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Developing Tailored Theory-Based Educational Content for WEB Applications: Illustrations from the MI-HEART Project

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Abstract

This paper describes how theory facilitated the development of educational content for the MI-HEART Project, a tailored Web-based intervention designed to favorably influence the appropriateness and rapidity of decision-making in patients suffering from symptoms of acute myocardial infarction. There were five steps involved: 1) formulating the behavioral goal, 2) defining intervention objectives based on an analyses of the determinants of behavior, 3) developing an assessment tool to measure a person's status on these determinants; 4) creating tailored content that address individual variation on determinants of the health behavior developing, and 5) developing algorithms and a computer program that link responses from the assessment to specific tailored communication. The approach we describe largely distinguishes Web-based applications that are designed to change health behavior from those that simply impart information. Developers of Web based applications that propose to improve health status by modifying health-related behaviors need the understanding that although it is said that we live in an "information age", simply increasing knowledge has not been effective in changing behaviors in most instances. Furthermore, the one-size fits all approach to developing educational content cannot address the needs, concerns and interests of different individuals. With informatics technology, our ability to collect information from individuals and provide educational content tailored to the specific information collected is not only possibly, but practical.

Introduction

There are many types of Web applications pertinent to health information and patient education. Numerous applications are developed simply to provide an information environment so that a user can learn about a particular health topic. Less frequently, applications are developed and evaluated toward the goal of assisting people to adopt healthful behaviors. This latter approach recognizes the pivotal role of health behavior in improving health status and that information, while necessary, is not sufficient to change health behavior.[1–2]

The purpose of this paper is to explore ways that behavioral theory can facilitate the development, implementation and evaluation of educational content for Web applications of the latter type that are designed to change health behavior. Specifically, this paper will suggest how behavioral theory can facilitate the definition of unambiguous objectives, strengthen the linkage between intervention objectives and content by identifying what aspects of users knowledge, attitudes, perceptions, self-efficacy and other cognitions should be targeted to achieve stated behavior change objectives for particular users, and assist in defining behavioral outcome measures for program evaluation. The steps suggested for developing educational content within a behavioral theory framework are illustrated using examples from the MI-HEART project, a Web-based tailored intervention funded by the National Library of Medicine currently in its third year of development.

The MI-HEART Project

The MI-HEART project is examining ways in which a clinical information system can help favorably influence the appropriateness and rapidity of decision-making in patients suffering from symptoms of acute myocardial infarction. Our hypothesis is that educational strategies tailored to information from a patients' medical record will exert a favorable influence on measurable parameters. The project uses patient-specific information from an electronic medical record to produce educational materials for patients at risk for myocardial infarction. Using a cognitive model developed for the purpose of this study,[3] we designed an assessment questionnaire to measure a variety of factors that influence decision-making. This questionnaire collects data on variables specified in our model not contained in the patients' record. The educational content for this intervention is linked directly to this cognitive model and is tailored to the parameters measured at baseline for each participant in the study.

Defining the Behavioral Goal

The first steps in planning our application were to define the goal and develop a set of associated objectives. The goal for the MI-HEART project is to modify the behavior of patients during the interval of time between the onset of symptoms and the affected person’s decision to seek medical care. Specifically, we seek to influence the way patients make their decision to seek help when responding to symptoms. This is the behavioral action of direct and primary interest and we expect change to result from exposure to our intervention.

It was at this stage of the project planning process that we distinguished our intervention from one that simply seeks to impart information. Several different types of behaviors may be the targets for change. Some of these are listed in Table 1.

Defining Intervention Objectives

A key to establishing intervention objectives is the understanding that behavior is a multifaceted, multidetermined phenomenon. Any one behavior is not caused by just one factor. Rather, health behavior may be viewed as a "tangled web" of causal factors, each increasing or decreasing the probability the action will be performed and each potentially affecting the influence of other factors.[4] Each factor identified as causal to the target behavior is associated with an intervention objective and it is assumed that these factors, when modified, will bring about the targeted health behavior change as stated in the goal. With this, it becomes evident that it is necessary to link more than one intervention objective to any behavior change goal.

