut down their cigarette use (action self-efficacy). A series of interactive games and quizzes and an online bulletin board are used within five distinct, tailored stages to deliver the intervention to the youth. The five sequential stages provide

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FIGURE 3 ***CyberIsle*** **Web Site Homepage (www.cyberisle.org)**

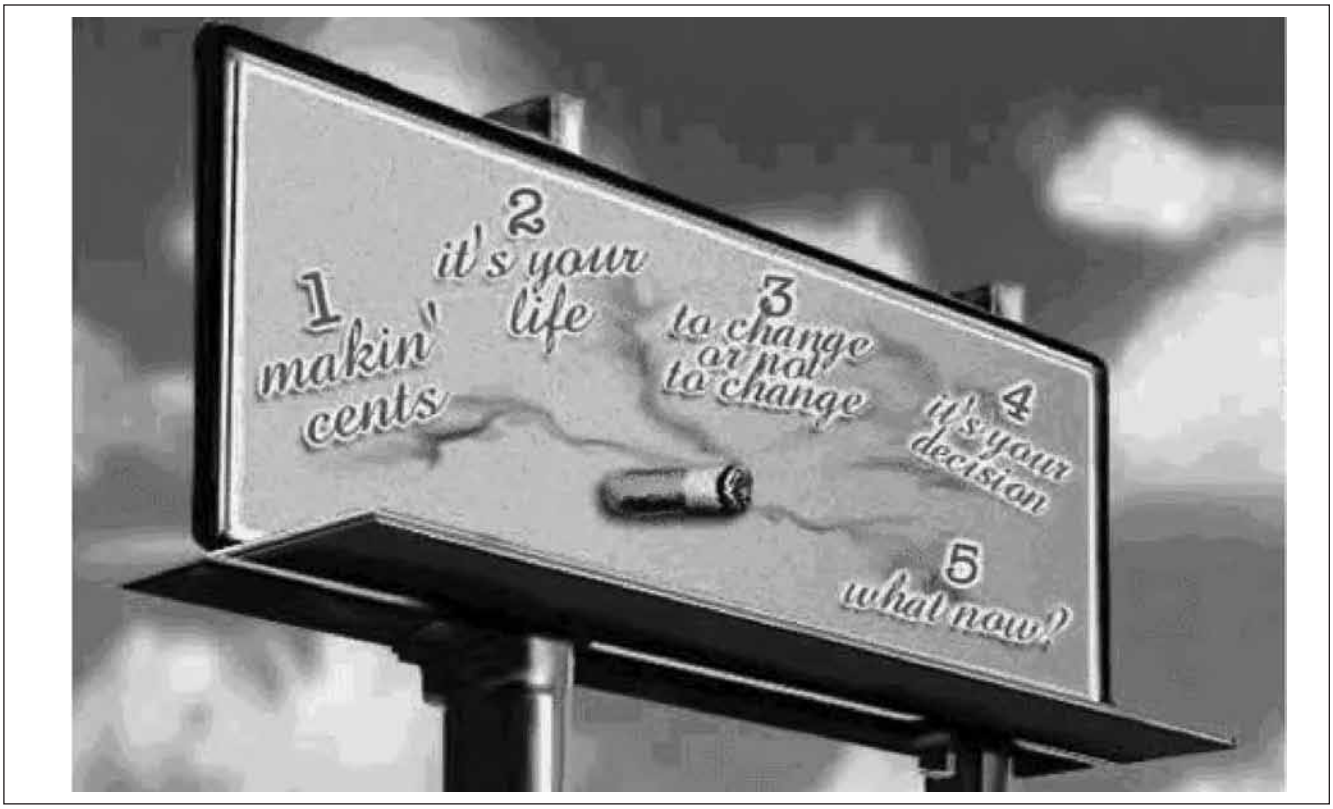

FIGURE 4 ***Smoking Zine*** **Five-Stage Navigation Page (www.smokingzine.org)**

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TABLE 2
Theory Incorporated Into the *Smoking Zine* Web Site

