Development and Evaluation of a Knowledge Requirements Engineering Model to Support Design of a Quality Knowledge-intensive eHealth Application

By

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Abstract

Quality online health information/knowledge is globally in high demand. Achieving such quality necessitates a multi-disciplinary requirements engineering approach that enables elicitation, analysis and representation of the viewpoints from a broad variety of related sources. These sources include health and health education/promotion professionals, health informaticians and application design experts, and health consumers, the primary users of such knowledge. In addition, maintaining and improving quality over time requires such a large set of viewpoints to be updated regularly. This dissertation endeavors to provide an enabling methodology to address the above needs specifically in the field of eHealth.

This research was conducted in two steps. In the first step, the existing methods of requirements engineering applicable into our particular scope of eHealth applications, aimed at health promotion/education, were reviewed to develop a framework for knowledge requirements engineering. In the second step, the usability and usefulness of the proposed framework were evaluated throughout a four-phase study (0-III). During this study, knowledge requirements engineering was used to specify the pieces of information that should be included in a quality health Web site targeting university students. Within the established framework, requirements data was gathered from various sources, including literature, existing Web sites, and interviews with local health professionals and university students. The evaluation results showed that the pieces of information and health topics specified using the framework consistently matched those the subjects preferred. In addition, the findings provided evidence that such information, when used by health search engines to index and retrieve online health resources, helped the subjects choose the resources that actually matched their interest. Finally, the data showed a higher satisfaction of the subjects with the health Web site that was built based on the knowledge requirements specified, as compared to the other selected health Web sites.

This dissertation makes significant contributions to the fields of health informatics, health promotion, and requirements engineering. It contributes to the field of health informatics by expanding the scope of requirements engineering to include the field of eHealth and knowledge provision. The approach presented illustrates how various viewpoints related to requirements knowledge should be elicited, analyzed, and reasoned to build valid knowledge requirements specifications representing viewpoints of all sources consulted. It also illustrates how such specifications can be used as a basis to build quality eHealth applications. In the field of health promotion, this dissertation demonstrates a knowledge provision methodology that is grounded in the models of health behaviour change. This methodology allows health educators to rationally and accurately specify not only the health topics of high interests to health consumers, but also the type of knowledge they would prefer to be provided in the related knowledge artifacts. More particularly, this research has specified the health knowledge content of preference to adolescent consumers. These specifications highlight the particular knowledge needs of this age group, which can be used as a basis for local to national health promotion activities targeting these consumers. Finally, the research contributes to the field of requirements engineering by illustrating an integrated requirements engineering approach that accommodates multiple viewpoints and allows transparent reasoning and representation of requirements.

It is anticipated that the concept of knowledge requirements engineering introduced and discussed in this dissertation will open a new area of research and practice for health informaticians. Subsequently, the methodology demonstrated can be improved and further advanced to address the needs of other domains of health and health-related knowledge.

Table of Contents

List of Figures

List of Tables

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This dissertation would not be possible without the remarkable support of so many people. Now that I am done, I find myself overwhelmed and wish to offer them all my thanks and my acknowledgement of their support. The following is not necessarily a hierarchy since each person made his or her own unique contribution and none could stand above the others in that regard.

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Much appreciation must also go to the many authors and researchers whose insights and research have inspired me in my research, including all the authors whose papers I have cited (or quoted) in this dissertation. Specifically, I am grateful to two scholars, David Werner and Dr. Gunther Eysenbach. David Werner has been my model as a consumer health educator. In the past 37 years, David has worked in more than fifty countries, mostly developing countries, helping to facilitate workshops, training programs, and approaches to "health education for change." What I have been inspired by the most, was the David's book, Where There is No Doctors. In this book, David has amazingly tailored the available health guides on a broad variety of topics, from the common cold to very serious and urgent care issues (childbirth and burns), to the knowledge level of people living in poor villages. This book is written (and the visuals drawn) in such an incredible way that, using it, individuals with minimum levels of education and with a very basic set of tools (that can be found almost everywhere) can take care of themselves or their beloved persons. David's works have aroused my enthusiasm for consumer health and self-care and have inspired me about the idea of health information tailoring and contextualization of health information provision as the focuses of this dissertation. I am very much grateful to him.

Gunther Eysenbach has been my model as a consumer health informatician. Gunther founded the first research group on eHealth, the leading eHealth journal, and founded and promoted the notion of a collaborative, open, semantic web of trust for health information on the web. He has also published more than 120 eHealth and consumer health informatics related publications in respected international journals such as JAMA, BMJ, and the Lancet. Several parts of this dissertation have been directly or indirectly affected by Gunther's research. I am very much grateful to him, as well.

Finally, I am grateful to a loving family that just never stopped giving of themselves in countless ways, both direct and indirect. I was going to start listing them all, but realized they are just too many to do them justice - so please accept the fact that you are all mentioned in my daily prayer of thanks to a loving God who will convey that gratitude in His own way back to "each of you."

Dedication

This dissertation is dedicated

To my wife, Vida,

who, after 13 years of married life together, is still my strength and purpose in life. You have gone through a very tough time and carried most of the burden so that I didn't have to. How do I say it, except:

"Thank you, my love!"

To my children, Hoda, and Hliya,

who, I sacrificed their many special times they wished to have me there, and who were always welcoming to a tired dad when he would go home.

"I love you both, you are my life"

To my mother, and my mother-in-law

who remotely supported us all these years with their encouragements and prayers.

"I could never pay you back for what you've done for me, thanks a lot"

And to my dad

who would have been proud.

"I wish you were here"

Chapter 1: Introduction

"Property may be destroyed and money may lose its purchasing power; but character, health, knowledge and good judgment will always be in demand under all conditions."

Roger Babson (1875-1967)

This chapter provides a brief overview of this dissertation. It begins with an introduction to the current issues of consumer health informatics and health information provision services as the main domain of concern and then lists and explains the objectives of this research in addressing some of these issues, the research questions to be answered throughout the study, and the significance of such potential contributions. The closing section will provide an outline of the chapters and their flow of content.

1.1 Synopsis of Dissertation

The main goal of this dissertation is to propose and validate a knowledge requirements engineering framework. This framework is expected to improve the quality of eHealth applications aimed at providing health knowledge. More particularly, this dissertation is concerned with the knowledge content of eHealth applications designed for the purposes of online health education/ promotion - what we will refer to as knowledge-intensive eHealth applications (KIEHA). KIEHA can be a consumer health information Web site (or tools), an online health directory, or a health search engine which all share similar knowledge-related properties. However, consumer health Web sites will represent KIEHA throughout this dissertation. In the following sections, demand for such application services as the main motive, quality as the main concern (and goal), and requirements engineering as the main enabler of such quality application services will be discussed.

1.1.1 Growing interests toward Web-based health information/knowledge services

In the last decade, the health informatics domain has witnessed a growing global interest in online health information services. Such interest is detectable at three levels: At the academic level, such interest is evident in the emergence of new research fields such as eHealth or Web health informatics (Eysenbach, 2001; Pagliari, Sloan et al., 2005) and e-health promotion (Evers, 2006) which aim at improving the health care of individuals using information and communication technology. At the service/technology level, such attention has resulted in tens of thousands of health-related Web sites (Cline and Haynes, 2001) across the Web aimed at helping millions of people make informed decisions about their health care (Shuyler and Knight, 2003). In addition to Web sites as current dominant types of knowledge-intensive eHealth applciations, a plethora of health directories (e.g., Google/Yahoo health directories, Medlineplus, and Canada Health Portal) and health search engines (e.g., HealthCyberMap, Healia, and Medhunt) are also available, facilitating global access to quality health information. Finally, at the consumer level, the evidence is the variety of studies (Lebo, 2003; Fox, 2006; Vermaas and Van de Wijngaert, 2005) illustrating the everyday enthusiasm of tens of millions of people (eight million a day in the United States alone) seeking health information online. Even a single quality health Web site, such as Medlineplus.org (provided by the US National Library of Medicine), has an average page visit of 90 million per month (Spring 2007) of which 10 million have been unique users (MedlinePlus, 2007). A study by Pew Internet and American Life Project revealed that in roughly 80 percent of cases, people find the information they are looking for on the Internet every day (Fox and Rainie, 2002), and every year more and more people believe that information they find online can improve how they take care of their health (Madden and Fox, 2006).

Overall, access to quality online health information is a growing demand.

1.1.2 Quality is the main problem

Quality is a main concern of online health information provision. A majority of literature systematically reviewed for indicators of quality (55 of 79) considered the "quality" of health information provision to be a problem (Eysenbach, Powell et al., 2002), even though "quality' as a goal is yet undefined. ISO 8402 defines "quality" as *the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.* One emphasis of this definition is "the totality of features and characteristics" according to which quality is seen as result of various characteristics that altogether (and not each separately) produce a desired satisfaction. For instance, Bates et al. found that improving one aspect of Web site quality may not necessarily affect the overall perceptions of users regarding health Web sites, even though it is an important factor on its own (Bates, Romina et al., 2007). The second emphasis is the fulfillment of the direct (stated) or indirect (implied) requirements as the goal of features or characteristics inclusion. In other words, as Petrasch describes, quality is not only related to the presence of characteristics that are bound to positive requirements, but also to the absence of characteristics related to non-requirements or neutral requirements (Petrasch, 1999).

The number of quality-related studies across medicine and health informatics literature is astonishing. These studies range from conceptual papers or reviews discussing general quality principles regarding online health information to case studies reporting example uses of such principles in the design or assessment of the related applications. Examples of the former are the guidelines of the American Medical Association (AMA) for health information Web sites (Winker, Flanagin et al., 2000) and the list of quality criteria extracted by Eysenbach et al. (one of the most cited studies in this area) (Eysenbach, Powell et al., 2002). These studies suggest several quality factors such as *ease to find*, *accuracy*, and *completeness*, which provide valuable directions regarding the features or characteristics to be considered in a design approach. Examples of the latter are several initiatives and projects that have proposed and operationalized a variety of element sets, which refers to concepts and criteria used, to sort, index, and filter the health information Web sites (based on their quality). The first element set of this type (called HIDDEL) was introduced in MedCERTAIN project (Eysenbach, Kohler et al., 2001) funded under the European Union's "Action Plan for safer use of the Internet." HIDDEL consisted of more than a hundred criteria of quality for health information Web sites (e.g., Provider Identity, or Creation Date). This element set has been modified over time in the succeeding funded projects of Quatro (Archer, 2005), WRAPIN (Gaudinat, Ruch et al., 2006) and MedIEQ (Mayer, Karkaletsis et al., 2006). In MedIEQ, the most current project, the element set has been downsized to include only eleven elements the presence of which in a health information Web site indicates its quality.

We found several shortcomings in the above studies.

1- **The presence of quality elements in the element sets (or the guidelines) has NOT been justified.** In other words, rationality of quality elements is not evident. For instance, the AMA guideline recommends that, *the dates that content is posted, revised, and updated should be clearly indicated*. (Winker, Flanagin et al., 2000) However, it does not show the range of support by various related stakeholders such as domain experts or health consumers other than the eight listed authors of the guideline. Similarly, the presence of an element, for instance, Last Update in MedIEQ has not been substantiated whether it is supported by evidence from empirical studies, expert consensus or any source of quality research.

2- **The studies lack multi-viewpoint/holistic methodologies to specify the quality elements.** Health information provision is a multidisciplinary service requiring expertise from various disciplines such as medicine, health promotion and education, human- computer interaction, and Web design. In addition, health consumers as the final recipient of information/knowledge materials also have the right to hold a reasonable share of votes toward any design decision. As Risk and Peterson emphasize, quality criteria often require additional evidence from other sources of requirements, e.g., the consumer audiences, in order to produce clear insights valuable for a Web site design (Risk and Petersen, 2002). Otherwise, the product may not be perceived as quality by their primary users. For example, Bates et al. found that the health information Web sites which contain some quality features, determined by the related experts, are not significantly perceived superior by health consumers (Bates, Romina et al., 2006). Therefore, it is logical to think that a fair aggregation of viewpoints from all the related sources of quality requirements is a prerequisite to an achievement of "totality."

3- **Currency of quality elements is not clear**. In most studies, the quality elements (or requirements) are assessed on a one-time basis within their limited range of scope and context. However, to reuse such requirements in further design, one must first ensure the current validity of the requirements through a re-assessment of the requirements references. For instance, hundreds of authors (265 and 440 – Google Scholar) have referenced the quality criteria suggested in the works of Eysenbach et al. and Jadad and Gagliardi (Jadad and Gagliardi, 1998; Eysenbach, Powell et al., 2002). However, very few have re-evaluated the range of quality factors suggested in those papers, and from the latter group very few have used the same range of references in their re-assessment (i.e. low reuse value). As result, the currency of such data as one of the required factors for their reusability is questionable.

1.1.3 Requirements Engineering as a method of linking problems to solution

To characterize quality elements of an online health promotion/education service design, current *requirements engineering* methods could be adapted to address the particular issues of health knowledge services. Requirements engineering (alternatively called *requirements analysis* OR *requirements assessment*) is a branch of software engineering that is concerned with elicitation, specification, and validation of requirements knowledge for a technology solution (Loucopoulos and Karakostas, 1995). If we simply believe that the goal of consumer health informatics or eHealth is to build technology in order to solve real-world health-related problems, then it is the requirements engineering that tells us what the problem actually is (Damian, Chisan et al., 2003), what to build (Brooks, 1987), and how to map the needs to solutions (Wieringa and Ebert, 2004). Requirements engineering involves rich *problem-solving* (Aurum and Wohlin, 2003), *knowledge representation,* and *domain modeling* (Sutcliffe, 1998; Yuquin and Wenyun, 2006), all tasks that have been identified by Musen (2002) as the original jobs of health informaticians. The final product of RE process is a requirements specifications document or an application model that can direct further design.

In summary, in order to understand the information needs of KIEHA users, a requirements engineering should support the following features:

1. **Multi-viewpoint** – It should provide knowledge aggregation tools to elicit, cluster, and summarize all varieties of recommendations, advice, algorithms, standards, and evidence of best practice from a wide variety of related stakeholders including the target audience.
2. **Lifelong/dynamic** – It should support the longitudinal evolution of quality evidence all throughout the application lifecycle. This capability should enable the requirements engineers or developers to check the integrity, and over time validity of requirements anytime during the lifetime of the application.
3. **Traceable** – It should make transparent the links between each quality element and the supporting evidence or statement in such a way that it enables re-appraisal and re-use of the evidence in further design.

1.1.4 Testing the solutions

If we claim that we have developed a new requirements engineering (RE) method that supports design of application of higher quality, then we should be able to demonstrate the actual improvement caused as result of using such a method. However, how to measure the impact of the method on quality is an issue. Obviously, whether we consider the knowledge content of a knowledge-intensive eHealth application as a Web site or page, a digital resource/document, or a learning object material (LOM) (McClelland, 2003), the knowledge content of which we aim to assess the quality of, is a set of knowledge meant to affect individuals' health-related behaviours. Therefore, as many studies have been seeking (Ahern, Kreslake et al., 2006) a logical evaluation approach seems to be a measurement of behavioural change rate caused in the consumers as result of receiving such materials. The other option is to accept the fact that "knowledge is neither a necessary nor a sufficient condition for behavior change" (Egger, Spark et al., 2005) and to consider quality a matter of perception by the recipients of the health promotion materials. According to this option, a knowledge content is considered as "quality" only when it addresses the actual varieties of the consumers' knowledge needs, and that is positively perceived by them as "quality knowledge". In this case, the positive change of attitude toward the application content could be used as measure for quality improvement.

The evaluation method used in this dissertation is based on both above visions, but focuses on the second. The rationale is that looking at Fishbein and Ajzen's model of knowledge-behaviour (Fishbein and Ajzen, 1975), which is one of the foundational bases of today' s health promotion activities, one can realize that a positive perception and interpretation is a prerequisite to any decision for behaviour change (Baum, Revenson et al., 2001). Therefore, for health knowledge to be effective, it must first be perceived as effective (useful and credible) by the consumer before causing any intension for change. Consequently, we evaluate our requirements engineering method by measuring the consumer-perceived quality improvement of the application content designed according to the requirements model produced.

1.2 Objectives of the Study and Research Questions

To specify quality elements for a knowledge-intensive eHealth application, we require a comprehensive understanding of knowledge needs and requirements of the application's primary users. However, to gain such understanding, we need a methodology to elicit and analyze the viewpoints of the related stakeholders of knowledge.

We asked four research questions:

1- Can we develop requirements engineering techniques and methods that accommodate multiple viewpoints, support traceability and requirements change over time?

2- Can we use such requirements engineering methods as the basis to specify the quality knowledge requirements of an eHealth application?

3- How will the primary users of an eHealth application perceive the quality of the knowledge elements specified using such a requirements engineering process?

4- Will the knowledge requirements specified in this manner support the design of quality knowledge content for an eHealth application?

Therefore, the objectives of the research are:

1- To review and discuss various aspects and issues of the current requirements engineering methods and techniques

2- To define our particular scope of knowledge-intensive eHealth application

3- To identify general types of consumers' knowledge needs for health knowledge

4- To develop a list of health knowledge stakeholders whose viewpoints could help us specify such needs

5- To develop a requirements engineering framework that allows us to elicit and analyze the viewpoints of the knowledge stakeholders

6- To test the practicality of the proposed framework in a small-scale implementation

7- To specify knowledge requirements for a KIEHA application during the implementation

8- To evaluate the reactions of the users to the knowledge requirements specified in regard to their quality

9- To evaluate the usability and usefulness of the specified elements in supporting the design of a KIEHA prototype

1.3 Significance of Research

The framework proposed in this dissertation and the approaches undertaken have significance to the fields of health informatics, health promotion, and requirements engineering.

First, the research has significance to the particular fields of health informatics (particularly to its related branches of consumer health informatics, public health informatics, and eHealth) in that it will illustrate a requirements engineering approach designed to specify knowledge requirements. This would not only be a contribution to the foundations of health informatics by developing original methodologies, but also a contribution to the outcome of health informatics applications aimed at health care of individuals. In addition, the existing quality criteria to index and filter online health resources require to be validated by linking to its supporting evidence. This dissertation will provide a methodology that allows the eHealth developers to specify quality criteria the elements of which could be traced to its sources of viewpoints. Finally, as Musen (Musen, 2002) emphasizes, health informatics is lacking original/foundational problem solving and knowledge representation methodology that addresses issues of particular importance or dominance in the discipline. This research will address this issue by presenting a novel framework that specifically addresses the design of knowledge artifacts. This framework can be adapted to support design of domain ontologies that are rational and updateable, by being linked to its evolving domain of supporting viewpoints.

Furthermore, the research will contribute to the field of health promotion in the area of quality health information/knowledge provision. According to the Elaboration Likelihood Model (ELM), health consumers are more likely to thoughtfully and carefully process a piece of information or knowledge if they find it matches their personal needs (Petty and Cacioppo, 1986). In addition, a plethora of studies has shown superior effectiveness of health information messages that are tailored to the particular needs of health consumers (Holt, Clark et al., 2000). Eliciting the knowledge needs of health consumers is the particular focus of the knowledge requirements engineering framework demonstrated in this dissertation. It is logical to expect that the knowledge content that is designed using such a framework will engender more positive attitude toward the content and more chances of behavioral change as a result.

Finally, our research has significance to the field of requirements engineering. It will advance the current versions of viewpoint-based requirements engineering by expanding their domain to include knowledge products and by improving their performance using metadata. This research will also illustrate a study design to evaluate the proposed framework that can be used as a basis to evaluate further models of requirements engineering.

1.4 Outline of dissertation

This dissertation consists of eight chapters:

1- **Synopsis of dissertation** – Provides an overview of the dissertation including the scope of research, the research questions, the objectives of the study, and the significance of the research.

2- **Literature Review: Aspects of Requirements Engineering** – Reviews and discusses available choices of requirements engineering methods, ways of eliciting various viewpoints of requirements, and approaches to aggregating the related knowledge requirements.

3- **Defining the Scope** – Defines the particular scope of eHealth application and the related concepts in this dissertation.

4- **Proposing a Knowledge Requirements Engineering Framework** – Describes the fundamental dimensions of a requirements engineering model specialized for eHealth application and proposes a model that addresses those dimensions. The chapter will also list the three particular research questions in detail and provide an overview of the methods taken to arrive at their answers.

5- **Methods** – Illustrates the four-phase study approach conducted to elicit and aggregate the requirements from various sources of knowledge requirements and to validate the results with a group of target consumer representatives.

6- **Results** – Presents the results from each of the four phases and demonstrates how the results were used to create and eventually tailor the knowledge requirements set being specified. In the evaluation section, the statistical analysis of the evaluation data from Phase III is presented.

7- **Discussion**–Summarizes the overall analysis methods and findings, answers the research questions, and discusses the limitations.

8- **Conclusion** – Presents potential contributions, potential areas of further research, and draws overall conclusions.

Chapter 2: Literature Review: Aspects of Requirements Engineering

"We can model what we think they said, we can model what we think the system will be like if implemented correctly, but we can't really model the requirements."

Colin Potts

This chapter provides an overview of our literature review. It reviews the current variety of the requirements engineering (RE) methods, outlines general techniques and concepts involved throughout the process and discusses some of the current issues as well as the solutions.

2.1 Introduction

Requirements Engineering (RE) is recognized as the "*the hardest single part of building a software system*" (Brooks, 1987), and a key issue of design success (Dubois and Pohl, 2003) whose underestimation has been identified as the cause for the majority of software reworks (Martin, 1984) and failures (TeStrake, 2001). Requirements engineering has different dimensions: field of science, engineering activity, and process. Zave defines the field of requirements engineering as:

> *the branch of software engineering concerned with the real world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior, and to their evolution over time and across software families* (Zave, 1997).

Nuseibeh and Easterbrook (2000) cite Zave's definition as the clearest available definition; and emphasize the multidisciplinary and human-centered aspects of requirements engineering. Jarke et al. (1993) consider requirements engineering a knowledge acquisition activity in which the requirements knowledge is continuously elicited (from what they call *system world*), specified, and validated, the resulting specification is used in design engineering to design information systems (Figure 2-1).

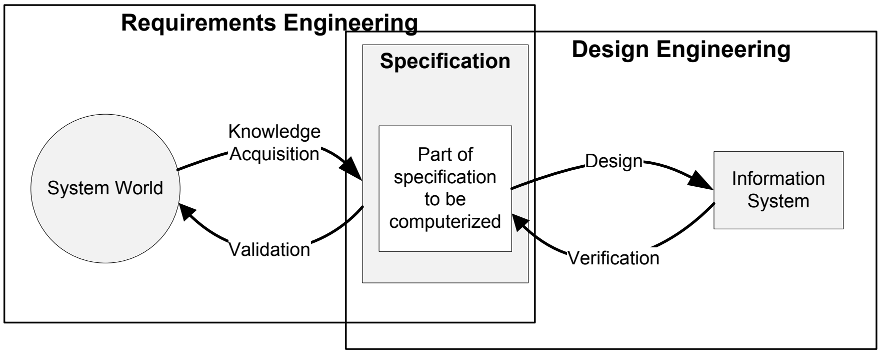

Figure 2-1. Requirements Engineering and Design Engineering activities (reproduced based on (Jarke, Bubenko et al., 1993)

Requirements engineering (RE) is also described as a process that begins with elicitation of requirements through collection of statements and evidence regarding user-defined and domain-imposed requirements and followed by analysis, modeling, and validation of the elicited requirements, followed by representation of the achieved knowledge as a requirements specifications model (Domges, Jacobs et al., 1996; Hofmann and Lehner, 2001). This model should specify the *functional* ("the description of what the product is intended to do" (Fanmuy, Populus et al., 2005)) and *non-functional* (the attributes of application quality (Mylopoulos, Chung et al., 2001)) requirements of the software artifact to be designed. The RE process is normally considered complete when the compiled specifications (e.g., *use cases* or *domain models*) are sufficient to lead to an artifact design that would satisfy stakeholders' needs (Domges, Jacobs et al., 1996). Such requirements are then reasoned to build homegrown appropriate solutions or be used in a problem-solving process to match with a software solutions (Maiden and Hare, 1998; Aurum and Wohlin, 2003; Wieringa and Ebert, 2004).

In this chapter, we review and discuss the methods and concepts of requirements engineering process including their major challenges in the following order:

1- General requirements engineering methods

2- Requirements Elicitation

3- Requirements Analysis and Validation

4- Requirements Representation

A clarification should be made. The scope of discussion in this chapter is intended to be broadly applicable to general eHealth applications. However, to keep the content manageable and particularly relevant, in the requirement representation section, we narrow down the available breadth to methods particularly relevant to our context of Web-based applications.

2.2 Requirements Engineering Methods

The scope of RE notion and practice has evolved over time. This evolution has been subject to a variety of practice frameworks across the industry. We identified a variety of subjects that we could use as basis to classify and discuss the available approaches. One of the common bases used across the literature is the particular focus of analysis. Using this, we identified three main categories of related approaches:

1. *Goal-oriented approaches* (van Lamsweerde, 2001; Mylopoulos, 2005), in which functional and non-functional requirements of application context/system are analyzed as hierarchies of goals and sub-goals,
2. *Scenario or Object-oritented approaches* (Coad, 1988; Sutcliffe, 2003), in which the application context (or system) is perceived as a set of software objects playing roles in various *scenarios* (Potts, 1995), and
3. *Viewpoint-oriented approaches* (Goldsack and Finkelstein, 1991; Kotonya and Sommerville, 1996; Kuloor and Eberlein, 2003), in which every aspect of an application is discussed in terms of the viewpoints involved in the design decisions.

There were few other RE approaches that did not fit into any of the above categories, nor did they contribute new major aspects to our discussions. We, therefore, did not include them in the discussion.

2.2.1 Goal-oriented Requirements Engineering (GORE)

Goal-oriented requirements engineering provides methods for reducing real-world non-functional goals (quality-related goals or *softgoals*) to functional machine-understandable goals (*goals*) (Mylopoulos, Chung et al., 1999). Goals provide rationales for the design (Mostow, 1985) which can be used as basis further in goal achievement. This includes all the models belonging to the GORE family—such as KAOS (Knowledge Acquisition in automated Specification) (van Lamsweerde, Dardenne et al., 1991), GBRAM (Goal Based Requirements Analysis Method) (Anton, 1996), and Goal-oriented Requirement Language (GRL) (2001). Regardless of the specific technique being applied, in a goal-oriented approach, functional and non-functional goals are linked based on their *types*, *attributes* (e.g., priority, utility), and/or *their temporal behavior* (i.e., how they are *achieved*, *maintained*, *optimized*), producing a *goal hierarchy/taxonomy* (van Lamsweerde, 2001). This model is then formulated into temporal-linear logic models using operators that allow further reasoning (goal *verification* and *validation*) (van Lamsweerde, 2001). In general, goal-based approaches present such a broad terminology and approach that they could potentially be adapted to fit any type and level of application design.

2.2.2 Scenario /Object-oriented Requirements Engineering

S*cenario-based* or *object-oriented* requirements-engineering approaches aim at modeling the real-world components and procedures of the system or application context being studied (Sutcliffe, 2003). Examples include OORA (Coad, 1988), SceneIC (Potts, 1999) and Use-Case Driven Analysis (Regnell, Kimbler et al., 1995). These approaches encompass methods to model the—possibly fuzzy and ad-hoc—happenings of a particular real-world frame generally expressed by related individuals as a story or scenario (in natural language), in order to transform the resulting models into abstract object-oriented models. Such stories (obviously in a more-detailed version) are then used as the basis for extracting *processes*, comprising *actors* (or agents), *objects*, and related *actions* (or *activities*) *,* and *goals* which are further represented as *activity-sequence diagrams* and *use-cases* (Some, 2006). Furthermore, produced use-cases are represented in a *use-case diagram* through languages such as UML (Unified Modeling Language) (www.uml.org) as a machine-understandable form of requirements (Some, 2006). For instance, Sutcliffe (1998), in his paper, demonstrates an example scenario for an ambulance system, in which real world entities (e.g., patient, ambulance, crews) and activities (e.g., treat patient, drive) are converted into a procedure of objects, agents, activities and goals to resemble the required functionalities required. An example method of a scenario-based approach is *socio-technical study* (Sutcliffe, 1998; Astin, Shapiro et al., 2003) during which the stories of social (formal-informal) activities within a system undergo some abstraction until the desirable technical version is produced. Scenario-based approaches are commonly applicable to design environments that involve formal processes and procedures ranging from small organizations to worldwide enterprises.

2.2.3 Viewpoint-based Requirements Engineering

Viewpoint-based approaches are based on the principle that multiple sources of requirements information provides a better understanding of a known issue and thus result in a more correct and complete set of requirements (Leite and Freeman, 1991). These methods emphasize the crucial role of different viewpoints in defining requirements and recognize viewpoint identification as the first fundamental task in the RE process (Kotonya and Sommerville, 1996). Viewpoint is a perspective that "*encapsulates partial knowledge about the application domain, specified in a particular, suitable formal representation, and* *partial knowledge of the process of software development* (Finkelstein, Kramer et al., 1990)*.”* For an online health record, for example, doctors, nurses, management, and developers might have considerably different viewpoints regarding what and how to build.

Earlier approaches of viewpoints, such as what Finkelstein et al. (1990) suggest, used to focus mainly on formal representation of requirements based on several viewpoints defined. However, later approaches have shifted the focus to identification and classification of viewpoints early in requirements elicitation, enriching the set of data to be elicited. For instance, Sommerville et al. (1998) demonstrate a model (so called PREview) in which they identified viewpoints early in the RE process and collected a set of six data elements (name, concerns, focus, source, requirement, and history) for each viewpoint elicited. They also describe a related case study, in which, they found a variety of advantages associated with their approach including early categorization of requirements data, easing the subsequent requirement analysis. Darke and Shanks (1997) suggest a somewhat improved model, called *User Viewpoint Model* of requirements engineering (Figure 2-2), during which a *viewpoint owner* (a particular user with concern) shares her or his *viewpoint knowledge* (e.g., requirements expressions) regarding a particular *viewpoint agent* (the particular role of a user’s area of concern) in a particular *viewpoint domain*. The particular contribution of this model relates to its *viewpoint link* in which a piece of requirement is linked to related expressions of other users. This would associate all the relevant requirements in a semantic network that thus facilitates further categorization and aggregation of requirements expressions. In addition, the model supports the traceability of changes and evolution by keeping a record of changes in viewpoint knowledge.

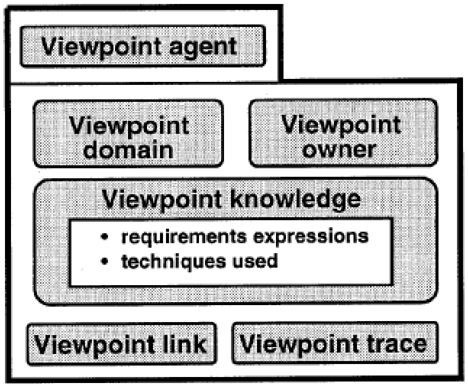

Figure 2-2. Darke and Shanks’ user viewpoint model

There are a number of advantages associated with viewpoint-based approaches. *Inconsistency toleration* is what Menzies et al. considers as key advantage of using viewpoints (Menzies, Easterbrook et al., 1999). Viewpoint-based approaches are specialized to capture variation of perspectives by aggregating multiple layers of requirements representation. In addition, this model particularly supports traceability by enabling tracing from a requirements statement to the original viewpoints supporting that particular statement (traceability will be discussed in 2.4.1.2). Overall, viewpoint-based requirements engineering seems the right choice when variation of perspectives is the focus.

2.2.4 Comparison

Each of the above approaches has its own general and particular implications and limitations. We found goal-based approaches typically idealistic formulations of WHAT the system or application MUST do and HOW IT SHOULD perform (van Lamsweerde and Letier, 2000) rather than WHAT IT IS in reality. We suspect that the latter vision, particularly in the health care system (and services), might ignore the requirements of the transitional phases (from reality to ideal form) and the magnitude of efforts that must be taken to match these two (reality and ideal). In addition, goal-based approaches depend on input from knowledgeable users who know what to expect from applications being designed. However, such input may not reasonably happen when the primary users are ordinary people (as in many eHealth applications) (Rajagopal, Lee et al., 2005). Furthermore, real world applications are often a combination of features and processes. Although goal-based approaches sound like the right choice for choosing the appropriate features, they hardly present methods that could capture and analyze processes and functions.

Scenario-based/object-oriented approaches have others limitations. We found all versions of scenarios, from story sketches on the board to object-oriented models, sequential products of a linear representation process. This means that, assuming the seamlessness of the transformation process, the quality of the result fundamentally depends on the validity and reliability of the primary transcripts of real-world stories. Knowing the transcript-use case transformation process to be often manual (at least in some parts) and the possibilities that stakeholders being interviewed may change their statements from one day to another (Weidenhaupt, Pohl et al., 1998), the reusability of use-cases over-time can be debated. In addition, there are some questions whether scenarios are expected to represent 'real reality,' which is often a 'messy' and 'ad hoc' picture in health care systems (Berg and Toussaint, 2003) or what it should ideally look like. We believe no single picture would be reasonably practical. More detailed comparison of Goal-based and Scenario/object oriented approaches are available in the articles by Misra et al. (2005) and Mylopulos (1999).

Finally, viewpoint-based approaches have their own shortcomings. First, variation of viewpoints is valuable when they can be related to a particular problem (in the application problem domain). However, as Jackson (1994) describes, stakeholders may hold varying problem frames making such viewpoints impossible to aggregate. Second, although inconsistency toleration is an advantage of viewpoint-based approaches, that should not encourage somebody to add as many viewpoints as they desire. Rather, as Menzies et al. (1999) argue, viewpoints of similar classes, such as two doctors with different opinions regarding a particular topic, are better to be merged into one world of viewpoint to condense the complexity of reasoning required to abstract all the viewpoints. Third, viewpoint-based approaches have fair capabilities to model system processes and objects, or to integrate goals into a single goal hierarchy when they are the focus. Thus, such models may not be the preference for the process-intensive and/or goal-intensive application context such as organization information systems or enterprises.

In general, we found that all approaches require compromises and thus cast our vote for no single framework. Despite some terminological differences, and a few particular indications of each, we cannot conclude that the overall results of any to be substantially superior. However, we could draw some conclusions. We would support Mylopoulos et al.'s recommendation (Mylopoulos, Chung et al., 1999) to consider goal-based and object-oriented (or scenario-based) approaches complementary to each other, and thus we recommend the use of the emerging combinatory approaches that blends both in order to address each one's shortcoming (Liu and Yu, 2004; Kim, Kim et al., 2006; Kim, Park et al., 2006). According to the joint approach, goals are set according to the scenarios of reality and thus are expected to be more realistic. Nonetheless, common practice (not necessarily best practice) may suggest scenario-based approaches because of the variety of related use-case tools, object-orientedness, and convenient integration with *extreme programming (XP)* as the modern choice of Web application design (Maurer and Martel, 2002; Xu, Yang et al., 2004; Ankori, 2005). Finally, we would see viewpoint-based approaches to be the right choice for cases when heterogeneity of viewpoints is crucial, when the traceability of requirements to the supporting viewpoints (such as knowledge-intensive environment) is important, and when the application context does not impose many processes or high-level goals.

Overall, the methods are reasonably overlapping. The existing differences can be used to select the exact approaches employed to communicate with the users, to elicit and document their expressions, and to negotiate and validate those as requirements specifications (which will be discussed next).

2.3 Requirements Elicitation

Requirements elicitation consists of two main tasks: Identifying sources of requirements, and choosing way(s) to communicate with sources (and collect data).

2.3.1 Sources of requirements data

Theoretically, "completeness" as a goal in requirements engineering (Zave, 1997), requires inclusion of any sources of requirements, i.e., anybody (i.e., requirements stakeholders) and/or anything (e.g., documents) that is anyhow relevant to the context of the application. However, in practice, such sources should be limited to a few manageable users and documents that are the most relevant. To discuss the sources of requirements, we split requirements data into two categories of *user-defined* requirements (or stakeholders'), and *domain-imposed* requirements (e.g., *constraints*), as suggested by Domges et al. (1996), and discuss varieties of sources for each.

2.3.1.1 User-defined requirements

User-defined requirements, one of the main sources of requirements data (Domges, Jacobs et al., 1996), are expected to bring a user perspective to requirements specification (Lindgaard, Dillon et al., 2006). "User requirements" refers to informal, fuzzy statements of application users that should be converted to formal specifications understandable by all design stakeholders (Sutcliffe, Fickas et al., 2005). A user-study for an eHealth application should identify the range of intended users for the application, the skills they need to effectively use the application (Jokela, 2003; Norman and Skinner, 2006), and their range of preferences for interactions and services (Bush, Wooldridge et al., 1999). Such analysis will help requirements engineers to list the type of services (functional) and their expected quality (non-functional) in the application. Users' needs and wants should be distinguished from user-verbalized requirements, even though both are user-defined. The former refers to individuals' personal needs and desires: the latter refers to any type of requirements elicited from (or expressed by) all context individuals.

To elicit user-defined requirements, a variety of user representatives should be selected and communicated with. This variation should reflect the diversity of the target user population, with a focus on who are affected the most by the application.This variation must also be sufficiently documented in requirements specification. We formulated this need in a question: What variety of representative users and in what quantity should be involved in requirements elicitation?, and what method of elicitation should be used? We address the answer in the following discussion.

2.3.1.1.1 Users' variety

Users (or stakeholders) and user- defined requirements are expected to bring a user perspective to requirements specification (Lindgaard, Dillon et al., 2006). A user-study for an application should identify the range of intended users for the application, a variety of factors that might affect their effective use of the application (Jokela, 2003; Norman and Skinner, 2006), and the users' range of preferences for interactions and services (Bush, Wooldridge et al., 1999). Such analysis will help requirements engineers to list the type of services (functional) and their expected quality (non-functional) in the application.

A broad variety of papers have used the term "user" and "user studies," as the application target individuals (e.g., (Sutcliffe, 2002; Lindgaard, Dillon et al., 2006)), but a very few have provided clarifying definitions. The elucidation seems particularly important when "user-centeredness" or "user involvement" is advocated as advancement associated with improved quality (Clavadetscher, 1998). Several authors (e.g., (Donahue, 2001; Kinzie, Cohn et al., 2002)) have specified the term by defining *end-user* as “the individual who ultimately will use the system developed” (Saiedian and Dale, 2000). In those studies, other relevant individuals are often called “stakeholders.” However, a matter of debate is that such a definition may not distinguish the important role of main users who primarily use the application from several other individuals who will only intermittently interact with the application of concern. For instance, in a context of a campus health information Web site, although the end users apparently will be university students benefiting from the knowledge services, the user studies should also involve the doctors, counselors and nurses (and other staff) who will be interacting with the application for updating and health education purposes.

One level deeper in this discussion is the matter of diversity within the direct user group. Faulkner (Faulkner, 2003) emphasizes the computer skill as a potential basis to group users. He then splits computer skill into users’ general experience with computer and their experience with a particular (type of) application. He suggests three categories (1) *novice/novice* (inexperienced computer users who had never used the application); (2) *expert/ novice* (experienced computer users who had never used the application); and (3) *expert/expert* (experienced computer users who were also experienced with the application). Norman and Skinner (2006) take this further and argue that users’ foundational skills in interactions with eHealth applications may vary in several dimensions. They then suggest two main categories, each encompassing three dimensions (which they call *literacy*): *analytic*, with three dimensions of traditional, media, information, and *context-specific*, with computer, scientific, and health as the related dimensions. They describe the first category as general skills users require to interact with any type of eHealth application, while the skills in the context-specific category are more relevant to the specific problem/content domain of the eHealth application. For instance, while the requirement for a basic level of information literacy—the ability to understand the basic information and knowledge (e.g., how to find, how to use)—is roughly the same in all domains of application, the level of computer skill required to interact with an eHealth application may vary from one application to another (Norman and Skinner, 2006). Kujala et al. expand this even further and argue that there are many other aspects of users’ characteristics that may directly and indirectly affect the user-application interaction and thus should be captured (in RE). In addition, they provide a classification of users' characteristics that consists of eleven subjects in three categories: *personal*, *task-related*, and *social/geographical* (Kujala and Kauppinen, 2004) and propose a framework in which developers (or requirements engineers) use such aspects to match the distribution of users' representatives to the actual (estimated) diversity of the intended users' population.

