1-1-2008

Systems Analysis Using the Transtheoretical Model of Behavioral Change: Encouraging Adoption of "Best Practices" Over "Standard Practices"

Morgan C. Benton
James Madison University, bentonmc@jmu.edu

Marilyn M. Tremaine
Rutgers University, marilyn.trmaine@gmail.com

Systems Analysis Using the Transtheoretical Model of Behavioral Change: Encouraging Adoption of "Best Practices" Over "Standard Practices"

Morgan C. Benton
James Madison University
bentonmc@jmu.edu

Marilyn M. Tremaine
Rutgers University
marilyn.tremaine@gmail.com

ABSTRACT

This paper describes a novel approach to systems analysis and design (SA&D) based upon the transtheoretical model of behavioral change (TTM). TTM was developed for the purpose of helping clinicians and patients change behaviors related to health such as smoking and exercise. The application of TTM to SA&D described here is appropriate when one of the key rationales for developing a new system is to alter user behavior with respect to task performance, particularly when use of the system will be optional. The key strengths of TTM include a structured approach to understanding behavioral change, concrete metrics that can be developed to measure specific behavioral change processes, and clear guidelines for the use and timing of various mechanisms for fostering change. This paper describes a system design in the field of educational technology designed to foster the use of best practices with respect to multiple-choice question writing, delivery, and analysis.

Keywords

systems analysis and design, transtheoretical model, behavioral change, best practices, multiple-choice questions

INTRODUCTION

Generally speaking, the primary goals of information systems are to improve the efficiency and effectiveness of people and organizations at accomplishing various tasks. A great deal of IS research focuses on the key metric of adoption, or how likely users are to actually make use of a particular system, e.g. UTAUT (Venkatesh, Morris, Davis, & Davis, 2003), or in what ways they are likely to make use of a system, e.g. AST (DeSanctis & Poole, 1994). Typically, the implementation of a software system involves determining what the "best practice" is with respect to a target task, and then figuring out how to automate that best practice or otherwise embed it into the software. Frequently this means changing the habits of the end users. This paper describes a new approach to the problem of changing user behavior via system implementation.

The approach described in this paper is based upon the work of Prochaska and Velicer, who are based at the University of Rhode Island's Cancer Prevention Research Center (CPRC) and work in the field of health psychology. When they developed the transtheoretical model of health behavior change (TTM) (Prochaska & Velicer, 1997), their goal was to comb the literature and discover and synthesize all of the extant theory and research on how and why people were successful at changing ingrained habitual behaviors related to health, such as smoking and exercise. The result of their effort was a broad framework that integrated a great deal of theory and practice in the health behavior field.

A TTM-based approach to systems analysis and design (SA&D) may not be appropriate for all systems development situations. This author originally encountered TTM in a UK-based report describing the various ways that research-based findings could be incorporated into the everyday practice of work (Walter, Nutley, & Davies, February 2003). The report cited a paper that described how TTM-based thinking could be used to change the way that physicians go about adopting new research and practices into medicine (Smith, 2000). Smith's description of the forces that prevent doctors from adopting the latest research findings into their practice resonates with many professions where a skilled professional has a great deal of latitude in deciding how a particular task gets accomplished. A TTM-based approach may be most appropriate in SA&D in situations when:

- Use of the system in question is optional
- The target user of the system has some degree of flexibility in choosing the means of task completion
- Faithful adoption of the system will require modifying habitual user behavior
- Task completion is frequently subject to time pressure
- The professionals may not be otherwise motivated to change their behavior
- Adopting "best practices" requires more effort than sticking with "standard practices" or status quo

This paper will first describe TTM in detail, and then describe its use in analyzing a system that was designed to influence teachers' behavior with respect to the writing of multiple-choice questions.

SUMMARY OF THE TRANSTHEORETICAL MODEL OF BEHAVIORAL CHANGE

For a full explication of TTM, the reader is directed to Prochaska and Velicer (1997), of which this section is a brief summary. TTM was developed to address health behaviors, such as smoking, and claims to be the only model of behavioral change that incorporates a temporal dimension. Whereas other models identify behavioral change as a more or less instantaneous event, i.e. the moment someone quits smoking or starts exercising, only TTM identifies change as a process that happens over time. It identifies six stages of change:

1. **Precontemplation**
   This is the period of time before a person is even considering change. During this phase, a person has no plans to change a "problem" behavior.