Component	*Theory/Concept*[a]
Stage 1. Makin' Cents Youth select the number of cigarette packs they smoke (or would smoke) in 1 month and the game automatically calculates the total amount per year. Then, the cigarette packs are used as currency in a virtual shopping mall where youth spend the equivalent of 1 year's cigarettes. This enables youth to become aware of the trade-off in amount of money they spend on cigarettes versus other items they value—a consequence of immediate relevance to them.	Consciousness raising
Stage 2. It's Your Life This self-assessment asks youth about the amount and frequency of tobacco use they engage in. Feedback is provided based on their responses to raise awareness of why they smoke, their smoking patterns, and what triggers their smoking urges.	Self-awareness Severity Susceptibility
Stage 3. To Change or Not to Change This quiz is tailored to youth's smoking status (identified in Step 2) and allows them to assess their readiness to change (quit or reduce smoking). In addition, youth assess how important (self-determination) this change is and their confidence (self-efficacy) in being able to change.	Readiness (stage) to change Self-determination Self-efficacy
Stage 4. It's Your Decision This section creates a decision balance that displays the pros and cons related to smoking and being smoke free. On completion of the matrix, youth can clearly see their thoughts about smoking and reasons to quit, reduce tobacco consumption, or stay the same. Completing the decision balance can help youth advance in their readiness to change.	Decision balance Expectancies Values Normative Belief Outcome Expectations
Stage 5. What Now? On completion of the first four stages, youth are presented with a summary of their results and options for "next steps" in Stage 5. For example, if a smoker is interested in quitting then the *Smoking Zine* will help develop a personalized quit plan based on cognitive behavioral principles. If youth are not ready to quit, then they are linked to the Personal Forecast quizzes that focus on areas in their life related to their smoking, such as close relationships. Youth are encouraged to return to the *Smoking Zine* at a later time to redo the quizzes, assess their current status, and make plans.	Personalized feedback Options: choice Behavioral Capability Affects (emotions) Self-regulation Reinforcement: Rewards and/or Incentives Situation and/or environment Relapse prevention

a. Key concepts taken from social cognitive theory, self-determination theory, transtheoretical model, health belief model, and theory of reasoned action and/or planned behavior (see Skinner 2002, chapter 7 for details).

a guided intervention based on information collected from the user during the intervention itself. This information is used to tailor the experience of the Web site to each user's particular needs and circumstances.

A description of the *Smoking Zine* Web site is provided in Table 2, along with a listing of key theoretical concepts that were incorporated into the design of each component of the Web site. The *Smoking Zine* evolved from Web resources that were originally embedded on the more broadly focused *CyberIsle* youth health Web site (www.CyberIsle.org). What follows is a step-by-step description of how the STAR Model was used to develop the *Smoking Zine*. Table 3 provides a summary of the guiding questions and key methods for each cycle.

Cycle I: Listen

The *Smoking Zine* was initiated based on, in part, the analysis of data from 10 focus groups conducted as a part of *CyberIsle*'s initial evaluation. The findings suggested that smokers and nonsmokers alike found *CyberIsle*'s smoking prevention and cessation resources helpful in resisting cigarette use. The groups also identified issues pertaining to Web site navigation and teen knowledge around using interactive resources. These initial findings suggested a redesign of the smoking prevention and cessation resources on *CyberIsle* could enhance usability, and that a larger, quantitative study was warranted to assess the impact of the site on smoking behavior.

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TABLE 3
Spiral Technology Action Research (STAR) Model Developmental Cycles