Furthermore, the matter of variation can also be broadened to include indirect users. Apparently, the requirements of individuals should not be limited only to users directly interacting with an application. Rather, there are various individuals who are relevant to (or involved in) the application/system's context (and their participation is necessary) even though they may not directly interact with the software. For example, Nuseibeh and Easterbrook state that expertise from individuals in the four domains of Cognitive Psychology, Sociology, Anthropology, and Linguistics are beneficial to RE approaches. In our context, such a list can also be expanded to include experts from health education/promotion, public health, and consumer health informatics, whose opinions are crucial to tailor a quality health information service. Furthermore, there are varieties of individuals who neither interact with an application nor hold any related expertise, but can still contribute to the application domain. For example, family members or close friends may provide helpful viewpoints regarding the preferences of a main user they are related to.

Overall, we conclude that the elicitation process should not be restrictively focused on the needs and wants of those who will mainly or directly use the system. Rather, <u>in the breadth aspect</u>, it is desirable that requirements engineers include input from all possible individuals reasonably relevant within the application context, which we classify as:

1- *Primary users* (or *target users*), who will primarily use the application,

2- *Secondary users*, who will partially or periodically interact with the application,

3- *Domain Experts*, who are sources of expertise relevant to the context of design, and

4- *Minor contributors*, who are neither users or experts but may contribute additional valuable viewpoints.

In the depth aspect, the variation depends on the exact context of an application and the type of individuals involved. For instance, university students as users may have no major differences in computer skills or literacy levels that would require in-depth classification. However, a population of health consumers, in general, as targets of a consumer health Web sites, or a population of employees being studied for hospital information systems may require in-depth classification. For instance, health consumers can be grouped based on their education level or age. Employees can also be classified to groups representing the variation of their responsibilities (such as doctors, nurses, and the staff).

To avoid confusion between the commonly accepted terms and what was defined (discussed) above as well as for convenience, in this dissertation we will use "user (or users)" to represent "primary users." We will also use "stakeholders" (defined by Glinz and Wieringa as " *a person or organization who influences a system's requirements or who is impacted by that system* (Glinz and Wieringa, 2007).") to refer to any member of the four user groups unless otherwise specified.

2.3.1.1.2 Sample size

Lawrence (2001) lists "inadequate user representation" as one of the risks of requirements engineering which should be avoided. There is disagreement between research and practice in the optimal number of user representatives to be involved. Kujala and Kauppinen (2004), in their article on different aspects of user-selection in user-centered design, emphasize user-variation as a determining factor in choosing the right sample size. However, they believe that a sample size as small as six could provide *extremely useful information* to support design. They have also reviewed seven case studies of user-centered designs whose sample size was in a range of three to seven. This is consistent with Virzi's finding according to which a sample of four or five participants allows usability practitioners to uncover 80 per cent of a product's usability problems, and the rate of new problem detection by participants steeply declines above this number (i.e., diminishing returns as a function of sample size) (Virzi, 1992). Another example is the Olsson study of active user involvement in which he used only four user representatives

(Olsson, 2004). As a matter of fact, the range of four to six (representative users) has been so popular (in software-related user studies) that Faulkner was motivated to challenge it in his article: *Beyond the five-user assumption: Benefits of increased sample sizes in usability testing*. In this article, Faulkner conducted an experiment in which he divided a sample size of 60 into smaller groups of five and asked each participant to comment on Web-based applications. She found that while one of the small groups was able to find 99 per cent of the problems, another small group found just 50 per cent of the problems. She concludes that a sample size of 20 would be an optimal number and predicts that the subjects can discover 95 per cent of design problems in the interface (Faulkner, 2003).

It is hard to arrive at a conclusion for an appropriate size, if it is ever possible. Earlier in this section, we mentioned that the main prerequisite of representativeness in a scientific approach is the need for variety of user types to reflect the diversity of the actual user population. As far as users are from a population of low diversity (e.g., university students), numbers such as 10-20, as suggested by Faulkner, sounds acceptable. However, we have doubt that such low numbers would reasonably apply to populations of users with high diversity.

2.3.1.1.3 Requirements communication/elicitation methods

The literatures propose or discuss a broad range of methods (and tools) for communication with requirements individuals in order. However, using the *involvement level* as a basis, the methods could be classified into two main categories: approaches that directly engage users (or their representatives) and those that use indirect methods of user studies. This classification is similar to Kotonya and Sommerville’s classification of viewpoints according to which inputs are classified into *direct* and *indirect viewpoints* (Kotonya and Sommerville, 1996). The *direct-involvement* (or active user-involvement) category encompasses all methods of elicitation that involve direct communication with users or their representatives. Direct involvement is recognized as a ”consistent factor of successful application” (Saiedian and Dale, 2000) that best accommodates the idea of user-centeredness. Direct-involvement consists of various brainstorming, interview, questionnaire and other elicitation methods that are used locally or remotely to collect the user-defined requirements. Using a more intensive type of approach (i.e., *participatory* or *collaborative design* (Sherry and Myers, 1998; Go, Takahashi et al., 2000)), a design group consisting of representative designers and users' representatives is established and performs social exchanges to find the common ground in application requirements (Sjöberg and Timpka, 1998). This category is consistent with the *user-participation* category of Iivari and Iivari's classification of *user-centeredness* (Iivari and Iivari, 2006) and is similar to the *co-designer* category in Olsson's spectrum of user-involvement (Olsson, 2004).

On the other hand, *indirect-involvement* (or passive involvement) refers to a variety of approaches during which the RE engineers/developers elicit the related requirements by striving to understand the context through available user studies (e.g., user surveys), user or domain documentation (job and workflow description), and/or *ethnographic observation* (Hughes, O'Brien et al., 1995; Viller and Sommerville, 1999). For example, instead of directly engaging a domain expert (in the application context), the RE engineer could personally collect the associated domain knowledge using related literature and publications and contextualize them to the context of the application (in order to extract the associated requirements). Iivari and Iivari describe *work-centeredness* as an indirect-involvement method, in which employees in a particular application context could be represented as actors in the workflow, and their range of interactions, required tasks and conversation skills are mapped according to what they should be (in reference to documentation of system and job definitions) rather than what and how they actually are. *Ethnography* is specifically suggested for socio-technical studies. It is the ethnography that enables requirements engineers to perceive the application's social context as it is perceived by the context individuals. Ethnography is also specifically used to "reveal the needs or practices 'users' may not be aware of" or what they might be "unable or unlikely to articulate" (Hughes, O'Brien et al., 1995).

In comparing these two categories, we found direct-involvement, while frequently recommended and advocated (Musen, 2002; Iivari and Iivari, 2006), to be very challenging. The first challenge can be described as the impracticality of active user involvement due to users' difficulties in verbalizing their preferences or habits when performing information tasks, or users' lack of sufficient knowledge in providing suggestions for improvement of an application's quality (Friedman and Wyatt, 1996). This has not only been considered to be one of the three main challenges of requirements elicitation (Rajagopal, Lee et al., 2005), but also has been identified by Musen as one of the major difficulties in gaining common ground in health-information systems (Musen, 2002). Furthermore, direct-involvement is often found to be less practical or efficient by developers. Vredenburg et al. surveyed professionals and found that even with those claiming to practice user-centered design, the reported practice of direct-involvement was very infrequent (Vredenburg, Mao et al., 2002). In addition, Iivari and Iivari cite several studies showing how this approach has been adopted much less often than the other method and is generally replaced by surrogate users (indirect methods) or used very limitedly. Saiedian et al. (2000) lists a variety of user types of resistance in which users may not be willing or be able to cooperate. We also found very few articles describing practices of user participation that presented a usable framework within their development process like that described by Olsson (2004), (Newman and Landay, 2000), and (Sjöberg and Timpka, 1998). Finally, several traditional methods of elicitation (e.g., brainstorming, focus group, etc.) seem impractical when access to users is limited - as in applications with a wide range of audience (e.g., Web-based applications) (Tuunanen and Rossi, 2004; Belani, Pripuzic et al., 2005).

We discovered some potential solutions. Some authors suggest a variety of ways to make direct involvement easier and more efficient. For example, Kujala et al. suggest utilizing lead users (more experienced/knowledgeable users) who are five-times more efficient than ordinary users (Kujala and Kauppinen, 2004). Therefore, it seems that using lead users may not only complement the (ordinary) users' lack of sufficient knowledge but also addresses the low efficiency of the interaction with users. In addition, recent elicitation technologies such as computer/Web-based or automated requirements elicitation methods as potential solutions seem promising. In a case study, Belani et al. (2005) report how automated Web-based surveys could replace paper-based surveys with a variety of benefits. They found Web-surveys helpful in enhancing the reliability of the responses (by avoiding missing or duplicate answers) and in handling the quantitative analysis afterward.

Furthermore, a second generation of solutions seems to be the models that advocate a combination of direct and indirect-involvement models. The Prosumer (Producer + Consumer) model of participatory design by Goodman et al. (Goodman, Jimison et al.,

2002) is a prominent example. According to Prosumer model, the requirements elicited from literature and interviews with professionals are used as a primary basis of requirements knowledge and are tailored over time with the inputs from the primary users. We specifically liked this model as it first, introduces a broad spectrum of requirements that may not possibly be achieved by communicating only with few user representatives. Second, it allows accommodation of multiple viewpoints in a particular order, so that the professionals' viewpoints are negotiated with the consumers in a WinWin-like approach (WinWin approached will be discussed later in Section 2.4.2) until satisfaction is achieved.

2.3.2 Domain-imposed requirements

Domain-imposed requirements, as one of the two main types of requirements data in NATURE's framework (NATURE: Novel Approaches to Theories Underlying Requirements Engineering), are described by Jackson (1994) as "facts of nature, including the social, organizational, and technical context, which have to be satisfied for a system to work." The concept is also in reasonable harmony with *system specification* or *development requirements* in other literature (Domges, Jacobs et al., 1996; Tuunanen and Rossi, 2004; Belani, Pripuzic et al., 2005; Rajagopal, Lee et al., 2005) in which more specific deterministic requirements of design are defined.

We found a broad variety of domain-imposed requirements ranging from the ones that contribute to the application's usability and interoperability (e.g., terminology) to policies or standards required by the government or other authorities regarding security, privacy, ergonomics, and quality of care, among others. As domain-imposed requirements are predominantly constraints of design specification, we have to compromise our intention of keeping the discussion broad and use specific examples.

We identified *content* and *interface language/terminology* as a constraint subject for the eHealth context. This subject refers to the terminology being chosen, which ranges from industry-supplied vocabularies, to special purpose developments compiled to cover the included content. Some relevant examples of the former (industry-available) were MeSH (http://www.nlm.nih.gov/mesh/) and UMLS (umlsinfo.nlm.nih.gov) by the National Library of Medicine, SNOMED (www.snomed.org) by the UK National Health Service, and GALEN from the European Community. Although the Web-based nature of eHealth application may require wide-audience usability, there is little doubt that requirements engineers may prefer the universally adopted terminologies. Hence, we found this choice fairly challenging. One challenge is that these vocabularies are primarily based upon the terms and concepts used in the professional/academic realm, and thus are ideal for eHealth applications that have health professionals as the intended users. However, in designing eHealth applications that include health consumers (lay people) as the primary user, developers must take into account a variety of mismatches (e.g., lexical, semantic, and explanatory) between consumers and professional terminology (Zeng and Tse, 2006). This problem has been approached in two major ways. First, a variety of attempts have been made to compose consumer-health vocabularies (Crowell, Zeng et al., 2005; Ownby, 2005; Zeng and Tse, 2006) that contain consumer equivalents for common biomedical concepts used by clinicians have been made. For instance, Personal Health Terminology (PHT) by Intelligent Medical Objects (http://www2.e-imo.com) is a consumer vocabulary that cross-maps 11,000 "patient-friendly" synonyms for each ICD-9 code to other standard vocabularies (e.g., SNOMED CT and UMLS) (Zielstorff, 2003). Second are the solutions based on bridging common consumer health expressions and professional concepts (Zeng and Tse, 2006) using a mediated-search engine (through a terminology server) or query assistants that allow consumers to directly query quality health information based on professional terminology (Cole, Kanter et al., 2004; Soergel, Tse et al., 2004). A relevant example is the GIN search engine (Gobel, Andreatta et al., 2001) by the GIN Austria project, a vector model search-engine approach that lets consumers build their own query consisting of MeSH Main Headings. A third approach has been to provide bi-directional online translation services between the professional terminology and their consumer equivalents that improve consumers' overall access to professional health content (Zielstorff, 2003). A second challenge we identified is the right choice of terminology for the content when main-users are broadly segmented. A relevant instance could be designing a single interface for both professionals and consumers (Carruthers and Jeacocke, 2000). In this case, a variety of factors including the distribution of users and the application goal should be considered to fairly encompass the asymmetry.

Moreover, when health information services are the focus of application services, design requirements regarding the quality of content (e.g., the proof and trust) that will be provided to users should be specified. These requirements are expected to specify the choice of internal and external resource quality controls over content. For instance, HONcode, maintained by The Health on the Net Foundation (http://www.hon.ch/), is an example of an external accreditation standard consisting of eight quality principles of eHealth content (e.g., authority, confidentiality, etc.) whose compliance is examined by a HON specialist. Also HIDDEL (www.medcircle.org/metadata/hiddel.php) is another vocabulary concerned with attributes of quality in health resources and consists of more than 300 elements in three to four levels (of classes and subclasses). In contrast, there are paper-based guidelines, such as the *e-Health Code of Ethics* (2000) by the Internet Healthcare Coalition (http://www.ihealthcoalition.org/), containing instructions for developers on ethics principles whose concepts can be internally incorporated throughout the development process to ensure the appropriate quality. Finally, we found a broad set of other constraints which are generally required by appropriate authorities or laws (local, federal, international) such as the requirements for security, privacy, and ergonomics, the details of which are beyond the scope of this paper.

To conclude, domain-imposed requirements can best be described as normative domain specific requirements of application consisting of what SHOULD be (suggested standards and methods of best practices) and what MUST be (constraints by law). Such requirements are often expected to be suggested by domain experts being consulted during requirements elicitation. However, one should not confuse these requirements with ad-hoc user-defined requirements stated by domain experts, which only represent their particular viewpoints regarding the specific context.

2.4 Requirements Analysis (Documentation, Negotiation, and Validation)

The goal of this step is to identify areas of agreements between requirements stakeholders. Nuseibeh and Easterbrook (2000) emphasize that the conversion of requirements data from informal expressions into explicit statements is a vital necessity to any requirements resolution validation. For informal and fuzzy requirements data to become formal, precise, and valid requirements specifications several transformation steps should be taken. Domges et al. identify three steps in the transformation (Domges, Jacobs et al., 1996):

1- *Conceptual modeling*, in which requirements data are converted to formal and informal notations,

2- *Process modeling*, during which activities are transformed into methodological guidance of system activities, and

3- *Communication and representation of requirements*, in which different views are shared among stakeholders to achieve final agreement and to specify the final requirements.

This scheme is in fair harmony with Potts' scheme of requirement analysis. Potts (2006) looks at requirements engineering as a problem-solving activity, during which supposedly "correct requirements" are elicited (within the elicitation phase), formally analyzed and corrected, and transformed into "*languages nearer to implementation concerns*." In particular, Mylopoulos et al. (Mylopoulos, Chung et al., 1999; Mylopoulos, 2005) describe the above transformation and analysis activity as a conversion process from non-functional requirements (soft goals) stated by requirements stakeholders to functional implementable requirements (goals) that could lead a design. Overall, requirements analysis activities can be described as a process in which requirements data of all types (video, audio, brainstorming, etc) are transformed into explicit requirements notations/statements (and process models if the context involves process) which will be analyzed for area of agreement and conflicts. Finally, conflicts are resolved through various approaches and areas of agreements are documented as requirements specifications. Figure 2-3 briefly illustrates the three steps explained.

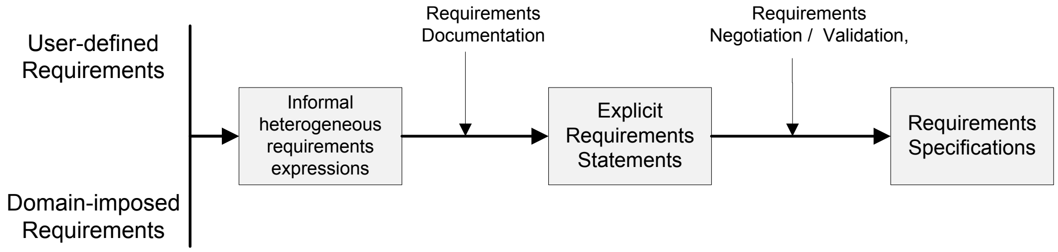

Figure 2-3. A summary scheme for requirement analysis

2.4.1 Requirements Documentation

For informal requirements expressions of the requirements stakeholders to become analyzable, they have to be initially converted into explicit statements/notations of requirements and classified into explicit categories. Nuseibeh and Easterbrook (Nuseibeh and Easterbrook, 2000) emphasize explication of requirements expressions as a prerequisite to any identification attempts of coherence, consistency, and domains of conflicts and incompleteness.

Studies have discussed various aspects of conversion and classification issues. Kotonya and Sommerville (Kotonya and Sommerville, 1996) refer to natural language ambiguity and its old known issues as a challenge of requirements transformation. They also point to the mismatch between requirements engineer(s) and stakeholders in their familiarity with the problem domain, which in many requirements engineering projects has resulted in misunderstanding of users' viewpoints. In a similar viewpoint, Potts (2006) relates the transformation issues partly to the linguistic matters in which the meanings intended by stakeholders are transformed into formal statements and specifications, which are only assumed to hold optative truth regarding the actual desires of their original expressers. He believes that such formalization downgrades the quality of inter-subjective meaning communication through abstraction, from a philosophical point of view. In addition, he cites some practices of requirements engineering and argues that prioritization or categorization of requirements, as part of requirements aggregation, adds additional tags into the requirements statements which were not stated by the original stakeholders consulted. Finaly, Nuseibeh and Easterbrook emphasize Kuhn's warning (Kuhn, 1962) regarding the growing domination of theory-driven approaches. They believe that the current requirements specifications are often selectively (or subjectively) validated by requirements engineers according to some principles instead of being based on stakeholder's actual needs (Nuseibeh and Easterbrook, 2000).

Several resolution strategies have been suggested to deal with the above transformation (and classification) issues. The standard card sorting method (Barrett and Edwards, 1995) is one of the common methods adopted by several studies to improve requirements classification. For example, Maiden and Hare (1998), demonstrate a requirements elicitation process during which the stakeholders (instead of requirements engineer) categorize their own requirements viewpoints. In this approach, the stakeholders (at least partially) replace the requirements engineers in the process of formalization and thus lower the chance of false classifications. They believe that such an approach would result in reusable requirements statements that can be stored in requirements libraries for further reuse. However, as Nurmaliani et al. (Nurmuliani, Zowghi et al., 2004) discuss, a successful card sorting requires the participants to be familiar with the domain terminology and classes. Otherwise, the resulting categories will be too dispersed. Another solution is Pohl's pathway of *pre-traceability* (Pohl, 1996). In this approach, the pathway from the original statements to the transformed statements becomes transparent and traceable. Pohl, in his original study (Pohl, Assenova et al., 1994), cites the notion of requirements traceability suggested by other authors (Gotel and Finkelstein, 1994; Ramesh, Powers et al., 1995) and uses their classification of traceability types as: *pre-traceability*, which is concerned with the path from requirements to their origins, and *post-traceability,* which concerns the interrelations of requirements and the following implementation (as illustrated in Figure 2-4). Pohl et al. believe that a traceable set of requirements knowledge could isolate the requirements engineers' viewpoints from stakeholders during his management of inconsistency, incompleteness, and abstraction, while allowing further formalization and revision of requirements decisions. They also believe that a trace repository, containing the traceable knowledge requirements, could enable requirements reuse in further design of the same or similar products.

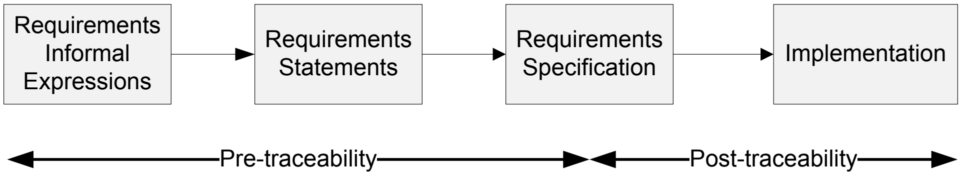

Figure 2-4. Suggested scheme of pre and post traceability (based on (Pohl, Assenova et al., 1994))

2.4.2 Requirements Negotiation and Validation

Documented requirements statements should be examined for areas of conflicts and inconsistencies. Conflict is part of requirements' nature (Mylopoulos, Chung et al., 1999) compelling requirements engineers to incorporate a sound conflict analysis strategy. Several aspects of conflict have been discussed across the literature. However, before addressing conflict management, a requirements engineer should initially examine the conflicts' validity. Statement conflicts may not always represent a valid conflict of users' needs and wants. Requirements engineers may misinterpret or misunderstand the users' expressions because of insufficient domain knowledge, or the formalization or abstraction processes may involve linguistic issues (as discussed in transformation section). Another possibility is that requirements may be elicited at different times and may have evolved over time. In this case, statements may falsely represent contradicting wants expressed in different periods (requirements change will be discussed in 2.4.4).

Obviously, when there is a valid discrepancy of requirement viewpoints, it is not a solution to select one and consider the others as wrong. Rather, reasoning/resolution methods should be employed to either encourage the stakeholders to arrive at an agreement or to find abstract areas of agreement representing comparably better (more feasible, usable, useful) requirements.

2.4.2.1 WinWin strategy

We found the WinWin strategy (Boehm, Bose et al., 1994) one of the most common requirements resolutions strategies across the literature. According to this approach, a spiral model is followed during which 1- stakeholders and their win conditions are recognized, and 2- win conditions of all stakeholders are aggregated in such a way that win-lose or lose-lose conditions are confronted (discarded as much as possible) and negotiated with the stakeholders for new collaborative win conditions. Bose (1995) considers WinWin a decision rationale model in which *win conditions* of stakeholders are sorted around a particular *issue* as *options* and reasoned to identify the areas of *agreement* (italic words are four components of the WinWin model). In et al. (2002) has furthered Boehm's model and suggest a more sophisticated one in which alternative win conditions are weighted by the stakeholders and negotiated using a multiple-criteria approach. In this model, ranks for various preferences of requirements are calculated and compared to a scale of dictatorial (a preference of one person) to democratic (most votes win) and lead to the final decision. In contrast, Gruenbacher (2000) claims an easier approach (as compared to Boehm's) which he calls EasyWinWin. The main difference in Gruenbacher's approach is that a domain taxonomy is used as a basis and tailored to the needs of the stakeholders according to their verbalized win-conditions (the opposite of the traditional models).

2.4.2.2 Reasoning

Reasoning between contradicting requirements is a more complicated task. Menzies et al. (1999) compare the use of logical deductive and abductive reasoning in resolving viewpoint contradictions. In general, we use deductive reasoning to make conclusions based on some supporting viewpoints/reasons. For instance, if some users like a particular application feature (e.g., a search box) and some others have neutral opinions regarding that feature, a conclusion could be made in favor of the inclusion. However, a major limitation of deductive logic, as Mensies et al. emphasize, is that it cannot resolve contradictions/conflicts. For instance, when the users' opinions are totally diverge regarding the inclusion of a feature, deduction may not help. In such cases, we may use abductive reasoning to make inferences, explanations, or reasons that are likely to be related with a fact. For example, we can use abduction to analyze the reasons why a particular user prefer the inclusion of a specific feature and compare the strength of such reasons across all users. Menzies et al. show how contradictions that are irresolvable using deductive approaches can be addressed through an abduction approach. According to their approach, every viewpoint in a contradiction exists in a different world (of context). Each world represents a set of goals defined by a viewpoint including the related proofs and explanations, which if each (proof or goal) is given a score, the related world around each viewpoint can be given a comparable total score. Then, this score can be used to select the more evidential viewpoint. Sommerville et al. (1998) provide a somewhat similar requirements resolution approach according to which each viewpoint is elicited accompanied with a set of additional data fields (concerns, focus, sources, etc.) and are aggregated based on each of those factors. Using the approach by Sommerville et al., one can calculate the intensity of requirements regarding a particular concern or focus and select the most frequent, justified, or explained requirement. We particularly liked Gonzales-Baixauli et al's *visual variability analysis* model. (Gonzales-Baixauli, Prado Leite et al., 2004). According to their models, various viewpoints are clustered based on their similarity of goals and their momentum toward some common goals are calculated using an explicit five-level scale of -2 (strongly opposing) to +2 (strongly supporting). Using this approach, they demonstrate how they could measure the overall momentum toward various high level goals in a visual traceable way.

The conflicts can also be resolved on a meta-level. Jackson (1995) relates the issue of conflict to the divergence of the stakeholders' perspectives (in meta level) on the problem domain, which he calls "problem frames." According to "problem frames," if the stakeholders do not agree in their problem frames, it is unlikely that they will ever agree on the requirements details pertaining to that frame. Therefore, agreement should be sought at a higher level (or meta- level). Leite and Freeman (1991) suggest a method of viewpoint analysis during which heuristics supporting various viewpoints are compared to identify meta-level agreement between stakeholders. In addition, van Lamsweerde et al. (1998) suggest a conflict management model (as part of the KAOS tool) according to which goals of various stakeholders are enriched with HOW and WHY questions and analyzed for patterns of divergence (in a meta level). Then, the areas of agreement are identified.

2.4.3 Requirements evolution

It is unrealistic to believe that requirements captured will be ever stable (Kotonya and Sommerville, 1996). The fact that "user needs evolve over time" is not a new issue (Brooks, 1987) and many other dynamic factors in the application context also evolve. Therefore, one-time requirements engineering is nonsensical. We identified three main reasons for such volatility. First is an effect related to the *learning curve* (Huey-Ing and Min-Num, 2005) according to which users' knowledge about the application and its capabilities and limitations is evolving over time until it reaches a plateau. During this period, new knowledge may induce new needs and wants (expressed by users)(Nanda and Madhavji, 2002; Rajagopal, Lee et al., 2005). Second, the application environment normally changes over time (with varying intensity) affecting the temporal validity of the requirements specification. For instance, Nanda et al. in their study of environmental effects on requirements change reported that the users' response to a particular question fell from Extremely High' to 'Slightly Low' within two years (Nanda and Madhavji, 2002). Another study shows a daily-varying pattern of users' statements (Weidenhaupt, Pohl et al., 1998). And finally, early requirements engineering (before the first prototype) is primarily based on some early perceptions and presumptions by all context individuals, including the developers, about the application being designed. However, once the application (or its prototype) is produced, it may induce not only a new round of thoughts and comments based on the actual application functionalities but also disclose users' interaction problems with the application, though the overall number of new problems falls over time (Hornbaek, 2006).

Various solutions across the literature discuss ways to deal with new requirements. However, almost all have two suggestions in common. Requirements engineering should be iterative (to elicit and analyze the new requirements), and adopted software design should be responsive to required changes. Sommerville et al. (1998) believe that the process of requirements specification must be seen as a long-term process and thus must be tolerant of temporary incompleteness. In other word, it should be possible to add new changes without need to rebuild an entire set of requirements. Ramzan and Ekram discuss the fact that the main decision in requirements change is the judgment whether or not to respond to a new requirement (Ramzan and Ikram, 2005). Nanda et al. (2002), reporting the lessons learned during their design attempt, mention that due to non-predictability of the evolving requirements, an *adaptive maintenance* approach should be adopted during which new requirements are analyzed, matured, and incorporated in the application being designed. Iivari and Iivari suggest *system personalization* during which an adaptable application is initially created and further adapted over time (Iivari and Iivari, 2006) to fit evolving needs. In addition, several studies demonstrate similar approaches in which the adaptation process is for the most part partially to fully automated by including machine-learning components processing input knowledge (Jimison, Pavel et al., 2003; Xu, Yang et al., 2004; Ankori, 2005).

We found various challenges and drawbacks associated with the above approaches. A main conceptual challenge concerns the idea of making applications flexible enough to respond to a variety of personalization directions (Kuhn and Giuse, 2001). In our exploration of literature, we found the actual case reports of adaptation were generally limited: first, to modern application design models (such as extreme programming) whose approaches are primarily built to be flexible and responsive; second, to functional requirements which are generally transparent and objective; and third, to main-users who are only one of the several sources of requests for change. In addition, most of the solutions for requirement change management are based on direct-user involvement with all its limitations as discussed above. We could not find a single prominent example showing how continuous relationship with users could be maintained throughout the usually lengthy design processes. Overall, building in flexibility is always desirable. However, as Saiedian and Dale mention, “It would be better to avoid the need for such changes altogether. And that is where an effective requirements elicitation strategy comes to play (Saiedian and Dale, 2000).”

2.5 Representing requirements knowledge

There is a wide variety of knowledge representation languages with varying capabilities regarding requirements representation. We limit our discussion to Web-based description languages (versus non-Web description languages), based on *metadata*. We have two rationales for this. First, such languages are specifically designed to (but not limited to) describe Web-based resources and services. Second, they support universal interoperability, which is one of the four dimensions of requirements engineering we seek in this dissertation.

To substantiate our choice of language, we first describe what we expect from a representation language. Then we define our scope of metadata, and review and compare the available variety of the major related languages to arrive at a decision.

2.5.1 A traceable representation of requirements knowledge

As described in Chapter 2, an appropriate knowledge representation should allow traceability of requirements knowledge from the informal expressions of stakeholders to requirements specifications. More particularly, a representation language should allow tracing back from any requirements specified (Level 4) to the formal (Level 3) and informal expressions (Level 2) supporting such requirements, and even the exact stakeholder(s)' (Level 1) verbalizing (or document containing) such expressions, as shown in Figure 2-5.

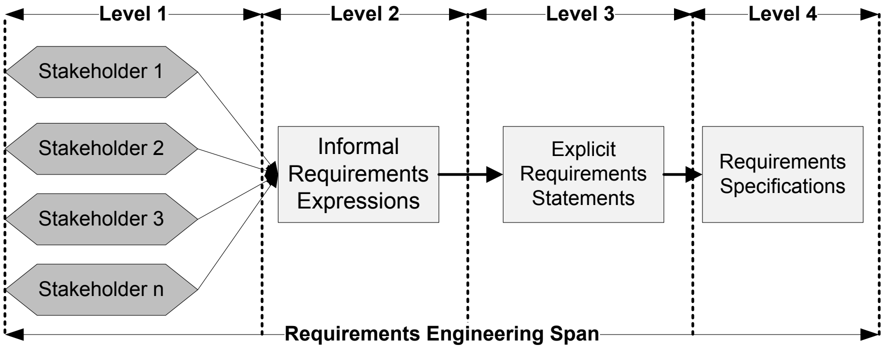

Figure 2-5. Levels of requirements knowledge in a standard requirements engineering process

This would require the language to support a wealth of association capabilities to help us both aggregate the requirements elicited and associate them with the requirements specified as a valid representation of all stakeholders' needs for knowledge. For example, if we specified a piece of information/knowledge such as Author's Name as a required piece of information for a quality health information Web page, we should also be able to show who (e.g., consumers, doctors, nurses) were in support of this, and under what expressions, and at what rate of agreement. In other word, the right representation language should support this path of rationale and the related analysis.

2.5.2 Metadata

The idea of Web metadata was first introduced during the initiatives aiming at establishment of the *Semantic Web*, with the introduction of the first content markup language—XML (extensible markup language)—in the mid-1990s. *Semantic Web* (SW), or a universal network of information/knowledge interconnected through its semantic relationship (rather than current physical IP (Internet Protocol) address) was the foundational goal in creating the World Wide Web (Berners-Lee, 1998). XML enabled using *metadata* with which one could describe the semantics of every piece of information shared universally.

Tim Berners Lee, the founder of World Wide Web, defines *metadata* as "*machine-understandable data about data*" (Berners-Lee, 1997), which is expanded by the American National Standard Institute (ANSI) as "*Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource* (ANSI, 2004)." For instance, if we consider a health Web page as a Web resource, the information regarding the author or the date of the updating is an instance of metadata for that resource. Metadata (such as author or update information) can be provided by the original provider of a resource or by a third party describing the resource (such as cataloging and content rating). This dissertation is concerned with the second type, in which the knowledge content of a quality Web resource is externally described (by various viewpoints) and specified using metadata-based description languages. Here, we review and compare RDF (resource description framework) and Topic Map as two of the most common metadata-based description languages on the Web. Both of these languages are based on XML.

2.5.3 RDF: Metadata-based Language of description

RDF (Resource Description Framework- http://www.w3.org/RDF/), introduced in the late nineties, allowed Web developers to associate semantic descriptions with their data object through their *Uniform Resource Identifier* (URI) (Berners-Lee, 1996). This capability provided a metadata framework to annotate (or to assert) any Web resources located at any URIs worldwide. To clarify URI, the accessibility of online information is made possible through their URI attributes, which is a general name for all Web identifiers that could locate an item on the WWW, including URL (Uniform Resource Locator -- commonly known as Web address). This accessible information (information objects, documents, or services) is called Web resources. Although RDF is originally designed to describe Web resources (with URI), as a knowledge representation language it can potentially describe any "thing" in the world.

RDF is a formal knowledge representation language based on formal logic and mathematical graph theory that is aimed at providing a machine-understandable version of knowledge (Pepper, 2002). RDF is based on a simple description-association architecture, called *RDF triple* (W3C, 2004). RDF triple is a Web resource that is associated with a description. This way of description is similar to the predicate statement used in a knowledge-representation language such as description logics (Horrocks, Patel-Schneider et al., 2003), which consists of a subject, predicate (property or element) and object (or value). For instance, a resource (a health Web guideline on STD) posted on a particular URI (for example, `www.campus-hits.ca/std`) has been given the following description:

www.campus-hits.ca/std (Subject) is an instance of (Predicate) consumer health guideline (Object)

The three components of the above requirement statement can be represented in a Graph Data model (W3C, 2004) using *nodes* (subjects and objects) and *arcs* (property) (See Figure 2-6). These two nodes and one arc constitute an RDF triple.

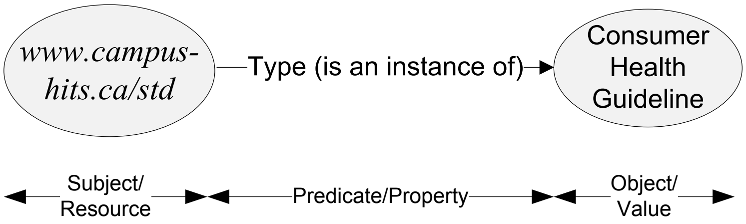

Figure 2-6. RDF Triple describing a resource located at www.campus-hits.ca/std

The above RDF triple about the resource can be represented in markup language, as below:

```
<rdf:Description
```

```
 rdf:about==“http:// www.campus-hits.ca/std”>
  <rdf:type>ch-guideline</rdf:type>
</rdf:Description>
```

In the above example, the health information resource is only described using one element, telling consumers only that it is a consumer health guideline. However, to examine its relevance or quality, a consumer might like to know, e.g., what it is about, who the provider is, and how current it is. To answer these questions, we need three more elements to describe the resource, making altogether a network of RDFs associated to the resource being described (Figure 2-7).

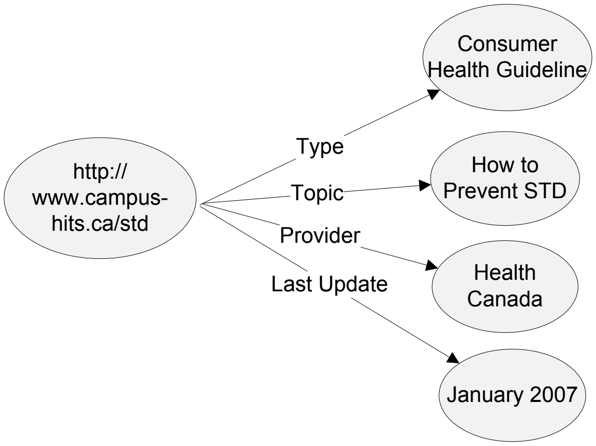

Figure 2-7. Network of four RDF graphs (triples) associated with our example resource

The above graph is represented in RDF markup language as,

```
<rdf:Description
 rdf:about==“http:// www.campus-hits.ca/std”>
  <TD:type>ch-guideline</rdf:type>
  <TD:topic>How to Prevent STD</rdf:topic>
  <TD:provider>Health Canada</rdf:provider>
  <TD:lastUpdate>Jan2007</rdf:lastUpdate>
</rdf:Description>
```

RDF allows us to simply describe any resource worldwide. For instance, we can use the above four elements to describe and index all the health information resources worldwide and store them in a Web directory or a health search engine database. Then, the four elements can be used by a health consumer to retrieve “the Web resources that are categorized only as consumer health guideline, AND are about How to Prevent STD, AND provided by Health Canada AND written after 2005."

However, to enable such worldwide usability, one should initially define a concrete set of elements and inform everybody worldwide, including all the automated knowledge acquisition applications, about the variation of elements (and terminology) he or she has used. Such a definition, for instance, should clarify the meaning of "provider" as compared to "author" or "creator" and must be accessible worldwide. To address this issue, the World Wide Web Consortium (W3C at www.w3c.org) suggested *RDF schema* (RDFS) (http://www.w3.org/TR/rdf-schema/) to be used jointly with RDF. RDF schema is a vocabulary-description language that allows us to define a hierarchy of possible elements (including classes and subclasses, properties and the range of appropriate values) that could be used in the associated RDFs to describe a resource. RDFS uses *XML namespace* (xlns) syntax to define the element set in a markup language. XML Namespace (or *qualified name*) provides uniqueness to the names of a property, class (or others) being used to describe a resource by associating them with a unique URI. For example, in Table 2-1, we have written an RDFS code defining the two elements of Provider and Update that we used in the previous code, with the namespace of TD (stands for This Dissertation). Using this code, which is posted at the address shown in the code, we have defined, e.g., the provider element as "whoever owns and or responsible for the content" and as an entity that can be a "person" or an "organization."

Table 2-1. An example RDF schema defining two elements of Provider and update

```
<?xml version="1.0"?>
   <rdf:RDF xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
            xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
            xmlns:TD="http://www.mtara.com/2007/05/rdf-schema#">

   <rdfs:Property TD:ID="Provider">
      <rdfs:comment>whoever owns and or responsible for the content
     </rdfs:comment>
      <rdfs:domain rdf:resource="#person"/>
      <rdfs:domain rdf:resource="#organization"/>
   </rdfs:Property>

   <rdfs:Property TD:ID="update">
      <rdfs:comment>the date a resource was last updated </rdfs:comment>
      <rdfs:domain rdf:resource="#resource dates"/>
      <rdfs:domain rdf:resource="#maintenance info"/>
    </rdfs:Property>

   </rdf:RDF>
```

RDF and its schema (RDFS) have two technical limitations that affect their usability as requirements representation language:

1- *RDF triples are binary representatives of relationship* (Pepper, 2002), meaning that they are specifically designed to represent machine-understandable explicit and simple statements. For example, they can describe a quality knowledge content with statements such as “`Quality knowledge content (subject) contains (predicate) Author’s Name (object)`.” However, as emphasized earlier (in section 3.7.1), we seek a requirements specification that present the n-ary relationships behind every requirement specified. As demonstrated in Figure 2-8, for the above requirement statement to become rational, it should be associated with information such as, WHO(s) supports this, WHEN they expressed their support, and WHAT they actually said and under WHAT context. In addition, it should differentiate the supporting (shown with plus sign) from opposing expressions (shown with minus sign) and also the neutrals (not shown in the scheme) which is related to information in Level 2 and 3. In addition, if we say “Tom said such and such,” then one may wonder WHO Tom is, and whether he is a consumer or professional, which are the information related to Level 1. Unfortunately, such n-ary sophistication of knowledge representation is considerably limited in RDF (but not impossible).