2. **Contemplation**
   Operationalized as the six-month period prior to making a major behavioral change, during the contemplation phase, a person is engaged in weighing the pros and cons of changing. This may or may not involve actively seeking information, or talking with others about these pros and cons. The six-month timeline is measured using a self-report questionnaire and has shown to be accurately determined by simple questions like "Have you been thinking about [changing behavior X]?"

3. **Preparation**
   Operationalized as the month prior to making a behavioral change (self-report), a person may engage in activities such as making detailed plans for change, enlisting the support of others, modifying one's environment. It is characterized by a heightened awareness of the pros of changing and the cons for not changing one's behavior.

4. **Action**
   Experts in the target behavior determine the set of activities that can be considered concrete indicators of change. Once these have been adopted, a person can be said to be in the action phase. For example, experience with people trying to quit smoking has shown that nothing less than 100% cessation can be considered action. Dropping back from two packs a day down to half a pack is a positive step, but does not constitute action for the purposes of TTM. People in the action phase report higher levels of temptation, and that it requires more attention and energy to continue the newly adopted behavior.

5. **Maintenance**
   The maintenance phase is characterized by a marked drop in reported levels of ***temptation***, an increase in feelings of ***self-efficacy***, and a continued positive ***decisional balance***. These measures will be described in more detail below.

6. **Termination/Acquisition**
   The distinction between the maintenance and acquisition phases is less clear, and for some behaviors it may not ever be possible for a person to be completely free of temptation to revert or relapse into the unhealthy behavior that was changed.

An attractive aspect of these six stages is that there is a concrete operational definition for when a person is in each stage. Furthermore, there is a relatively straightforward strategy for developing interventions designed to help a person move forward at each stage. TTM describes ten processes associated with lasting change that can be used in a successful intervention strategy:

1. **Consciousness-Raising**
   These interventions are designed to provide concrete facts and figures related to the behavior in question. The individual will learn more about the pros of changing and the cons associated with not changing one's behavior.

2. **Dramatic-Relief**
   This type of intervention is primarily emotional and may take the form of testimonials, pep-rallies, or other sorts of events or experiences designed to create a hopeful and positive attitude toward change, and a belief that change is possible.

3. **Self-Reevaluation**
   Journals or diaries, therapy, and counseling are all intervention strategies that involve some measure of introspection and examination of one's current behavior. The goal is to take an honest look at current problem behaviors so that there is a clear understanding of where one should go next.

4. **Environmental-Reevaluation**
   This involves an assessment of how one's behavior impacts the people and places one inhabits. It involves recognition that one's actions can serve as an influence or role model to others. It may involve rational or emotional processes. An example is seeing the impact of second-hand smoke on the people with whom one lives and works.

5. **Self-Liberation**
   Self-Liberation is associated with what people refer to as "willpower" and actions toward self-liberation may take the form of promises or commitments, e.g. New Year's resolutions, to make certain changes in one's behavior. The chances of success increase when multiple options (three options seems optimal) for change are available. The perception of choice seems to make it easier for people to choose to keep their commitments.

6. **Social-Liberation**
   This process involves increased opportunities in social environments, such as smoke-free zones, salad bars, and other places where healthy behavior is socially promoted. Conversely it also involves removing oneself from unhealthy social environments, where the social norm is to practice the undesired behavior.

7. **Counterconditioning**
   Counterconditioning involves learning behaviors that can serve as a substitute for the unhealthy behaviors being replaced. Chewing gum instead of smoking cigarettes is an example.

8. **Stimulus-Control**
   This process involves examining and removing temptations from the immediate surroundings. If temptations, e.g. cigarettes or unhealthy foods, cannot be removed, it may be necessary for the person to alter his/her environment by moving to a new location or taking a new route. Taking part in self-help groups or otherwise putting oneself into a positive environment also fall into this category.

9. **Contingency-Management**
   When people engaged in behavioral change institute rewards and/or punishments in reaction to their efforts to change, they are using contingency management.

10. **Helping-Relationships**
    This involves enlisting the aid and support of close friends, family members, or advisors who can be supportive throughout the stages of change.

Application of the various processes has been found to be appropriate during different stages. A key question when helping a person decide how best to change their behavior is exactly when each of the processes or treatments above should be applied? Three concrete measures for identifying in what stage a person resides have been developed, which are decisional balance, self-efficacy, and situational temptation.