Guiding Questions	*Methods*
1. Listen Cycle	Qualitative research methods
What needs, gaps, and opportunities exist within the community?	Focus groups
What are current and projected patterns of technology use in general and specific to the community?	Surveys Market research
What relationships need to be established to ensure ongoing community participation throughout the project collaborations, partnerships?	Environment scans Stakeholder analyses
What terms of reference will guide the project: values, scope, approaches, resources, timeline?	Community forums
Do the primary stakeholders understand and agree to these terms of reference?	
2. Plan Cycle	Story boarding
What is the aim of the project?	Technology consultations
What are the specific objectives?	Community advisory groups
Who will do what and when (workplan)?	Market research
Is the production plan feasible in terms of available technological, financial, and human resources?	Balanced scorecard and clinical compass models for measures
What accessibility standards will guide development, including literacy level and technological access?	
How will the Web site be evaluated to ensure that it meets the aim and identified objectives?	
What measures do we need to collect?	
What tools and training are needed?	
3. Do Cycle	Rapid prototyping
How will we know that each step of the plan is completed?	Incremental design
Who will monitor and check progress?	Community member consultation
What methods will be used to ensure representation from the relevant community?	Community member employment
What processes will be used to include community members in project development (staff positions, consulting, advisory board)?	
At which points will prototypes be reviewed by technical staff and community members to ensure continued a fit with the project and/or community aim and objectives?	
4. Study Cycle	Process evaluation
What evaluation model and methods will be used?	Informal reviews (reality checks)
What indicators and processes will be used to measure how the community responds to the eHealth Web site (or prototypes)?	Focus groups and focus testing Usability and relevance testing
How will community ownership of the Web site be defined and fostered?	Impact evaluation
What are the results of the evaluation (minitests)?	Analysis of user data from Web site
If results were different from our aim and predictions, why?	
What did we learn about the study that can be applied in future cycles?	
5. Act Cycle	Cycle back to the appropriate stage of the STAR model based on results of evaluation
What actions will be taken based on evaluation results of the Web site (or prototype)?	
What steps will be taken for promotion and dissemination of the eHealth resource?	Utilize and encourage ongoing feedback from current users (e-mails, discussion boards, contact forms)
What mechanisms exist to enable ongoing feedback and involvement by the community?	
What steps will be taken to support ownership of the Web site by the community?	
Is the cycle complete, or is there a need to return to an earlier stage in the model?	
What plans exist to revisit the Web site to ensure its continued refinement and relevance for community?	

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Another consideration in the listening phase pertained to the use of technology and ensuring it was relevant and accessible to the community of interest. Frequent scans of the information technology (IT) and eHealth literature, monitoring of Internet trends, and frequent "reality checks" with small groups of youth reviewing the Web site were used in this phase. To supplement this information, TeenNet also collected data from participating youth in TeenNet's other research programs on their experiences using various forms of information technology. The knowledge gained through this process was used to establish Internet browser accessibility standards and to select specific Web site tools (e.g., Flash-based applications, see www.macromedia.com).

In addition to listening to youth and "to the technology," recommendations from the tobacco control community were identified through the literature and best practices. One of the challenges tobacco control has tried to address is the development, implementation, and dissemination of evidence-based resources (Centers for Disease Control, 1999; Manske, Maule, O'Connor, Lovato, & Harvey, 2003). This project offered the opportunity to contribute to these goals through a program of research into eHealth and tobacco control with youth.

After listening to these various groups, TeenNet began to improve the usability of its Web-based smoking prevention and cessation resources with the view to creating an enhanced Web resource and implementing a large-scale impact study of the resource on teen smoking prevention and cessation. These enhanced resources would become the *Smoking Zine* (www.smokingzine.org).

Cycle II: Plan

To guide the overall development of this new resource, the *Smoking Zine*, a Youth Working Group (YWG) was established with 10 youth (smokers and nonsmokers). The YWG met weekly with project staff to plan and develop the *Smoking Zine* Web site. A number of methods relevant for youth were used to facilitate participation: meetings were regular (weekly) and kept to 1 to 1½ hours; staff sent out reminders; roles and tasks were defined; commitment to the YWG was kept to a defined period (4 months); and remuneration was provided in the form of transit tickets, food, and a small honorarium.

Youth for the *Smoking Zine* YWG were selected from previous or preexisting TeenNet YWGs or were recruited through TeenNet's community partners. Involving youth from previous YWGs provided some continuity to the project as well as providing participating youth with the opportunity to see how feedback from previous evaluations was incorporated into the final program.

All youth were introduced to the TeenNet Research Program structure and to the principles and theories that frame its work in tobacco control including harm reduction (Marlatt, 1998) and self-determination theory (Ryan & Deci, 2000). This dialogue is important for ensuring participants bring a shared understanding to the process and reduces the likelihood of disconnection and misunderstanding during the development stage.