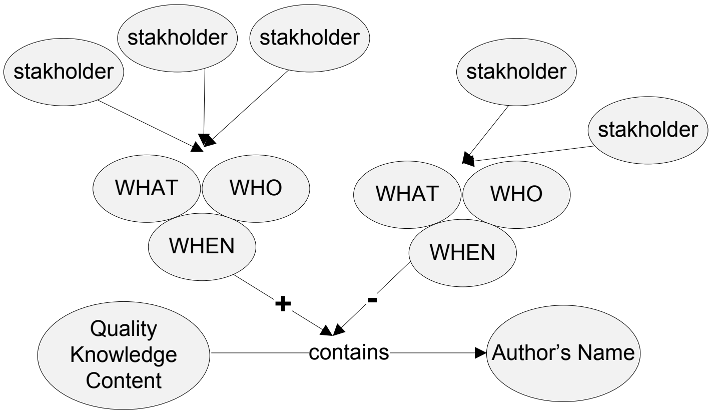

Figure 2-8. An example n-ary relationship behind a requirement specification

2- *RDF is resource-oriented* (Pepper, 2002). In RDF, it is assumed that there exists a resource that needed to be described. As a matter of fact, this is the flip side of what actually happens during the requirement specification process. We normally begin an RE process with informal, ad-hoc requirements expressions, such as the ones listed in Table 2-2. Such expressions (from fictive consumers (#1-3) and professionals (#4)), have to be transformed into formal statements with clear categories. For instance, expression #1 can be converted into “I neither like nor dislike author’s name in a Web page” and associated with content element “Author’s Name.” Also, Expression #2 can be converted into three statements of “quality content must contain provider information,” “Provider Information can be presented by logo,”, and “Logo should be placed on the upper left,” and then all would be associated with element “Provider information.” Using this direction of requirements representation, which is the actual direction, such above examples of requirements expressions are eventually converted, associated and aggregated until structured Level 4 knowledge is achieved. This capability of mapping ad-hoc knowledge with no initial structure is conspicuously absent in RDF.

Table 2-2. Example requirement expressions of Level 2 knowledge

1- "*I don't care who wrote the guideline.*"
2- "*ASHA Web site is just incredible; they have cool pictures for everything.*"
3- "*I just like the new content, not the oldish one*."
4- "*Place the Logo on the upper left.*"

2.5.4 The Use of Topic Map to Complement RDF

Topic Map (ISO/IEC 13250) is a description language focused on the findability/indexing attributes of knowledge. Despite many similarities, RDF and Topic Map have a few fundamental differences. The Topic Map model has its roots in semantic networks and conceptual graphs (Sowa, 1984) in which every concept is linked with every concept in a network. For instance, Figure 2-9 shows a conceptual graph representing two statements about Adam: "Adam works for university" and "Adam lives in Victoria." As apparent in the graph, the RDF triple of two nodes and one arc has turned into three nodes, meaning that (despite RDF in which association were simple predicates) associations are represented in nodes, which are called *topics*. This particular property of Topic Maps allows associations to be re-associated with other topics such as the persons supporting the association or the date it was made.

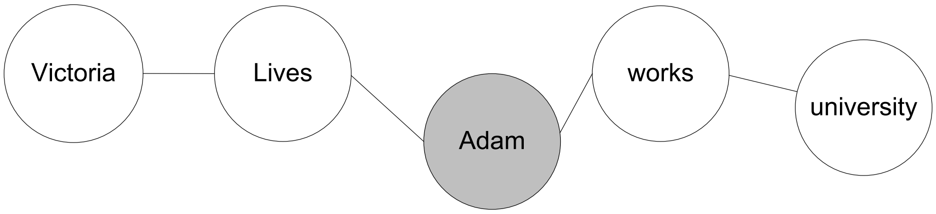

Figure 2-9. A conceptual graph describing Adam as a topic

The Topic Map model is based on three basic concepts (Biezunski, Newcomb et al., 2001): *Topics* that are interconnected through *associations* and their *occurrences* in the knowledge domain of concern. *Topic* is defined as:

> "*A* ***topic****, in its most generic sense, can be any "thing" whatsoever — a person, an entity, a concept, really* *anything* *— regardless of whether it exists or has any other specific characteristics, about which anything whatsoever may be asserted by any means whatsoever* (Pepper, 2000)."

Topics are linked to other topics through *association*, which are also topics. Occurrence is a piece of referable evidence regarding a topic or association. For instance, the topic Adam can be linked to his university home page as evidence of him working for a university. Topics can also have (one or more) *types,* which describe the category of the topic we are talking about, or an *instance-class* relationship. For instance, Adam, in the above context, is a type of person. In addition, when a topic links two other topics (e.g., works for Adam and university), it plays an *association role*, which describes the type of relationship. For instance, in the above example, "lives" plays an association role of "person-workplace." Furthermore, topics can have various *base names* in different contexts. For instance, "Adam" might have a nickname of "Eddie" among his friends, and "Ad" at home. A particular combination of topic type, base name, and association role(s) used to describe a specific association is considered as the *scope* of the topics/associations. A topic can have *attributes* that act like metadata regarding the topic. Those metadata are the ones not worth being a separate topic, for example, Adam's birthday or the date the association statement regarding him working has been mentioned (because he might be working only in that particular period). Finally, topics have a *subject identity*, which is an addressable information resource that makes a topic a unique entity (such as a URL).

To explain Topic Map better, we offer an example related to our particular context. Suppose that we are conducting a requirements engineering process during which we would like to aggregate the viewpoints regarding the concept of "quality health knowledge content" and possible criteria to identify such content aggregated from academic literature. Using the Topic Map model, we consider "quality health knowledge content" as a topic, and associate it with the concepts it relates to (quality, health, knowledge, content). If we consider the resource space, the domain of research literature, then using Topic Maps we can associate all the concepts discussed across the literature in relation to "quality health knowledge content" (Figure 2-10). In addition, we have linked "Author's Credentials" as a topic, which is in association with "quality health knowledge content" with "criteria" playing an association role between them. This association (which can be stated as Author's Credentials is one of the criteria to identify "quality health knowledge content") has occurred once in the literature (in our example) in a research study of Eysenbach et al. (2002). The above association may occur in more studies confirming Author's Credential to be a strong indicator of quality. However, the researchers' opinions may also be dispersed, in which case a Topic Map would show the intensity of occurrences for the related concepts (and their supporting evidence).

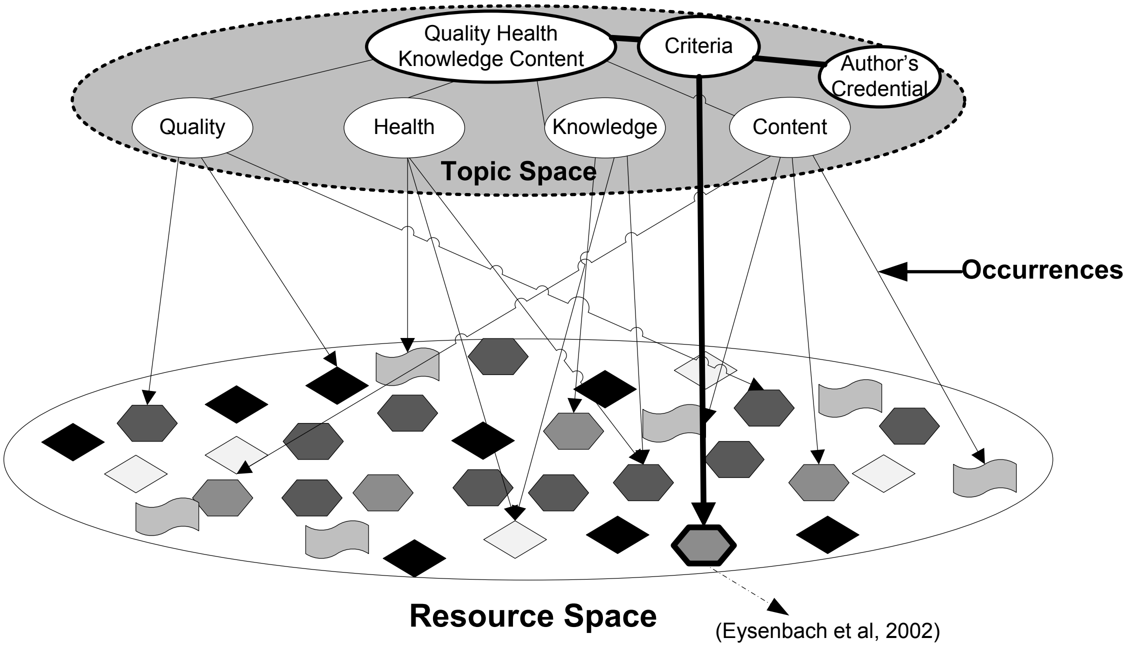

Figure 2-10. An example topic map linking the topic of "quality health knowledge content" to its related concepts (in the Topic Space) and their occurrences across the literature (in the Resource Space). The topics and relations in bold line and edges show a specific occurrence of an association in which a study supports "Author's Credentials" as criterion for a quality of health knowledge content.

As can be deduced from the above brief descriptions, in the Topic Map model, everything is "topic" (except attributes) and hence, a <u>Topic Map is self-defined/expressed</u>. That means that every concept, topic or association being used in the topic map (by “Topic Map” with capital letters we refer to the model, whereas, by “topic map” we refer to an instance of a map produced using the model) can be traced to its origin or occurrence and show its supporting evidence or viewpoint. In addition, every topic can participate in a potentially unlimited number of associations (but with a different type, name and role). Therefore, the Topic Map can represent an n-ary relationship between topics in a particular domain of knowledge (e.g., a requirements specification). Finally, the Topic Map is subject-oriented (Pepper, 2002). It is designed to represent concepts in the real world of messy and ad-hoc knowledge (called “infoglut” (Biezunski, Newcomb et al., 2001)), rather than explicit entities (e.g., resources) as with RDF. In other words, Topic Map is destined to create a semantic traceable map in order to turn infoglut into a manageable space of information.

In conclusion, Topic Maps seem to have features more relevant to our particular context needs. We need a representation language to help us map the infoglut of heterogeneous requirements expressions and associate them with the formal statements related to them. Topic Map would also show the occurrences of evidence supporting a particular topic or association, through which we can locate the areas of requirements agreement and conflicts. Finally, it allows us to describe topics (using metadata) and to define the scope for each topic. Using these features, we can represent e.g., the time a requirements expression or statement was made, their category and context, and a reference to related evidence.

Do the above reasons mean that RDF has no use in our context? Absolutely not. RDF is still the best language (and the most commonly used in the field of Ehealth and metadata, as will be discussed next) to describe a well-defined resource or topic when the elements of such a description are already agreed upon. The best examples are libraries or journal databases in which both resources being described and the description used to describe them are reasonably clear (ANSI, 2004). As a matter of fact, RDF deals with what Topic Map is lacking, which is an agreed basis of knowledge organization. For instance, in the context of requirements engineering, when we refer to a viewpoint, in the Topic Map model we may or may not provide information regarding the viewpoint other than, e.g., name. However, RDF enforces a minimum description set for every topic, requiring, e.g., a viewpoint to be described with at least a name, an identification number, category (consumer or professional) and possibly more. Perhaps a good analogy is systematic reviews (as an example of topic mapping). In a systematic review, various concepts regarding a particular topic (or topics) are associated together in a concept map and new statements are built based on the occurrences of supporting evidence across the literature. The result of a systematic review is then reported in the statements traceable to its original reference (through citations and bibliography). In this approach, while the original concepts stated across the literature were infoglut, the literature information has to be standard (author name, publication date, etc), which is where the role of RDF seems vital.

The above examples and explanation show why RDF and Topic Map are perceived as complementary and not as competitors to describe knowledge. This is also why the World Wide Web consortium (and several studies (such as (Biezunski, Newcomb et al., 2001; Lacher and Decker, 2001; Moore, 2001)) has decided to integrate both as a complete description language to best describe knowledge space (W3C, 2006). It also demonstrates why most domain-specific research regarding elements of quality knowledge are focused on RDF, rather than Topic Map (to describe the area of agreement and not the existing heterogeneity). We will review some of these relevant metadata-based attempts to describe quality criteria.

2.6 Summary

We, here, summarize our findings and suggestions for a requirements engineering approach regarding eHealth application design. Requirements engineering for a general eHealth application design begins (after defining the application scope, intended variety of users, and the choice of application type and architecture) with a course during which intended users and respected domains are studied, and their expressed needs and wants are formalized, analyzed, validated and documented in requirements specification. As long as the requirements captured are evolving, the requirements engineering process will continue and thus will never end. Crucial is a requirements representation language to record and represent everything that happens during the requirements engineering process in a dynamic, transparent and traceable way and to allow such reuse over-time and revisions of such requirement knowledge throughout the lifecycle of an application.

We found three aspects of requirements engineering particularly influential:

1- **Rich user/viewpoint variation**: Requirements stakeholders are the actual authors of requirements specification. The better their selection (number of representatives, variation, etc), the richer the quality of the specifications produced will be. "Inadequate user representation" is recognized as one of the five top risks that may impede the quality of requirements engineering, (Lawrence, Wiegers et al., 2001). As we discussed earlier, the elicitation process should not be restrictively focused on the needs and wants of those who will primarily use the system. Rather, it is desirable that requirements engineers include input from all possible individuals reasonably relevant within the application context that can be identified through a careful definition of application context (and purpose).

2- **Requirement traceability**: Several challenges of requirements analysis, such as natural language conversion, misunderstanding, and reasoning seem to have been around as long as human beings exist. However, we believe that the support for traceability in a requirements engineering method could minimize the effect of such issues. As discussed earlier, a traceable requirements specification would allow us to always go back to the supporting viewpoints or expressions of a requirement, examine the integrity of the conversion, update the viewpoint over time, and/or revise the requirements specified based on new understanding. Traceability would also help the requirements engineer to inspect the balance of supporting statements across various functional and non-functional requirements. That would protect the seamlessness of requirements specification against three additional top risks (requirements overlook, imbalance toward functional requirements, and lack of inspection) that Lawrence et al. rank among the five highest risks. Therefore, we agree with Nuseibeh and Easterbrook that requirements traceability "*lies at the heart of requirements management practice in that it can provide a rationale for requirements and is the* *basis for tools that analyze the consequences and impact of change* (Nuseibeh and Easterbrook, 2000).*"*

3- **Requirement evolution**: iteration and eventual grounding in the context in a *life cycle* mode are recommended for requirements engineering. However, we do not believe that the idea of a life cycle as defined by IEEE Standard 100-1988, as "starting when a software product is conceived and ending when the product is no longer available for use," is realistic. As Lindgaard (2006) emphasize, it is conceptually pleasing to imagine that the software development process is continued for an unlimited time and that all the key players would be willing to participate in this lifelong design and adaptation process. However, the feasibility of reshaping applications even in the first iteration is still questionable in reality. On the other hand, there is no doubt that applications continue to evolve throughout their lifetime e.g., through adaptations required by changes in the technical environment. Therefore, we would suggest the design of a new prototype only when there are sufficient requests for change and if it would be efficient. Otherwise, as soon as the rate of new requests for change falls substantially into a certain low level (determined by the requirements engineer) and the verbal satisfaction of respected individuals is achieved, the development process should be considered 'ready to be terminated.' That would require a dynamic requirements engineering environment that could survive throughout the application lifecycle. In other words, we suggest a *universal life cycle* for every application domain through which the knowledge achieved during Requirements and usability engineering studies of every design experience is modeled in a reusable way and will be used further to inform the next design. Then, such cumulative knowledge would last for infinite numbers of iterations.

4- **Requirements Representation**: We discussed a variety of Web-based knowledge representation languages that we can use as a basis to represent the knowledge requirements of individuals. We reviewed and compared RDF and Topic Map as two currently prominent Semantic Web (metadata) languages and concluded that a blend of features from both languages could fulfill our expectation of a sound language for representing knowledge requirements.

Chapter 3: Defining the Scope

This chapter specifies the scope for the requirements engineering approach being sought (or the scope of application being designed). In this chapter, we review and discuss some of the definitions and considerations for eHealth as a field of application and define our particular scope of eHealth application (knowledge-intensive eHealth application) in this dissertation. We will also discuss some of the main health behavior models and use them as bases to define quality health knowledge.

3.1 Defining the scope of application

We will define our particular scope here, considering the broad scope of the eHealth context. To do this, we strove to find a commonly-accepted definition of eHealth (alternatively referred to as "e-health" and "E-health" (Eysenbach, 2001; Lutz and Henkind, 2001; Demiris, 2004))—as a term or concept—across the relevant literature to use as basis. As result, while we found the eHealth domain well examined rather than well-defined, we came across areas of reasonable consensus revealed by several articles of systematic reviews. Two of the most outstanding reviews are the recent independent papers of Oh et al. (2005) and Pagliari et al. (2005). Both studies consist of a broad systematic review of articles from a wide variety of scientific databases providing definitions of eHealth, followed by a quantitative-qualitative analysis. In these explorations, the authors have identified and analyzed 51 (Oh, Rizo et al., 2005) and 36 (Pagliari, Sloan et al., 2005) definitions of eHealth and highlighted the areas of consensus. Despite some areas of methodological differences between the studies (e.g., the range of data sources or the method of analysis), the studies have arrived at similar conclusions. Both studies identify care and information services as the primary purpose of eHealth (applications) and the Internet as the primary medium for associated services and agree that—according to their findings—Eysenbach's definition (Eysenbach, 2001) of eHealth as "*health services and information delivered or enhanced through the Internet and related technologies*" is currently the best definition representing eHealth.

The above description/definition(s), while informational, are still too general to specify an application context, which is the purpose of this discussion. Hence, we checked the Medical Subject Heading Index (MeSH), as an academic reference for taxonomic structure of research databases, which was also a main reference in Pagliari et al.'s attempt to map eHealth. As we illustrated in Figure 3-1, the MeSH hierarchy only includes two categories of informatics (with four subcategories of Medical, Dental, Nursing and Public Health) and Medical Informatics (with two categories of Medical Informatics Application and Medical Informatics Computing).

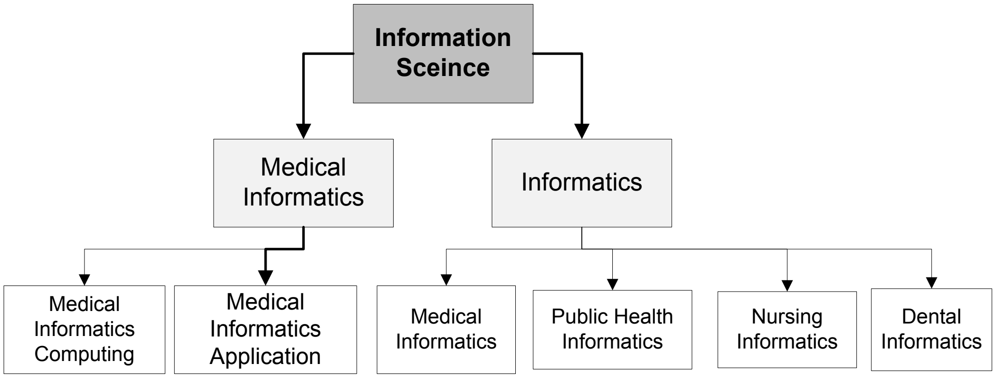

Figure 3-1. MeSH categories relevant to field of informatics

Therefore, we found the MeSH tree of categories relevant to the field of health informatics rather incomplete and confusing. The rationale is that if we consider Eysenbach's definition of eHealth (Eysenbach, 2001) which considers "Medical Informatics" and "Public Health" as two building blocks of eHealth, then the MeSH category of "Public Health Informatics" seems the most relevant category. From the other side, if we consider the viewpoint of the editorial board of the Journal of Medical Internet Research, as the leading journal of eHealth (JMIR Editorial, 2007), which considers eHealth as a field with significant overlap with "consumer health informatics," then we arrive nowhere, as such a category does not exist in the MeSH tree at all. In (yet) a third vision, Pagliari et al. consider eHealth as applications related to the MeSH category of *Medical Informatics Applications*, which are distinguished from others by their use of Internet technology.

To map eHealth applications, I combined the above visions. A limitation we found in the MeSH tree is the traditional tree-based knowledge representation method it uses, which limits categorization of multidisciplinary domains such as health/medical informatics and eHealth. To address this limitation, we added Consumer Health Informatics as a category under medical informatics and included eHealth as a multidisciplinary category of Web/network-based Application under the MeSH category of Medical Informatics Application, which is also linked with both categories of consumer health informatics and public health informatics (See Figure 3-2). Then, I re-explored the definitions and themes listed in both articles and compiled a brief taxonomy of potential application categories under eHealth applications.

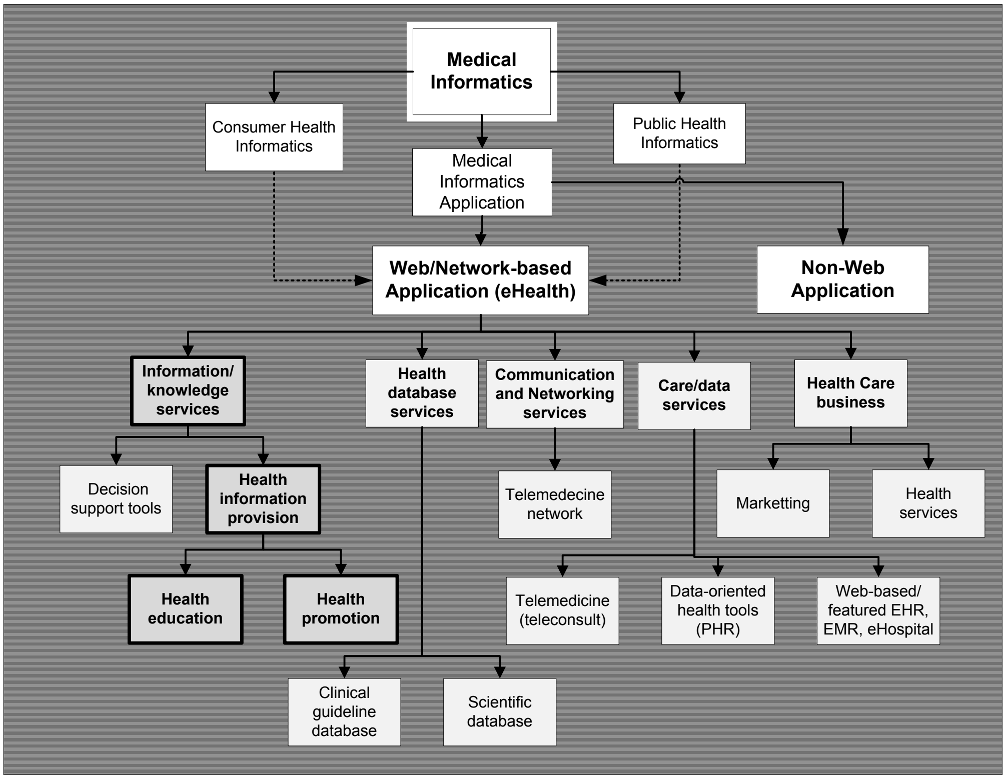

Figure 3-2. A suggested taxonomy of potential candidate branches for eHealth application (and services) category. Dark gray-filled topics represent the categories immediately relevant to the scope of this dissertation (Dotted arrows show addition potential top categories for the topic)

Looking at the taxonomy created, for this dissertation, we define our particular scope of eHealth (what I call Knowledge-intensive eHealth Application or KIEHA) as *applications that enable or facilitate <u>Health information/knowledge services</u> to <u>consumers</u> using <u>Web and Web services architectures</u>*. Three components of this definition will be the main areas of focus in this dissertation:

1- '*Information/knowledge services*' is used in contrast to 'data services' and thus excludes many possible data-oriented cases of eHealth application and services ranging from health records to corporate or enterprise-based large-scale information systems in which computing and data processing are the main task;

2- *Consumers* is meant to exclude an eHealth application providing information and knowledge services to health professionals, or health care businesses as the primary target (such as clinical health guidelines, decision support tools, and medical references). In addition, "consumers" is meant to emphasize the main purpose of information/knowledge services to be health education, health promotion, and self-care support, and

3- *Web and Web services architecture* is meant to emphasize Web standards (e.g., presentation and representation standards) as the main application and to exclude applications using the Internet exclusively as networking medium.

The particular scope of eHealth, elaborated above, is highlighted with dark gray-filled color in the above taxonomy (Figure 3-2). In the next sections, we will discuss the above three and their related concepts in more details.

3.2 Information and Knowledge

We use the definitions of information and knowledge by Bellinger et al. (2000) as basis of our discussion. These definitions are in harmony with two independent definitions by Rouse (2002) and Landauer (1998) and are used by Dotsika (2003) as a basis in the particular context of eHealth application.

Bellinger et al. (2000) defines "information" as "*data that has been given meaning by way of relational connection*" and define data as "symbol" or what "*simply exists and has no significance beyond its existence (in and of itself).*" For instance, "STD" as a set of three language symbols can be a piece of data that does not hold any meaning by itself. However, as soon as we link STD with other pieces of data, such as "STD is a type of disease," it turns into information. However, as Bellinger et al. explain, the meaning people require is often more complex than "who," "what," "where," and "when." For example, to answer a health consumer's question of "how to prevent STD?" one may need to provide the health consumer with several pieces of information, for example, what STDs (sexually transmitted diseases) are, what ways of transmission there are, and what the consequences are, which altogether address the information needs of that particular consumer. Bellinger et al. called this "*appropriate collection of information, such that its intent is to be useful*" as *knowledge*. In other words, "knowledge" is a purposeful provision of information.

Unfortunately, this clean and convincing distinction is not very widely accepted yet. Hence, the use of the terms is overlapping in the existing literature. This puts the author in a dilemma of either using terminology consistent with existing resources or creating confusion by deviating in the terminology used from the resources perused. We chose the former option i.e., using terminology consistent with existing literature, which as a consequence, may result in the occasional violation of the differentiation made here.

3.3 Consumer Health Education/Promotion as the main purpose

Knowledge-intensive eHealth applications are designed for variety of audiences (e.g, consumers to professionals) and a variety of purposes (e.g., health education to sophisticated decision support systems). This dissertation is particularly concerned with knowledge-intensive eHealth applications that target health consumers for the purpose of health education/promotion. The theoretical foundation of health education/promotion activities is based on several theories and models such as the *health-belief model* (Becker, 1974), *social learning* and *social cognitive theories* (Bandura, 1977; Bandura, 1989), and *the theory of rational expectations* (Fishbein and Ajzen, 1975). The general principle of all above, as Sapp (2002) describes, is reflected in Lavidge and Steiner's *hierarchy of effects* (Lavidge and Steiner, 1961; Palda, 1966) according to which "*beliefs (knowledge) cause affect (attitudes) which causes conation (intention), which causes behavior*." There have been also several studies which have provided evidence of the validity of such models (e.g.,(Janz and Becker, 1984)) or their comparisons (e.g., (Rosenstock, Strecher et al., 1988; Baum, Revenson et al., 2001)). Summarizing all of the above, we can say that in the context of this dissertation, "awareness enhancement and behavior change" (O'Donnell, 1989) or what together is called "empowerment" (Korp, 2006) is what eHealth knowledge services seek to enable or support.

3.4 Web Services Architecture

Web Services Architecture is a standard described by W3C Consortium, which is concerned with principles required for software-based service communication and semantics over the Web (W3C, 2004). According to this architecture, a Web service is described as an interaction between a provider and a requester entity that are persons or organizations mediated through their software agents (provider and requester agents). However, a precondition to this interaction is agreement between both entities about descriptions of the service itself.

Figure 3-3 illustrates a general scheme of Web Services Architecture. According to this architecture and in the context of eHealth applications, a health knowledge service is engaged when a requester entity (e.g., a health consumer) negotiates and agrees to a service description (description of health knowledge content) provided by a requester entity and completed by service interaction (granting access to information).

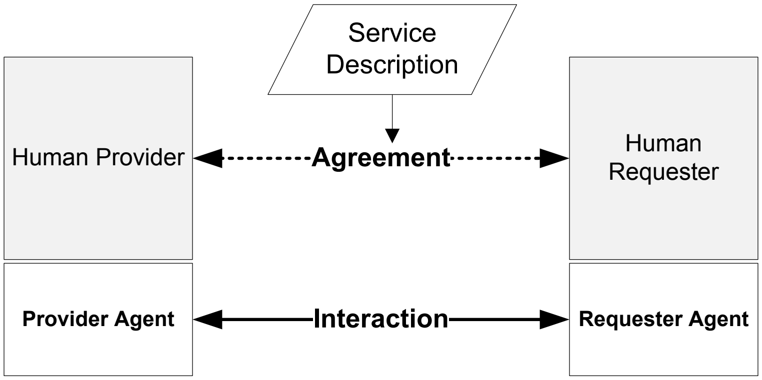

Figure 3-3. A simplified scheme of Web Services Architecture (adapted from (W3C, 2004))

In the above architecture, it is assumed that the knowledge service is already available and its description is already posted on the Web. For instance, it is assumed that a health information Web site has already been designed by a health provider according to his knowledge of consumer needs and been posted on the Web. A health consumer negotiates and agrees to the description of the Web site through a search engine and the provider agent finally grants access to the Web site (Web server). However, in this dissertation, we are assuming that the description of quality health knowledge service does not exist and we should be eliciting such descriptions through a knowledge requirements engineering approach.

3.5 Service Description or Knowledge Content Specifications

In order to provide quality knowledge service as a main function of a knowledge-intensive eHealth application, we need to discover and describe the specifications of knowledge content to be provided. As explained in the previous section, such specification should match the knowledge descriptions of interest by the requester entity (i.e., health consumer) that is to result in a service agreement and engagement. The AMA (American Medical Association guidelines for health Web sites (Winker, Flanagin et al., 2000)) defines "content," in the context of online health information, as "*all material (including text, graphics, tables, equations, audio, and video) and menu/directional icons, bars, indicators, listing and indexes*." This definition can be summarized as, a collection of Web compatible information of any type. Using this definition as the basis, we can now arrive at the following definition of "knowledge content" (in our context of KIEHA) as

> "collection of Web-compatible information that addresses health knowledge needs of particular health consumer(s) of concern and that enables or supports health awareness enhancement and health behavior change in that individual(s)."

However, more precise specifications are required to lead a design. Such specifications should particularly involve the health topics and elements of information to be included in the content. For example, if we consider university students as consumers of concern, knowledge content specifications (or descriptions) should provide the health topics (and subtopics) specific to their need, and the information/knowledge elements of their preference.

Three final clarifications/distinctions are important:

1- The emphasis of knowledge content, particularly in this dissertation, is only on informational components of content. Therefore, specifications of software and design related features of KIEHA such as graphic styles (font size and styles, color schemes, etc) or search features are outside the scope of this dissertation and thus will be excluded.

2- Knowledge content is not necessarily limited to health information. As the above definition of knowledge content implies, knowledge content for a particular group of consumers may include non-health metadata information (metadata is data about data or information about information). This type of information encompasses a variety of information items such as privacy policy, provider contact information, or update information that, that are not part of the health-related education material. However, they contain useful information for consumers, which they can use as a basis to e.g., accept or reject the content. For instance looking at the provider information for a particular health Web page, the reader may decide whether she or he would trust in the content. In addition, such information may boost the effectiveness of content by improving consumers' perceptions regarding the content and thus support the final service goal. Therefore, to make the distinction, we identify three categories of knowledge content:

   a. *Knowledge topics* (or *health topics*): The hierarchy of health topics and subtopics the information regarding which is provided in a KIEHA application

   b. *Knowledge elements*:

      i. *Content comprehension elements*: The elements of health and health-related information in a KIEHA content page. For instance, in a Web page providing information on Sexually Transmitted Diseases, content comprehension element can be a piece of information regarding "how to prevent STD," an information item regarding "Frequently Asked Questions" or even some links to "Online Resources" that provide more STD-related health information.

      ii. *Metadata element*: The non-health information elements regarding the content provided, e.g., provider or author information

3- One should differentiate Web knowledge content from Web site and Web page content (which will be used frequently throughout this document). W3C defines Web site (W3C, 2003) as "*A collection of interlinked Web pages, including a host page, residing at the same network location*" and Web page as "A collection of information, consisting of one or more Web resources, intended to be rendered simultaneously, and identified by a single

URI (Universal Resource Identifier).” In other words, any number and combination of Web pages of any purpose could constitute a Web site as long as they are located (and interlinked) at the same network address, and any collection of information of any purpose could make a Web page as far as it is posted on the same browser page (with a URI), meaning that both concepts are technically independent of any informational purpose. For example, a university Web site may include only a few health Web pages for health education purposes along with other pages (such as administration pages). In contrast, a Web page can be so long that it could technically incorporate the entire health knowledge content. The same Web page could also be so short that it only hosts a small portion of content regarding a health topic. Therefore, the above concepts might be overlapping. We will define our particular scope of Web site and Web page in Chapter 5.

3.6 Quality as goal

As explained in Chapter 1, producing quality knowledge content specification is the final goal of this dissertation. To define “quality,” we use the following five principles:

1. The definition of Health Promotion (WHO, 1986; O'Donnell, 1989; Korp, 2006): According to which behavior change is the ultimate goal,
2. The Hierarchy of Effects (Lavidge and Steiner, 1961; Palda, 1966) : According to which right knowledge may cause right attitude, intention and finally right behavior,
3. The Elaboration Likelihood Model (Petty and Cacioppo, 1986): According to which, people are believed to process and absorb information/knowledge better when they find them tailored to their personal needs,
4. The theory of tailored health messages (Kreuter and Holt, 2001): According to which, it is expected that tailored health information elicits,
    a. greater attention,
    b. greater comprehension,
    c. greater likelihood of discussing the content with other people,

   d. greater intention to change the behaviors addressed by the content, and
   e. greater likelihood of behavior change (Kreuter and Holt, 2001);

as compared to non-tailored health information. The definition of "tailoring" in this context is:

"*Any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment* (Kreuter and Skinner, 2000)," and

5. The theory of Persuasion (Petty, Cacioppo et al., 1994), based on which Kreuter and Holt believe that tailored information is more likely to stay longer in memory and to cause more permanent behavior change.

Summarizing all above, we define "quality knowledge content," as "the information or knowledge that are tailored to one's needs;" and use the classification of needs by Bradshaw (1972) which have been used as basis by Ewles and Simnett in the context of needs analysis for health promotion activities (Ewles and Simnett, 2003), as:

1. Normative needs, or what is recognized by the related experts, as needs of a target population (e.g., what health professionals on campus recommend regarding health knowledge needs of the university students)
2. Felt needs, the needs that are felt by the target individuals but may or may not be expressed
3. Expressed needs, the felt needs that are expressed
4. Comparative needs, or to generalize the needs of an individual similar to the target individuals

Considering the above classification of needs, we define "quality health knowledge content" for a particular (or group of) consumer(s) as

> "the health information or knowledge whose topics, content, and metadata elements are tailored to particular health consumers' needs of health knowledge assessed on the basis of the summary of needs felt

> and/or expressed by them, recommended by related professionals, and what has been recognized as needs in similar individuals."

The above definition while defining our scope of quality, stresses the main thesis of this dissertation as well: "quality" is an attribute of knowledge content whose requirements should be specified by a variety of related viewpoints, particularly the recipient of such knowledge.

To tailor online information to knowledge requirements of online consumers, we need a set of specification/description representing information needs of those users. We could then use such a set of descriptions knowledge (or requirements specification) as basis for:

1- identifying and indexing quality information, or

2- building the knowledge content.

Example products of the former are the health information directories or search engines, and ones of the latter, are consumer health Web sites.

3.7 Summary

In this chapter, we defined our scope of "knowledge-intensive eHealth application (KIEHA)" as applications that enable or facilitate health information/knowledge services to consumers using Web and Web services technology. We also defined "knowledge" (in knowledge services) as a purposeful provision of information whose purpose in our context is "awareness enhancement and behavior change." It is then shown that an effective health information/knowledge provision service is the one the knowledge content of which is tailored toward the various knowledge needs of its particular target individual(s) as defined by various stakeholders of health education/promotion. In other words, quality health knowledge content is defined as

> "the health information or knowledge the topics, content, and metadata elements of which are tailored to particular health consumers' needs of health knowledge. For such piece of knowledge (or information), the knowledge needs of the consumers are assessed on the basis of the summary of needs felt and/or

> expressed by them, recommended by related professionals, and of what has been recognized as needs in similar individuals.”

Chapter 4: Proposing a Knowledge Requirements Engineering Framework

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This chapter presents the stepwise approach we followed to ground various techniques of requirements engineering (as discussed in Chapter 2) into the context of knowledge-intensive eHealth application (as discussed in Chapter 3), and to propose our knowledge requirements engineering framework. The chapter also outlines the study design we used to test the hypothesis made.

4.1 Introduction

In Chapter 2, we characterized a sound requirements engineering model for general eHealth application as a model that:

1- Involves a reasonable variety of viewpoints from all types of requirements stakeholders.

2- Supports requirements traceability by providing a traceable set of requirement specifications.

3- Supports requirements change by maintaining a reusable updateable database of requirements.

Here, we contextualize the above characteristics into the context of KIEHA described and discussed in Chapter 3. We describe a sound knowledge requirements engineering model, particular to our context of knowledge-intensive eHealth applications, as a model that:

1- Involves a reasonable variety of viewpoints related to three types of consumers' knowledge needs, encompassing:

   a. Normative needs, as what local-to-global health and eHealth-related professionals or organizations recommend as appropriate health knowledge to be learnt by health consumers.

   b. Felt or expressed needs, as the knowledge needs that are felt by the health consumers but which may or may not be expressed.

   c. Comparative needs, as a generalization of the identified knowledge needs of individuals similar to the target health consumers.

2- Supports knowledge requirements traceability through which every piece of health topic or knowledge element included in the specification of quality knowledge content can be traced back to its supporting expressions and viewpoints.

3- Supports and reflects the dynamicity of consumers' knowledge needs. It should enable requirements updates in terms of new health knowledge topics (e.g., new diseases, new drugs, new treatments) and knowledge content elements (i.e., the set of content elements to be included in a page such as Author's Name, Quality Seal, etc). In addition, it should dynamically sort and shift the focus of health topics presented according to the present focus of the health topics in the consumers' community.

4- Not only addresses the health topics of interest but also any other elements of content such as metadata (e.g., Provider Information, Last Update) and content comprehension elements (e.g., Frequently Asked Questions, Online Resources) that could help consumers develop trust in the content or better comprehend it.

5- Supports Web standards to enable universal usability of the requirements knowledge.

In the following sections, we propose a knowledge requirements engineering framework, which we call Telescopic Metadata-based Knowledge Requirements engineering Model (TM-KREM), that accommodates the above five characteristics.

4.2 Stepwise grounding of requirements engineering techniques

We follow a stepwise approach to ground the techniques of requirements engineering we explained and discussed in Chapter 2 (and partially in Chapter 3) into the context of eHealth applications described in Chapter 3 (Figure 4-1). To maintain consistency, we will pursue the same order as in Chapter 2 (except for Step 4, which was discussed in Chapter 3). We will first select a general method of requirements engineering that matches our particular context of design, and proceed with identification of the stakeholders whose viewpoints might be beneficial in specifying the quality knowledge content. In Step 3, we will review the possible variety of requirements sources. Then, we make our selection regarding an appropriate method of knowledge acquisition/representation to record and represent the related knowledge (in Step 4). In Step 5, we then make our selection regarding appropriate requirements negotiation/validation strategies and specify how we would evaluate our framework. Finally, in step 6, we will propose a study design to evaluate the framework proposed.

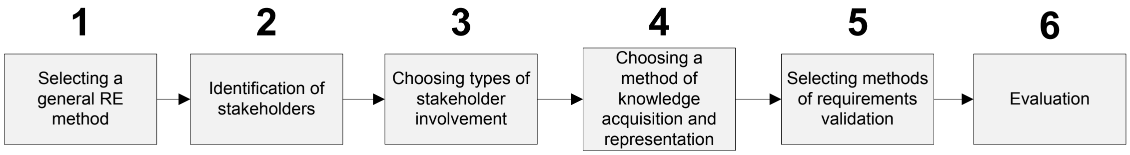


Figure 4-1. A suggested procedure to ground requirements engineering techniques

4.2.1 Selecting a general RE method

Knowledge content of KIEHA, as the particular context of this dissertation, does not involve any processes, tasks, or software objects. Hence, the scenario-based or object-oriented approaches seem irrelevant. In addition, goal-based approaches, while relevant, have limited implications. One limitation is the ambiguity of non-functional goals in health knowledge services. Both awareness and behavior change, described as the purposes of knowledge provision (Section 3.3), are goals that are too vague to be connected to some functional goals that could enable their achievement (in a cause and effect relationship). The other limitation of goal-based approaches in this context is their top-down process. This means that we will normally begin with higher goals (soft goals) and follow with their enablers in the lower levels. However, in our context, eliciting consumers' knowledge needs is the first low-level step. In this process (needs assessment), individuals do not have to substantiate their choice by assigning positive goals. One consumer may want to know if he can sober up with a cup of dark coffee, while another might want to know if bisexuality is common among students. In these cases, a knowledge requirements engineer's duty is to aggregate all the needs and represent the area of agreement in the specifications.