Decisional balance refers to the subject's self-reported perception of the pros and cons associated with making a given behavioral change. It is a fairly simple measure—a person is simply asked to list as many pros and cons as he or she can think of related to a given behavioral change. In a study of twelve health-related behaviors it was found that in every case movement towards positive change was correlated with a significant increase in the perception of pros coupled with a decrease in the perception of cons related to change (Prochaska, et al., 1994). This study found that, on average, behavioral change was accompanied by a one standard deviation increase in the perception of the pros and a half standard deviation decrease in the perception of cons.

Self-efficacy and ***temptation*** are the second and third measures of stage of change in TTM. The measure of self-efficacy was adopted from Bandura, and is "the situation-specific confidence people have that they can cope with high risk situations without relapsing to their unhealthy or high risk habit," (Prochaska & Velicer, 1997, p. 40). Temptation is a measure of the degree of presence of factors such as emotional distress, positive social atmosphere, and craving. Questionnaires measuring these two constructs are developed with respect to the target behaviors. Positive change and the ability to maintain a target behavior are associated with an increase in self-efficacy and a decrease in the experience of temptation over time. Based upon these measures it is possible to design individualized interventions that have shown to be very effective at achieving favorable measures of change (Prochaska & Velicer, 1997):

- ***Recruitment***—the proportion of the number of people contacted to the number of people who enroll into a behavioral change intervention program; in a systems context this might be viewed as adoption
- ***Retention***—measured at fixed intervals (e.g. every three months), a comparative measure showing attrition rates between TTM-based and other intervention programs

- ***Progress***—a measure of how much time people spend in each stage of change
- ***Process***—participants' reported satisfaction with the intervention process (system satisfaction)
- ***Outcomes***—a measure of the proportion of participants that make it to the maintenance stage

The transtheoretical model has a number of aspects that make it appealing as a framework for attacking the problem of changing behaviors. First of all, it is general enough to be applied to most any type of behavior. The authors of the model have developed interventions to address smoking and other drug use, weight control, sun exposure, safer sex practice, and having regular mammograms (CPRC). Second, the principles of the model appear to be applicable to organizations or groups (Prochaska, Prochaska, & Levesque, 2001). Third, and very importantly, the model gives specific guidelines for measuring and evaluating the progress of the intervention at each stage which makes it attractive in situations when accountability is an issue. Fourth, the developers of TTM have documented examples of how to set up and run a large-scale intervention based on their strategies and have even shown that the model is amenable to automation via expert systems (Prochaska, Velicer, Fava, Rossi, & Tosh, 2001). The next section of this paper will demonstrate how to apply TTM to an SA&D process.

USING TTM IN SYSTEMS ANALYSIS & DESIGN

Perhaps the easiest way to describe the use of TTM in SA&D is via an example. This section will first describe the background for the example. Second, it will describe a software analysis problem, and then describe how TTM could be employed in developing the final system.

The QuesGen Project—Developing a System to Help Teachers Write Better Multiple-Choice Questions (MCQs)

The following example summarizes the analysis phase of an ongoing project to build QuesGen, a web-based application that teachers can use to write, and to get better as writing, MCQs. A beta version of QuesGen has been built and tested (Benton & Tremaine, 2008). However, as of yet, the system does not yet support the full range of functionality that a TTM-based analysis indicates. One of the drawbacks of the TTM analysis methodology is that the range and breadth of functionality it uncovers is frequently time-consuming and expensive to implement. Future papers will address the effectiveness of systems built following the model. This paper is confined to discussing TTM in the context of the SA&D process alone.

The Problem—Getting Teachers to Adopt "Best Practices" for Writing MCQs

The software system that will be developed is a tool to help teachers write better MCQs. Problems with teachers' ability to write MCQs have been demonstrated in past research (Benton, Tremaine, & Scher, 2004). Teachers are a good test case for the TTM methodology because:

- Teachers can reasonably develop MCQs via means other than the system to be built
- Teachers are not generally required to follow one particular methodology for developing MCQs
- Teachers' MCQ writing styles are likely to have become ingrained over time
- Teachers are often under time pressure to write questions
- There may not be a lot of external motivation driving teachers to change their MCQ writing style

If successful, the system would generate data on when, and how quickly teachers change their behavior with respect to MCQ writing practice. In beginning the analysis, the first element to be described will be the design team.

The SA&D Team

As in many systems analysis methodologies, it is necessary to assemble domain expertise from a number of quarters. A TTM-based design strategy is no different. Figure 1 shows the members of such a team for the current problem. These roles may be filled by four separate people, or some people may play more than one role.