The set of intervention objectives defined will be designed to influence the most important set of underlying factors or determinants that require change to initiate and sustain the process of behavioral change. The ability to identify these factors requires the understanding and application of existing theories that explain health behavior.

Theories that have prominence in behavior change are those that have empirically demonstrated their value in predicting health behavior. The Health Belief Model (HBM) is among the most widely applied theoretical foundations for the study of health behavior change. It is a value-expectancy model in which behavior is seen as a function of the subjective value of an outcome and the subjective probability that a particular action will achieve that outcome.[5] The HBM postulates that health behaviors are influenced by perceptions of severity, susceptibility, benefits and barriers associated with a health action.6 According to the model, people are more likely to engage in a health behavior if they think they are at risk for a condition they consider to be severe, they believe that the health action can protect them against the threat, and the barriers to doing so do not outweigh the potential benefits. HBM recognizes that behavior change is not a function of knowledge or understanding alone. Rather, it recognizes that until

one expects some value in making a behavior change, there will be no reason to even consider the change. Similarly, if they do not expect to be able to perform the behavior, they will have little reason to attempt it.

Social Cognitive Theory (SCT),[7] another prominent model, places emphasis on individuals' perception of their ability to perform a behavior. This construct, defined as self-efficacy, mediates the application of knowledge and skills in the pursuit of behavioral attainments. When people judge themselves to be efficacious, they are confident in their capability to overcome the difficulties inherent in changing a specific behavior and are more likely to attempt it. Outcome expectation (whether a certain behavior will lead to a certain outcome), analogous to perceived benefits in the HBM, is also emphasized in SCT. If persons do not expect that a health behavior will yield a beneficial result, they have little reason to act. Both self-efficacy and outcome exception are necessary. Self-efficacy expectations are related to success of behavior change attempts, but in initial stages of consideration attempts will not even be considered if outcome expectations are not strong.

Other theoretical models are often used in health behavior research and thus can serve as a frame of reference: Theory of Reasoned Action8, Theory of Planned Behavior9, Transtheoretical Model[10]. All these models map determinants to health behavior. The two that have been explained (HBM, SCT) have been simplified for the purpose of illustration. Even this cursory description however, is sufficient to enable an understanding and appreciation for behavioral analysis. The more detailed the understanding of the factors that determine a behavior, the more likely the intervention and message content will be directed and not miss the mark toward achieving the behavior change goal.

No single theoretical model has been universally accepted as sufficient to encompass the range of human experience.[4] The classification and selection of determinants of behavior is based on the review of more than one theoretical theme, and the selection of those that have been proven especially applicable and appropriate to the type of behavior being targeted.

In MI-HEART, the model for patient decision-making incorporates several behavior models (HBM, SCT), and includes somatic and emotional awareness, perceived threat, expectations of symptoms, self-efficacy and outcome expectations to explain the response of an individual their symptoms. We used formal behavioral theories, an extensive review of published empirical investigations, and qualitative methods to guide the selection of these factors. Table 2 provides a summary of variables in our model, their theoretical origin, and a brief description.

Developing the Assessment Tool

Once the determinants associated with a behavior are identified, they are measured for each participant using an assessment questionnaire. While similar in design to a tool used to collect baseline data in a research study, the distinguishing feature is the close-ended nature of the questions. In order to create all possible tailored content before the assessment takes place, the response choices to each question must be known. In the MI-HEART project, data on behavior-influencing variables specified in our cognitive model not contained in the patient medical record were collected with an on-line questionnaire. There is benefit to abstracting data from the medical record when it exists because it reduces user burden, the time it will take for an individual to complete the questionnaire. MI-HEART participants receive the online assessment questionnaire immediately after they log on to the Web site, and are blocked from education content until all questions are answered.