Furthermore, determination of particular consumers' knowledge needs is not just at their discretion. As explained in Chapter 2, a health knowledge service targeting, e.g., university students should not be limited to what the students themselves describe as knowledge needs. Rather, normative viewpoints are required to specify what some target users may need regardless of their awareness. For instance, a new dangerous drug may be appearing on campuses, a new infection may be spreading, or a new prevention method may be available. As a matter of fact, this heterogeneity of viewpoints is crucial to complete the knowledge need assessment. Therefore, we prefer a viewpoint-based approach, which allows the use of a variety of requirements opinions to understand the domain of requirements. In particular, we found the *User Viewpoint Model* of requirements engineering by Darke and Shanke (1997) and the PREview model of Sommerville et al. (1998) the most relevant. The rationale is that the Darke and Shanke model is one of the very few viewpoint-based models that supports all three features of multi-viewpoints, traceability, and requirements association (which will be discussed later in this chapter) in one model.

4.2.2 Identification of Stakeholders

A viewpoint-based requirements engineering process begins with identification of stakeholders whose viewpoints should be included in the requirements specifications. In our context, we identified three types of stakeholders:

1- Health and eHealth related professionals or organizations (local to global or international). By eHealth-related we emphasize the potential values of opinions of the relevant professionals from health education/promotion to psychology and epidemiology to health informatics and health Web designers. By organization, we value the opinions that represent a related organization value that is normally supported by a range of affiliated professionals (such as Health Canada). By including global or international, we aim to emphasize the universality of health and knowledge, since many useful recommendations of knowledge may come from the professionals or organization with more general perspectives such as the WHO or the National Library of Medicine.

2- Health consumers or the primary users, to express their own knowledge needs.

3- Consumers' peers, or individuals with a reasonably similar range of knowledge needs (for instance, a university student may share many knowledge needs with a non-student teenager in the same age group).

4.2.3 Choosing types of stakeholder involvement

It seems impractical to prescribe a generic type of stakeholder involvement as best-of-all in the context of KIEHA. However, by this step, we would like to elaborate on possibilities of requirements sources that can represent the opinions of some unreachable stakeholders from the above list. In the stakeholders' list, we identified local to global health and eHealth related professionals as sources of normative needs. However, in reality, except for some local professionals who might be accessible to a requirements engineer for, e.g., a consumer health Web site, any direct involvement such as participation in an interview or focus group, or even accessibility through remote methods such as a survey, seems unachievable. Rather, we suggest three types of resources that could represent these stakeholders' viewpoints:

1- Standard documentation and guidelines: For instance, AMA guidelines represent the American Medical Association's viewpoint (or that of its affiliated professionals) regarding the content element to be included in quality health content.

2- Research literature: This could represent the conceptual to empirical viewpoints of the professionals from a variety of related disciplines. For instance, Eysenbach's list of elements for quality health information aggregated from the 79 studies reviewed could represent the viewpoints of related authors and researchers in this regard.

3- Best practices of KIEHA artifacts: Prominent examples of KIEHA (which we call KIEHA exemplars) with a similar context could represent the widest range of viewpoints from related professionals. For example, the popular health Web site built by the Society of Obstetricians and Gynecologists of Canada (SOGC) on sexual health (for teenagers and young adults) reflects the suggested topics under the category of Sexual Health by related professionals (on the national level). In addition, it indicates, at least partially, the range of knowledge elements to be included in a quality Web site with similar context. We particularly prefer this one, as a source of knowledge requirements viewpoints, among the above three for the following reasons:

    a. These artifacts include <u>a complete set of knowledge elements and topics</u> to be included in a quality knowledge content, whereas research literature being analyzed or a health professional (e.g., a nurse) being interviewed may only provide a limited viewpoint regarding what should be included.

    b. They represent <u>an integrated holistic view</u> of the related professionals' viewpoints (from health and health-related to Web design) rather than a viewpoint of one or few from a particular discipline (e.g., in research literature).

    c. They can be used as <u>sources of comparative needs knowledge</u>. That means that, for instance, the list of health topics that have been recognized by a similar health promotion project targeting similar individuals are applicable to our target individuals as well.

The taxonomy of consumers' knowledge needs and the related stakeholders whose opinions should be elicited in a knowledge requirements engineering process is shown in Figure 4-2

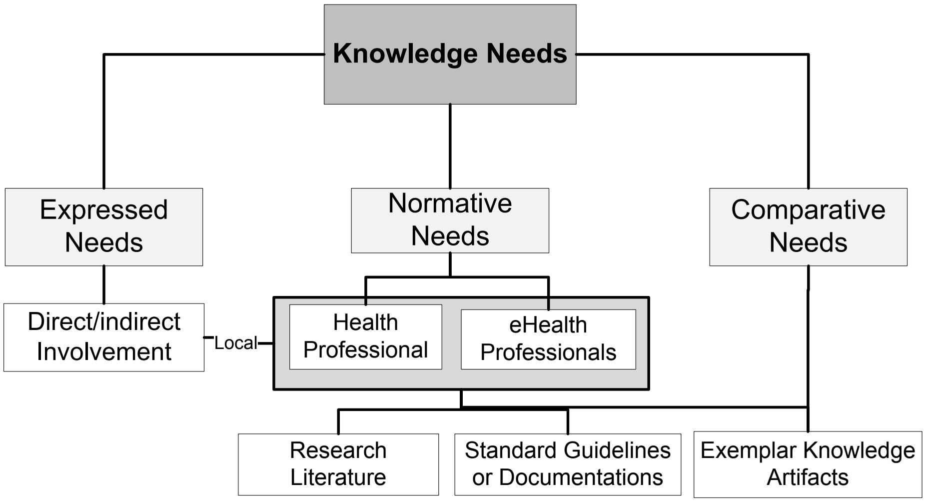


Figure 4-2. Taxonomy of knowledge needs, the related stakeholders and sources. As shown, while local professionals could be directly approached for their viewpoints, the others' viewpoints (national-international) should be sought within the available resources or artifacts

4.2.4 Choosing a method of knowledge acquisition/representation

As substantiated in Chapter 2, we suggest a combination of Topic Map (TM) and RDF to cover the four levels of requirements knowledge (and their links) explained in 3.7.1. To enable Topic Map (consisting of topics, association, and occurrences), we conceptually consider stakeholders, their viewpoint expressions, requirement statements, and requirements specifications, four levels of topics that are associated with each other in a sequential path (Figure 4-3). In addition, to represent occurrences, we should provide a physical reference for every topic (such as a link to an audio file containing the verbal expressions of a stakeholder).

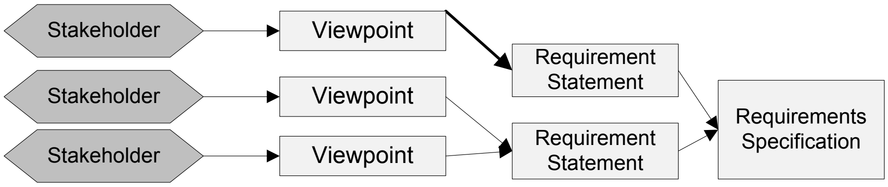


Figure 4-3. The sequential path of requirement knowledge from stakeholders to requirements specifications

To represent the above topics (including their association and occurrences) in a machine-understandable language, we need several levels of preparation and processing. To begin a topic map on the computer, we use an example. Suppose we are building a campus health Web site for university students studying at a particular university. We call the project Campus-HITS (or Campus Health Information Tailoring Service) and identify the list of our stakeholders (according to Figure 4-2) as students (target consumer/primary user), doctors/nurses/counselors on campus (as local professionals), and some related exemplar campus health Web sites (as a source of viewpoints for non-local professionals). We have interviewed a (fictious) university student (named Tom) regarding his viewpoints with respect to what should be included in a quality health Web page that is going to be designed for students. The following is one of his viewpoint expressions:

"I wouldn't care about the Author's Name in a Web page."

We create a knowledge requirements database to capture all the requirements knowledge. To record the above statement, we create a sub-database called viewpoints database. Using ideas from topic map, a viewpoint record can be as simple as below (in XML):

```
<viewpoint>
    <viewpointExp>I wouldn’t care about the Author’s Name in a Web
   page</ViewpointExp>
    <viewpointOwner>Tom</viewpointOwner>
    <viewpointOccur>MainDrive\TDProject\tom.avi</viewpointOccur>
</viewpoint>
```

A corresponding visual topic map is shown as Figure 4-4:

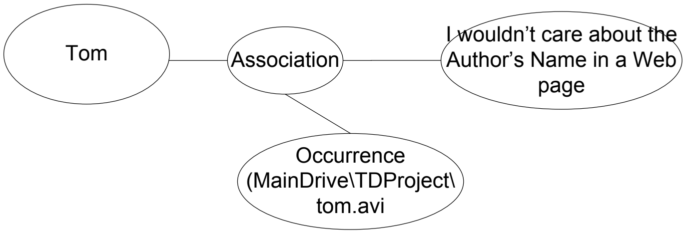


Figure 4-4. A simple topic map representing a single viewpoint of a consumer

However, the above dataset is too abstract. For instance, we may want to know who Tom is or when he said this and in what context (assuming we only have the above dataset regarding the viewpoint). To answer this, we require metadata. These pieces of metadata information are needed for further categorization and analysis of viewpoints. As we emphasized in section 3.7.4, Topic Map by its nature does not force any metadata to be included with the topics and associations. Therefore, we use RDF to impose such an attribute to be recorded. We found seven elements of metadata whose inclusion seemed necessary (Table 4-1).

Table 4-1. The primary fields suggested for a viewpoint metadata element set (i.e., viewpoint record) (the examples are fictious)

Element	Definition	Example
1- viewpoint ID	A unique identifier (a URI or a code)	TD1234
2- viewpoint expression	What is stated by the viewpoint owner	I wouldn't care about the Author's Name in a Web page
3- viewpoint context	The context in which the viewpoint was collected	Campus-HITS
4- viewpoint category	The particular category the viewpoint belongs to	Content elements
5- viewpoint source	The viewpoint source (owner)	TD5432 (source ID)
6- viewpoint reference	The reference to the actual document containing the viewpoint	MainDrive\\TDProject\\tom.avi
7- viewpoint date	The date the viewpoint was stated	January 2007

These elements are shown below in RDF code:

```
<rdf:Description
```

```
 rdf:about="TD1234">
  <rdf:viewExpress>I would not care about the Author's Name in a Web
page</rdf:viewExpress>
  <rdf:viewContxt>Campus-HITS</rdf:viewContxt>
  <rdf:viewCtgry>Content elements</rdf:viewCtgry>
  <rdf:viewRef>MainDrive\\TDProject\\tom.avi</rdf:viewRef>
  <rdf:viewDate>January 2007</rdf:viewDate>
</rdf:Description>
```

In addition, the stakeholders owning the viewpoints (we refer to this as requirement source) should be described as well. These descriptions should address questions such as who Tom is and in what context he was contacted and a reference to other related information. We describe every stakeholder using a similar element set (Table 4-2).

Table 4-2. The primary fields we suggested for a requirement source metadata element set (i.e., source record) (the examples are fictitious)

Element	Definition	Example
1- source ID	A unique identifier (a URI or a code)	TD5432
2- source name	The name (of the person) or the title of resource	Tom Anderson
3- source context	The context in which the source was communicated/used	Campus-HITS
4- source type	Type of source (e.g., person, resource, artifact)	Person – student participant
5- source reference	The reference to a document containing the source information	MainDrive\\TDProject\\rlist.doc
6- source date	The date the source was added	January 2007

Finally, to associate the viewpoints with the viewpoint owners, we define association and association roles as explained in Chapter 3 (section 3.7.4). As a matter of fact, association is the heart of our approach, which enables both rationality and traceability for the requirements specifications. To enable this we define the following set of elements to describe every association between two topics (e.g., to associate Tom with his viewpoint).

Table 4-3. The primary fields we suggested for a requirement association metadata element set (i.e., association record) (the examples are fictional)

Element	Definition	Example
1- association ID	A unique identifier (a URI or a code)	TD4444
2- association context	The context in which the association was defined	Campus-HITS
3- association topic 1	The first topic in the association (on the left)	TD1234
4- association topic 2	The second topic in the association (on the right)	TD5432
5- association role	The type of relationship between topic 1 and 2	viewpoint owner-viewpoint
6- association reference	The reference to the association proof	MainDrive\\TDProject\\tom.avi
7- association date	The date the association was made	January 2007

The above association (Table 4-3) shows that the viewpoint ID=TD1234 is expressed by source ID=TD5432 who is a student participant named Tom, and the proof of such association is the available audio-video recording of the interview session. A particular feature of the above element set is that it addresses a major limitation of Topic Map associations in which all associations are bidirectional (Pepper, 2002). This means that an association role of subtopic-topic between Sexual Health and Birth Control can be interpreted both ways (Sexual Health is a subtopic of Birth Control and vice versa). This is especially confusing when a requirements engineer plans to build a hierarchy of topics, e.g., in a navigation menu for a health Web site. The framework we propose differentiates the direction of topics participating in an association by identifying the topic on the left side (of an association) as Topic 1 and the topic on the right side as Topic 2. In addition, the inclusion of the date element in all three databases has particular advantages. One advantage concerns the issue of requirements change in that it allows the requirements engineer to occasionally examine the validity of requirements over time. This can be particularly beneficial in the volatile domain of health topics, since both the variety and focus of health topics may change over time, so that a quality health Web site, for instance, must dynamically adjust the focus of content.

In Figure 4-5, we have illustrated Tom's viewpoint in a metadata-rich visual topic map. Our approach in metadata enrichment of the requirement knowledge is a grounded (and advanced) version of the models of Darke and Shanks (1997) and also Sommerville et al. (1998) of viewpoint knowledge.

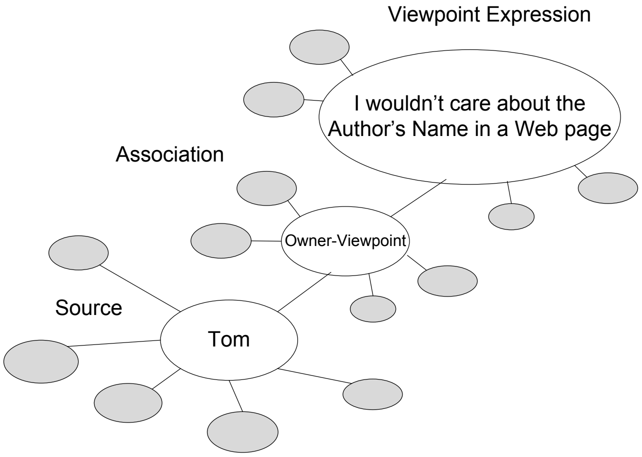


Figure 4-5. A visual topic map representing a metadata rich association between a viewpoint expression and its owner (gray bubbles represent metadata)

Association definition can be more complex. For example, various associations between topics can be suggested by various stakeholders. An example would be when the requirements engineer wants to build a topic menu (navigation menu) for a health Web site. To build the menu, one may ask the stakeholders' opinions on, e.g., the topics to appear under Sexual Health. Tom may suggest Birth Control as a topic under Sexual Health. This simple suggestion requires the requirements engineer to

1. record Birth Control as a suggested health topic under a viewpoint (assuming Sexual Health already exists),
2. associate the viewpoint with Tom,
3. create an association between Sexual Health and Birth Control, and

4. associate the above association (its ID) with Tom (his ID) with an association role of "association owner-association."

A similar scenario must be pursued when a requirements engineer analyzes a university health Web site and finds Birth Control listed under the category of Sexual Health (in which case the association owner is the site provider).

4.2.4.1 Viewpoint expressions to formal statements (Transformation/Documentation)

In this step, the requirements viewpoints of informal expressions must be converted to formal statements to ease further analysis. For example, Tom's expression of "I wouldn't care about the Author's Name in a Web page" can be converted to a statement like "Author's Name element may or may not be included in a Web page" that shows Tom's formal neutral position regarding the inclusion of Author's Name in a quality health Web page. The above step is what we referred to as requirements transformation or documentation in Chapter 2. We discuss our choice of transformation approaches in two sections: Requirements Integration and transformation transparency

4.2.4.2 Requirements integration

To represent the transformation of knowledge requirements from expressions to statements, we should integrate all the repetitive/similar informal expressions into a few manageable formal statements. For instance, if forty student participants are interviewed about their opinions on the inclusion of Author's Name, their viewpoints can be summarized (or abstracted) into three statements:

1. *positive* (Author's Name element should be included in a quality health Web page),
2. *neutral* (Author's Name element may or may not be included in a quality health Web page), and
3. *negative* (Author's Name element should not be included in a quality health Web page).

In such a case, each of the forty opinions (assuming they are all relevant and eligible) can be associated with one of the above three formal statements, each representing one occurrence of opinion. There is at least one precondition here. We presume that all the stakeholders have a common understanding of the application domain knowledge and the terminology used and thus their opinions will have substantial commonalities. However, as Sommerville et al. (1998) discuss in their model, there should always be some basis to enable integration of what they call *stakeholder's concerns.* To create this common ground, we found two solutions applicable to our framework. The first is the card-sorting method used by Maiden and Hare (1998) and also Nurmuliani et al. (2004) to classify the requirements. Adopting that model, we allow the stakeholders to categorize their own viewpoints. In our context, that is applicable when we would like to sort the health topic into three levels of health topic main categories, health topics, and their subtopics. A second solution, as Gruenbacher (2000) suggests, is to have stakeholders comment on a shared domain taxonomy rather than to merely brainstorm. We will discuss this in the negotiation section.

4.2.4.3 Transformation transparency

As discussed under requirements documentation in 2.4.1, it can always be debated whether transformed requirements expressions represent the actual viewpoint of the original viewpoint owner or are only misinterpreted/biased versions of the original ones enforced by the requirements engineer. For instance, one may argue that Tom's expression actually means he does not like the inclusion of the Author element. We believe our framework could address this issue in two ways: First, we suggest that we define the requirements engineer as a requirement stakeholder holding some viewpoints. Having him or her defined as a requirement stakeholder, we can associate all the formal statements that are originally proposed by the requirements engineer with him in an association role of "statement owner-statement." Then, we can associate all the expressions supporting the statement with an association role of "supporting viewpoints-statement." (Figure 4-6) Using this approach, any external viewer or examiner can differentiate the original expressions (from users) from the formal statements objectively assigned (by a requirements engineer) as their equivalent. In addition, the path of association can allow the external viewer to trace every statement to its supporting expressions. Therefore, we have enabled traceability.

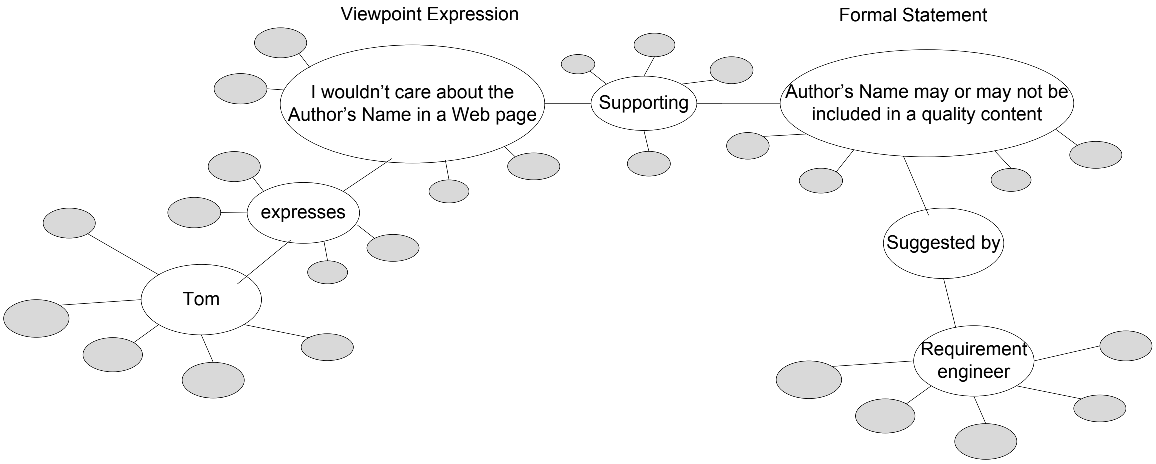


Figure 4-6. Expression-statement path. An informal viewpoint expression by Tom is associated with a formal statement suggested by the requirements engineer in a supporting association. Using this scheme, one can trace back the requirement statement to its supporting viewpoint expression. The gray bubbles around a node represent the metadata available regarding that node.

We also generalize the issue of transparency to the domain of all assertion. We believe that the debate regarding bias, mistakes, and misunderstanding can apply to all the machine-based associations entered by a second viewer, which is the requirements engineer. Therefore, it is crucial, particularly to the collaborative knowledge project with more than one requirements engineer, to endorse all the association and viewpoint entries into the requirements database. To address this, we recommend inclusion of three more metadata elements of `annotator name`, `annotation context`, and `annotation date` with all the three requirements databases (viewpoint, source, association) we created.

4.2.5 Selecting methods of requirements negotiation and validation

We discuss our choice of negotiation and validation approaches in two sections: identifying the areas of requirement agreement, and prioritizing/reasoning

4.2.5.1 Identifying the areas of agreement

Topic Map can highlight the area of agreement by the occurrence rate of supporting statements. For instance, to specify whether Author's Name should be included in a quality

Web page on Campus-HITS Web site, we simply compare the rate of viewpoints supporting the positive statement to the ones with a negative statement and document the statement of stronger consensus in the requirements specifications. However, there is a major drawback here. Requirements expressions originating from varying sources have varying values. For instance, the opinion of a health professional who has worked on a Campus clinic regarding the health topics to be included in the Campus-HITS Web site cannot be simply considered as equal in value to the viewpoint of a first-year university student who also suggests his preferred health topics. As a matter of fact, the normative nature of knowledge needs recommended by domain experts necessitates their inclusion (assuming there is agreement between the related experts), unless they are, implicitly or explicitly, disliked by the target consumers. In addition, the opinions of domain experts can be assigned varying values. For instance, local professionals (campus health professionals) in direct contact with the target users of a health Web site are more eligible to discuss what those users' specific knowledge needs are than a related national or international society.

The second issue concerns the comparability of requirements expressions. In requirements engineering, a main presumption is that users/stakeholders share a reasonable understanding of what they comment on. In other words, users/stakeholders are presumed to have a common basis for their viewpoints. Obviously, requirements specifications could not represent hundreds of viewpoints each suggesting a different feature as an element of quality content with hardly any area of consensus.

To address the above two issues, we combine EasyWinWin approach proposed by Gruenbacher (2000) and Prosumer approach by Goodman et al. (2002) in a model we call telescopic tailoring model. According to our model, we use the requirements statements of the domain experts as requirements bases and eventually tailor the requirements to the needs of consumer stakeholders. For instance, we elicit the health topics recommended for a university student (or an individual in that age group) from global/international to local sources (stakeholders, documents, artifacts), and use that as a basis for the student participants (e.g., in a requirements engineering project for a campus health Web site) to specify their particular areas of interest. Therefore, our viewpoints are narrowed down in a telescopic tailoring path. Figure 4-7 illustrates the telescopic viewpoint tailoring approach. As shown, the global knowledge regarding the domain of application is first filtered by the requirements engineer to a number of domain experts (and resources or artifacts), which specify the normative needs of knowledge by the target consumers (i.e., primary users). Then, the requirements recommended are tailored to the needs of the consumers by associating them with the supporting expressions from the consumers' representatives. Similar to a standard WinWin approach, there are iterations. In every iteration, all the statements would pass to the next level, unless there is clear proof of disagreement from primary users. In addition, as we explained earlier in the integration section (4.2.4.2), we integrate the consumers' contribution into the initial taxonomy (through other methods such as brainstorming and card sorting) by appending their original expressions into the viewpoint database and by monitoring their rates of occurrence. The U1 to U4 specifications in Figure 4-7 represent these contributions.

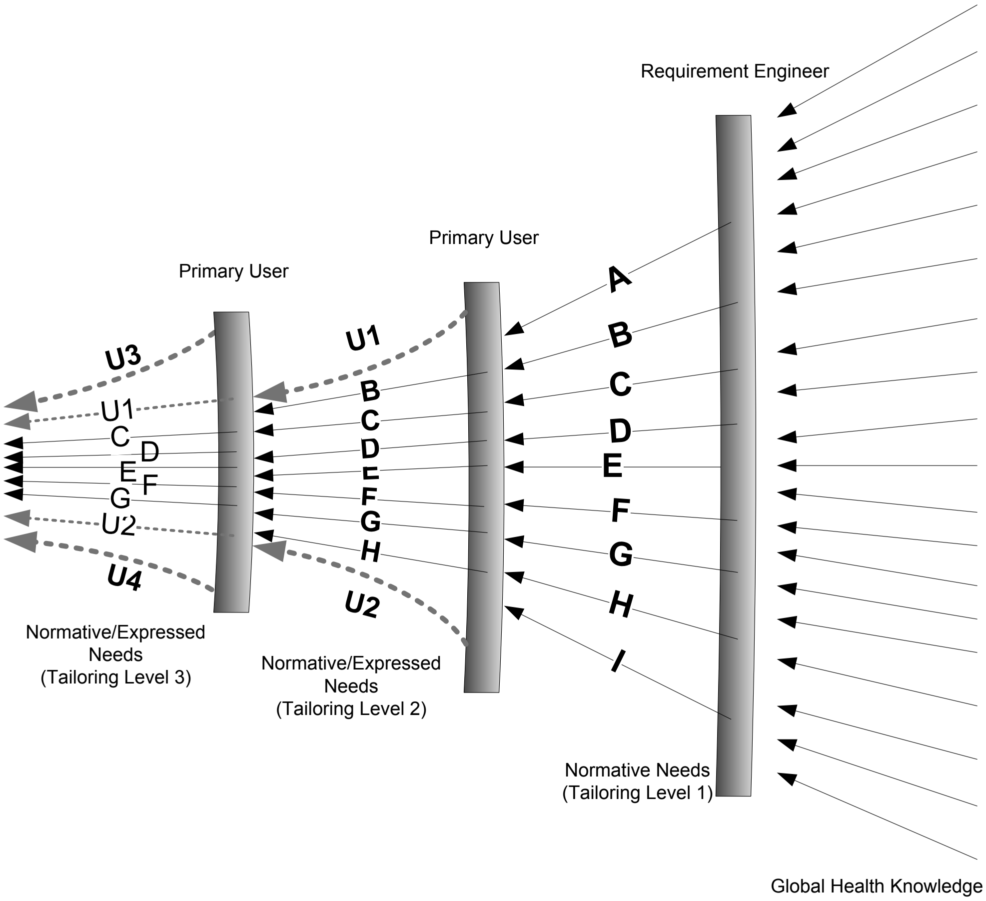


Figure 4-7. Our proposed telescopic viewpoint tailoring approach. As shown from nine viewpoints of A-I, only five viewpoints could match the particular preferences of the primary users and passed

through their filter. In addition, primary users contributed additional four original specifications of their own which are shown as U1-4.

We will use an example from Campus-HITS to clarify the telescopic approach proposed. In Campus-HITS, for the first level, we shortlisted the relevant local to global/international domain experts, resources and artifacts into a manageable list of exemplar Web sites and local health professionals. In the next step, we elicited and analyzed the knowledge requirements from these sources and produced a primary hierarchy of health topics that were agreed upon by the domain experts (and the Web sites). We then shared the list (as a taxonomy of recommended health topics) with the representative students and asked them to share their areas of likes or dislikes about the topics (while allowing them to include their own). We can repeat the negotiation until appropriate agreements are achieved.

4.2.5.2 Prioritizing/Reasoning

We often need to prioritize the areas of agreement either to determine the appropriate focus of content or to rule out the areas of less agreement (when the areas of agreement are more than can be managed). An example of the former case would be sorting the agreed health topics to build a topic menu (navigation menu) with several levels. In this case, we may want to know which health topics (or topic categories) are the most preferred to appear in the first level. An example of the latter is when the knowledge elements suggested and agreed by all stakeholders should be reduced to half for a particular design project. In each case, such sorting is only possible if a weighting feature is included.

To enable sorting, we include ranking in our framework. We add two metadata fields of “association rank” and “association rank type” to the association element set (i.e., association record). The rank field contains the value for the rank (potentially any number or string), and the rank type specifies the ranking scale used. To use a rank type, it first has to be introduced to the topic database, explaining the title, the scale it uses, and its reference (Figure 4-8). For instance, the university students in the example explained earlier, may show their interest regarding the inclusion of Author’s Name in a Likert style questionnaire valued from -2 (strongly disagree) to +2(strongly agree). They may also share their perception regarding the usefulness of Frequently Asked Questions as a knowledge element on a scale of 1 (useless) to 5 (very useful). In either case, similar to the scoring method suggested by Menzies et al. (1999) and particularly the variability analysis by Gonzales-Baixauli et al. (2004) , we can sort the overall interest regarding a particular topic or element by adding up all the ranks given in the supporting expressions and considering that as topic or element score. By enabling a precise sorting method, we expect to prevent over-emphasizing one requirement over the others, which is one of the biggest risks of requirements engineering (Boehm and In, 1996). We would also address the issue of incompleteness, in which the requirements of lesser value (low rank or low occurrence rate) are saved until sufficient rates are achieved over time.

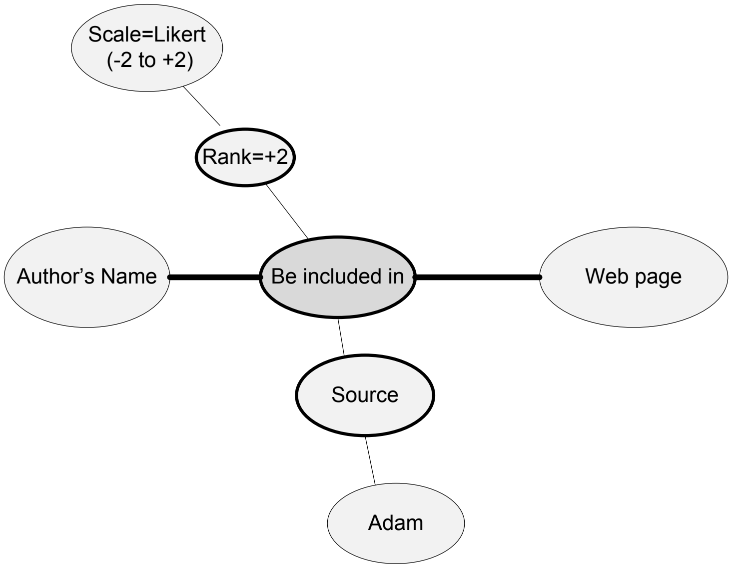


Figure 4-8. A single viewpoint (by Adam) strongly supporting (rank +2 in a Likert-style five level scale from -2 to +2) the inclusion of Author's Name in a Web page (metadata bubbles are not shown)

4.3 Our ontology of concepts, features, and base models and techniques for knowledge requirements engineering

To summarize the above, we have mapped the concepts, features, base models, and techniques discussed and selected for a knowledge requirements engineering model supporting design of a KIEHA application in an ontology/taxonomy (Figure 4-9). We built this self-descriptive ontology for three purposes, first, to show the particular aspects of requirements engineering we covered (and discussed) in this dissertation; second, to highlight our selection of main models and techniques we used as basis to propose our framework; and third, to demonstrate the theoretical foundations of our framework by including appropriate references.

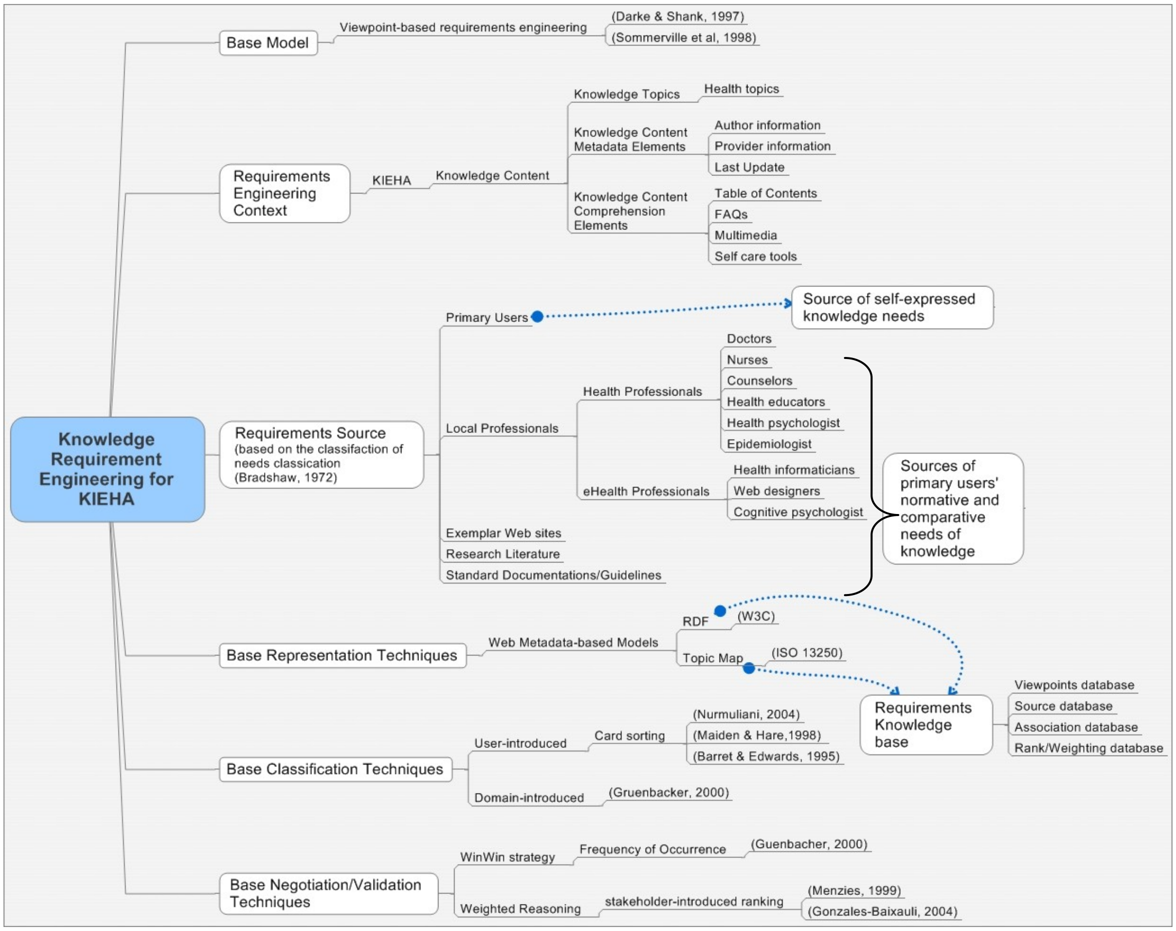


Figure 4-9. The ontology of features and concepts selected and discussed for a knowledge requirements engineering to support design of an eHealth application

4.4 Telescopic Dynamic Metadata-based Knowledge Requirements Engineering Model (TDM-KREM)

We propose Telescopic Dynamic Metadata-based Knowledge Requirements Engineering Model (TDM-KREM) as an effective framework to elicit, analyze, validate and specify the knowledge requirements of quality health knowledge content in the context of knowledge-intensive eHealth application. We characterize the framework (or model) as:

1- **Telescopic**, which enables eventual tailoring of local to global viewpoints regarding various knowledge needs of individuals. According to the telescopic approach, agreed recommendations of domain experts (or related resources or evidences of best practices) are examined against the preferences of target recipients of health knowledge in an iterative way until appropriate agreement is achieved.

2- **Metadata-based**, which uses ideas from Topic Map and RDF to associate requirement specification with underlying statements, requirement statement with supporting viewpoint expressions, and viewpoint expressions with the stakeholders owning the viewpoint. By enabling such Web representation standards, part of or the entire requirements engineering process could be posted and shared on the Web for collaboration and further reuse and revisions. In addition, such a network of association strongly supports traceability, with which an external viewer could trace a requirements specification to its root (the supporting viewpoints).

3- **Dynamic**, which keeps the requirements database open to new inputs from any stakeholder throughout the lifecycle of an application. In addition, the date stamps of viewpoints and association will also allow occasional revisions of the viewpoints based on some intervals.

Figure 4-10 shows a visual representation of TDM-KREM. The following features are demonstrated in the TDM-KREM scheme:

1- Telescopic /multi-viewpoint: The scheme represents the capability of the framework to accommodate multiple viewpoints originating from a variety of relevant stakeholders (e.g., Primary user (PU1), local professionals (LP), exemplar Web site (WS), and research literature (RL)). It also shows how normative viewpoints from LP, WS, and RL are used as a basis by primary users to classify their expressions. In addition, primary users are allowed to contribute to the original basis (as in V7 and V8 both supporting S3). Furthermore, the statements resulting from the first iteration of requirements elicitation are shared with a second group of users for their supporting or opposing viewpoints. As shown, the second requirement statement (S2) from iteration one has not been agreed by the primary users of the second iteration (PU2) and thus was not identified as eligible to proceed to specifications. Rather, S4 has been contributed originally by the users (PU2).

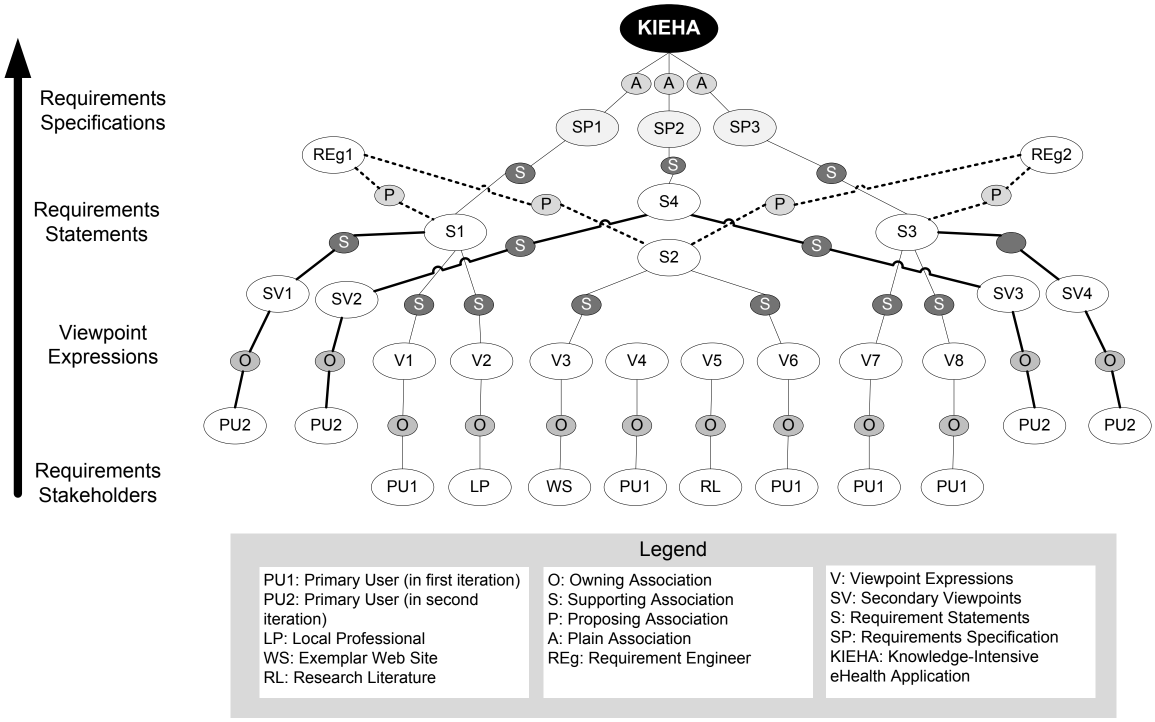


Figure 4-10. Telescopic Dynamic Metadata-based Knowledge Requirements Engineering Model (TDM-KREM)

2- Metadata-based: Although the scheme does not show the metadata richness of the requirement components (e.g., viewpoints and associations), it shows the Topic Map based semantic association of all the related concepts in an interconnected network of requirement entities.