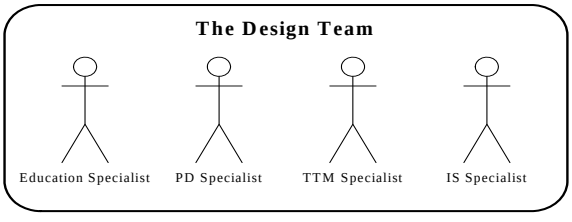

Figure 1. A SA&D Team for a TTM-based System

The ***Education Specialist*** would provide expert guidance in what research has proven to be the most appropriate methodology for writing MCQs. The ***Professional Development (PD) Specialist*** would devise a plan to incorporate that

methodology into teachers' everyday practice. The ***TTM specialist*** would be responsible for designing appropriate behavioral interventions composed of the various processes of change that TTM describes to accomplish the goals set out by the PD specialist. The TTM specialist would also devise metrics to discover and describe teachers' state of change. The ***IS specialist*** would then bring the research in Information Systems to bear in designing software artifacts that will implement the interventions specified by the TTM specialist. The resulting specification could then be implemented as software.

Step 1: Identifying the Target Behaviors and Best Practices to Implement

Arriving at the set of target behaviors—in this case, the techniques for writing high quality MCQs—is a non-trivial task, and in a complete software specification, would deserve a thorough analysis. For the sake of space and relevance in the current example, the relevant behaviors will be briefly described noting key references. The Education Specialist is the first contributor to the analysis, and in this case is likely to conclude that the "best practices" with respect to MCQ writing are those described by Haladyna, Downing, and Rodrigues (2002) who describe over twenty common flaws in MCQs, and explain how to avoid them. A second key area of educational theory that applies to the writing of MCQs would also be Bloom's taxonomy of educational objectives (Anderson & Krathwohl, 2001), which gives useful guidance on how to choose MCQ content. A third key area is the concept of formative assessment, also known as assessment for learning (Black, Harrison, Lee, Marshall, & Wiliam, 2003), which provides useful guidance about when and how to use MCQs to foster more and better learning, as well as strengthen the relationship between the teacher and student.

The second contributor to the analysis is the PD Specialist, who is an expert in understanding how to implement professional development programs. The PD Specialist is likely to reference the following passage describing effective PD:

> *[Effective professional development programs (PD) are] well planned over the long term using evaluations of past PD opportunities to inform future PD. The PD is structured around a specific need of participants, proximal to teacher practice and supplying usable information to teachers. The participants should either already be in a community or should have common ground for forming a community, such as teaching the same unit, teaching in the same school, etc. The PD should take place over an extended period of time, to promote the creation of a community of practice whose participants have common goals addressed by the PD. Finally, the PD activities themselves must offer opportunities for teachers to engage in inquiry of either content or pedagogy. (Kubitskey & Fishman, 2005, p. 2)*

This description of effective PD is part of Kubitskey and Fishman's Knowledge, Beliefs, and Attitudes (KBA) Framework. The KBA Framework takes its name from prior research which establishes that the best way to determine if teacher change programs have been effective is not to look at the specific practices of individual teachers, which are highly contextual, and likely to vary considerably across classrooms, but to look at the underlying knowledge that teachers have about pedagogical practice, the beliefs they have about their students knowledge and abilities, and the attitudes they have towards teaching, learning and their classrooms. The knowledge, beliefs, and attitudes of teachers who are effective tend to be very similar and are a better indicator of the success of various PD.

When the Education Specialist and the PD Specialist have finished their analyses, we will know the following about our proposed system to help teachers write better MCQs:

1. It should incorporate the best practices described by Haladyna et al. and flag instances of poorly formed MCQs
2. It should incorporate Bloom's taxonomy and flag questions that are targeted inappropriately
3. It should encourage the formative use of MCQs to foster better learning
4. The system should be immediately useful to the teachers
5. Teachers should have an opportunity to use it over the long term
6. The system should support communities of teachers writing questions
7. The system should encourage teachers to engage in deeper thought about the use of MCQs in the classroom

The next thing to do will be to figure out how to translate these items into the language of TTM.

Step 2: Using TTM to Determine the Processes of Change

TTM is designed to help people stop unhealthy behaviors, in this case writing poor MCQs, and adopt healthy behaviors, in this case writing better MCQs and using them effectively. The TTM specialist would first begin to identify system feature sets that fit within the ten processes of change:

1. **Consciousness-Raising**
   These features are purely informational, and provide pedagogical content knowledge. These might include videos or other tutorials, written manuals or help screens, tooltips and other contextual help. The content of these items would

include both the positive evidence supporting the desired behaviors as well as the negative evidence contraindicating the undesired behaviors with respect to MCQs.