Technical developers are given a similar introduction with an emphasis placed on the need for the project to be relevant and accessible to youth. When developing Web sites, finding balance within the tension between using what's new, fun, and innovative and ensuring the Web site created meets the project's standards of accessibility is important. One of the key challenges the project has faced has been ensuring the Web site remains accessible to the broadest range of youth. Ensuring access meant referring to the lessons learned from the listen phase that indicated the types of technology youth had access to. Our Web site access logs suggested that a recognizable segment of youth accessing our Web sites were using Web browser versions below general market levels and was supported through TeenNet's preliminary evaluation work in the community. It was, therefore, essential that these standards served as the focus for the new site to ensure the broadest possible access to our Web site content. Technological needs and guidelines are consistently revised at various stages of the development process to address changes in technology and needs of the consumer.

Cycle III: Do

During the do stage of the *Smoking Zine* development, the YWG worked with project staff to draw ideas for the Web site, review images developed by the graphic designer, and decide on Web site navigation and functionality. YWG members felt an urban look would appeal to other youth, and this was confirmed through subsequent pilot testing with diverse youth populations in inner-city, suburban, and rural settings (Cycle IV). The urban look idea led to the concept of using a billboard for navigation along with images depicting urban settings (trucks, chain fencing, graffiti, etc.). The YWG also suggested some fun ideas such as having the cigarette on the navigation billboard reduce in size as a user completes the different stages in the *Smoking Zine*. An important part of this stage in the process is the negotiation between staff and the youth on the project possibilities given technical and budgetary constraints. For example, the youth initially wanted the cigarette image on the homepage of the *Smoking Zine* to reveal information in animated "puffs of smoke." This was not possible under the project's available budget and technical guidelines so the image was redesigned to include key words in the smoke.

Cycle IV: Study

This cycle is an important way to obtain community feedback beyond the YWG members. Not all types of community members will want or be able to participate

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in working groups. To ensure a broad spectrum of feedback, a wide range of mechanisms must be used. As part of developing the *Smoking Zine*, three types of evaluations were used: reality checks, community-based pilot tests, and comparison reviews of the *Smoking Zine* with another youth smoking prevention and cessation Web site. Preliminary evaluations were conducted at diverse locations to assess any potential effects of setting on the site. Special efforts were made to engage street-involved youth and other traditionally hard-to-reach populations in the evaluation efforts to ensure that their perspectives were represented in the project. These evaluations are discussed in further detail.

Reality checks are informal test groups with users and stakeholders. For one of the *Smoking Zine* reality checks, the YWG reviewed the Web site content with other youth. In this reality check, the YWG reviewed the list of coping strategies they had developed for different smoking pressures with other youth for comprehensiveness and relevance.

Once the first prototype of the *Smoking Zine* was launched, an initial pilot test evaluation was conducted to determine the appropriateness and feasibility of conducting a future systematic evaluation. A small, randomized trial was conducted ($N = 118$) at 15 diverse settings throughout the province of Ontario. These settings included shopping malls, youth centers, public libraries, and youth employment centres in urban, suburban, and rural settings. Youth (ages 12 to 19 years) were randomly assigned to complete the *Smoking Zine* or a guided Web-surfing task. Participants completed a survey on smoking attitudes, beliefs, and intentions about smoking at baseline and postintervention. Data were compared to determine any short-term shifts in the measured variables on tobacco use. Additional data were collected from youth who completed the *Smoking Zine* through a short, 1-page qualitative feedback form. The results of the trial were promising and encouraged the development of a larger scale randomized trial discussed later in this article.

In the third study, eight youth between ages 15 to 19 years compared the *Smoking Zine* program with another youth Web resource on smoking. Each youth spent between 15 and 30 minutes reviewing the *Smoking Zine* and a Web site with similar goals, but different approaches and architecture. After reviewing both sites, youth participated in a 1-hour discussion of the activity, and their comments about the Web sites were recorded and fed back into the ongoing decision-making process about the Web site.

The study phase produced decision-making data that TeenNet used to further enhance the *Smoking Zine* and design a systematic evaluation of the site. The results of the study phase suggested that the site was engaging, had greater appeal than other similar Web resources, that the program merited further evaluation, and modifications to the program would be required to facilitate a well-designed evaluation trial including changes to the site's navigation, and the need to provide alternatives to printing Web pages in a multiuser environment where it is hard to guarantee confidentiality of responses.