3- Traceability: Every specification (SP1-3) listed in the requirements specification (on top) can be traced back (pre-traceability) to its supporting statements, expressions and stakeholders.

4- Transparency: Every viewpoint or statement is transparently linked with related requirements stakeholders, including the requirements engineer (REg). This is made possible by defining varying association roles between a topic (e.g., a statement) and the related individuals. For instance, the requirement statements S1-3 have been marked as proposed (P associations) by requirements engineer(s) and as supported (S associations) by several viewpoint expressions.

To keep the scheme's complexity manageable, we did not include the dimension of evolution of the requirements over time. However, we have left a clue. Viewpoints four and five are both left as orphans because of insufficient support. This may happen, e.g., in a case when a new health topic has arrived (and been identified, e.g., by local health professionals) and the primary users are not yet aware of (e.g., a new drug) and thus are not supportive of that topic. On the flip side, some of the primary users may become interested in some new type of knowledge elements (such as a new question & answer feature) whose values are not yet recognized by the professionals or the other primary users. In both cases, the viewpoints are not discarded. Rather, they will be saved for further revisions.

4.5 Research Questions (Evaluation)

To evaluate our framework, we extended the four research questions we primarily asked in Chapter 1, as follow:

1- Can we develop requirements engineering techniques and methods that accommodate multiple viewpoints, support traceability and requirements change over time?

2- Can we use such requirements engineering methods as the basis to specify the quality knowledge requirements of an eHealth application?

3- How will the primary users of an eHealth application perceive the quality of knowledge elements selected for inclusion using the proposed requirements engineering framework? Specifically, will they recognize those elements as pieces of knowledge that,

  a. are required in the application,

  b. contain useful information,

   c. make the application look credible, and
   d. match their overall interest?

4- Will the knowledge requirements specified using the proposed framework support the design of quality knowledge content for an eHealth application? More specifically, will these specifications, if used as the basis of design,

   a. improve the quality of an exemplar search engine in such a way that it helps the users choose the health resources they actually prefer?
   b. improve the quality of an exemplar health Web site in terms of ease of use, wealth of health topics, content organization, and overall quality?

4.6 Overview of the research study

The goal of the research study is to demonstrate the practicality of the requirements engineering framework proposed in this dissertation (and the validity of the requirements specifications being produced) through an attempt to design a campus health Web site/page targeting university students. The study has four phases:

4.6.1 Phase 0

The goal of Phase 0 is to capture/extract the variety and types of common knowledge elements (topics, metadata, and content comprehension) being used within the current examples of related best practices (i.e., selected quality health Web sites) as sources of normative and comparative knowledge needs of the target consumers. Aggregating the collected viewpoints, we would expect to come up with a substantiated primary set of knowledge elements that could represent the norm of knowledge wealth across the exemplar Web sites or the recommendations and advice by related professionals.

4.6.2 Phase I

Phase I aims at eliciting the knowledge requirements from two sources of requirements: 1- the health professionals (doctors, nurses and counselors on campus) who are particularly related to or familiar with the health information needs of the target consumers and

2- the target health consumers (i.e., students). Both approaches will employ one-to-one interview sessions with representatives of both populations to gather the relevant data.

4.6.3 Phase II

The goal of Phase II is to conduct a co-design approach through which another group of consumer representatives would be instructed to follow a three-step knowledge artifact design (topic collection, element selection, and presentation assignment) and to build their preferred form of quality knowledge artifact (a consumer health Web page) on a particular topic. In this approach, the participants will evaluate the set of topics and elements captured during Phases 0 and I and may re-assess their choice by being given the chance to see the result of their selections.

4.6.4 Phase III

The goal of Phase III is to evaluate the final set of knowledge elements and topics selected as a quality knowledge requirements specification through a series of interview sessions with a group of student participants. During this Phase, the participants will be asked to evaluate each of the elements in the final set of requirements and to compare two knowledge artifacts (a health resource index and a student health Web site) built based on the final set against other knowledge artifacts designed based on conventional methods. The result of the Phase III tasks will be used to answer our research questions.

Chapter 5: Methods

This chapter presents a detailed view of the qualitative-quantitative research design and methods we employed to collect the data required to address the research questions outlined in Chapter 4. The chapter provides an overview of our four-phase study design, the recruitment process, the materials (hardware and software) and methods we used to collected the data, and the procedure we followed in each phase to perform the related tasks. A brief review of the analysis methods will end the chapter.

5.1 The Scope

This study concerns a requirements engineering approach, based on our framework, to support design of a student health Web site. During this study, we will specify and assess the quality of the knowledge requirements for the content of an example health education/promotion Web site (as an instance of KIEHA) targeting students at the University of Victoria (UVic). The scope of KIEHA and knowledge content in this research follows our definitions in Chapter 3.

To avoid unnecessary complexities, we considered the Campus-HITS Web site to be a collection of health Web pages sharing the same set of knowledge specifications (but concerning various health topics), and linking to each other through their health topic menu (i.e., navigation menu) (Figure 5-1). According to this architecture, each health topic Web page is considered as self-contained and with the full range of Web site controls, e.g., navigation menus, search bar, etc. Using this rationale, while we specified the variety of health topics for the entire Web site, we specified only one set of knowledge requirements, which would be applicable to all the related health Web pages. In other words, we specified the knowledge content of a generic student health Web page that contains a full health topics menu plus a set knowledge elements that represent the pages' content.

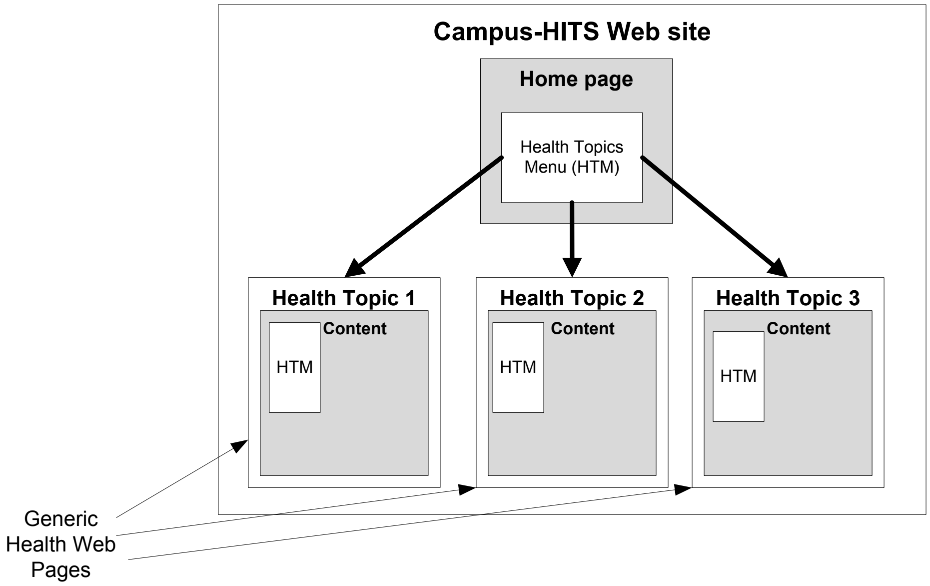


Figure 5-1. The defined architecture for the Campus-HITS Web site. As shown, except the home page, which includes the health topics menu as its main content, the Web sites consist of generic health Web pages sharing an identical health topic menu and a common set of knowledge specifications.

We limited the scope of the requirements sources to the following individuals and resources:

1- Local health professionals on UVic Campus as sources of normative needs.

2- Exemplar health Web sites as a source of normative and comparative needs.

3- University students (primary users) as the source of expressed needs.

The research was not content-specific. In other words, we did not build/write the actual page content. However, some of the techniques and tasks we used to elicit the requirements compelled consistency of content (e.g., health Web site analysis). For example, to analyze the content elements of the exemplar health Web sites we needed to extract one representative health Web page from each Web site. For such cases, we chose Sexually Transmitted Disease or its equivalent Sexually Transmitted Infection (STD/STI) as the particular content representative. We chose STD for two reasons: First, it is one of the few health topics that concern both dimensions of health promotion activities, wellness (e.g., safe sex, birth control) and illness (diseases and their consequences). Second, we found STD a health topic common to all the university Web sites. Nonetheless, we would not consider our knowledge requirements specifications to be biased toward any particular health subject.

5.2 Study design

Two types of study design were employed throughout the four phases.

1- Descriptive-analytic: We used a descriptive-analytic design in Phases 0 to III. We analyzed the exemplar health Web sites' content and the subjects' descriptions of their preferred health Web sites for their suggestions regarding an appropriate set of information for a health Web site. We also measured the subjects' level of interest in various types of information selected to be included in a health Web site.

2- Experimental: Experimental design was used in Phase III. We modified one search engine and two health Web sites (based on results from our descriptive-analytic approach) and measured the subjects' reactions in the pretest (using the original designs) and posttest (using the modified designs). The design was single-blind as the Phase III subjects were kept blind in terms of differentiating the modified versions from the originals. In addition, randomization was used to minimize the order-bias. We randomly set up the order of testing for the original and modified designs.

In the following sections, we describe and discuss in greater detail our study design including phasing, recruitments of subjects, materials, and the methods we used to elicit the requirements data and to run the analysis. Due to the volume of content regarding the data collection and analysis methods, we discuss those in separate sections.

5.2.1 Phasing

We designed a four-phase study plan (0-III). As described in Chapter 4 (Section 4.6), Phases 0 to II concern various activities of knowledge requirements engineering that will be conducted to specify the knowledge content of a generic health Web page in the Campus-HITS Web site (i.e., development phases). The order of activities in Phases 0-II was designed according to our proposed telescopic approach (Figure 5-2). As shown in Figure 5-2, in Phase 0 we analyzed a selected number of health Web sites (for their wealth of health topics and content elements) and interviewed some health professionals on campus for their recommendations on the topics and elements, then documented all viewpoints as a primary set we called CHEKES I (Campus-HITS knowledge element set-I). In Phase I, we interviewed the first group of students (called Primary Users 1) and included their viewpoints into the primary element set (now called CHEKES II). In Phase II, we interviewed a second group of students and asked them to assess the health topics and elements listed in CHEKES II using questionnaire scales. We added their viewpoints into the element set and finalized the set as CHEKES III. Phase III consisted of a quantitative-qualitative evaluation regarding the user-perceived quality of CHEKES III elements and two types of knowledge artifacts built based on those elements (and topics). In the following, we will describe the phases in more details.

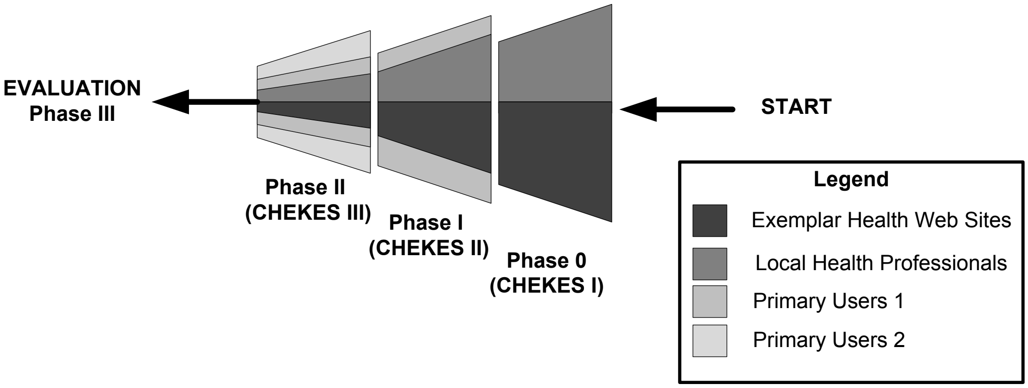


Figure 5-2. Our four-phase study design reflecting the sequential steps in a telescopic requirements engineering approach. As demonstrated, in each phase the normative view of knowledge elements is more and more tailored to the particular needs of the primary users.

5.2.1.1 Phase 0

The goal of Phase 0 was to capture/extract the variety and types of common knowledge elements being used within the current examples of related best practices (of related health Web sites) or recommended by local health professionals. As explained in Chapter 4 (Section 4.2.5.1) regarding the telescopic strategy, we used the requirements data from this step (normative needs) to build a domain taxonomy (e.g., of health topics) and use it as the basis in Phase II to elicit the primary users' viewpoints. To elicit the viewpoints, we chose to conduct interviews with local health professionals to gather their particular recommendations (Level 2). In addition, we selected and sorted a list of exemplar student/consumer health Web sites whose analysis would reveal the recommended set of knowledge requirements. Aggregating all of the above, by the end of Phase 0 we would expect to come up with a substantiated primary set of knowledge elements (CHEKES-I) that would contain elements that were either reasonably common among the current examples of selected artifacts or particularly emphasized by relevant health professionals during the interviews.

5.2.1.2 Phase I

The goal of Phase I was to obtain/capture the preferences of the primary users (i.e., students) regarding the CHEKES set of requirements. To enable direct communication with primary users, we planned several interview sessions with representatives of the primary users' population during which the participants would perform a series of tasks and fill out a computer-based questionnaire. The participants in Phase I were also asked to describe the exemplary elements of their (three) favorite Web sites for their potential peer audience. We would expect to use the results of Phase I as a basis to further enhance, modify and/or eliminate the elements from CHEKES I requirements set (then called CHEKES II).

5.2.1.3 Phase II

The goal of Phase II was to conduct a co-design approach through which another group of student participants would be instructed to follow a three-step knowledge artifact design (topic collection, element selection, and presentation assignment) and build their preferred example of a generic health Web page on a particular topic. Using this approach, we would expect not only to capture the users' preferences regarding various CHEKES II elements but also to allow a holistic co-design approach through which the participants would have opportunities to optimize their final design for maximum usability and usefulness. We would expect the result of Phase II to enable the final revision of CHECKES II (now called CHEKES III).

5.2.1.4 Phase III

The goal of Phase III was to evaluate various aspects of the final requirements specifications, CHEKES III, using another group of student participants, in three steps:

1- to measure the users' attitude toward a health Web page when it includes each of the CHEKES III elements;

2- to measure the compared usability and usefulness of a simulated Google-like search engine (we called it Simulated Google) when it uses selected CHEKES elements to index the Health Web pages to a conventional Google index; and

3- to measure the attitude of users (in various dimensions) toward a student health Web page that is based on CHEKES III compared to those based on conventional structures but sharing the same content and graphical interface.

5.2.2 Site Selection and Subject Recruitment Methods

We used various methods to select the exemplar health Web sites, and to recruit the health professionals and students, as our three sources of requirements data. We will discuss each below.

5.2.2.1 Selecting Exemplar health Web sites

To portray the existing norm of health topics and knowledge elements by related health Web sites, we needed to find a reasonable number of exemplars as the knowledge artifacts for which at least some characteristics could be regarded as praiseworthy by the related (national-international) knowledge experts (and thus representing their viewpoints). Considering the scope of the study using the telescopic approach, we identified various types of relevant Web sites as example areas of best practice that are: 1- local-national (Canadian) health Web sites; 2- international health Web sites. In addition, considering the target audience, we identified two other categories of 1- student health Web sites (more specific), and 2- consumer health Web site (more general). We should emphasize that our rationale to include the international exemplar Web sites was first to include some broader viewpoints in regards to the domain of requirements, and second to increase the quality of recommendation by including those quality Web sites that are not necessarily Canadian but are internationally high-ranked health Web sites. While there is no particularly recommended sample size in such qualitative approaches, we found 20 exemplars with the following distribution a convenient and adequate number to uncover the commonly used knowledge elements across quality Web sites. Our objective as to identify:

1- Five top international/global consumer health Web sites.
2- Five top Canadian consumer health Web sites.
3- Five top international student health Web sites.
4- Five top Canadian student health Web sites.

We defined criteria to search and locate the exemplars for all the groups (Table 5-1).

Table 5-1. Our criteria to select the exemplar Web sites

1- Must be in English.
2- Must offer original (also called self-party) health knowledge/information content (rather than administrative or directory services).
3- Must cover a fair variety of health topics particular to the target group (rather than Web sites focusing on specific health topic such as diabetes or nutrition).
4- Must have a trusted professional provider (governmental, academic, and major known organizations or institutes).
5- Must be a TOP Web site in terms of their content quality and NOT only or primarily the interface design, according to some objective ranking.

A major challenge here was to locate matching Web sites from tens of thousands of available health Web sites. The first issue was that, except for language, no search engine was available to sort the Web sites based on the above criteria. In addition, we found no practical standard scale to rank the tens to thousands of health Web sites in each category (to choose the top five), but creating an original substantial ranking tool was also far beyond the scope of this study. Therefore, we switched to a more manageable approach.

We shifted the order of the criteria and began the filtering with a number of already available lists of top trustworthy Web sites (Criterion 5). The most prominent lists we found for the consumer health Web sites were the “Top 100” and “Top Ten” lists provided by the Medical Library Association (MLA), available at CAPHIS (www.caphis.mlanet.org) or MLAnet (www.mlanet.org). However, while the supposedly international MLA list was helpful with the first category (top generals), it surprisingly lacked almost any Canadian health Web sites. Luckily, the problem had already been perceived by CHIPIG (Consumer Health Information Providers Interest Group) from the Canadian Health Libraries Association and a similar list, Top Ten Canadian Health Web Sites, is available (at http://www.chipig.ca/TopTenCHIsitesCHLA2006.pdf). As claimed in the report, CHIPIG has used the same criteria as MLA to rank the Canadian Web sites, including credibility, sponsorship/authorship, content, audience, currency, design, etc.

Our last step to select a final five top (for general international and Canadian Web sites) was to examine every Web site (from the top-ranked sites) against the criteria described (Table 5-1). We had no particular problem finding the five top general health Web sites. However, the selection of two Web sites may need some clarification: the first was the teen health Web site (teenhealth.org), which appears on both the “Top Ten” and “Top 100” as kidshealth.org, which is the mother Web site for teenhealth.org (but is the same Web site). The second was Medlineplus.org by the National Library of Medicine. Medlineplus offers a combination of directory (or portal) type pages and pages with original or self-party content, and therefore would partly violate the number 2 criterion. However, some of its unique characteristics, such as being the number one worldwide consumer health Web site with millions of worldwide visitors every month (MedlinePlus, 2007) and also the broad similarities of its page content and structure elements to the ones from content-rich consumer health Web sites, convinced me to ignore the violation and include it.

We had more issues regarding the Canadian health Web sites. We found only three out of ten top Canadian Web sites met the criteria, while the other seven either held only a directory page to other health Web sites (violating criterion 2) or was limited to a particular group or topic, e.g., kids, diet, etc., that was irrelevant for our study (violating criterion 3). As result, we added two other known and relevant Canadian Web sites:

1. Canadian Teen Health Web site, produced by a partnership between the Nova Scotia Capital District Health Authority and Medical Informatics group from Dalhousie University, and
2. Sexuality and You Web site, a popular health promotion Web site administered by the Society of Obstetricians and Gynecologists of Canada (SOGC), thus completing the list of five.

Again, we had two minor violations:

1. Canada Health Portal is mostly a directory/portal oriented Web site, but for reasons similar to the ones we explained for Medlineplus we let it in.
2. Sexuality and You may not be titled as a general health Web site (which we defined as the Web sites covering many varieties of health topics). However, the Web site is a number one reference Canadian health Web site for sexual health and teens/young adults. Hence, we found both its health subject of focus and its target audience match which is the particular focus of the KIEHA in this; and thus we put it in.

Table 5-2 shows the list of the Web sites finally selected for the first two groups.

Table 5-2. Ten top global and Canadian consumer health Web site and their URLs

Category	Web Site Title	Web Address
Top five global general consumer health Web sites	1- MedlinePlus	http://www.medlineplus.org
	2- Familydoctor.org	http://familydoctor.org/
	3- MedicineNet.com	http://www.medicinenet.com/
	4- Mayoclinic	http://www.mayoclinic.com/
	5- Teen Health	http://www.teenhealth.org/
Top five Canadian general consumer health Web sites	6- Canada Health Portal	http://chp-pcs.gc.ca
	7- Health Canada/CHN	http://www.hc-sc.gc.ca/
	8- BC Health Guide	http://www.bchealthguide.org/
	9- Teen Health	http://www.chebucto.ns.ca/health/TeenHealth/
	10- Sexuality and You	http://www.sexualityandu.ca/

By contrast, while there were a wide variety of ranking lists for universities (overall), we found no major ranking list based on the student health Web sites (international or Canadian). There was also no evidential correlation between a university scale or rank (at the national or international level) and the type or quality of their health information Web sites, if they had a rank. Therefore, we used a compromise approach and scanned the ARWU list of the top 500 global universities (Academic Ranking of World's Universities - available at http://ed.sjtu.edu.cn/ranking.htm). We shortlisted the 50 top English-based universities into a manageable list of 20 top global sites that conformed to our four criteria and randomly picked five. It is noteworthy that although a few non-U.S. English universities (e.g., Cambridge, Oxford, etc.) were among the top 50 global sites, only the U.S. universities comprised health Web sites that fit all the criteria. Furthermore, ARWU lists only 22 top Canadian universities, of which only five passed the criteria. Table 5-3 shows the final selection for both university categories.

Table 5-3. Ten top international and Canadian student health Web site and their URLs

Category	Web Site Title	Web Address
Top five global university health Web sites	1- University of Princeton	http://www.princeton.edu/
	2- Stanford University	http://stanford.edu/
	3- University of Wisconsin	http://www.wisc.edu/
	4- University of New York	http://www.nyu.edu/
	5- Harvard University	http://www.harvard.edu
Top five Canadian university health Web sites	6- University of Toronto	http://utoronto.ca
	7- McGill University	http://www.mcgill.ca/
	8- University of Ottawa	http://www.uottawa.ca/
	9- University of Calgary	http://www.ucalgary.ca/
	10- University of Victoria	http://www.uvic.ca/

The final step in the Web sites' selection was to locate their representative health Web page or STD Web page. We checked each Web site's topic menu and located the main health Web page related to STD information and saved their URL for further analysis. Appendix 1 shows the complete list of the Web sites and their STD pages we selected.

5.2.2.2 Subject Recruitment: Local health professionals

We recruited six local health professionals (two physicians, two nurses, and two counselors). The rationale for choosing the professionals of the above three types was to have representative professionals from the entire health topics spectrum on campus (physical health to mental health).

To recruit the professionals, we first contacted the directors of both related departments, Health Services and Counseling Services at the University of Victoria, and explained the study goals, procedures, reimbursements, etc., and attained their initial approval for recruitment. For reimbursement, we decided to pay a flat rate of $100 to all the health professionals. A recruitment letter was prepared explaining all of the above in detail and sent off to both departments, to be distributed among the relevant health professionals. Interested health professionals (chosen by the related director) were then contacted and informed about the details of the interview procedure and a schedule was set according to their availability. Using this method, we recruited the six local health professionals: two physicians, two nurses, and two counselors.

5.2.2.3 Subject Recruitment: Students

We defined criteria to recruit the student subjects (Table 5-4). We recruited only students who attended (at the present time) academic programs at the University of Victoria, were between 18 and 21 years old, and were native or fluent English speakers. The latter would allow us to avoid the possible effect of a language barrier on the quality of interview communications since every statement was valuable as a proof of consumer comments or feedbacks. We also limited the age range of volunteers to 18-21. Our rationale was that students in this range (the end of adolescence) would have many commonalities on age-related health concerns compared to a broader age range of university students. This consistency of user characteristics would also save us a reasonable amount of time that we would otherwise need to process the possible extra complexities of students' viewpoints on various requirements due to their age differences.

Table 5-4. Our recruitment criteria for student subjects

- Must attend an academic program at the University of Victoria
- Must be native or fluent English speaker
- Must be 18-21 years old

We used a research participation pool run by the Psychology department at the university (the Psychology Research Participation Pool - PRPP) to recruit the subjects. In this pool, students from a variety of undergraduate programs that include Psychology 100A/B courses are required to participate in approved research projects and to earn a particular number of credits for their participation as part of the course assignments. In addition, the entire recruitment, student enrollment, and credit assignment are conducted using a central Web interface available to the pool's committee, the interested researchers and students. PRPP uses the SONA online experiment management system (http://www.sona-systems.com) to facilitate the recruitment and credit assignments. To recruit the participants using the SONA system, researchers of projects approved by PRPP's committee can post their recruitment ads, including a description of the tasks involved and their recruitment restrictions and prerequisites, on the SONA Web site and have the eligible participants voluntarily sign up for the study. Then, students who wish to participate will sign up for a time of their choice from those posted by the experimenter.

We posted the recruitment ad for each phase approximately one week before the planned interview schedules. Overall, we recruited 35 subjects for Phase I (we called it the Primary Users-I group), 20 for Phase II (called the Primary User-II group), and 10 for Phase III (called the Evaluation group), for an overall number of 65. No cross-participation was allowed across phases.

5.2.2.4 Student Helpers

We hired a number of student helpers to help us pilot test the study tasks (for each phase) or to make small decisions regarding minor elements or topic selection. The student helpers were a group of seven undergraduate students who had already participated in the

PRPP program or were in it at the present time. In both cases, we found it reasonable to consider them valid representatives of the student population. We will call them student helpers or advisory group in this dissertation.

5.2.3 Materials

We used a combination of hardware and software settings to enable user input, recording and backups during the interview sessions and the data analysis following each phase. We also used a variety of software to organize data and run the statistical computations and analysis after each phase. Below, we will explain our choices and related rationales for each category.

5.2.3.1 Hardware & Software: Interview sessions

A number of hardware and software settings and types were used to enable the following three functions in the interview sessions:

1- **User input**: The setting consists of several hardware and software components to enable data input and analysis, session recordings, and backup. We designed and used a fairly original hardware and software setting to capture the participants' direct input (using keyboard or mouse), and verbal/non-verbal comments or feedback. For the hardware setting, we used the dual presentation software on a laptop (IBM T41P) and set up a T-shaped dual-display computer (Figure 5-3) so that the second display, while sharing the same desktop, uses a wireless keyboard and mouse, enabling a second user (e.g., the participant) to interact with the interface. We used the T-shape position of the displays to be able, first, to directly observe the participants (by having them in direct sight), and to monitor and follow their gestures while interacting with system, and, second, to reduce the possible feeling of discomfort that may be caused by direct counter display positions (face to face). We originally tested the design with the advisory group and we found them reasonably comfortable with the T-shape setting.

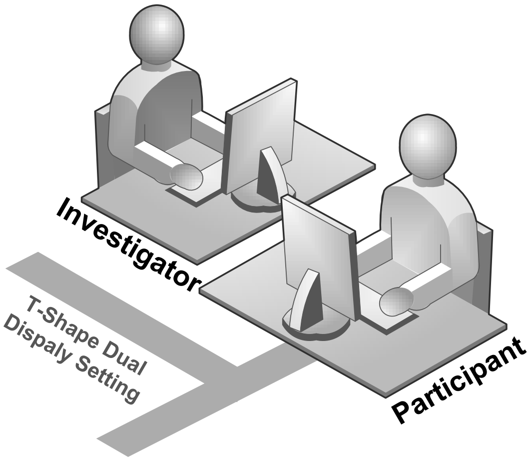


Figure 5-3. T-shape dual display design for the Campus-HITS human-computer interaction lab. In this setting, the participant's display is set at a 90 degree angle to the investigator's display so that the researcher faces the participant and her or his screen while the participant faces only the second display.

On the software side, we chose a number of commercial applications either to design the tasks we would use during the interview sessions or to use as a medium for user data input. We used Mindmanager Pro (version 6.0) to run the multi-scale questionnaire and brainstorming (Phase II and III), Microsoft Visio (2003 and 2007) for co-design tasks (Phase II), and the form features of Microsoft Word (2003 and 2007) for the questionnaire and forms we used to capture direct user input (Phase I, II, III).

2- **Recording**: We recorded the participants' input in four different ways:

  a. file-based recording of the direct input, e.g., keyboarding into the software (such as questionnaires, forms, co-design tasks);

  b. Audio/video (AV) recording of the happenings on the computers plus the verbal comments by the participants, using a commercial screen recording application called Hypercam (version 1.3);

  c. Audio recording of the verbal comments (duplicate) using an external digital voice recorder; and

   d. paper-based recording (notes) from our direct observation of participants interacting with the computers during the sessions.

3- **Backup:** As an incident such as a computer crash could easily corrupt both the video and the questionnaire/co-design interface, and a hard drive failure could destroy the study's data in a moment, a seamless backup is always critical. In our lab setting, we used an original double synch and backup method to protect the data against the above two issues. We used two external USB-based hard drives, in parallel, one storing a real-time synchronized copy of the session files while the other kept a mirror copy of the first in an after-session incremental backup procedure. Using this method, we not only maintained a real-time copy of our data but also saved most of the lengthy backup gap (during which the computer was unresponsive to additional required tasks) we had to spend between two sequential sessions in order to perform incremental backups. Figure 5-4 briefly summarizes the overall lab setting explained above.

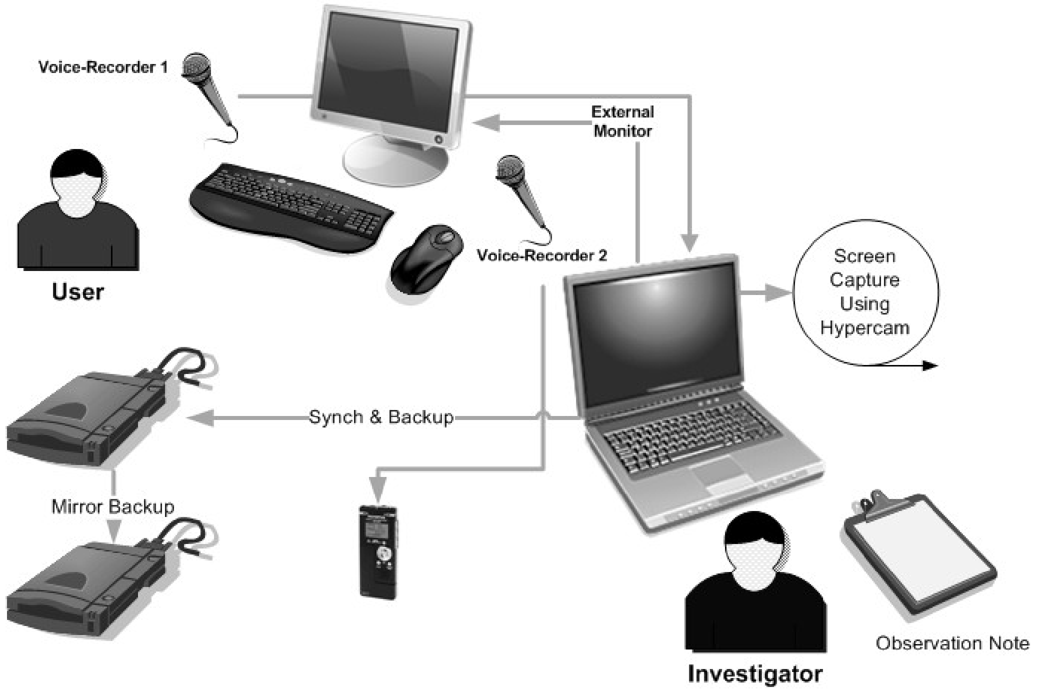


Figure 5-4. The overall lab setting we designed to enable the user input, recording and backups during the computer-based interview sessions.

5.2.3.2 Hardware & Software: Analysis

We used four commercial applications to perform the statistical analysis and the requirements representation tasks. We used Microsoft Excel (2003 and 2007) and SPSS 15.0 to organize and analyze the requirements data, Oxygen XML editor (version 8.0) for the XML related tasks, Microsoft Access (2003 and 2007) to build and analyze the relational databases. Once again, the choice between both above applications and their competitors were made based on their availability of application to the investigator and his familiarity with the interface.

5.3 Data Collection Methods

In general, we employed two types of data collection methods: one to elicit the primary or original viewpoints, and one to capture the secondary viewpoints. The former concerns those requirements elicitation tasks during which the requirements stakeholders (the Web sites, professionals and the primary users) share their original viewpoints regarding inclusion of knowledge topics or elements, e.g., the wealth of health topics and topic categories suggested by an exemplar Web sites. The latter relates to the tasks during which e.g., a user evaluates another stakeholder's viewpoint and decides on his or her level of like or dislike (or agreement-disagreement). We have marked the first type in our TDM-KREM (Figure 4-10) with "O" or owned viewpoints, and the second type with "S" as supporting (in various levels) viewpoints.

5.3.1 Primary viewpoints elicitation (Phases 0-II)

In compliance with the techniques we selected in our framework (as explained in Section 4.2.4.2 and 4.2.5.1), we employed a card sorting method similar to the approaches by Maiden and Hare and also Nurmuliani et al. (Maiden and Hare, 1998; Nurmuliani, Zowghi et al., 2004) but operationally based on the operational guideline by Hudson (2005). The card sorting approach helped us to elicit the primary viewpoints and classify them at the same time. A major difference between common card sorting method and our method was that both card introduction and sorting was performed by the participants, whereas in the standard card sorting method, the participants' job is limited to sorting the already prepared cards. We also adapted the method to fit our metadata-based knowledge acquisition/representation model. In this adaptation, both card sorting and the following cluster analysis were performed through association creation and association integration as will be described below. Overall, every viewpoint (as a topic card) to be included in our requirements database and become classified underwent two steps:

5.3.1.1 Viewpoint entry (or topic introduction)

In this step, every health topic or knowledge element suggested by a participant or available on a related Web site (e.g., in their health topic menu) was appended into a viewpoint database created for this purpose. The viewpoints were collected in different forms, varying in the Web sites and the participants.

5.3.1.1.1 Web sites' viewpoint extraction/entry

When analyzing the exemplar Web sites' content, we assumed their health topics and knowledge elements being viewpoints of the related Web sites professionals (the health and eHealth professionals who developed (or contributed to) the Web site). Therefore, we extracted those viewpoints and included each as one viewpoint in the database. To run the analysis, we printed off the STD Web page for each health Web site. By STD Web page, we mean the Web page that provides rather general information regarding sexually transmitted diseases but that may or may not include specific sections for particular types of STDs. To extract the elements, we identified all the knowledge elements, marked them on the paper page, and assigned them labels. We designed criteria to identify elements. For a piece (or multiple pieces) of information/knowledge to be considered an element, it:

1- must NOT be a software or design-related feature or service such as email, Web-based form, print option, style, search, and so on.

2- must be available within the Web page frame. We defined the Web page frame as all the Web page's information whose content or a direct link to it is visible in the related browser's page, including the pop-up menu. Therefore, information available if users navigated through the entire Web site or used the search bar to locate it was ignored.

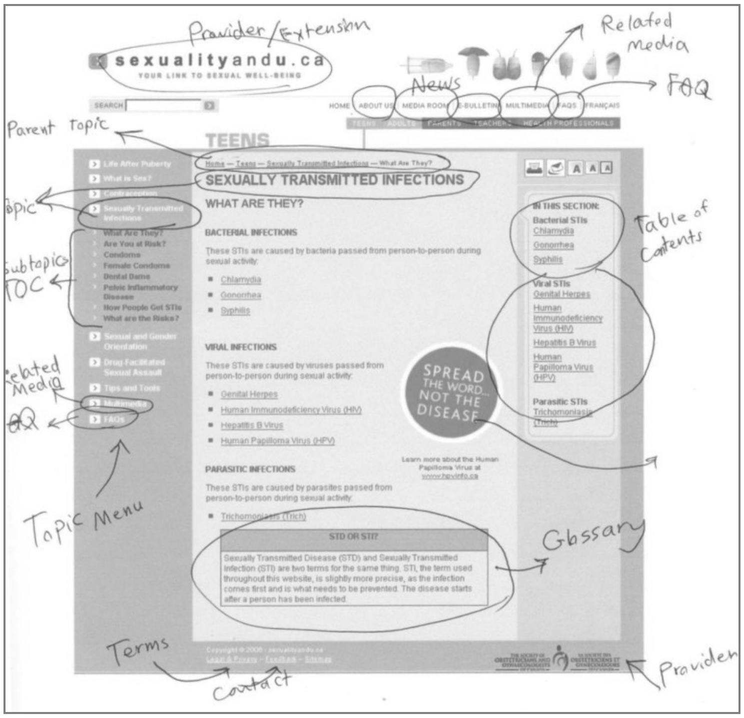
3- must provide information directly relevant to health information provision as the main purpose of the Web page. Therefore, administration and service information such as insurance information, appointments and forms, and staff directories, which were often available in the Web sites, were disregarded.

4- must be explicitly meaningful (and not just by assumption). For instance, a piece of information about a date such as "*02/03/06*" at the bottom of a Web page with no title or a logo without a textual title or information could not possibly refer to a clear element and was thus ignored.

We should also emphasize that we did not assess the usability or accessibility of the elements identified within the Web pages. For example, when a Web page presented the provider information in a line of text in a very small font at the very bottom of a long Web page, this element is virtually invisible from the users' and usability point of view. However, we assumed that such an inclusion would still represent its perceived importance by related experts and thus we included that in our data sheet.

Using the above criteria, we scanned the page and tried to divide the knowledge content of the Web page (excluding the design-related features) into meaningful chunks that could each represent a matching knowledge element. We marked each with a surrounding line and chose a label for it. Often, the information relating to a particular element was scattered across several design locations. For instance, the site title and logo in the logo bar, the organization title at the bottom, and more comprehensive information under the "About Us" link all belong to the same concept, which we labeled as "provider." In such cases, no matter how scattered they were, we considered all as one occurrence of the related element.

To choose the right label, we used our judgment and picked a common matching name. However, at the end of the analysis, we changed some of the labels to the titles/labels suggested by the exemplars. For instance, we changed "external links" to "online resources." Figure 5-5 shows an example analysis sheet for one of the Web sites (Sexuality and You Web site).



SEXUALLY TRANSMITTED INFECTIONS

WHAT ARE THEY?

BACTERIAL INFECTIONS

These STIs are caused by bacteria passed from person-to-person during sexual activity.

- Chlamydia
- Gonorrhea
- Syphilis

VIRAL INFECTIONS

These STIs are caused by viruses passed from person-to-person during sexual activity.

- Genital Herpes
- Human Immunodeficiency Virus (HIV)
- Hepatitis B Virus
- Human Papilloma Virus (HPV)

Learn more about the Human Papilloma Virus at www.hpvinfo.ca

PARASITIC INFECTIONS

These STIs are caused by parasites passed from person-to-person during sexual activity.

- Trichomoniasis (Trich)

STD OR STI?

Sexually Transmitted Disease (STD) and Sexually Transmitted Infection (STI) are two terms for the same thing. STI, the term used throughout this website, is slightly more precise, as the infection comes first and is what needs to be prevented. The disease starts after a person has been infected.

Figure 5-5. The analysis sheet for Sexuality and You Web site. Each surrounded area of content (plus their linked area, if there is/are one(s)), represents an identified element. The arrows point to the labels chosen at the time.

We experienced a few challenges here. One challenge was the inconsistency of the Web pages (across the Web sites) in their locations of elements. For instance, the last update information, if it exists, could be almost anywhere in various Web sites. The challenge increased when the page was cluttered with various content and design elements. In those cases, we used the Ctrl+F (text finder) option to search for variations of the element label, e.g., “updated,” “written,” “date,” to find their location within the page. Another challenge was to differentiate between design-related and subject-specific elements (that should not be included) and knowledge elements (that should be included). Although many of the design-related elements such as “RSS,” “listserv,” “print this,” and so on were clearly distinguishable, some, such as FAQ or Self-care charts, were sometimes so intermingled with the content that it was hard to decide if they represented a separate content element.