2. **Dramatic-Relief**
   The goal of these features is to raise the spirits and make the teacher feel hopeful and upbeat about the potential for achieving the desired change. While for many software systems, this type of material is restricted to the marketing collateral of a particular software system, it is important to note that within TTM, it is recognized that these affective elements may be as important to changing behavior as the more objective content within the system. A portion of the system screen might be reserved for success stories, case studies, or other pieces which demonstrate the positive role that effective MCQ use has in the lives of students and teachers.

3. **Self-Reevaluation**
   These features would implement introspective elements that allow examination of one's current practice with respect to MCQs. The goal is to take an honest look at current practice so that there is a clear understanding of where one should go next. In this context, this might mean analytical tools that help a teacher to see the flaws in his or her current questions, or in the questions that teacher might get from a textbook's online question bank.

4. **Environmental-Reevaluation**
   These features need to help the teacher see how his or her MCQs impact students, for example, by showing how students were confused or misled by poor MCQs in the past. It also might demonstrate one's influence on the use of MCQs by one's colleagues.

5. **Self-Liberation**
   It is very important that teachers perceive that they have a choice about how to tackle the goal of writing better MCQs. Turning this process into software features might involve devising multiple paths through the software to arrive at the same end. It also might involve allowing some features to be enabled or disabled until the teacher is ready to use them. Teachers should feel that they can attack this in their own way.

6. **Social-Liberation**
   It is in this phase of analysis that the need for social networking within the system becomes evident. Some means for publicly recognizing teachers who are making significant progress toward optimal behaviors is indicated.

7. **Counterconditioning**
   Counterconditioning involves learning behaviors that can serve as a substitute for the unhealthy behaviors being replaced. In this case, this might be some mechanism which encourages a teacher to refrain from giving an assessment in which the MCQs have not been carefully prepared, in other words, controlling the impulse to give quizzes and tests no matter what.

8. **Stimulus-Control**
   This process involves examining and removing temptations from the immediate surroundings. In the case of MCQs this might be the temptation to use pre-written questions: either last semester's tests, or perhaps poor questions provided by a textbook publisher. The system may require all questions to go through some sort of review process upon being imported into the system.

9. **Contingency-Management**
   If this software is to be implemented by the school or educational system, an appropriate reward system might be set up to provide perks or bonuses to teachers who exhibit exemplary effort at improving their MCQ-writing ability.

10. **Helping-Relationships**
    A complete set of collaborative features could be implemented. For example, teachers might be able to review the quality of other teachers' questions and vice versa. A supportive forum and community surrounding the test questions would motivate system users to improve. These features might be particularly productive in a state where teachers are responsible for meeting ambitious targets for standardized tests.

Hopefully by now the benefits of using TTM for feature analysis are beginning to emerge. In following the process above the designer can begin to have confidence that a sufficient and complete set of system features has been identified. However, sufficiency and completeness are not left to chance.

Step 3: Use TTM to Identify Metrics of Change

The sufficiency of the above feature set will not be known unless system performance is measured throughout the software's lifetime. At this stage in the process the TTM Specialist would need to work with the Education Specialist and the PD

Specialist, as well as with members of the target user population to develop instruments for measuring three metrics of change: decisional balance, self-efficacy, and situational temptation. The trickiest part of this stage is finding clever ways to incorporate mechanisms to gather data on these metrics into the system itself. Examples of this type of data gathering are things like Google and Microsoft's requests to collect system usage data, and some other commercial websites' asking site visitors to fill in surveys about the helpfulness of the site. This system might require new users to fill out a new user profile of some sort that allows the system to generate preliminary metrics and determine the user's stage of change. Once the user's state of change is known, then these metrics can be used to selective and automatically enable and disable system features so as to prevent information overload.

Step 4: Use the Metrics of Change to Determine the Timing of Change Process Delivery

The above feature set is beginning to get quite daunting, and is very likely to be overwhelming to a new user. To prevent information overload, some of the more "advanced" features of the system should be hidden until the user is more comfortable using the more basic features. But what features should be hidden? A key finding of TTM research is that different processes of change are more applicable to different stages of change. In other words TTM provides clear guidance and rationale as to which features to hide and which to display. TTM's contribution to this process is an understanding of user behavior that is grounded in the relevant psychological work on ingrained habits and how to change them.