Creating Educational Content

The assessment questionnaire provides the framework for developing tailored content. When questions in the assessment questionnaire have been developed to address the most important determinants underlying a health behavior, the process is fairly straightforward. Managing the process involves the following steps: 1) write down each question contained in the assessment tool; 2) for each assessment question, list all its reponse choices; 3) create unique content that would be appropriate for a person who gave each particular response to the assessment question. Response items for each question in the assessment tool then guides the development of educational content. For example, if one question measures self-efficacy, and a response item is "low", content can be designed to enhance self-efficacy by showing a person similar to the user successfully performing the desired behavior. Skill building exercises and clearly elucidating the users' success and skill acquisition can also enhance self-efficacy. This type of learning, referred to as vicarious experience[7] is effective because visualizing people similar to oneself perform successfully typically raises efficacy beliefs in observers that they themselves posses the capability to master comparable activities. They persuade themselves that if others can do it, they too have the capabilities to raise their performance.

To increase outcomes expectations, educational content can be designed to demonstrate the relationship between the behavior and outcome and provide opportunities for users to experience specific outcomes as a result of the decision he or she has made. It is important to conceptualize the outcomes of interest as immediate and tangible, not as long-term health benefits to attain in the distant future.

In the MI-HEART project, we used the process of *microtailoring* to enhance the individualization of content by allowing an even greater amount of tailoring to occur in the messages themselves. Table 3 shows this tailoring methodology related to *expectation of symptoms*. *The expectation of symptoms* variable is defined as a persons ability to match the signs and symptoms to their concept of how a heart attack should feel. We used microtailoring for this variable since we know that certain characteristics of an individual may affect the types of signs and symptoms experienced. A description of this reasoning follows.

Since heart attack symptoms may differ among persons with varying characteristics, the message content for this variable would be most relevant to each individual if it varied to match these characteristics. The decision as to what are the relevant characteristics was made using clinical judgement, standardized guidelines[17], and published research. The following considerations were used.

First, angina was regarded as a relevant characteristic because the symptom sets for patients with angina that could be warning signals for AMI are different than for the general population. Persons with angina or more than two CVD risk factors need to be aware of symptoms that may lead to unstable angina. Second, foreknowledge of COPD and CVD risk factors were regarded to be relevant characteristics since persons with this condition are likely to experience unstable angina and anginal equivalent such as shortness of breath, symptoms with potential to be confounded with the symptoms of COPD. Third, having an active prescription for nitroglycerine was regarded as a relevant characteristics since these individuals need to be informed that shortness of breath and chest pain that does not go away after taking nitroglycerine are considered to be warning signals as specified by the AMA. Forth, scoring high or low on the expectation symptom variable itself was regarded to be a relevant characteristic because the framing and content of the message for persons with high levels must be designed specifically to avoid redundancy, while content for persons with low levels must be provided in detail. Thus, Table 3 distinguishes 18 messages based on a combination of the relevant characteristics.

The distinguishing feature enabled by web technology is that it is possible to deliver a tailored mix of educational content directed simultaneously at motivation, beliefs, skills - the multitude of determinants that affect a single behavior. Because we know that behavior change does not come about by providing a single uniform message, this feature has strong advantages over mass communications that are directed to everyone but no one in particular. Even individuals who need to make similar behavior changes are likely to differ on factors that influence their health behaviors[16]. One individual may not feel at risk for developing a specific disease and thus may not perceive the need to be screened for that disease. This individual should have different content than someone who avoids the screening procedure because they fear finding out that they have the disease. It should also be noted that while tailoring has distinct functionality well suited to facilitate behavior change, developers need to carefully consider that even the benefits of tailoring interventions depend heavily on which kinds of behavioral determinants and individual characteristics are targeted. Sophisticated tailoring to weak or irrelevant determinants and individual characteristics will yield poor results.[7]

Remaining Steps: Tailoring Algorithms, Programming Logic, and Evaluating Efficacy

It is not feasible, nor is the purpose of this paper to explain in detail tailoring algorithms, computer programming, and efficacy evaluation aspects of tailoring. Instead, only the most general concepts are presented.