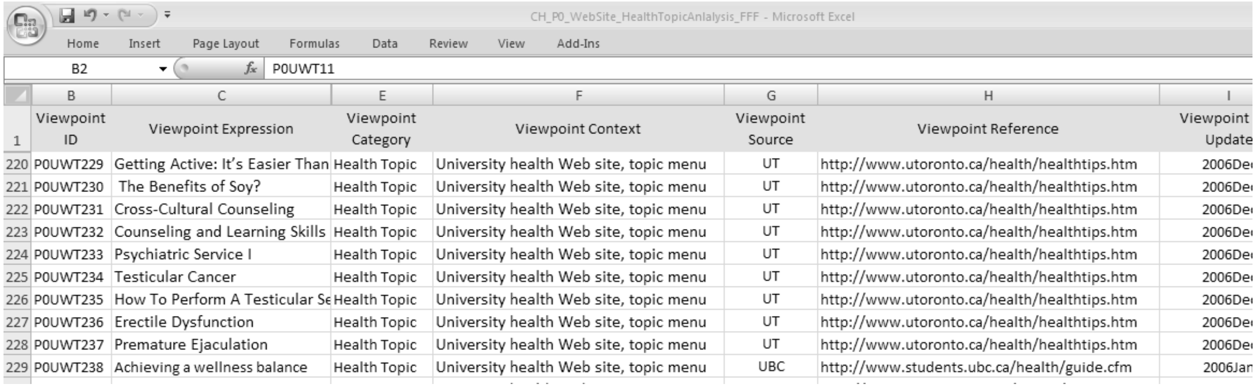
The analysis of health topics was different in two aspects:

1. We limited the domain of Web sites to include only university Web sites. The reason was that general consumer health Web sites would comprise almost all the health topics available rather than something particular, e.g., to an age group. The list of health topics were too broad to be used as a basis for university students.
2. It was important that the levels of topics in the Web site's health topics menu represent the priority of health topics for our target audience (i.e., students), which was not the case in general consumer health Web sites.

To record a viewpoint, we added a new record in the viewpoint database for each health topic. For instance, the student health Web site by McGill University suggested "Nutritional Health Matters" and "Nutrition and Stress" as a health topics of interest by students. We included these topics in the viewpoint database with their metadata information. The XML-based code below shows the record for "Nutritional Health Matters."

```
<viewpoint>
   <viewID>P0UWT619</viewID>
   <viewExpress>Nutritional Health Matters</viewExpress>
   <viewSrc>Student Health Site - University of McGill</viewSrc>
   <viewCtxt>Web site Health topic menu</viewCtxt>
   <viewCtgy>main topic category</viewCtgy>
   <viewRef>http://www.mcgill.ca/studenthealth/information/
    </viewRef>
   <viewDate>Aug 2006</viewDate>
   <viewAntr>Mahmood Tara</viewAntr>
   <viewAnCtxt>Campus-HITS Research Project - Phase 0</viewAnCtxt>
   <viewAnDate>Feb 2007</viewAnDate>
</viewpoint>
```

For convenience of viewpoint entry and further analysis, we used XML-based Microsoft Excel data sheet to enter the viewpoints' information in rows (Figure 5-6).



P0UWT11

	B	C	E	F	G	H	I
1	Viewpoint ID	Viewpoint Expression	Viewpoint Category	Viewpoint Context	Viewpoint Source	Viewpoint Reference	Viewpoint Update
220	P0UWT229	Getting Active: It's Easier Than	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
221	P0UWT230	The Benefits of Soy?	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
222	P0UWT231	Cross-Cultural Counseling	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
223	P0UWT232	Counseling and Learning Skills	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
224	P0UWT233	Psychiatric Service I	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
225	P0UWT234	Testicular Cancer	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
226	P0UWT235	How To Perform A Testicular Se	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
227	P0UWT236	Erectile Dysfunction	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
228	P0UWT237	Premature Ejaculation	Health Topic	University health Web site, topic menu	UT	http://www.utoronto.ca/health/healthtips.htm	2006De
229	P0UWT238	Achieving a wellness balance	Health Topic	University health Web site, topic menu	UBC	http://www.students.ubc.ca/health/guide.cfm	2006Jan

Figure 5-6. A screenshot of the XML-based Excel data sheet we used to capture the health topics related viewpoints

5.3.1.1.2 Participants' viewpoint extraction/entry

The approaches we used for the participants' viewpoints were slightly different. Three types of methods were used:

1. *form-based*, in which the participants (the professionals and students) listed their health topics of interest in the order of their importance (Phase 0 and I),
2. *Mindmap-based*, using which the participants (the professionals and students) used the brainstorming and mapping features of Mindmanger Pro as a card introduction interface (Phases 0, I, and II), and
3. *Free descriptions*, during which the student participants were asked to describe the quality elements of their recommended health Web site.

The viewpoint entry in the first two approaches was similar to the ones with the Web site. In both cases, the topics suggested were entered into the viewpoint database linked with their related viewpoint owner (or source). A minor difference was that for ranked topics, the rank value was also entered into the database linked to the scale information in the rank database.

The idea of free description was primarily based on an experiment by Mummalaneni (2005), during which he asked the university students to describe the characteristics of some selected Web sites and analyzed their descriptions to list the quality elements and characteristics identified by the students. In our research, the overall idea (for free description or home task) was to ask the participants to describe the praiseworthy elements of their favorite Web sites' for their potential peer audience, on the assumption that such Web sites would contain at least some worthwhile knowledge elements that represent the viewpoints of the related primary users. The tasks were included (and instructed) in a computer-based form that they could fill out at home at their convenience and send back through email. To increase the quality of the descriptions, we provided an additional incentive (additional to a PRPP extra credit for their time spent). We decided to make the task like a contest in which the best submission (best topics, links, and description) would win a reasonable award (with no draw); the judges would be some of their campus peers. After consulting with some students, we found iPod nano media player as the best affordable incentive to motivate the participants to provide quality links and descriptions.

To enter the viewpoints implied in free description, we had to initially convert them to formal statements. For instance, when a student said as a desirable feature, "The info on this Web site is updated," we converted it to "update element should be included in a health Web page," link them to each other (in a supporting association), and mark the formal statement as the requirements engineer's suggested statement. More details about the procedure will be explained in the procedure section (Section 5.5).

5.3.1.2 Viewpoint classification

We used two types of association to classify the viewpoints: one for the knowledge elements and the other for the health topics. For the knowledge elements, we associated all the suggested viewpoints of knowledge elements with "Health Web page Knowledge Element," a suggested topic by the requirements engineer, with an association role of "Element - Element Category." For instance, as shown in Figure 5-7, when a Web site (BCHealthGuide) showed Author's Name in the page, we first entered the occurrence as a viewpoint into our viewpoint database and then associated its viewpoint ID with "Health Web page Knowledge Element" in the association database.

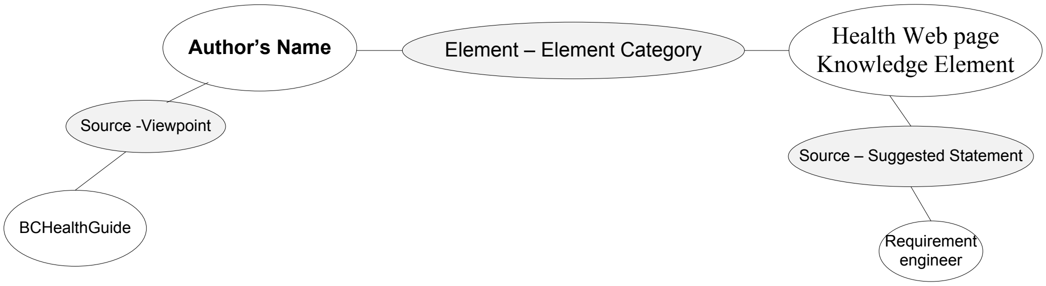


Figure 5-7. A classification example for Author's Name (a viewpoint) suggested by BCHealthGuide Web site. As shown, the viewpoint has been associated with "Health Web page Knowledge Element" as a category suggested by the requirements engineer.

The approach for the health topic was similar to the card sorting task. In card sorting, the participants sort the cards by defining various categories and stacking the relevant cards under that category. Here, we asked the participants (the professionals and students – Phase 0, and II) to categorize their suggested health topics using the mindmapping feature of Mindmanger Pro. Figure 5-8 shows an example of a sorted hierarchy of health topics by a professional participant.

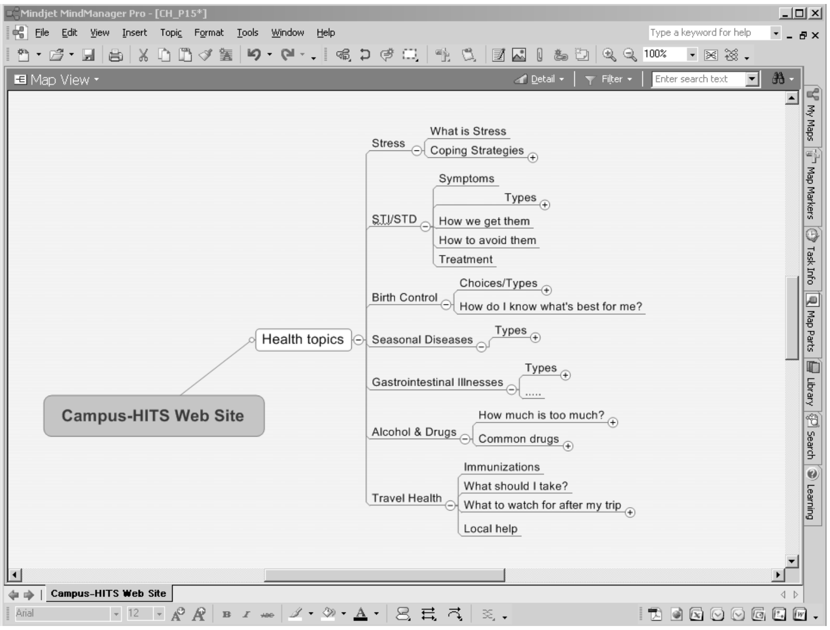
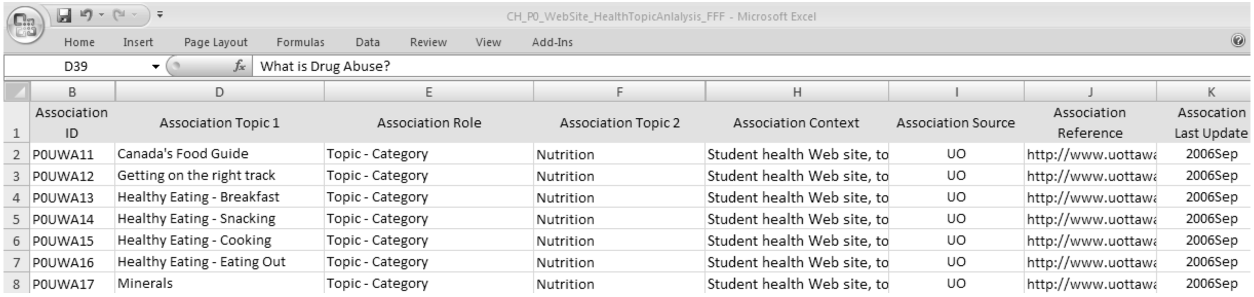


Figure 5-8. An example sorted hierarchy of health topics by a professional participant in Phase 0.

For the Web sites, we envisioned them as card sorters who have already categorized their health topics and presented the results as their health topics menus. Therefore, we considered their health topics menus as equivalent to the participants' mindmap of health topics. In both cases, categories suggested by the Web sites or the participants were already recorded in the database as viewpoints. Therefore, to classify a health topic, we associated that topic with other topics suggested by that source (the Web site or participant) with an association role of "Topic-Category." For instance, the McGill Web site categorize "Nutrition and Stress" under "Nutritional Health Matters." The following code shows the record for such an association.

```
<association>
<assnID>P0UWA104</assnID>
<assnTop1>Nutrition and Stress</assnTop1>
<assnTop2>Nutritional Health Matters</assnTop2>
<assnRole>Topic - Category</assnRole>
<assnSrc>Student Health Site - University of McGill</assnSrc>
<assnCtxt>Web site Health topic menu</assnCtxt>
<assnRef>http://www.mcgill.ca/studenthealth/information/
 </assnRef>
<assnDate>Aug 2006</assnDate>
<assnAntr>Mahmood Tara</assnAntr>
<assnAnCtxt>Campus-HITS Research Project - Phase 0</assnAnCtxt>
<assnAnDate>Feb 2007</assnAnDate>
</association>
```

Similar to viewpoint entry, we used the XML-based data sheet by Microsoft Excel to gather all the associations' information (Figure 5-9).



What is Drug Abuse?

	B	D	E	F	H	I	J	K
1	Association ID	Association Topic 1	Association Role	Association Topic 2	Association Context	Association Source	Association Reference	Assocation Last Update
2	P0UWA11	Canada's Food Guide	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
3	P0UWA12	Getting on the right track	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
4	P0UWA13	Healthy Eating - Breakfast	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
5	P0UWA14	Healthy Eating - Snacking	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
6	P0UWA15	Healthy Eating - Cooking	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
7	P0UWA16	Healthy Eating - Eating Out	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep
8	P0UWA17	Minerals	Topic - Category	Nutrition	Student health Web site, to	UO	http://www.uottaw	2006Sep

Figure 5-9. A screenshot of the XML-based Excel data sheet we used to capture the association

5.3.2 Secondary viewpoints elicitation

We discuss these methods in two sections: Questionnaires and complementary techniques

5.3.2.1 Questionnaire

We used various types of questionnaire to elicit the participants' viewpoints regarding other participants or the Web sites' viewpoints, or the requirements engineer's suggested topics or statements. For instance, we asked the student participants about their degree of interest regarding Travel Health as a health topic suggested by some health Web sites and some professionals.

We designed four computer-based questionnaires (one in each phase) with two main formats. The first type was a standard radio/checkbox-based single-scale table, which was built using the developers' features of Microsoft Word. The second type was a tagging interface that would allow the multiple-scales rating built within Mindmanager Pro environment. Overall, the following types of questionnaire items were used to capture the participants' preferences/perceptions regarding various viewpoints or statements:

1- *Ranking* (Phase I), using which the participants would rank a series of health information sources in an order of 1 to 6;

2- *Importance rating (single scale)* (Phase 0-III), using which the participants would share how they would perceive the importance level for every knowledge element suggested to be included in a consumer health Web page using a five-level scale (from "highly important" to "not important at all");

3- *Likert-style rating (single scale)* (Phase I), using which the participants would share their level of agreement with the provided statements using a five-level Likert-style scale (from "strongly agree" to "strongly disagree"); and

4- *Multiple-scale rating/tagging* (Phases II and III), using which the participants were asked to rate/tag the provided statements or elements using three (Phase II) or five (Phase III) different rating scales (three-level to five-level).

To develop the questionnaire items, we adapted the *user-perceived Web quality instruments* suggested by Aladwani and Palvia (2002), and *questionnaire items of Web site's success* by De Wulf et al. (2006). In addition, we adopted the approach suggested by Fang and Holsapple (2007) to test the quality of our topic hierarchy using three factors of ease of use, overall satisfaction, and correct answer ratio. However, instead of asking the participants questions regarding health topics and evaluating the correctness of their answers, we asked the participants to list the three health topics that are the most important for a university health Web site and measured the occurrence of those topics in the hierarchy. In Phase III, we also used the characteristics of the quality Web sites suggested by the Phase I participants (during the free description task), as criteria to evaluate the CHEKES set.

For each questionnaire item, we tested the wording and understandability of the items with the students from the advisory group, and included the suggested corrections. We should emphasize three more points:

1. We did not use the questionnaire items in a scale of combined items. Hence, we did not test the reliability of multiple scale items to describe an element. However, in our analysis we used Cronbach's Alpha to examine if we can recommend our combination as a reliable scale (will be discussed in Chapter 6).

2. We used a few reversed worded items in the questionnaires. For those items, the responses or the ratings were adjusted during the analysis process.

3. We used two control knowledge elements, User Rating and Number of Visitors, that were not suggested by the exemplar Web sites (thus were non-telescopic) to compare them with the knowledge elements chosen during the telescopic approach. However, we changed the Number of Visitors to First Created Date (the

date a Web page was first created), as we found Number of Visitors and User Rating too close (both relates to visitor information) to be used as separate control elements.

4. Due to some changes of study plan and also to keep the workload in a manageable range, some of the questionnaire items, for example, the ones that were related to third party information provision were discarded.

5.3.2.1.1 Phase 0 Questionnaire (Health professionals)

The phase 0 questionnaire (Appendix 2) was a Word-based (computer-based) form consisting of the following sections (and items):

1- Demographic information, consisting of three items regarding the participants' area of expertise, academic degree, and their familiarity with computers and the internet (on a scale of 1 to 10).

2- Health topic entry form using which they were asked to type in the five most common health topics among students on campus in free-text.

3- Web site suggestion/location form, through which they were asked to suggest up to three health-related Web sites that, in their opinion, are the most useful/suitable for the students on campus. They were also asked to search and locate up to three Web sites (that they would recommend to students) regarding the first three health topics they had suggested, using their choice of browser.

4- Importance rating for a list of selected elements from the Web sites (twelve items). As visible on the form, the list was left open to accommodate new elements suggested by the participant.

5.3.2.1.2 Phase I Questionnaire (Student participants)

Similar to the professionals' questionnaire, the student participants in the phase 0 used Word-based (computer-based) questionnaire (Appendix 3) consisting of the following sections (and items):

1- Ranking items, using which the participants were asked to rank five types of health information source based on their perceived importance (rank of 1 to 5). They were also given opportunity to include one additional source to the list and expand the ranking to six levels.

2- Health topic entry, using which the participants were asked to type in the three health topics (or queries that included them) that in her opinion are the most common among her peers.
3- Locating exemplar Web sites, in which there were asked to use their choice of browser and search engine to locate a quality health Web site regarding the health topics they had suggested (a page that she would recommend to her peers). This part was meant to be practice for the home task participants were asked to accomplish later.
4- Likert-style items (20 items) to capture the participant's attitude toward some of the Web pages' knowledge elements and to find out about their search and browsing norms.
5- Importance rating of some knowledge elements (12 elements).
6- Likert-style items to capture the participant's attitude toward knowledge elements appearing in index pages (such as a search engine result page) (12 items)

5.3.2.1.3 Phase II Questionnaire (Student participants)

For the participants in Phase II, we designed a multiple-scale questionnaire using the Mindmanager Pro Map Marker features (Figure 5-10). The form consisted of seventeen CHEKES II elements with up to three design artifacts for each (are not shown in the screenshot). For each element, the participants would rate the "importance" (using a five-level scale from Very Important to Not Important at All) and the usefulness (using a five-level scale from Very Useful to Not Useful at All). The form was also designed in such a way to accommodate new elements suggested by the partipants.

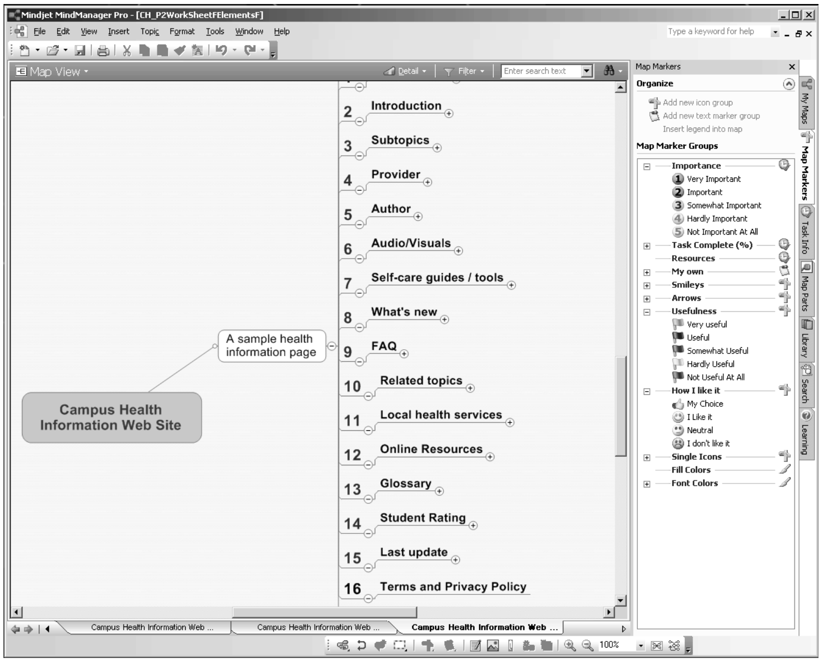


Figure 5-10. The mindmap-based list of CHEKES-II elements to be rated and selected using multiple scales provided in the right column.

5.3.2.1.4 Phase III Questionnaire (Student participants)

The phase III questionnaire similar to the one from Phase II except in two parts: 1- the elements included were CHEKES-III elements, and 2- we used five scales to enabling rating for different aspects of knowledge elements. These scale consisted of:

1- Overall reaction: Five levels from I would like it very much to I would not like it at all

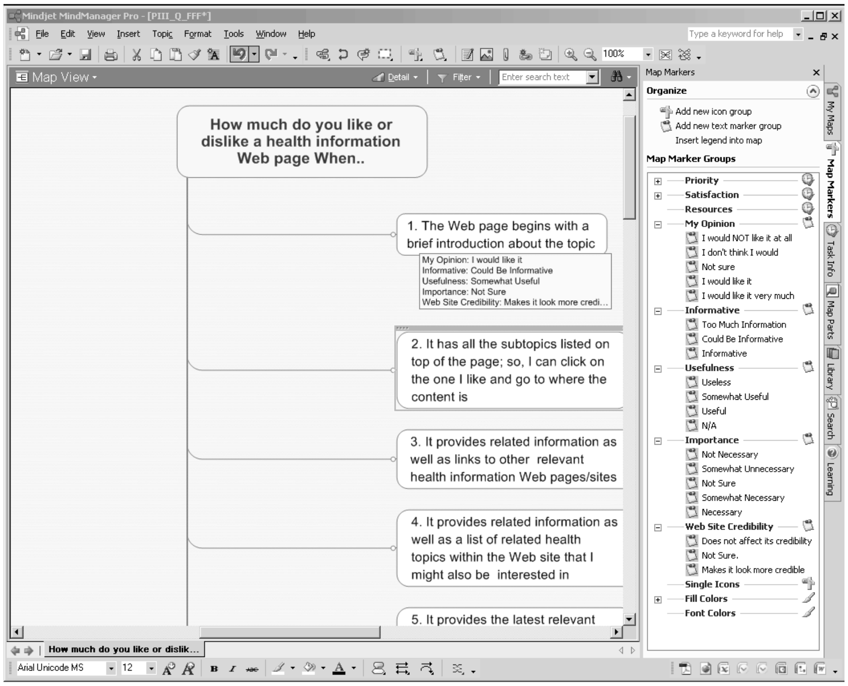
2- Usefulness: Three levels from Useful to Useless

3- Informativeness: Three levels from Informative to Too much information

4- Importance: Five levels from Necessary to Not necessary

5- Credibility: Three levels from Make the Web page look credible to Does not affect the credibility

We also added two control elements of First-created Date (for a Web page) and User rating to compare the related responses with CHEKES III elements. Figure 5-11 shows the Mindmanager-based multi-scale questionnaire used in Phase III.



How much do you like or dislike a health information Web page When..

1. The Web page begins with a brief introduction about the topic

My Opinion: I would like it
Informative: Could Be Informative
Usefulness: Somewhat Useful
Importance: Not Sure
Web Site Credibility: Makes it look more credi…

2. It has all the subtopics listed on top of the page; so, I can click on the one I like and go to where the content is

3. It provides related information as well as links to other relevant health information Web pages/sites

4. It provides related information as well as a list of related health topics within the Web site that I might also be interested in

5. It provides the latest relevant

Figure 5-11. The Mindmanager-based multi-scale questionnaire used in Phase III. To fill out the questionnaire, for each item the user would conveniently click on the item and select and click on her favorite tags from the tag list (on the right).

5.3.2.2 Artifact comparison: Simulated Google (Phase III)

In Phase III, We designed a simulated Google interface using some of the elements from CHEKES III and asked the phase III participant to compare the included link information with the actual Google interface (for the same resources). The goal of this task was to test the usability and usefulness of adding a few selected metadata elements (from CHEKES III) in indexing health information resources such as Web sites.

To design both interfaces, we built the following online search scenario (and read it aloud to every participant in Phase III):

"Suppose that you or a friend of yours wonders how you would know if you have sexually transmitted infections/diseases and/or would like to learn about the symptoms of sexually transmitted infections/diseases (STI/STDs). You go online and search online for relevant information. And here are the first ten results….!"

The first challenge we encountered was to convert the above scenarios into several queries resulting in very different first-page results. To address this, we entered the following eight queries, which seemed the most relevant to the scenario, into the Google search box and saved the results for each (Table 5-5). The queries were either the ones suggested by student helpers or the ones used by participants in Phase I.

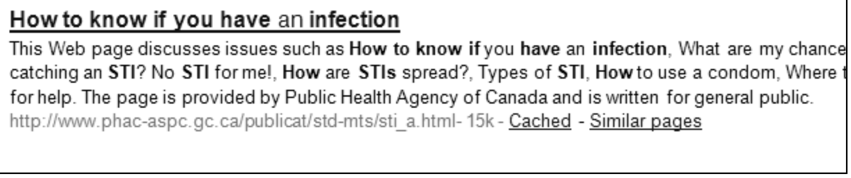
Table 5-5. The eight queries holding variances of combinations to search for health information relevant to the scenario

“Sexually transmitted diseases”
“Sexually transmitted infections”
“Sexually transmitted infections” AND symptoms
“Sexually transmitted diseases” AND symptoms
How do I know if I have sti?
How do I know if I have std?
STD AND symptoms
STI AND symptoms

Then, we chose the first three hits of all the results pages and randomly picked ten unique hits from all. We sorted the result in a Google result page we designed, and saved it.

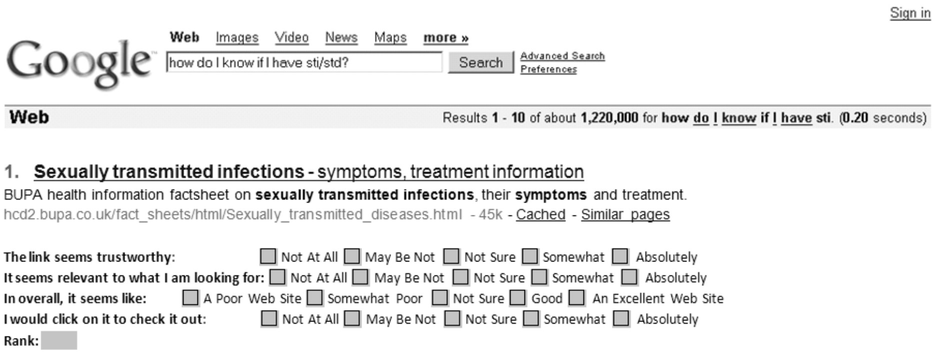
To build the simulated Google page, we picked four relevant metadata elements from CHEKES III, which were identified as important by the student participants in Phase II (title, subtopics, provider, target audience). We re-ordered and rebuilt the Google results (particularly their description) using an XML-based template designed for this purpose. Table 5-4 shows how the same hit from the actual Google result page (on top) has been converted to a metadata-based description (below) built based on actual Web site information using the XML-based template (in the middle).

Table 5-4. Metadata-based representation of a Google result using an XML-based template (in the middle)

An actual result from Google	 6. What you need to **know** about **STI - Sexually Transmitted Infections** **How** to **know if** you **have** an infection. Some people with an **STI have** few or no symptoms at all; others **ha** obvious symptoms. Be aware of any changes in **...** www.phac-aspc.gc.ca/publicat/std-mts/**sti**_b.html - 15k - Cached - Similar pages
XML-based result template	<pageTitle> This Web page discusses issues such as <subtopics>. This page is provided by <provider> and is written for <targetAudience>. <pagelink>
An example result item using the template	 **How to know if you have** an **infection** This Web page discusses issues such as **How to know if** you **have** an **infection**, What are my chance catching an **STI**? No **STI** for me!, **How** are **STIs** spread?, Types of **STI**, **How** to use a condom, Where for help. The page is provided by Public Health Agency of Canada and is written for general public. http://www.phac-aspc.gc.ca/publicat/std-mts/sti_a.html- 15k - Cached - Similar pages

We also included in a small questionnaire after each hit asking the participants to rate "trustworthiness," "relevance," "overall quality" and her "desire to click" on the link in five-level scales and only using the information provided for each hit (they were not allowed to click and visit the page). The scales are shown in Figure 5-12. Appendices 4 and 5 show the final interfaces we used in Phase III.

To compare the both interfaces in providing more informative and useful link information (index information), we asked the individuals to visit the actual Web pages (of the ten links used in both interfaces) and rate and rank their quality using two scales of "overall quality" and "relevance." (Appendix 6) We compared the results from this form to the results from both interfaces and measured the correlations (to answer our second research question).



how do I know if I have sti/std?

Results **1** - **10** of about **1,220,000** for **how do I know if I have sti**. (**0.20** seconds)

1. **Sexually transmitted infections -** symptoms, treatment information

BUPA health information factsheet on **sexually transmitted infections**, their **symptoms** and treatment.
hcd2.bupa.co.uk/fact_sheets/html/Sexually_transmitted_diseases.html - 45k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

Figure 5-12. A screenshot (just the top part) of the actual Google page used in the study showing the four five-level scale we designed

5.3.2.3 Artifact comparison: Campus-HITS prototype

The goal of this task was to compare a CHEKES-III based designed Web page/site (we called it the study Web site) with two other Web sites (which we called the control Web sites) designed based on conventional methods. To produce the Web page, we designed a graphic template, similar to the official Web site of the University of Victoria, that integrated the nineteen different design artifacts built by Phase II participants, and included the CHEKES-III health topic, metadata, and content comprehension elements. A screenshot of the Campus-HITS Web page is illustrated in Appendix 7.

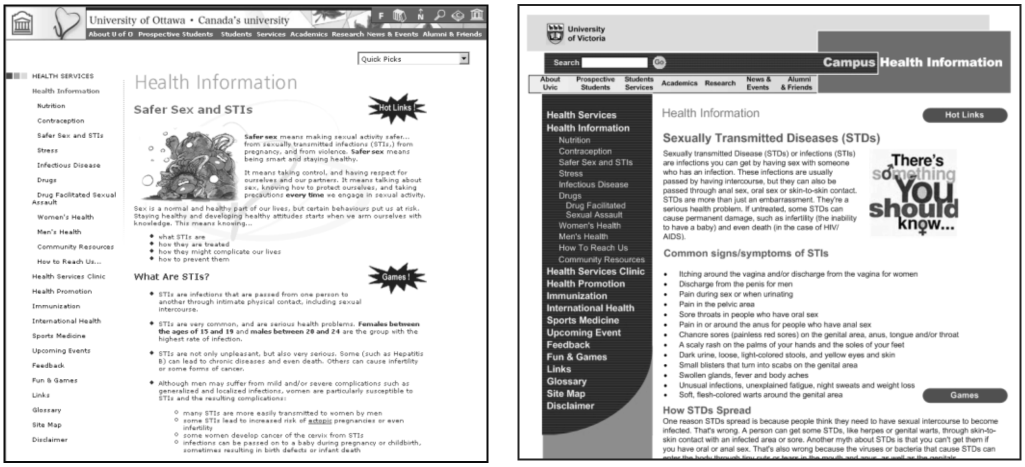
To select the other Web sites We picked one consumer global general and one university health Web site from the list of exemplars we analyzed in Phase 0. From the Web sites of global general, we selected Teenhealth Web site available at www.teenshealth.org, provided by the Nemours Foundation. There were two reasons: first, the Web site content focused on the teenage/young adult group, which was the closest to our study population; and second, it had a specialized topic menu aimed particularly toward the subjects of concern by a teenage population. The Teenhealth Web site is one the superior health information Web site particularly targeting teens /young adults; it has been recommended for teen health issues by the National Library of Medicine (medlineplus.org) and also by the American Academy of Family Physicians (familydocotor.org).

For the university Web site, we decided to pick a Canadian site as likely closer to the study population than the global Web sites. From the list of five Canadian health Web sites, we randomly picked one, the health Web site of the University of Ottawa. We should mention that in our preliminary scan of a wide variety of university Web sites across Canada, we found the University of Ottawa health Web site one of the most content-rich Canadian student health Web sites.

There were two challenges in making the Web sites scientifically comparable. First, the purpose of the comparison was to measure exclusively the possible user-perceived improvement caused by non-design elements; therefore, we needed to eliminate the variance of design by making all Web sites design features as similar as possible. In particular, we applied the generic GUI of our study Web site to both control Web sites (same color scheme, logo and menu bars, font style, etc.), but left the sites' locations of links and menus and content structure intact.

In addition, during pilot testing with student helpers, we realized that a similar cross-effect was also possible if a Web page offered richer subject-specific content (i.e., STD) as compared to others. Therefore, we decided to use the same pieces of content (even the same pictures if they had any) that we used in the prototype (cut and pasted from different STD Web pages) for all three, but preserved their original wealth of knowledge elements.

As result, all three Web sites were almost identical in their Graphic User Interface (general theme) and the main (subject-specific) content, but they all kept their original knowledge elements and topics. Figure 5-13 shows an example of how the original health Web site of the University of Ottawa (on the left) was converted into the control Web site (on the right) by applying the changes mentioned above.



Health Information

Safer Sex and STIs

Safer sex means making sexual activity safer... from sexually transmitted infections (STIs,) from pregnancy, and from violence. **Safer sex** means being smart and staying healthy.

It means taking control, and having respect for ourselves and our partners. It means talking about sex, knowing how to protect ourselves, and taking precautions **every time** we engage in sexual activity.

Sex is a normal and healthy part of our lives, but certain behaviours put us at risk. Staying healthy and developing healthy attitudes starts when we arm ourselves with knowledge. This means knowing...

- what STIs are
- how they are treated
- how they might complicate our lives
- how to prevent them

What Are STIs?

- STIs are infections that are passed from one person to another through intimate physical contact, including sexual intercourse.
- STIs are very common, and are serious health problems. **Females between the ages of 15 and 19** and **males between 20 and 24** are the group with the highest rate of infection.
- STIs are not only unpleasant, but also very serious. Some (such as Hepatitis B) can lead to chronic diseases and even death. Others can cause infertility or some forms of cancer.
- Although men may suffer from mild and/or severe complications such as generalized and localized infections, women are particularly susceptible to STIs and the resulting complications:
  - many STIs are more easily transmitted to women by men
  - some STIs lead to increased risk of ectopic pregnancies or even infertility
  - some women develop cancer of the cervix from STIs
  - infections can be passed on to a baby during pregnancy or childbirth, sometimes resulting in birth defects or infant death

Health Information

Sexually Transmitted Diseases (STDs)

Sexually transmitted Disease (STDs) or infections (STIs) are infections you can get by having sex with someone who has an infection. These infections are usually passed by having intercourse, but they can also be passed through anal sex, oral sex or skin-to-skin contact. STDs are more than just an embarrassment. They're a serious health problem. If untreated, some STDs can cause permanent damage, such as infertility (the inability to have a baby) and even death (in the case of HIV/AIDS).

Common signs/symptoms of STIs

- Itching around the vagina and/or discharge from the vagina for women
- Discharge from the penis for men
- Pain during sex or when urinating
- Pain in the pelvic area
- Sore throats in people who have oral sex
- Pain in or around the anus for people who have anal sex
- Chancre sores (painless red sores) on the genital area, anus, tongue and/or throat
- A scaly rash on the palms of your hands and the soles of your feet
- Dark urine, loose, light-colored stools, and yellow eyes and skin
- Small blisters that turn into scabs on the genital area
- Swollen glands, fever and body aches
- Unusual infections, unexplained fatigue, night sweats and weight loss
- Soft, flesh-colored warts around the genital area

How STDs Spread

One reason STDs spread is because people think they need to have sexual intercourse to become infected. That's wrong. A person can get some STDs, like herpes or genital warts, through skin-to-skin contact with an infected area or sore. Another myth about STDs is that you can't get them if you have oral or anal sex. That's also wrong because the viruses or bacteria that cause STDs can

Figure 5-13. An example of Web site conversion for control Web sites (screenshots). As shown, the STD health Web page of the University of Ottawa (on the left) was adapted as a control Web site (on the right) by applying the design template and subject-specific content used in the study Web site.

5.3.3 Complementary techniques

We used two complementary techniques to increase the quality of the elicited requirements. We described those here.

5.3.3.1 Think aloud (Phases I-III)

We asked all the participants to think aloud while performing all the tasks (even when they filled out the questionnaires). For example, when they were scanning and comparing the three Web sites they were given in Phase III, we would ask them to share their feelings about every aspect of the Web sites that they liked or disliked; or we would ask them to think aloud while they were filling out the questionnaires in all three Phases. We sought two particular purposes by using think aloud. First, we wanted to boost the accuracy of viewpoint by ensuring that the participants would mark the answers they really meant to. During the interviews, we came across several cases, in which the participant's verbalized opinion was different from the answer inserted. In the majority of such cases, the differences were either because of a misunderstanding of the item or due to a simple mistake in choosing the exact rank or rate they had intended to choose. Second, we intended to use the audio-video recording of the participants as a strong proof of their viewpoints. The rationale is that none of the computer-based elicitation methods we used could possibly prove if the viewpoints elicited are originally from the particular participant. For instance, we realized that a requirements engineer could, accidently or intentionally, modify the original answers on a questionnaire with no leaving trace.

5.3.3.2 Co-design exercise (Phase 0 and II)

To examine the quality of the secondary viewpoints regarding knowledge elements (in Phase 0 and II), we employed a co-design exercise. We originally had this concern that the participants might not be necessarily familiar with all the element names as used across the Web sites. In such case, there was a chance that their viewpoints (opposing to supporting) would not reflect their actual perception regarding those elements and thus confuse the requirements data.

We created a Visio-based Web design interface that would allow the student participants to build their preferred from of a generic health Web page. We included all the CHEKES II elements listed in the Phase II questionnaire in a palette with up to three choices of design for each. Using this, we gave the participants a chance to familiarize themselves with the elements and their various common forms on the Web sites. For each element on the questionnaire item, we showed the participants up to three examples from the Web sites, and asked them to visually drag and drop (or to tell us where to drop) their choices of elements into the blank Web page provided. In addition, we provided them with instructions on how to perform more design changes (colors, fonts, size, location, etc.) using Visio toolbars, and gave them enough time to do it at their own pace. After they announced their satisfaction with their final design, we saved the artifact and asked them to share their final viewpoints. Using this approach, we made sure that viewpoints elicited in Phase II were reasonably accurate. Figure 5-14 shows an example generic Web page built by a student participant in Phase II.

Last updated: March 13, 2007
Created: June 11, 2002

Sexual Health>Men's Health>STD's

STD's

User Rating: (77 ratings)
Written by: Dr. Richard Rosenberg MD PhD

What are the common types?
How do I know if I have STD?
What are the symptoms?
How can I get treatment?
How can I get Local Health Services?
What are the STD's frequently asked questions?

Introduction
This page talks about common symptoms of STD, their different types and the actions you can take if you find or feel any of those symptoms…….

Common Symptoms
Some people with an STD have few or no symptoms at all; others have very obvious symptoms. Be aware of any changes in your health, or symptoms such as:

* different or heavier discharge from the vagina
* discharge from the penis
* a burning feeling when urinating (peeing)
* sores, particularly in the genital or anal areas
* itchy feeling around the sex organs or anus
* appearance of a rash
* swollen glands in the groin.

These symptoms might appear alone, or in combination. Having a symptom doesn't mean you do have an STD but if you are having sex and taking chances, you should see a health professional for a

HPV

Cold Sore: small blisters around and in the mouth caused by the herpes simplex virus.

The *Herpes simplex* viru es genital herpes. Type 1 often affects the cold sores, but can affect the genital are fects the genital area, upper thighs, and can also affect the oral area. The virus is spread by direct skin-to-skin contact from the site of infection to the contact site, but can also be spread during periods where there are no noticeable symptoms. Oral sex can spread herpes from the mouth to the genital area and from the genital area to the mouth. Cellulitis is often a consequence.

Local Health Services

Island Sexual Health Society
Address: 200-1770 Fort Street, Victoria, BC V8R 1J5
Phone: 250-592-3479
Email: jgibson@islandsexualhealth.org
Web Address: http://islandsexualhealth.org/

The Canadian Federation for Sexual Health, previously called Planned Parenthood Federation of Canada, is a non-government, pro-choice organization in Canada that provides services, information, and counselling exclusively on sexual and reproductive health.

What's New!
A new type of STD coming
Vaccinate yourself against HPV!

Related topics
How to talk to your partner about STD
Condoms and STD
HIV: How to avoid

Online Resources
STD and students (National Institute of Health)
How do I know if I have STD? (U of T Health Services)
Safe sex and STD (Centre for Disease Control)

FAQ
- What is the relationship between STDs and HIV?
- Why is knowing whether I have an STD important if I am pregnant or planning to become pregnant?

Figure 5-14. An example generic Web page built by a student participant in Phase II

For the professionals participating in phase 0, due to the limited time available, we only built a simple Web site to explain the purpose of the brainstorming task regarding the health topics.