Step 5: Apply Relevant IS Theory to the Design

Finally, the IS Specialist will take the feature set developed so far by the other three design team members and draw up an appropriate software requirements specification, taking into account relevant IS theory and practice. At this point, screens can be designed, storyboarded, submitted to user testing and iteratively moved towards a final implementation. Based on the TTM metrics developed, built into the system will be a concrete means for evaluating the performance of the software at regular periodic intervals, and the data should also be able to be interpreted in a straightforward manner in terms of updates and maintenance that will need to be applied to the system. A visual representation of this entire process can be seen in Appendix A.

SUMMARY AND CONCLUSIONS

In summary, there are several very clear benefits to incorporating the transtheoretical model into the SA&D process:

1. **TTM provides a structured approach to understanding behavioral change**
   By using the processes of change it is possible to be confident that the system design being developed adequately meets the full range of needs users will have in order to foster productive use of the system.

2. **TTM provides clear metrics for measuring behavioral change and system performance**
   The TTM metrics of change are simple and easy to develop. Once created, they are relatively straightforward to interpret. Incorporating the metrics into the system may pose a challenge, but if overcome allows the system to gather data that can be used in the regular maintenance of that system.

3. **TTM provides clear guidance for timing the delivery of various feature sets to end users**
   By tying the metrics to the stages of change, it is possible to have a more clear sense of when it is appropriate to present system users with hidden features of the system. In the past, this type of control has not been possible.

Due to the newness of this methodology, a full implementation of the process has yet to be undertaken and tested. The researchers look forward to doing so, and comparing notes with others who may find that TTM offers valuable insight to the SA&D process.

REFERENCES

1. Anderson, L. W., & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives.* New York: Longman.
2. Benton, M. C., Tremaine, M. M., & Scher, J. S. (2004). Computer Aids for Designing Effective Multiple-Choice Questions. *Proceedings of the 2004 American Conference on Information Systems.* Washington D.C.
3. Benton, M., & Tremaine, M. (2008). QuesGen: Clarifying the Dimensions of Multiple-Choice Question Quality. *Annual Meeting of the American Educational Research Association,* (pp. 1-15). New York City.
4. Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2003). *Assessment for Learning: Putting it into practice.* Berkshire, England: Open University Press.
5. CPRC. (n.d.). *Measures*. Retrieved March 3, 2008, from Cancer Prevention Resource Center: http://www.uri.edu/research/cprc/measures.htm
6. DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science , 5* (2), 121-147.
7. Haladyna, T., Downing, S. M., & Rodrigues, M. C. (2002). A Review of Multiple-Choice Item-Writing Guidelines for Classroom Assessment. *Applied Measurement in Education , 15* (3), 309-334.
8. Kubitskey, B., & Fishman, B. (2005). Untangling the Relationship(s) Between Professional Development, Enactment, Student Learning, and Teacher Learning Through Multiple Case Studies. *Proceedings of the Annual Meeting of the American Educational Research Association,* (p. 29). Montreal, Canada.
9. Prochaska, J. M., Prochaska, J. O., & Levesque, D. A. (2001). A Transtheoretical Approach to Changing Organizations. *Administration and Policy in Mental Health , 4,* 247-261.
10. Prochaska, J. O., & Velicer, W. F. (1997). The Transtheoretical Model of Health Behavior Change. *American Journal of Health Promotion , 12* (1), 38-48.
11. Prochaska, J. O., Velicer, W. F., Fava, J. L., Rossi, J. S., & Tosh, J. Y. (2001). Evaluating a Population-based Recruitment Approach and a Stage-based Expert System Intervention for Smoking Cessation. *Addictive Behaviors , 26,* 583-602.
12. Prochaska, J. O., Velicer, W. F., Rossi, J. S., Goldstein, M. G., Marcus, B., Rakowski, W., et al. (1994). Stages of Change And Decisional Balance for 12 Problem Behaviors. *Health Psychology , 13,* 39-46.
13. Smith, W. R. (2000). Evidence for the Effectiveness of Techniques to Change Physician Behavior. *CHEST , 118* (2), 8S-17S.
14. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly , 27* (3), 425-478.
15. Walter, I., Nutley, S., & Davies, H. (February 2003). *Developing a Taxonomy of Interventions Used to Increase the Impact of Research.* Economic & Social Research Council UK Centre for Evidence Based Policy & Practice.

APPENDIX A—VISUAL REPRESENTATION OF THE TTM MODEL IN CONTEXT