The main function of tailoring algorithms is to formalize the logic, or decision rules that link response options in the tailoring questionnaire to the educational content. In MI-HEART, tailoring algorithms were written - mostly a series of if/then logic statements that joined each assessment response with the appropriate tailored content. When all the tailoring algorithms and computer code were created, they were tested extensively with a sample of subjects prior to participant recruitment. A mishap in providing the wrong tailored content to the wrong recipient could not only affect the credibility of the project, but also could harm the recipient if inappropriate actions are recommended.

Efficacy evaluation involves comparing the behavior and cognitive changes of program participants, measured at baseline and again at designated intervals after they have received the intervention. This is the same behavior (specified by the behavioral goal) and cognitive factors (identified as the determinants of the focus behavior) that lead to the development of educational content during the planning phases of the intervention. It is here that the clarity and plausibility of the behavioral and intervention objectives generated in the process of planning the intervention provide the foundation for evaluating intervention impact. In fact, there is no need to develop special indicators to assess impact. The assessment questionnaire used in the earlier phases of the tailoring process is an appropriate tool to ascertain baseline measures for both intervention and comparison groups. This same assessment questionnaire, minus the demographics, can be used to obtain follow up measures.

CONCLUSIONS

This paper has described how behavioral theories and models can guide the development of educational content for WEB based applications. The major contribution of behavioral theory is that it enables developers to link educational content to the underlying determiners of the focused behavior. The more detailed the understanding of the factors that determine a behavior, the more likely the message content will be directed and not miss the mark toward achieving the desired behavior change.

It is said that we live in an "information age" brought forth by "information technology". However, it is clear that we must do more than simply provide information. Web-based applications have the potential to contribute significantly towards the advancement of behavior change interventions and prevention in general. Their functionality can provide participants with educational content individually tailored to their needs, personalized guidance, and informative feedback, features once only possible in clinical encounters. An approach that combines the functionality enabled by technology and the theories that guide behavior change is likely to make the promises of health promoting technology a reality in this still emerging area.

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Table 1

Types of Health Behaviors

BEHAVIOR TYPE	EXAMPLE
Asymptomatic screening	Mammography screening, pap smears
Lifestyle modifications	diet, exercise
Cessation of addictive behaviors	tobacco, alcohol use
Medical regimen compliance	glucose monitoring, pill taking
Treatment	informed decisions regarding surgery

Table 2

Patient Response to AMI: Summary of Variables

Variable	Theoretical Origin	Description
Somatic & Emotional Awareness	Published Studies[11]	Individuals ability to identify inner experiences of emotion and body sensations
Perceived Threat Vulnerability Seriousness	Health Belief Model[5–6]	Individuals perception of his or her risk of getting an AMI Feelings concerning the extent of harm that could result from an AMI
Expectations of Symptoms	Published Studies[12]	Individuals ability to match the signs and symptoms to their concept of how a heart attack should feel
Outcome Expectations	Health Belief Model[5–6] Social Cognitive Theory[7]	Individuals estimate that their behavior will lead to a certain outcome
Self-Efficacy	Social Cognitive Theory[7]	Individuals confidence in his or her ability to take action by performing the behaviors necessary

Table 3

Tailoring of Messages with Regard to Expectation of Symptoms

Characteristic	**PATIENT PROFILE**								
Past History	No Angina					Angina			
Risk Factors	No	> two risk factors				Regardless of Risk or No Risk Factors			
Nitroglycerin	Regardles	No	No	Yes		No	Yes	No	Yes
COPD	Regardles	No	Yes	No	yes	No	No	Yes	Yes
Expectation of Symptoms:									
Low	Message A	Message B	Message C	Message D	Message E	Message F	Message G	Message H	Message I
High	Message J	Message K	Message L	Message M	Message N	Message O	Message Q	Message R	Message S