We should emphasize that the distinction between the primary and secondary viewpoints elicitation methods was not clear-cut. As explained earlier (Section 5.2), a vital feature of our telescopic approach is that the primary users should always have chances to tailor the knowledge provided to them. Part of this tailoring is their contribution of new elements or topics that should be captured in any stage. Using this rationale, in Phase II, we allowed the student participant to add their own health topics and elements to the list of primary viewpoints they were provided. Although, the suggestions were not many, we found them enthusiastic to include those few of their own.

5.4 Analysis Methods

We used two main methods (Association analysis, statistical analysis) to analyze the data from each phase, which we discuss here. More details about these methods will be discussed in Chapter 6 (Results).

5.4.1 Association analysis

The goal of association analysis was to shrink the broad variety of viewpoints to a few manageable viewpoints representing the majority. To analyze the associations, we used a slightly modified version of cluster analysis suggested by Hudson (2005). This method consists of two techniques: approximation, and aggregation.

5.4.1.1 Viewpoint Approximation

To perform approximation, we combined, merged, or integrated the viewpoints with reasonable similarities. For example, we found a broad variety of health topics in relations to two topics of “Nutrition” and “fitness.” Variety characterized the topics, which included:

1. the <u>synonym topics</u> such as “Diet,””Healthy Diet,””Eating Healthy””Healthy Weights” or the topics,
2. <u>relevant topics but not necessarily equal</u>, such as “Exercise,””The Fats of Life,””Body Image,” or
3. <u>the topics that combine those topics</u>, such as “Nutrition and Fitness,””Healthy Eating and Body Image,” and “Healthy Weights and Diet.”

We used a common strategy for the above three cases. We chose one of the more general topics (often the most frequent one) and associated it with all the other relevant topics as supporting viewpoints. We used viewpoint approximation particularly for health topics (Phase 0 – II).

5.4.1.2 Viewpoint Aggregation

To aggregate the similar viewpoints, we simply made a representative statement and associated it with all the related viewpoints in a supporting (negative to positive) relationship. The method we used here was similar to variability analysis model by Gonzales-Baixauli et al. (2004). According to this approach, we split the viewpoints regarding the inclusion of a particular knowledge element into three conditions of opposing (-1), neutral (0), and supporting (+1). Using this approach, we integrated all the five-level scale viewpoints into the above three choices (the three-level scale viewpoints were already matching). For instance, when the participants, e.g., in Phase II, rated Frequently

Asked Questions (FAQ) as Not Important at All or Hardly Important, or Not Useful at All or Hardly Useful, we considered all four cases as -1 and associated them with the statement “FAQ should not be included in a health Web page.” We followed the same procedure for neutral and supporting viewpoints. We used viewpoint aggregation particularly for knowledge elements. A major challenge we experienced in this step, was how to rank absence of an element or topic in a Web site or description. For example, we thought of at least (but not limited to) three reasons why a Web site/page did not contain the author information:

1- The related eHealth professionals would not prefer to include the Author information because of a variety of reasons.

2- The professionals would not object the inclusion of that information, but did not find it necessary as well.

3- The related professionals were not aware of such information and its potential values for the target audiences.

According to the framework we suggested, we would normally associate the first one above with -1 supporting value, and the second one with 0. In case of the third assumption, we should discard the viewpoint as the absence does not hold any viewpoint of the related stakeholder(s). However, our challenge was that we knew neither of the above, and thus we could not come up with any. What we were sure about was that such absence would not be definitely supportive. Therefore, we made a compromise and only recorded the presence of elements as supportive viewpoints (+1) and ignored the absence of elements in those Web sites. We treated the subjects’ descriptions of quality Web sites in the same way.

5.4.2 Statistical analysis

We used two types of statistical analysis: viewpoint agreement analysis, and statistical measures.

5.4.2.1 Viewpoints agreement analysis

To find the area of agreement, we simply cross-tabulated the database based on the occurrence of topics and elements viewpoints. Cross tabulation is a common statistical method of finding clusters of associations. In database environment, cross tabulation is similar to search queries. For example, to discover the comparable occurrence of opposing to supporting viewpoints regarding the inclusion of Author's Name, one can cross tabulate the association database to only show the viewpoints that are associated with Author's Name element and present an association role of ”`Supporting viewpoint-statement`.” In addition, one can sort the viewpoints based on their type of viewpoints being positive (supporting), neutral, or negative (opposing) and calculate the total occurrence of each type.

We used Microsoft Excel, Microsoft Access, or SPSS to create pivot table and perform cross-tabulations. As result, we were able to measure the overall momentum toward the inclusion of a particular element based on the sum of all associated viewpoints (negative, neutral, and positives).

5.4.2.2 Statistical Measures

Various statistical measures were used in Phases 0 to III. However, we particularly used such measures in the evaluation to quantitatively answer our research questions. The most common measures we used were descriptive statistics (i.e., Mean and Standard Deviation). We compared the mean rating of supporting versus opposing viewpoints regarding various knowledge elements in all the phases. For instance, in Phase III, we compared the mean importance rating (and the percentage) given to various CHEKES III elements in order to sort the elements. We also measured the standard deviation to discover possible bipolarity of the responds due to different reasons.

We used one-way and two-way ***t***-tests to compare the significance of difference in the participants' responses between Google and Simulated Google. We also used two-way ***t***-test to conduct similar comparison between various prototypes. In addition, we used Pearson Correlation to assess the correlation between the subjects' responses to Google and Simulated Google and their actual rating of the Web sites' quality to compare the usefulness of the interfaces. To run the correlation, we primarily created a scale to measure the overall quality of each link listed and tested its reliability using Cronbach's Alpha. Then, we ran the Pearson correlation to assess the likeliness of Simulated versus Google to help the user choose the higher quality health Web sites.

5.5 Ethical Considerations

A detailed version of the protocol (methods and materials) used in this study was shared with the review board at University of Victoria Human Research Ethics (HRE) prior to the interventions. The board reviewed the protocol and determined that it met the ethical principles recommended or required by HRE. In addition, four amendment letters were sent afterward, during the time of the study, to share the requirements for a few minor but vital changes to the originally planned protocol; in all cases, the suggested amendments were granted.

5.6 Procedure

Here, we describe the actual operational steps we took to conduct each of the four phases.

5.6.1 Phase 0

Throughout Phase 0, we elicited the normative viewpoints from the local professionals and the exemplar health Web sites (representing the viewpoints of local to global health and eHealth professionals).

5.6.1.1 Web site analysis

We started the Web sites' topic and element extraction and analysis early in 2006. The related approaches has already been explained in Section 5.3.1.1.1 (Web sites' viewpoint extraction), Section 5.3.1.2 (viewpoint classification) and Section 5.4.1.1, which described the two analysis methods we used to analyzed the collected viewpoints.

We encountered two challenges early in the health topic extraction. First, we found three of the Web sites (UH, UV, and UN) did not contain a real hierarchy of topics Instead of topic menus, they only included lists of topic instance pages. For instance, UH offers only a A-Z flat list of health topics that range from very broad (Birth Control) to very narrow (Coumadin Information). Such flat lists would make those Web sites unusable for the analysis purpose. To resolve this, only for the use of this analysis, we replaced those Web sites with three others containing valid topic menus using the same Web site population. To do so, checking the ARWA university ranking list, we located two other global (John Hopkins University (UJH) and University of Columbia (UCO)) and one other Canadian (University of British Columbia (UBC)) Web sites to replace the university Web sites mentioned above. UBC was one of the top-ranked Canadian universities, which was originally discarded in the Web site selection because of its directory-orientation. However, we found no evidence showing that such a shortcoming could possibly affect the wealth of a Web site's topic hierarchy. The second challenge was that the topic menus of most university health Web sites contained a variety of service related topics (e.g., staff directory, laboratory services, vaccination information) that were beyond the scope of this study. Those topics were excluded from the sorting exercise. The determination of relevance was at the discretion of the investigator.

5.6.1.2 Interview with local health professionals

This stage consisted of one-hour interview sessions conducted in the Campus-HITS Lab location with six health professionals (two physicians, two nurses, and two counselors). At the beginning of each session, after the initial greetings, each participant was asked to review and sign the consent form provided. After obtaining consent, we provided a short overview of the tasks we expected her or him to perform and checked if she or he is ready to begin (or if there were any questions).

Each interview session included the following tasks (in the order conducted):

1- Filling in a computer-based questionnaire form (Appendix 2), as explained in Section 5.3.2.1.1.

2- Health topic mapping, during which we asked the participants to use a basic set of six health topics (based on the Web sites' topics and using the wordings suggested by student helpers) as the basis and develop a topic hierarchy that would include the variety of common health issues needed by local students (Figure 5-15).

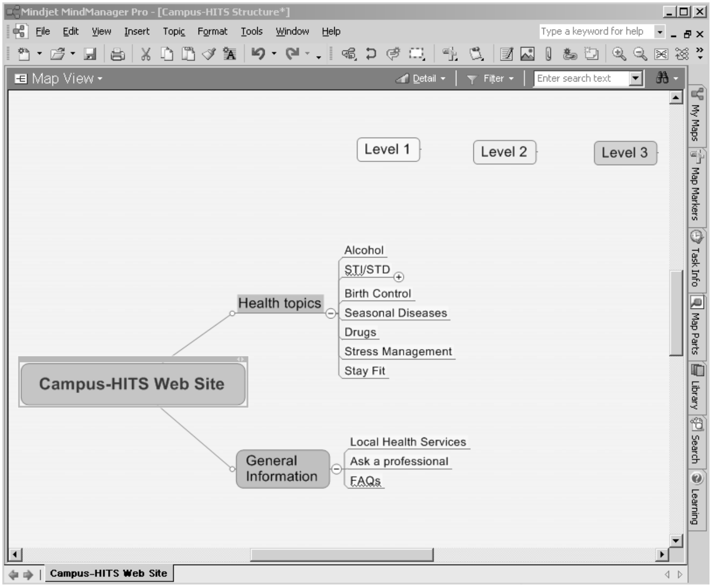
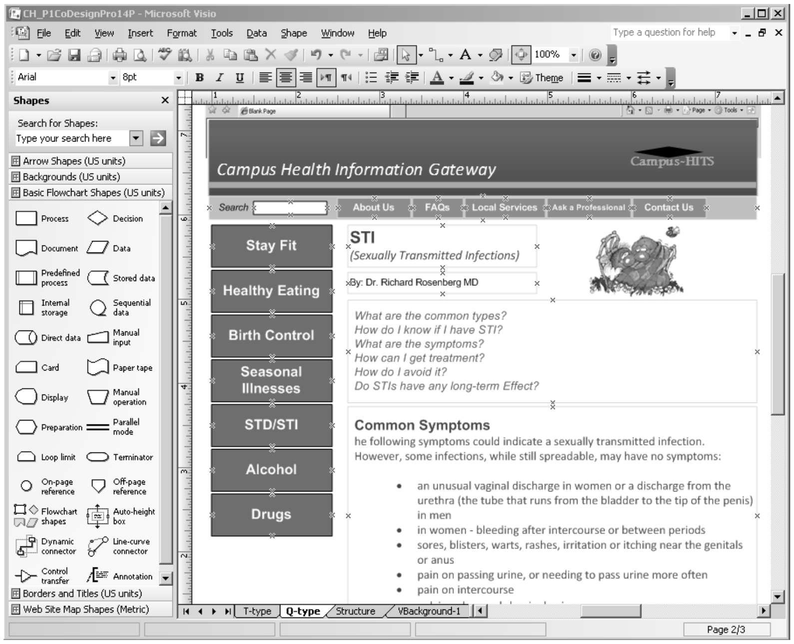


Figure 5-15. The mindmap-based interface for health topic mapping by local professionals

3- Web site evaluation task, during which we shared a basic design of an example health information Web page containing common categories of knowledge elements we extracted during Web site analysis and sought their suggestions to reshape (reword, reposition, remove, etc.) the Web page to be more useful and usable (Figure 5-16). This task also ended the interview session.



STI
(Sexually Transmitted Infections)

By: Dr. Richard Rosenberg MD

What are the common types?
How do I know if I have STI?
What are the symptoms?
How can I get treatment?
How do I avoid it?
Do STIs have any long-term Effect?

Common Symptoms

he following symptoms could indicate a sexually transmitted infection. However, some infections, while still spreadable, may have no symptoms:

- an unusual vaginal discharge in women or a discharge from the urethra (the tube that runs from the bladder to the tip of the penis) in men
- in women - bleeding after intercourse or between periods
- sores, blisters, warts, rashes, irritation or itching near the genitals or anus
- pain on passing urine, or needing to pass urine more often
- pain on intercourse

Figure 5-16. The Visio-based co-design interface showing the pre-built Web page to be modified by local professionals.

5.6.2 Phase I

In this step, we originally scheduled 35 one hour, one-to-one interview sessions with the student participants in Primary Users -I group, but we had four dropouts, either no-shows or explained absences, leaving a final total of 31 subjects. The 31 subjects who filled out the Phase I questionnaires had an age range of 18 to 20 (~80% at 18) and a gender distribution of 55% female and 45% male (Figure 5-17). All subjects described themselves as fluent English speakers and 87 percent were native English speakers.

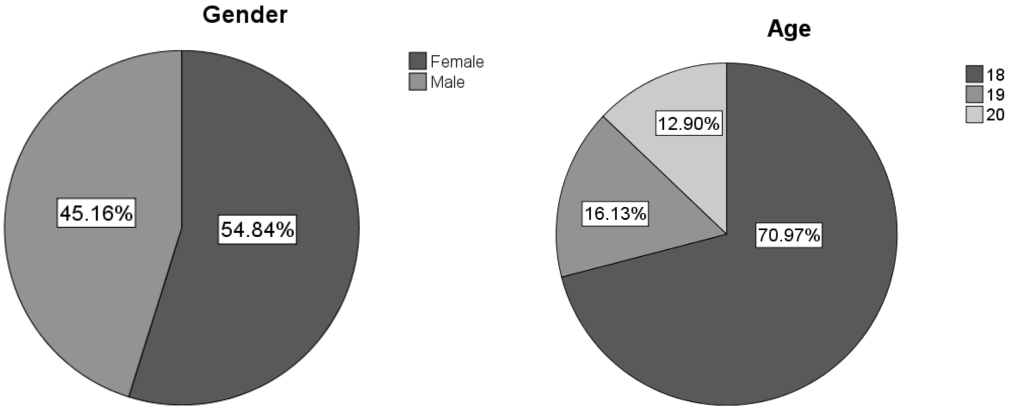


Figure 5-17. Phase I - Age and gender distribution of the participants

Before starting the interview series, we checked the integrity, understandability and seamlessness of the scale and flow of the interviews with several individuals ranging from student helpers to the committee members (supervisory committee). After including the recommended changes, we re-tested the final version with the student helpers to make sure that all the tasks would flow (and be perceived) as they were planned to.

The interview session would begin with me (the main investigator) welcoming the participant and leading her to her seat, and providing her with a short overview of the project (name, general goals, etc) using a brief on-screen presentation. Then, the participant was asked to review and sign the consent form provided. After obtaining consent, I provided a particular overview of the tasks I expected her to perform and checked if she was ready to begin (or if she had any questions). The tasks for Phase I consisted of a computer-based questionnaire, which was explained is Section 5.3.2.1.2, and a free description (or home task) which was described in 5.3.1.1.2.

As mentioned earlier, the participants were asked to think aloud while they completed each section, including when they filled out the questionnaire. A few of the participants needed several reminders to think aloud.

After the completion of the questionnaire, I would ask each participant if she was willing to participate in the home task (as explained earlier). For those who were interested, I would send the home task form attached to email with a three-day deadline. Overall, 28 out of 31 agreed to participate in the home task; of those, only 17 sent back the forms by the deadline (a response rate of 60%). Each interview session (the task sections) took approximately 45-50 minutes to complete. All interview sessions (in Phase I) ended with a debriefing presentation about the project goals, phases, and theoretical background, which was a requirement for all researchers using the Psychology 100 Pool.

The interview sessions (after receiving the free description form) were followed with immediate analysis of the results, during which the students' viewpoints were recorded and added into our viewpoint database. The results of all analysis were used to suggest the variety of the (so far) appropriate elements and topics in CHEKES II.

5.6.3 Phase II

We scheduled 90-minute interview sessions with each of the twenty the participants from the Primary Users-II group. We had only one no-show; with the others, the sessions were conducted as planned. All the subjects except two were 19 or 20 years old, and there was a gender distribution of 53% female and 47% male (Figure 5-18). All described themselves as fluent English speakers (in the recruitment process): 90 percent (17 out of 19) were native English speakers.

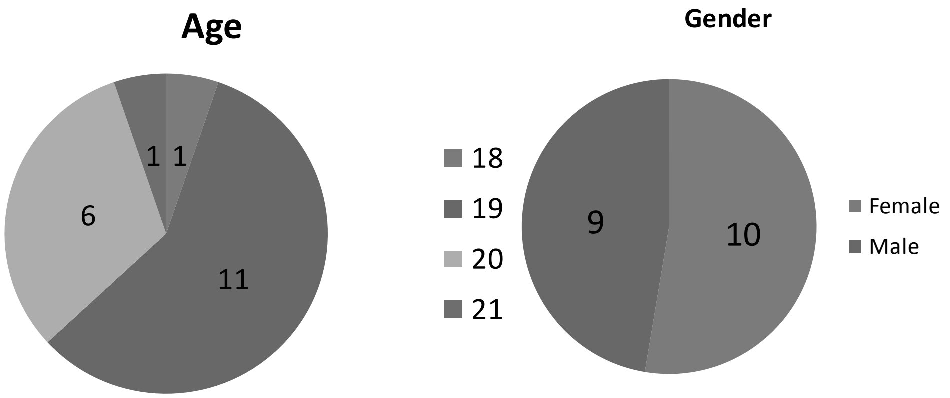


Figure 5-18. Age and gender distribution of the Phase II participants

As in Phase I, I pilot tested the tasks with various individuals and made sure that everything (including the timing) would flow as expected.

All interview sessions followed the same routine. They began with the initial greeting, obtaining the consent, and some initial instruction, then continued with three study tasks, and ended with a debriefing presentation. Once again, I asked the participants to think aloud while they were performing each task or subtask. Phase II was designed as a series of tasks that resembled a co-design approach (for an example health Web site), beginning from health topic mapping and testing, content and design element selection, and prototype design. More particularly, these tasks would consist of (in the following order):

5.6.3.1 Health topic mapping and evaluation

This comprised several subtasks during which the participants suggested some health topics, and tailored (i.e., add, remove, modify, or relocate elements) a health topics hierarchy we included (based on the results of Phase 0) until they were satisfied. As part of the evaluation, I asked the participants to predict what a suggested health topic category would contain. Then, they were given a five-level scale to rate all the topics in terms of their importance for inclusion in a health Web site being built. This task, including all its subtasks, was conducted using mindmap-based interfaces customized and specialized for this purpose (Figure 5-19).

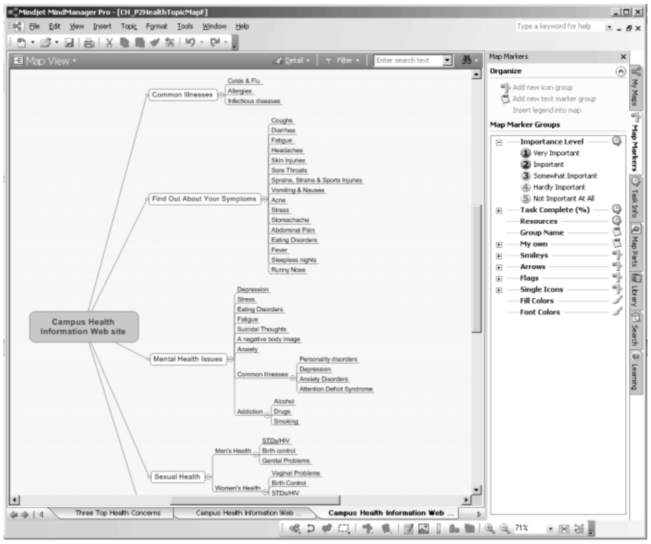


Figure 5-19. The mindmap-based interface used for health topic mapping by student participant in Phase I. The right column contained the five-level importance scale the participants could use to rate each health topic on the final hierarchy.

5.6.3.2 Element selection & design (A combinatory step)

During this task, I explained to the participants that the task's aim was to design a generic STD Web page (a representative Web page for the health Web site being designed) and gave them a sample piece of content regarding STD to start with. Then, I asked the participants to navigate a mindmap that contained all CHEKES II elements, including up to three design and position variations for each, then rate each element's importance (for inclusion) and usefulness (how useful the element would be for students) using the five-level scales provided (i.e., multi-scale tagging). Also, we gave the participants a blank standard Web page frame, in a Visio-based interface (Figure 5-20), and asked them to choose a design and position for each element from a provided list of elements (Figure 5-10), and to design the actual prototype page with her final choice of each.

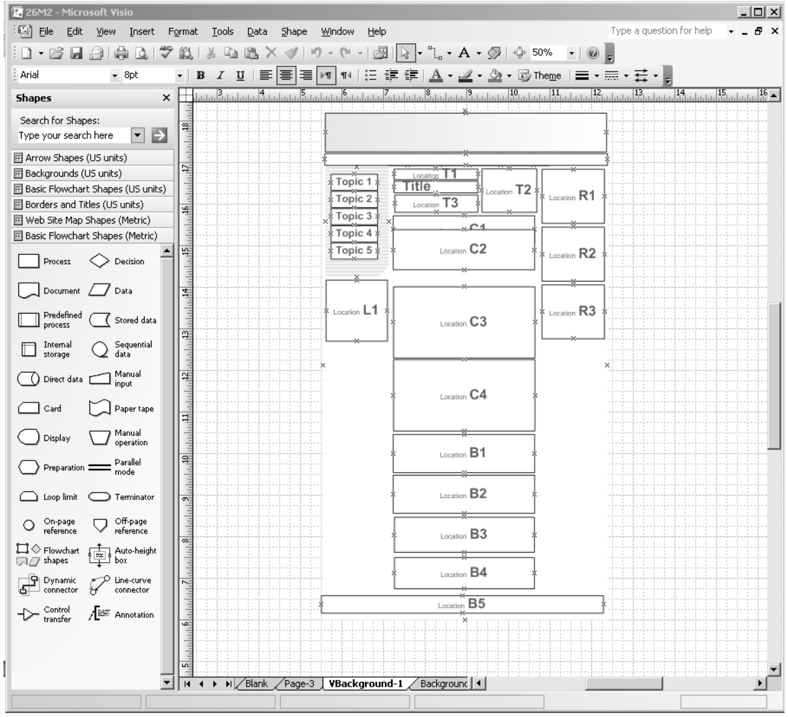


Figure 5-20. The Visio-based blank frame used by Phase II participants to position their selected design and knowledge elements.

The co-design exercise was conducted exactly as described earlier in Section 5.3.2.2. We found some of the participants more comfortable with them selecting and leading and me performing the physical positioning of the elements. There were also several cases where the participants would change their choice of elements after seeing the result of their selection in the visual exercise.

After finishing with all the elements listed, I gave the participants a brief instruction on how to use some extra design tools in the interface and gave her enough time to finish the page. I often found participants enjoying this part, playing with different elements (mostly with colors, locations and sizes) and giving a feel of full control over what was being designed. After they announced their satisfaction with their modifications, I asked them to describe (verbalize or type it in) their perception regarding the Web site they created on whether it was informative, visually appealing, etc. A debriefing presentation would close each session. Altogether, the three tasks in Phase II took 65-75 minutes to complete.

We analyzed the data from Phase III as secondary viewpoints regarding the normative viewpoints we elicited in Phase 0 and primary users' viewpoint we aggregated in Phase I.

We then used the results to make appropriate changes in CHEKES II and save the element and topic set as CHEKES III.

5.6.4 Phase III

Every subject in the Evaluation group participated in one 90-minute, one-to-one interview session. We had one cancellation and one no-sign-up, which left eight subjects for the sessions. Eight students with an age range of 19-21 (Figure 5-21) participated in individual one-to-one interviews to perform the three study tasks defined. Half of the students were female (and the other half, male), all were native English speakers.

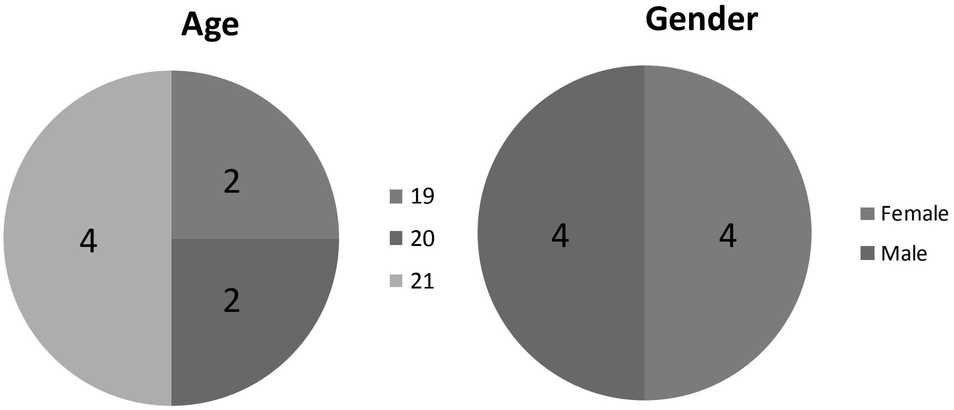


Figure 5-21. Age and gender distribution of the Phase III participants

The same four-step routine (initial greeting and consent attainment, brief instruction, study tasks, and debriefing presentation) as in Phase I and II was followed for each session. Before starting each task, I would briefly describe the task setting and the computer interface to enter inputs and provide an example of how possible answers or choices could be selected or typed in.

Phase III consisted of three summative evaluation tasks that aimed to finalize the CHEKES versioning, and to collect the data required to answer our research questions. I would explicate different aspects of each task in the order they happen during the interview session:

5.6.4.1 CHEKES multi-scale rating

A mindmap-based multiple-scale questionnaire, as described in Section 5.3.2.1.4, was used to elicit the users' viewpoints/attitude toward a Web page when it contains any of the CHEKES-III elements. For every element, e.g., page's author information, I asked the participants to rate:

1. how much they liked to see this piece of information in a Web page,
2. how necessary it was to include this in a health Web page,
3. how informative that would be in terms of providing the right information,
4. how useful that piece of information would be for their peer audiences, and
5. how that element would contribute to the page's credibility (if it did) (Figure 5-11).

We found the introductory instruction especially helpful for this task as the participants had to choose multiple tags for the same elements to indicate their attitude. For instance, to avoid possible confusion between informativeness and usefulness, I gave the participants examples on how some information could be useful but at the same give too much information for a Web page, and then made sure they could differentiate this while thinking aloud.

5.6.4.2 Simulated Google

The goal of this task, as described in Section 5.3.2.2, was to test the usability and usefulness of adding a few selected metadata elements (from CHEKES III) in indexing health information resources such as Web sites. To run the test, I read the following text aloud to every participant:

"Suppose that you or a friend of yours wonders how you would know if you have sexually transmitted infections/diseases and/or would like to learn about the symptoms of sexually transmitted infections/diseases (STI/STDs). You go online and search online for relevant information. And here are the first ten results…!"

Then, I opened the prepared Google page (Appendix 4) and asked them to rate (the trustworthiness, relevance, overall quality, and their desire to click) the ten links provided using the questionnaire appended to each link (without clicking on the link). After they were done with all ten, they were asked to choose the best three links and rank them in an order of one to three. The same procedure was repeated for Simulated Google (Appendix 5). In the last step (in this task), I asked the participants to visit ten Web pages and rate their overall quality and relevance (to the above scenario) by scanning through and examining its different aspects, and to insert their rating in a separate questionnaire page built for this purpose (Appendix 6).

One thing worth noting was that the subjects were not aware that the links in all of the above three subtasks were identical (e.g., Link #5 in Simulated Google pointed to the same Web page as Link #1 in Google). In our pilot testing with the student helpers, we found that the user who noticed such similarities of link sets would tend to stay rather consistent in their rating across the interfaces. For example, a user who noticed that Link #10 in Simulated Google refers to the same Web site (FamilyDoctors.org) as Link #10 in Google, included the same low rating she had given in Google (even though Simulated Google clearly showing its trustworthy provider and its relevant subtopics). That was the reason we changed the order of links in Simulated Google and Actual Page visit.

5.6.4.3 Prototype evaluation

The goal of this task was to compare a CHEKES-III based designed Web page/site (I called it the study Web site) with two other Web sites (which I called the control Web sites) designed based on conventional methods.

To run the comparison, I first asked the participants to type in three health topics that in their opinion were “very important” to be included in a university health Web site. Then, I told them that we had come up with three candidate designs for a health information Web site targeting students at the University of Victoria and needed their feedback on each to choose the best. I also explained that we would not be offended by any negative comments about any of the three artifacts, and we were completely open to all types of comments. Then, using a browser, I opened the first Web site and asked them to scan the site while thinking aloud. I also asked them to locate the health topics they had primarily suggested in the Web site’s topic menu and to tell me what they thought about the hierarchy provided. After the participants were done with the first Web site, I asked them to use a seven-item questionnaire (Appendix 8) to tell me how they felt about the Web site (the topic menu, visual appeal, informativeness, etc). The same routine was done for two other Web sites as well. To avoid the effect of order, I randomly changed the order of Web site appearance for every participant. At the end, the participants were asked to rank the Web sites based on six different factors and overall using the order number of the Web sites. For example, they might put 3, 1, 2 for the "easiest to use." The ranking would end the tasks and the debriefing presentation afterward would close the session. Each interview session took between 70 to 90 minutes to complete.

We statistically analyzed the phase III results using the analysis methods briefly explained in 5.4.2.2, and provided appropriate answers to our research questions. A detailed view of the analysis process will be discussed in Chapter 6.

Chapter 6: Results

This chapter presents our results from each of the four phases and demonstrates how the results were used to create and eventually tailor the knowledge requirements set (CHEKES) being specified. The chapter particularly provides an overview of the analysis methods used in Phase III and the related findings. These findings will be used in Chapter 7 as the basis to answer our research questions. To make understanding easier, the approaches to analysis and the results will be kept in their order of occurrence in the related phase(s), as described in Chapter 5.

6.1 Phase 0

The main objective in Phase 0 was to elicit and analyze the viewpoints of local professionals and selected exemplar Web sites concerning the pieces of information (knowledge elements and topics) to be included in a student health Web site. The results of Phase 0 will be discussed in two separate sections, knowledge elements and health topics.

6.1.1 Web sites: Knowledge elements

Following the approach, we proposed for TDM-KREM, each incidence of knowledge element was recorded in the viewpoint as a primary viewpoint. In addition, the viewpoints were associated in association database with the knowledge element they support (or relate to). For instance, a detected occurrence of Author information in a web page was recorded as a viewpoint of that Web site in the viewpoint database and associated in the association database with Author element in association role of Viewpoint-Element.

Seventeen knowledge elements of varying frequency of occurrence were identified across the Web pages studied (See Table 6-1). Table 6-1 shows the separate results for general consumer Web sites, university/student Web site, overall. For convenience, the presence of elements were only recorded in two-level scale of 1 (presence) and 0 (absence). Therefore, the percentages only show the rate of elements' presence in the corresponding group.

Table 6-1. The list of the study exemplar Web sites and their assigned reference codes

	Knowledge Element	General	University	Overall
1	Title	90%	100%	95%
2	Author	63%	0%	31%
3	Provider	100%	100%	100%
4	Parent Topic	70%	40%	55%
5	Table of Contents	80%	70%	75%
6	Related Topics	70%	50%	60%
7	Related Media	80%	20%	50%
8	Related SCS Tools	70%	10%	40%
9	Related News	40%	20%	30%
10	FAQ	50%	30%	40%
11	Glossary	50%	10%	30%
12	Local Services	70%	100%	85%
13	Online Resources	80%	70%	75%
14	Terms	90%	40%	65%
15	Accreditation	40%	30%	35%
16	Update	90%	40%	65%
17	Contact Information	100%	100%	100%

In the next sections and for each element, we describe the main characteristics of the information included in the element (or what was excluded), challenges or particular issues during the analysis (if there were any), the statistical analysis of the occurrence rate and, finally, the descriptive analysis of the variations. The terminology used for designating the labels for knowledge elements, such as “Author,” were based on our preference. There are not empirically selected over potential alternatives, e.g., “originator,” “creator,” or “writer.” Such element terminology may warrant further study.

To make frequent references to the Web site titles in the element sections simpler, we created a two-letter acronym as reference code for each Web site using the letters of its title words. For the two Teen health Web sites I also added a number to avoid duplication. Table 6-2 shows the complete list of Web sites with their reference codes.

Table 6-2. The list of the study exemplar Web sites and their assigned reference codes

Web site title	Reference code	Web site title	Reference code
MedlinePlus	MP	University of Princeton	UP
Familydoctor.org	FD	Stanford University	US
MedicineNet.com	MN	University of Wisconsin	UW
Mayoclinic	MC	University of New York	UN
Teen Health	TH1	Harvard University	UH
Canada Health Portal	CP	University of Toronto	UT
Health Canada/CHN	HC	University of McGill	UM
BC Health Guide	BC	University of Ottawa	UO
Teen Health	TH2	University of Calgary	UC
Sexuality and You	SU	University of Victoria	UV

6.1.1.1 Title

By "Title" as an element, we mean the actual title of the subject-specific content within the Web page. This should not be confused with the Web page's title, which resides at the title html tag in the Web page presentation code and appears on the browser's title bar. For instance, the SU's STD page has a contents title of "SEXUALLY TRANSMITTED INFECTIONS," but the Web page's title is "Sexually Transmitted Infections | Teens | sexualityandu.ca - Your Link to Sexual Well-Being."

Table 6-1 shows the occurrence of the element "title" across the Exemplars analyzed. All Web sites but one (95%) presented a title element within their Web pages. The exception was CP, in which the page oddly begins with a generic header "targeting health" (as on all related pages), followed by the description of the subjects (STDs) discussed in the page. In all the others, the title was clearly on top and in two common forms: a one-part title (the majority), such as "Exposure to Sexually Transmitted Disease" in BC, or a two-part title separated by a semi-colon, such as "STI's: Learn How to Protect Yourself" in UC. In one case, the title was embedded in a pictorial artifact (TH1) that made us count the Web page as "no title" in the first round of analysis.

6.1.1.2 Author

By the element "Author," we mean the information about the individual(s) who created the page's subject-specific content, such as author(s), editor(s) or reviewer(s), and any other direct contributors to the page (e.g., illustrator). We did not include in the analysis information regarding the Webmaster or people mainly responsible for page design and technical matters. Table 6-1 shows the occurrence of the author element within the Web sites. Five Web sites (28%) had the author element in their STD Web page: all were global Web sites. No university Web site had any form of author information included. The author information was not applicable to two of the Web sites, GG1 and CG1, as they would not include original subject-specific content (because they are portal Web sites).

The information included for the author element (within the page or a page linked by the author's name) ranged from full name (e.g., TH) and credentials to very comprehensive information such as a detailed biography (e.g., MN and BC). The author information for BC was unique among the global and Canadian Web sites we scanned in our preliminary review as it contained a full resume of the author, including appointments, affiliations, certifications, and etc. Also, two of the Web sites, MC and FD, had a general link in all their Web pages to their lists of the entire editorial teams involved in the content preparation and maintenance. No Web site provided the author's contact information.

The range of contributor type (reviewer, editor, etc.) included with the author name varied as well. For instance, TH included only the main author, while FD had a long list of individuals who were involved with the page creation in a variety of ways.

6.1.1.3 Provider

By the element "Provider," we mean the information identifying the organization, association, company, etc. officially responsible for the Web site's composition and content, such as the organization logo or title name. Such information was only considered (and included) as an element when the information or a related link (e.g., "About Us") was reasonably visible within the page's frame.

The occurrences of the provider element within the Web sites are shown in Table 6-1. All 20 Web sites (or 100%) had provider information within their pages. In most, the provider information was presented in a combination of textual and pictorial formats, either in the logo bar (e.g., FD, MP), at the bottom (e.g., SU, TH2), or both (e.g., TH1). Also, in most cases, the information provided was limited to the title of the organization (e.g., MedicineNet, Inc. for MN or Nemours Foundation for TH1), which might not necessarily clarify the organization type, i.e., academic, private sector, and etc. In such cases, users have to consult the comprehensive information often included under “About …” to get access to this kind of information.

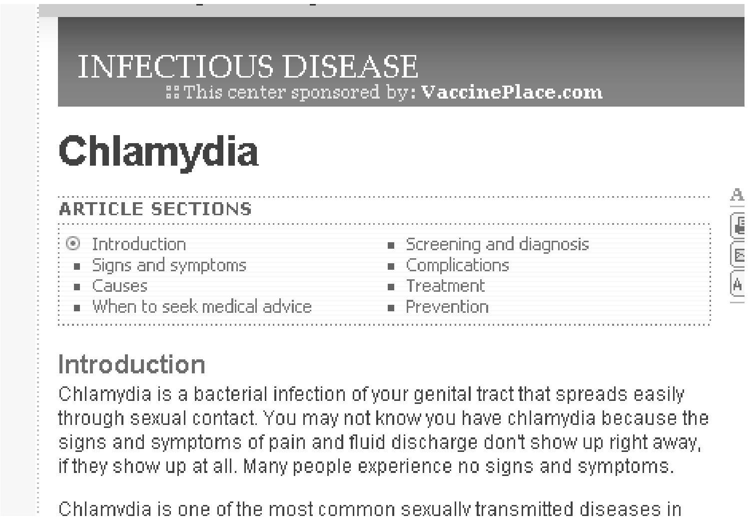
6.1.1.4 Parent Topic

By “Parent Topic” (also called breadcrumb (Shneiderman, 2006) or topic category) as an element, we mean the information about the parent topic(s) of the particular Web page topic that could help readers learn if they are in the right category or find their way to the parent and neighbor topics. This is especially important when a reader jumps into the page through Google and would like to navigate to other related pages from the Web site as well.

As shown in Table 6-1, seven general (70%) and four university Web sites (40%) contained this element within their STD Web page, for a total of 11 (55% of all Web sites). The style varied from a single parent topic (mostly located above the title), which represented only the immediate level one up in the topic hierarchy (e.g., UO) , all the way to sophisticated drop-down menus showing a variety of clickable parent (and neighbor) topics (e.g., BC). However, the most common was a linear hierarchy of clickable topics beginning from the root and ending with the current topic (e.g., TH1, MN, CP, HC, SU, FD, etc.).

6.1.1.5 Table of Contents

By “Table of Contents” as an element, we mean the set of headings or subtopics listed within the page, most often on top, to ease navigation between different intra-page contents. In other words, “Table of Contents” is the intra-page portion of topic menus for the Web sites. During analysis, we included as occurrences of this element any set of subtopics matching the actual available subtopics in the page (in cardinality and order), regardless of their location or design features (hyperlinked, active, etc.). Figure 6-1 shows a typical form for a table of contents (a screenshot from MC), in which the subtopics are bulleted and clickable.



INFECTIOUS DISEASE

:: This center sponsored by: VaccinePlace.com

Chlamydia

ARTICLE SECTIONS

- ⊙ Introduction
- Signs and symptoms
- Causes
- When to seek medical advice
- Screening and diagnosis
- Complications
- Treatment
- Prevention

Introduction

Chlamydia is a bacterial infection of your genital tract that spreads easily through sexual contact. You may not know you have chlamydia because the signs and symptoms of pain and fluid discharge don't show up right away, if they show up at all. Many people experience no signs and symptoms.

Chlamydia is one of the most common sexually transmitted diseases in

Figure 6-1. A typical hyperlinked Table of Contents listing the subtopics being discussed within the Web page frame (adopted from MC)

As shown in Table 6-1, eight general (80%) and seven university (70%) Web sites contained this element within their STD Web page, for a total of 15 (75% of all Web sites). A fair majority of the Web sites that offered the element had the subtopics sorted underneath the element title (e.g., MC, MP, US, UH). The other, less-frequent artifacts included side menus (e.g., SU, FD), and pop-up menus (e.g., UO). Also, in the table of contents, the variation could be classified on the basis of placing subtopics into:

1. *question form*, in which the contents are presented in question and answer form or Q&As (e.g., FD, SU),
2. *phrase form*, in which subtopics were listed using different phrasal forms, and
3. *topic form*, in which the headings are listed as one (or more) word topics (e.g., US, UT, MC) or a combination of two or more (e.g., HC, BC).