Cycle V: Act

In the initial evaluations of *CyberIsle*'s smoking prevention and cessation resources, the findings suggested a redesign of these resources would enhance usability and that a larger, quantitative study was warranted to assess the impact of the site on smoking behavior. Through the various stages of the STAR model, the *Smoking Zine* was refined and enhanced to achieve these two goals.

To assess the impact of the *Smoking Zine* on teen smoking, a large-scale randomized controlled trial was recently conducted in 14 Toronto-area high schools in partnership with Toronto Public Health. One thousand four hundred and two students in Grades 9, 10, and 11 participated in the study. Students were randomly assigned to complete either the *Smoking Zine* or a control Web site program; they also participated in a short motivational discussion group. The intervention was completed in one classroom session (typically 60 to 70 minutes). The impact on resistance to smoking initiation and smoking behavior was examined immediately following the intervention and at 3- and 6-month follow-ups. Overall, the *Smoking Zine* had greater influence with boys than girls, and with students in Grade 10 more than other grades in terms of reducing smoking-related intentions and smoking behavior.

The results of the current study illustrate the positive benefits that the STAR model can produce in practice, supported by evidence. The findings from the randomized trial suggest that the *Smoking Zine* significantly influenced students' behavioral intentions to smoke and cigarette consumption.

This trial was designed to provide specific evidence regarding the use of the *Smoking Zine* as a tobacco control resource with teens. The findings from the current evaluation will be disseminated to the community (youth, health practitioners, the research and policy makers) in what will become a new listen cycle—thus completing one STAR cycle and initiating another.

This research is part of a larger global health initiative that is evaluating the relevance of culturally adapted versions of smoking prevention resources for youth in different countries and the applicability of the STAR model for cultural adaptations. In 2003, the *Smoking Zine* was adapted into simplified and traditional Chinese, in collaboration with the Shanghai Center for Disease Control, for smoking prevention with youth in China as well as with recent immigrants to Canada. Similarly, work is under way on Portuguese and Spanish adaptations of the *Smoking Zine* for youth smoking prevention in South America (Brazil, Argentina, Chile), and Arabic/Hebrew/Farsi adaptations are being done for studies in the Middle East. Thus, our

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research is addressing the increased globalization of the Internet and implications for global health (Eysenbach, 2003).

CONCLUSION

With its five iterative cycles, the STAR model provides a comprehensive yet practical guide for the development, evaluation, and dissemination of eHealth promotion resources. The process is ongoing and dynamic. By actively involving the target population (e.g., youth), technical developers, researchers, and community organizations, the STAR model provides a framework for program renewal that is applicable across diverse ICT technologies, settings, and populations. The emphasis on open engagement stimulates effective knowledge exchange among researchers, health promotion practitioners, and consumers. Each group is constantly learning from one another.

Although the STAR model described in this article used an example focused on adolescent health, this model is equally appropriate for use with other life stages and populations. One of the model's advantages is that applications can be tailored to a specific population or targeted to a broader population-level context, depending on the aim of the health promotion initiative. This is a major focus of current research by TeenNet on cultural adaptations of eHealth resources for global health initiatives.

A key concern about eHealth technology is that it can exacerbate health disparities if access to these resources is not equitable across varying socioeconomic groups. This situation is problematic on an international scale when comparing high and low Internet access countries, and in local communities where quality access is often a function of socioeconomic status. By grounding IT development in the needs of the community, the STAR model can help redress inequities by designing relevant programs and underscoring the need for initiatives to enhanced access to the technology. Thus, the STAR model can be used to guide the development of eHealth resources that not only build on advantages of the technology but also address the social reality of diverse and often disadvantaged groups.

Continual reflection and improvement are critical for success. Like offline health promotion programs, technology-based programs must be relevant and useful to their intended audience(s) or risk being ignored. The STAR model achieves relevance through its focus on ensuring an authentic community voice. This authenticity of involvement does more than produce eHealth resources—it leads to personal empowerment that is fundamental to health promotion. The following statement written by a member of the *Smoking Zine* youth working group succinctly illustrates this point:

> My name is Vashti, and I am a part of the Youth Advisory Committee that helped design the Smoking Zine. . . . What I personally enjoyed about being part of the group is meeting new people, learning things about myself, and most of all it makes you feel like your opinion really does matter to others.

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