Almost all the occurrences of Table of Contents provided hyperlinks to the actual subtopics in the page.

6.1.1.6 Related Topics

By “Related Topic” as an element, we mean linked pages or pieces of intra-Web site information that are reasonably relevant to the particular topic of content. For instance, a related topic for an STD Web page could be pages titled “How to use condoms” or “Alcohol and unprotected sex.”

we included any set of links (one or more) to relevant Web pages within the Web site as an occurrence of this element in the matrix. As shown in Table 6-1, seven of the general Web sites (70%) and five of the university Web sites (50%) contained this element within their STD Web page, for a total of 12 (60% of all Web sites).

The occurrences varied in their structure and location. The variation included: a) a set of hyperlinked titles as a portion of the main menu (e.g, UM and UO), b) a list or list box of links within the Web page (e.g., FD, MP, MN, HC), c) a simple link to the page containing the links (such as TH1), d) a more sophisticated form of the element in which the related topics are categorized based on common subtopics such as facts, basics, tools, procedure, medications (e.g., MN and MP provide); and e) a multi-box (e.g., MN) in which an additional side box was also included, listing Top Ten popular related articles offers. TH1 was particularly unusual as it included two or three lines describing the content of each link.

6.1.1.7 Related Media

By “Related Media” as an element, we mean any type of audio, video, image, or flash file that contains relevant subject-specific content and helps better comprehension of the subject(s) being discussed. Therefore, we did not include varieties of media artifacts (within the page) posted for various other purposes such as design (a background non-subject-related image or music) and advertisements.

As demonstrated in Table 6-1, eight of the general Web sites (80%) and only two of the university Web sites (20%), contained the element within their STD Web page, for a total of 10 (50% of all Web sites). In the vast majority of occurrences, images were the only type of media available (or the main type) (e.g., FD, UT, TH1 and 2), but other types of media such as educational and diagnostic flashes (e.g., MP, SU, MN) and videos (e.g., MN) were also available. we did not come across any instance of audio files in the exemplars.

6.1.1.8 Related Self-Care Support (SCS) Tools

By "Related SCS Tools" as an element, we mean any type of self-care tool, such as quizzes, if-then charts, games, and educational media (e.g., picture series, flash-based presentations), that help users provide self-care or make better-informed decisions about their health. There is a conceptual overlap between this element and related media. By related media, we mean various forms of physical representation, whereas by related SCS tools, we would like to call attention to the variety of type and purpose of the knowledge material. For instance, a quiz is a common type of self-care tool in which users can, e.g., find out if they have drinking problem or not. However, such quizzes can be represented in a variety of physical forms, including media. Nonetheless, there were a few cases in which the same piece of information was counted as an occurrence for both types.

As shown in Table 6-1, seven of the general Web sites (70%) and only one of the university Web sites (10%), contained the element within their STD Web pages, for a total of eight (40% of all Web sites). There was a variety of self-care tools across the Web sites with a slight preference toward self-care charts. Self-care charts, were most often a series of pictures through which a self-care procedure, e.g., how to use condoms (e.g., in SU and TH2), would be presented and explained. Some self-care charts would only use text instead of pictures (e.g., FD). Quizzes were the other type offered in simple textual (e.g., UO, MN, MC, MP) and flash-based forms (e.g., CP and SU). BC offered a symptom-checker chart allowing users to check their symptoms in a textual chart and find a relevant guideline for their health issue. A sophisticated type of self-care support tool, a self-care decision-support tool in which users could use a visual 3D body to locate their area of health issue(s) and learn more about the possibilities of diagnosis, was also available through MN.

6.1.1.9 Related News

By "Related News" as an element, we mean any piece of information with the latest news about the health topic under discussion. The news could be specifically relevant to the topic, e.g., "A new method of STD treatment," or generally relevant e.g., "A new infectious disease is coming to campuses!"

As Table 6-1 shows, four of the general Web sites (40%) and two of the university Web sites (10%) contained the element within their STD Web pages, for a total of 5 (25% of all Web sites).

The types of this element included links to relevant news from a news agency (e.g., MP), an electronic newsletter (e.g., SU, UT and MC), original health news, and general or local news (e.g., MN and UN).

6.1.1.10 Frequently Asked Questions

By "Frequently Asked Questions" or "FAQ" as an element, we mean a set of common questions (from the particular audience for the content) and answers (from the provider or author(s)) whose content or a link to is posted within the Web page of concern. There were two challenges in counting the FAQ occurrences. One we encountered during the analysis was that often the main content was written in the form of questions and answers (Q&As) and it was not clear if the questions were asked by an actual audience (e.g., UC, UN, FD), or only written in this format to make the site appear more interactive. Since even in the Web sites that have a separate FAQ section it is often not clear if these are original questions, we considered all cases of content chunks with a consistent Q&A format (embedded or separate) as occurrences of FAQ. For the same reason and because it was not consistent, CP, MN, and TH2 were not considered to have FAQ despite having a few Q&As.

A second challenge was the issue of relevance. Certainly, it would be more convenient and useful if the FAQ provided was specific to the particular subject of the Web page. However, there were cases such as TH1 in which the FAQ section contained many questions related to different health topics. As either case still represents the requirements felt necessary by the knowledge provider, we included them as well.

As demonstrated in Table 6-1, five general Web sites (50%) and three university Web sites (30%) presented the element within their STD Web pages, for a total of eight Web sites (40%). In the majority of cases, the questions were embedded within the content followed by their answers (e.g., UN and FD). Another type included a link to a FAQ (or Q&As) page (e.g., TH1 and SY).

6.1.1.11 Glossary

By "Glossary" as an element, we mean any definitional information, distinguishable from the main content, regarding selected content's subject-specific terms in order to make the content more accessible/understandable to the audience. As demonstrated in Table 6-1, five general Web sites (50%) and only one university Web site (10%) offered glossary services within their STD Web pages, for a total of six (30% of all Web sites). The styles were either a glossary-labeled link to the glossary page (e.g., UO and MN) or hyperlinked terms within the content that would direct the user to the page with related information (e.g., TH1 and BC). None offered in-page glossary services (definitions included within the page).

6.1.1.12 Local Services

By "Local Services" as an element, we mean information on how to find or access local health-related facilities offering relevant subject-specific services, including the descriptions of the services offered. we included as occurrences of the element the relevant information whether as brief as a name and phone number (for a local clinic) or as comprehensive as directory pages of local services.

As shown in Table 6-1, seven of the general (70%) and all of the university (100%) Web sites contained the element within their STD Web pages, for a total of 17 (85% of all Web sites). A major subject of variation was the depth of information provided for each resource, ranging from a simple name and phone number (e.g., UP and UN) to comprehensive direction and/or descriptions (e.g., BC, UH). A more sophisticated type that allowed users to find their closest STD-related health services using a visual map or a stepwise locator was available in MP and MN.

6.1.1.13 Online resources

By "Online Resources" as an element, we mean links to (or information on how to access) other Web pages offering relevant subject-specific content. This element is almost identical to "related topics" except that the linked resources/Web pages are located externally to the Web site's content.

We included all occurrences of reference to relevant content of other health Web sites, whether embedded within the main content or listed as a distinguishable set of links. As demonstrated in Table 6-1, eight general (80%) and seven university (70%) Web sites contained the element within their STD Web pages, for a total of 15 (75% of all Web sites).

The degree of relevance was subject to broad variation. The Web pages analyzed offered a spectrum of types, from links to very particularly relevant Web pages (e.g., CP and HC) all the way to general links to home pages of other consumer health Web sites (e.g., UV and UT), and to a combination of both (e.g., MP, US). Occurrence of "Online Resources" could also be classified by the information provided for each resource, ranging from name only (of the Web site) (e.g., UT and UV) to comprehensive information about the resource and the related provider (in a separate page) (e.g., BC).

6.1.1.14 Terms

By “Terms” as an element, we mean information such as “terms and conditions,” ”privacy policy,” “disclaimer,” which contain various legal/official terms and notices regarding the Web page’s content.

Here, as with all the other elements, we only counted the presence (or absence) of an element (as 1 and 0) within a Web site and not the number of occurrences. In other words, all instances of terms-related information in a Web site were counted as one occurrence. Also, we counted only the “terms” whose link or information was available to users within the STD Web page (and not the home page or others). As Table 6-1 shows, nine of the general Web sites (90%) and four of the university Web sites (40%) contained this element within their STD Web pages, for a total of 13 (65% of all Web sites).

The variation was mostly limited to the variety of term types included. For the vast majority of sites, the element was represented in a single link to one long page containing all legal information and notices (e.g., MN, FD, SU, BC). There were also cases in which more than one policy was included (e.g., MC, TH1) or in which the notices were included as a couple of paragraphs at the bottom of the Web page (e.g., UC).

6.1.1.15 Accreditation

By “Accreditation” as an element, we mean those pieces of information, either textual or pictorial, that represent the proof of health content accreditation by related accreditation bodies. A single logo of a known accreditation body or a list of titles for the related association that approved the content counts as an occurrence of this element. For instance, Figure 6-2 shows the HON (Health On the Net) logo and its related information as the accreditation body that quality checked the medical subject-specific content for MN.

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HON @ CODE ACCREDITED 10/2006

We comply with the HONcode standard for health trust worthy information: verify here.

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Figure 6-2. HON logo and information as an occurrence of element "accreditation" in MN

As shown in Table 6-1, four of the general Web sites (40%) and three of the university Web sites (30%) contained the element within their STD Web pages, for a total of seven (35% of all Web sites). Three of the occurrences were HON accreditation (logo and verification link) (TH1, MC, MN), two had endorsements by the Accreditation Association for Ambulatory Health Care (a hyperlinked logo) (UP and UW), and the other two had multiple accreditations (US and BC).

6.1.1.16 Update

By "Update" as an element, we mean various update information regarding the creation, edition(s) and maintenance of the Web page's subject-specific content. A challenge arose during the analysis when the Web site contained a date as part of copyright information (i.e., "copyright date") that might not necessarily refer to the time the page content was last updated. Such occurrences were excluded.

As demonstrated in Table 6-1, all general Web sites but one (90%) and four of the university Web sites (40%) contained the element within their STD Web pages, for a total of 13 (65% of all Web sites). The cases vary mainly in the range of dates included and in the amount of information on each occurrence. In most cases, the element was as simple as a last update date, such as "Last updated May 23, 2005" (e.g., SU, MN, CP). However, there were cases in which the creation date or reviewer(s) information was also included (e.g., FD, BC), or in which the date included would disclose the exact hour and minute of update!

6.1.1.17 Contact Information

By “Contact Information” as an element, we mean information on how to communicate with the provider of the Web site for comments, concerns, and questions. We counted all varieties of standard contact information, which most often included email (Web form or email address), phone number, and/or local address. As shown in Table 6-1, all 20 exemplar Web sites (100% of all Web sites) contained the element within their STD Web pages.

In the majority of cases, the information was provided in a separate page accessible through a “Contact” (also called “Contact Us,” “Contact Information”) or “About…” link available in the page (e.g., US, CP, HC). In some cases, this information was conveniently available underneath all pages (UM, UT, UH, UP).

6.1.1.18 Others

There were occurrences of knowledge/information elements within the Web sites that either were very infrequent or were not significant enough to be considered and recorded as new elements. For example, MN offers a list of suggestions for topic-related reading. It also includes advertisements within the Web page. SU provides a poll tool on various health topics. MP includes links to related journal articles, research, and statistics for more sophisticated users. UM offers an online sex health shop selling a variety of related products. UC provides links to real, relevant stories from students. Finally, some Web sites such as MP, SU, and UH offer a site map that will be discussed under topic analysis (next section). In contrast with the above infrequent elements, it was also realized that a majority of theWeb pages studied began with an introductory paragraph through which the authors provide information such as a brief overview of content, the purpose(s) of the guideline, and etc. However, consideration of such information as a separate element was needed more evidence. In the next step, we analyzed the occurrences of health topics across the Web sites’ topic menus.

6.1.2 Web sites: Health Topics

The purpose of the analysis was to find the areas of agreement on health topics, and the way they should be organized in a navigation menu. Health topic hierarchy enables users to navigate through the health Web pages. It also provides a basis for elements such as Parent Topics (i.e., Topic Category) or Table of Contents (i.e., Subtopics).

As with most Web sites, a topic hierarchy consists of a root topic (e.g., Student Health Information), health topic categories that have at least one subcategory and often no content pages (e.g., Nutrition and Fitness, Mental Health), and topic instances which contain resource/content pages and often subtopics but NOT subcategories. Health topic categories have several levels (two or more), as well. All topic categories could potentially be used as topic instances but not often vice versa. For instance, “common cold” can hardly be a topic category (it is a topic instance).

Following the pattern in the majority of Web sites analyzed, we set our number of goal levels at two. Figure 6-3 shows an example of a two-level topics menu. In this menu, Mental Health, as level 1 category consists of three level 2 subcategories or content pages such as Depression, Stress and Self-image, from which Stress (as a content page or topic instance) addresses subtopics such as Coping with Stress, Exam and Anxiety, Stress and Medications.

Root…….…………Level 1………….……Level 2................Subtopics

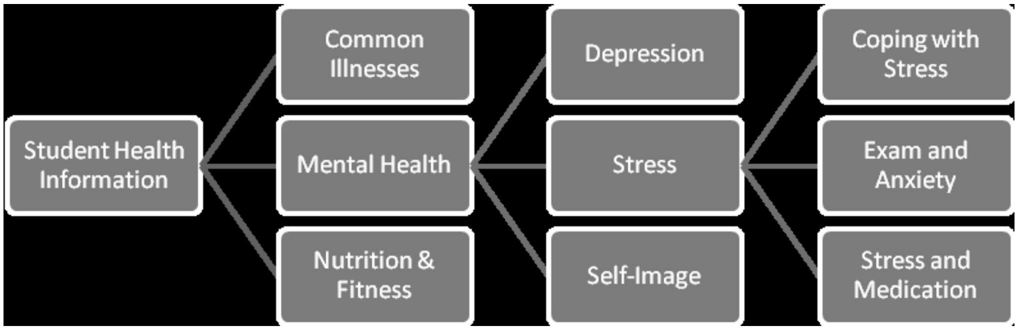
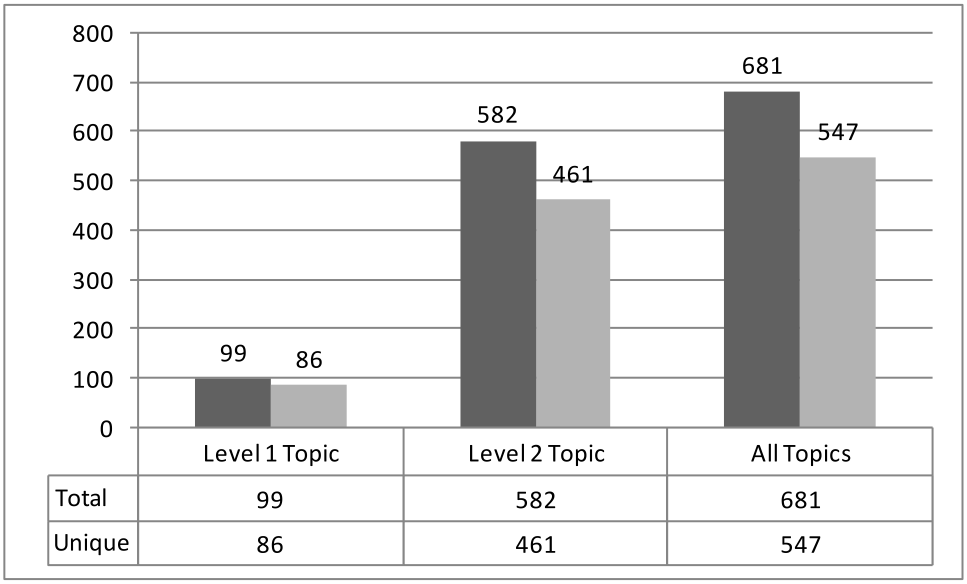


Figure 6-3. A two-level health topic hierarchy in which the level 1’s are the main health topic categories whilst the level 2’s contain content pages or topic instances with subtopics

We took the two steps we described in Chapter 5 (Primary viewpoints elicitation at 5.3.1 and association analysis in 5.4.1) to analyze the health topics. The main health topics of focus for a student health Web site are often only a portion of a plethora of health topics that could potentially appear on a consumer health Web site (which potentially encompasses all the world's health topics). This is why we narrowed down the domain of analysis to include only the student health Web sites.

6.1.2.1 Primary viewpoints (Topics) elicitation: Results

Overall, 681 topics were recorded in the viewpoint database. All Web sites offered only two levels of topics (main level + topic content pages). The topic labels included ranged from very broad topics such as "Wellness" to very specific topics such as "Salt." From 681 topics recorded, 99 topics were of "Main Category" or Level 1 type (17%) and 582 were of Level 2 type (83%). There was an average of ten Level 1 health topics and almost sixty Level 2 topics (or 6 subcategories per main category) per Web site. Finally, 86 Level 1 topics (87%) and 461 Level 2 topics (79%) had unique labels. The rest were using different labels, even for the same context. We used the "automated duplicate removal" tool in Excel to determine the rate of uniqueness (only for the topics' wording). This tool, as usual with automated text recognition features, listed identical topics of slightly different labels such as "Mono" and "Monos" as separate unique topics (but the cases were few). Figure 6-4 illustrates the distribution of topic level types and the associated rate of unique topic labels in each category.



	Level 1 Topic	Level 2 Topic	All Topics
Total	99	582	681
Unique	86	461	547

Figure 6-4. An early result of topic statistics illustrating the distribution of topic types and frequency of occurrence

The associations between each pair of Level 1-Level 2 topics were recorded in the association database with association role of topic-category. A total of 582 associations (equal to the number of Level 2 topics) were recorded. In the next step, we combine and integrate the topics to produce a representative health topics menu.

6.1.2.1.1 Level 1 Health topics (Topic categories)

An approximation approach was taken to merge Level 1 topics into new combined categories and the results were recorded as new associations in the association database. Using this approach, we could organize all but eight (of the 99) Level 1 topics in ten combined categories. For the remaining eight topic categories, we associated them with "Others" with association role of Topic-TempCategory. As a result, eleven combined categories were created based on 99 Level 1 topics (See Table 6-3).

Table 6-3. An early result of topic statistics illustrating the distribution of combined categories and the related number of Level 1 topics associated with each

Combined/Suggested Categories	Number of Level-1 Topics Associated
General Health /Common Illnesses	17
Mental / Emotional Health	14
Sexual Health & Relationship	12
Nutrition & Fitness	11
Healthy Lifestyle	10
Alcohol & Drugs	9
Others	8
Travel Health	5
Women's Health	5
Men's Health	4
Skin Health	4

Using pivot table (described earlier in Section 5.4.2.1), we measured the number of associated Level 2 topics within each category (to enable sorting). As Figure 6-5 shows, General Health / Common Illnesses holds the widest range of related health topics because of its broad label. After that, the four categories of Mental / Emotional Health, Alcohol & Drugs, Sexual Health & Relationship, and Nutrition & Fitness hold the second to fifth population of related topics in a close competition. In addition, if we merge both Men’s Health and Women’s Health with Sexual Health & Relationship, which share a reasonably similar range of Level 2 topics, Sexual Health & Relationship would constitute the second largest topic of interest in the student health Web sites.

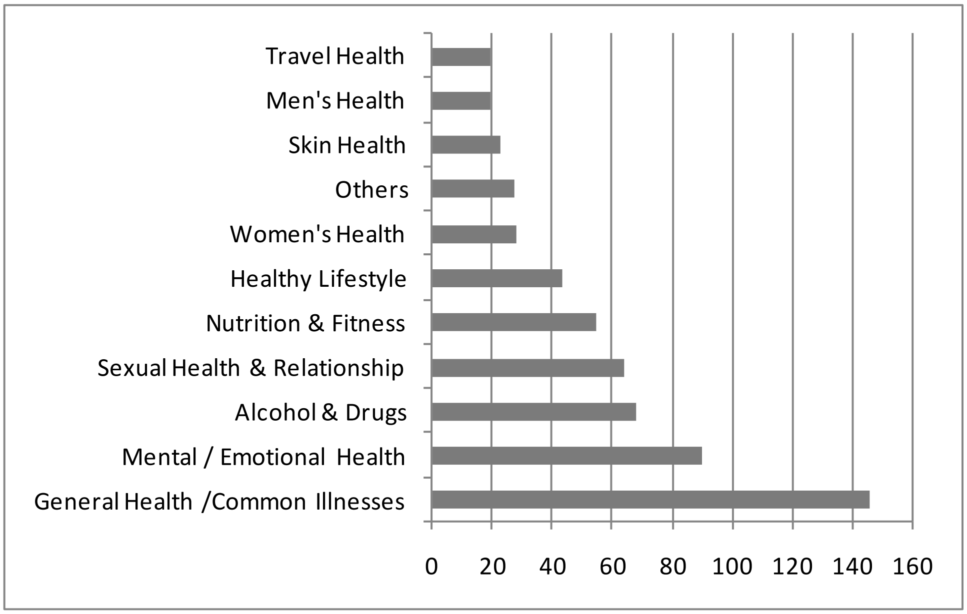


Figure 6-5. Combined/suggested categories sorted based on the occurrence of their related Level 2 topics

6.1.2.1.2 Level 2 Health topics (Topic instances)

We found the approximation approach cumbersome to perform for Level 2 topics for two reasons. First, the Level 2 topics were widely distributed in topic labels (461 unique labels), thus making it inefficient to manually select and combine appropriate topic labels and associate them with the relevant topics whereas in Level 1 topics, the labels were reasonably similar, and combined categories selected were already available in the list. The second reason was that almost all Level 2 topics were topic instances, containing content pages, and there was a risk that any approximation would eliminate many topics of highly varying content only because of their seemingly similar labels. Obviously, scanning and comparing thousands of content Web pages to optimize the approximation was also impractical. For instance, looking at all the Level 2 topics associated with “Skin Health” in Table 6-4, there was hardly any way to merge the 90% of labels without eliminating some of the contents provided. In addition, a valid elimination would make prioritization of health topics based on some ranking desirable. Such ranking was not available.

Table 6-4. An example list of the available subtopics across the health Web sites under Skin Health (the subtopics are separated by comma)

Skin Health:

Acne, Warts, Prickly Heat, Skin Cancer: What You Need To Know, Skin Sores, sun safety, piercings, Athlete's Foot, Poison Ivy, Sumac and Oak, chronic conditions, Skin Cancer, Eczema, Sun Protection, General Skin Care Tips, Sun Sense, Moles, Keratosis, Pilaris, Not Another Cold Sore!

As result, it was decided to leave the Level 2 topics intact until the availability of supporting evidence (in further Phases) in favor of some topics which could substantiate the possible elimination.

6.1.3 Health Professionals

Six professionals participated in the one-to-one one hour interview sessions. The subjects consisted of two medical doctors (one MD and one MD PhD), two counselors (one MD and one MD PhD), and two nurses (both RNs). All the participants rated their Internet skill between 5 and 7 on a ten-level scale (from 1=hardly able to use the Internet, to 10=Web professional) with an average of 6.3 (Std. Deviation=0.76). Only one subject could recommend more than one consumer health Web site to students. Other Web sites suggested were "All government Web sites," "PubMed," "Merck," etc which were either too general or hardly suitable for students. Four out of six subjects mentioned that they would rather recommend non-Web materials to their clients/patients.

6.1.3.1 Health Professionals: Knowledge elements

The purpose of this analysis was to sort and analyze positive (+1), neutral (0), or negative (-1) types of viewpoints regarding some knowledge elements. We called such value of momentum toward an element, the **element score** (ES). **Total element score** (TES) reflects the sum of all the element scores given by various participants. **Average element score** (AES) for a particular element represents the overall nature (minus to plus) and occurrence of the related associated viewpoints (the numbers are rounded). All the numbers for the element scores should be read as positive (or plus) unless minus sign was added.

Table 6-5 shows the element scores results regarding the three elements of Author (Name and Credentials), Provider, and Last Update. As demonstrated, the subjects showed strong agreement on the high importance of the Update and Provider (TES=6, AES=1.0, SD=0.0), but their interest varied toward Author's Name, with a minor overall tendency in favor of the element (TES=1, AES =0.2, SD=1.0). However, in cases where the Author's Name was being used, there is a reasonable agreement among the subjects (TES=4, AES =0.7, SD=0.8) that the Author's Credential should accompany the Author's Name, whenever the element is being used.

Table 6-5. Statistical analysis of the three knowledge elements, Author (Name and Credentials), Provider and Last Update

	Author's Name	Author's Credentials	Provider	Last Update
Valid	6	6	6	6
Missing	0	0	0	0
AES	0.2	0.7	1.0	1.0
Std. Deviation	1.0	0.8	0.0	0.0
TES	1	4	6	6

For the two control elements, the results varied (Table 6-6). As explained in Chapter 5 (Section 5.3.2.1), we used the control elements to compare the responses of the participants to out of framework non-CHEKES elements (or non-telescopic elements). The subjects had an overall neutral opinion about the presence or absence of Number of Visitors (TES=0, AES=0.0, SD=0.6) in a student health Web page, whereas in Students' Rating, the responses were fairly more positive (TES=3, AES=0.5, SD=0.5).

Table 6-6. Statistical analysis of the two control elements, Number of Visitors, and Student Rating

	Number of Visitors	Student Rating
Valid	6	6
Missing	0	0
AES	0.0	0.5
Std. Deviation	0.6	0.5
TES	0	3

Finally, the subjects suggested five more elements they would consider important element(s) or factor(s) for a health Web page. As shown in Table 6-7, three of them thought “Contact Information,” which they would define (verbally) as information about how to reach the professionals, to be an important element. Two others suggested that “Content Organization” or “Layout” were important factors affecting the readability of materials provided. “Visual Appeal,” “Local Help,” and “Page Index” were also suggested as important elements/characteristics to be included or considered in health Web pages.

Table 6-7. Suggested elements by Phase I Professional Participants

Element / Factor Suggested	Frequency of Occurrence	Element Score
Contact Information	3	3
Content Organization	2	2
Visual Appeal	2	2
Local Help	1	1
Page Index (or TOC)	1	1

6.1.3.2 Health professionals: Health topics

The professional participants suggested two sets of health topics, a ranked list of the first to the fifth most common health topics among students, and second, a mindmap-based hierarchy of all common health topics useful for students.

6.1.3.2.1 Ranked health topics

The participants suggested 35 health topics ranked from one to five (first to fifth most important/common). One participant felt he/she could not be limited to five topics and felt it necessary to include ten. To analyze the health topics, we followed the same steps as the Web sites. The only difference was that the topics suggested here hold different ranks of importance. Therefore, we created a score we called **topic score**, to represent both frequency of occurrence and the importance ranking (given rank) for each health topic. The formula we created for the topic score is shown in Figure 6-6.

$$TS_t^u = \sum_t^u AR$$

- TS_t^u=Topic Score for a particular topic assigned by some particular users
- AR= Adjusted ranks, or the reversed values of the given ranks by some particular users

Figure 6-6. The formula created to calculate the topic score for a particular health topic

To calculate the adjusted rank, we first converted the five-level importance ranking into three (1 and 2 as 1, 3 as 2, 4 and 5 as 3), reversed the ranking number for every occurrence (1 as 3, 2 as 2, 3 as 1), and used the result as adjusted rank for that occurrence. For instance, if “STI/STD” as a health topic had nine occurrences of first importance, four occurrences of second importance, and two occurrences of third importance, the topic score adds up to 37 i.e., (9*3) + (4*2) + (2*1). In cases of health topics integration (i.e., combined categories), we added up the topics scores for all the associated health topics with a combined category/topic and called it **category score**.

Eight combined categories were produced and sorted based on the category scores. Table 6-8 (below) shows a summary of the results. The table indicates that Mental Health and Relationship has the highest category scores followed by STD & Infectious Diseases and then Birth Control. Once again, the low score of categories such as Travel Health suggests the need to further merge of those categories within the larger relevant categories. Appendix 9 shows the detailed version of results including all the original topics suggested by health professionals.

Table 6-8. Eight categories of health topics suggested by the professional subjects

Combined/Suggested Categories	Category Scores
Mental Health & Relationship	28
STD & Infectious Diseases	20
Birth Control	17
Healthy lifestyle	11
Others	10
Alcohol & Drugs	4
Injuries	3
Travel Health	2

6.1.3.3 Hierarchy of health topics

Each professional participant compiled a health topic hierarchy, which in their opinion represented the common campus health issues best. Early in the analysis, we encountered two minor issues. First, every professional expanded the hierarchy most often according to his/her own area of expertise. For instance, the hierarchy suggested by a counselor focused predominantly on issues such as healthy lifestyle, stress, depression, whereas the nurses mentioned topics such as immunization, travel health, injuries. The doctors also included medical-school types of topic categories such as chronic diseases, gastrointestinal diseases, etc. Although originally the suggestions by varied professionals seemed like a limiting factor, ultimately the collection covered all the main campus health concern and thus was useful for the purpose of analysis. The second issue was that the topics suggested, despite the instructions and introductions given, would not necessarily represent a health topics label but rather a subject label. For instance, topics such as *Today's lifestyle determines tomorrow's chronic disease and death,* or *So, you don't think you have a Drinking Problem!* basically could not be used as health topic labels for a Web site. To resolve those issues, we associated those topics with the appropriate combined categories that represented their main purposes.

Overall, a total of six hierarchies with 189 health topics (an average of 32 health topics per hierarchy) in two to three levels (45 Level 1 and 144 Level 2 and 3) resulted. Similar to the topic analysis approach in Phase 0, we appended them all to the viewpoint and association database and processed them (approximation and associations) to reveal the areas of consensus.

In the approximation process, we categorized all the lifestyle topics (particularly the ones beginning with "healthy" such as healthy sleep and healthy eating) under healthy lifestyle (a suggestion made by a couple of the professional participants). In addition, we categorized all cases of common illnesses and symptoms under General Health /Common Illnesses. And finally, an "Others" category included those health topic categories which were suggested only once (in most cases), such as sport injuries or immunization. Table 6-9 shows the final combined categories sorted according to their occurrences: with Healthy Lifestyle at the top, followed by Stress / Depression /Mental Health, STI/ Birth Control / Pregnancy / Sexual Health, and Alcohol & Drugs as three categories of similar occurrences. The occurrence rates listed, although not necessarily representative of the topics' popularity on the UVic campus, may indicate the topics' perceived importance by health professionals dealing with such issues on campus.

Table 6-9. Final combined categories suggested by professional participants sorted based on their frequency of occurrence

Health Topic Categories	Occurrence
Healthy Lifestyle	28
Stress / Depression /Mental Health	18
STI/ Birth Control / Pregnancy / Sexual Health	18
Alcohol & Drugs	18
General Health/Common Illnesses	17
Others	9

6.1.4 CHEKES-I

We gathered all the Phase-0 viewpoints regarding knowledge elements and health topics in a set we called CHEKES. Figure 6-7 shows a simplified visual example of this association in which an occurrence of Author information in a Web site (BC Health Guide) is positively supporting (+1) the inclusion of Author information in the CHEKES element set (All the occurrences of knowledge elements or health topics across Webs sites were given a default rank of +1).

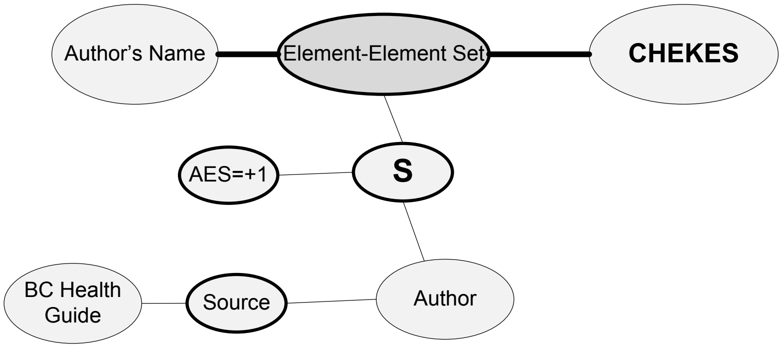


Figure 6-7. A visual association scheme illustrating how the inclusion of the Author element in CHEKES is supported by an occurrence of Author information in a health Web pages analyzed

Operationally, we calculated the average element score for each element suggested and listed all the knowledge elements with AES of minimum positive values (we set as +0.1) as CHEKES-I element set. Table 6-10 shows the list of elements included in CHEKES-I with the summary of occurrence statistics, sorted based on the elements' mean of occurrence across Web sites. As evident, Contact Information, Provider, and Title Elements were the elements with most supporting viewpoints across the Web sites, followed by fourteen other elements and ending with the Author element as the least agreed. A similar pattern was detected with the professionals' viewpoints (shown with (P) in the table) in which the Provider information was the most and the Author's Name was the last. We saved all the other viewpoints of lower element scores, including the additional elements suggested by the health professionals, in the viewpoint database. Later inclusion of such elements will be possible if further viewpoints support their inclusion.

Table 6-10. Eighteen CHEKES-I elements sorted based on their average element scores (the professional's viewpoint are marked with (P) in the element column)

Elements	N	Total Element Score	Average Element Score
Contact Information	20	20	1.00
Provider	20	20	1.00
Title	20	19	.95
Local Services	20	17	.85
Online Resources	20	15	.75
Table of Contents	20	15	.75
Update	20	13	.65
Terms	20	13	.65
Related Topics	20	12	.60
Parent Topic	20	11	.55
Related Media	20	10	.50
Related SCS Tools	20	8	.40
FAQ	20	8	.40
Accreditation	20	7	.35
Glossary	20	6	.30
Related News	20	6	.30
Author	18	5	.28
Provider (P)	6	6	1.0
Last Update (P)	6	6	1.0
Author's Credentials (P)	6	6	.70
Author's Name (P)	6	6	.20

To sort health topic categories, we calculated the category scores by giving each associated Level 2 health topics a default topic score of +1 and computing the total topic scores for each category as its category score. Table 6-11 shows the results for all the topic categories by both the Web sites and the professionals (including their category scores). As shown in the table, the health topic categories supported by both sources have reasonable similarities. To finalize the health topics, we simply merged the categories of similar topics such as "Stress/Depression/Mental Health" and "Mental and Emotional Health" as "Mental/Emotional Health" and left the rest as they were. Due to its low category score, "Injuries" was not included. "Others" was not also included as it referred to sporadic occurrence of health topics categories, which were less frequent to be included as agreed categories. As mentioned earlier, we saved all the Level 2 topics for further analysis in the next phases.

Table 6-11. The combined categories supported by the Web sites and the health professionals sorted by their category scores

Web sites' health topics
General Health/Common Illnesses 146
Mental/Emotional Health 90
Alcohol & Drugs 68
Sexual Health & Relationship 64
Nutrition & Fitness
Healthy Lifestyle 43
Women's Health 28
Others 27
Skin Health 23
Men's Health 19
Travel Health 19
Professionals: Health topics hierarchies
Mental Health & Relationship 28
STD & Infectious Diseases 20
Birth Control 17
Healthy Lifestyle 11
Others 10
Alcohol & Drugs 4
Injuries 3
Travel Health 2
Professionals: Ranked health topics
Healthy Lifestyle 28
Stress / Depression /Mental Health 18
STI/ Birth Control / Pregnancy / Sexual Health 18
Alcohol & Drugs 18
General Health/Common Illnesses 17
Others 9

Table 6-12 shows the final list of knowledge elements and topics, which received reasonable supporting viewpoints from the sources of normative knowledge needs.

Table 6-12. CHEKES-I Element/Topic Set

Knowledge Content	Author, Provider, Last Update, Contact Information, Title, Local Services, Online Resources, Table of Contents, Terms, Related Topics, Parent Topic, Related Media, Related SCS Tools, FAQ, Accreditation, Glossary, Related News, and Contact Information
Health Topics	General Health/Common Illnesses, Mental/Emotional Health, Alcohol & Drugs, Sexual Health & Relationship, Nutrition & Fitness, Healthy Lifestyle, Women's Health, Skin Health, Men's Health, Travel Health,

6.2 Phase I

The main objective in Phase I was to elicit and analyze the viewpoints of the student subjects (Primary Users 1 Group) regarding their preferred types of information and health topics in a health Web page. The results of student sessions are discussed in two sections: questionnaire results and home task (Free descriptions).

6.2.1 Questionnaire Results

To ease references to the questionnaire (Appendix 2), we include identifiers for the related questionnaire items for each section and subsection (at the beginning of each section) in an X-Y format in which X represents the related questionnaire part and Y represents the related item number (in that part). For instance, item 4-9 is Item 9 within Part 4 of the questionnaire.

6.2.1.1 Sources of Health Information (Part 1)

In this analysis, the subjects' provided ranking (1-6) was considered to be the numeric value representing the source rank (e.g., 1 for the number one preference, and 2 as second preference, and so on). In addition, a value of 0 was assigned when a source was not preferred at all. The majority of subjects (84%) considered Internet as one of their first three sources of health information in cases of non-emergency health issues followed by close friends (77%) and health services (on and off campus, 68% and 65%, respectively). (see Table 6-13) Just over half (55%) of the subjects selected "else" as one of their three first choices of health information source and typed in "parents" or "family" as a description. It should be noted that subjects had the option to give the same ranking to demonstrate equal preference to some sources.

6-13. Statistical analysis of the Phase I subjects' responses regarding their main sources of health information in cases of non-emergency health issues

	Health Guides	Close Friends	On Campus	Off Camp	Internet	Else
Valid	31	31	31	31	31	31
Missing	0	0	0	0	0	0
Mean	3.5	2.2	2.9	2.8	1.9	2.7
Std. Deviation	1.0	1.2	0.9	1.2	1.3	1.7
First Preference	0%	32%	3%	16%	55%	26%
First to Third Preference	32%	77%	68%	65%	84%	55%
Not Preferred At All	39%	6%	13%	0%	3%	23%

6.2.1.2 Health Information Web site versus Search Engine to find health information (Part 2, Items 4-4, and 4-5)

The Majority of the subjects could not remember a single health information Web site (Table 6-14)**.** Only 17 percent could remember a name or address for a health information Web site that was known to them or that they would recommend to their peers. The Majority of subjects (83%) would only use a search engine such as Google to find health information. These results were also in harmony with the responses to items 4-4 and 4-5. In the responses to those items, the vast majority agreed (Mean=4.3, SD=1.0) that they would always use a search engine to find the health information they needed. In addition, a minority agreed (Mean=2.0, SD=1.0) that they would go to a Web site they knew to located the health information about their concern. The results were corrected for one missing value detected.

Table 6-14. Search Engine vs. Web Sites as Main Source of Health Information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Web Sites	5	16.1	16.7	16.7
	Search Engine	25	80.6	83.3	100.0
	Total	30	96.8	100.0	
Missing	System	1	3.2		
Total		31	100.0		

6.2.1.3 Browsing habits and skills (Items 4-1, 2 and 3)

To analyze items 4-1 to 3, the responses in five-level scale were numerically valued, 1 to 5 representing strong disagreement to strong agreement, and the mean and standard deviation were calculated. All subjects were frequent users of the Internet (for information seeking) (Table 6-15). A vast majority of them agreed (Mean=4.7, SD=0.45) that they frequently used the Internet to find information and that they would feel comfortable searching and finding information online (Mean=4.7, SD=0.55). However, subjects' opinions varied a bit (Mean=3.5, SD=0.85) on the ease of finding reliable health information (Table 6-15), with a fair dominance perceiving the task (finding reliable information) as easy.

Table 6-15. The subjects' browsing skills, habits, and perceptions

		Frequently use Internet	Comfortable searching and finding information online	Finding reliable health information is easy
N	Valid	31	31	31
	Missing	0	0	0
Mean		4.74	4.65	3.48
Std. Deviation		.445	.551	.851

6.2.1.4 Knowledge elements

Similar to the approach we used in Phase 0, we calculated the total and average element score for each of the following knowledge elements using the subjects' responses.

6.2.1.4.1 Web page's Author (Items 4-9, 10, 11, and 5-1, 5-2)

Not many subjects were interested to see who the author of a Web page was (Table 6-16). As shown in Table 6-16, the majority of subjects (TES=-26, AES=-0.8, SD=0.52) would not check the Web page's author's name when they browsed Internet, and only 2 out of 31 subjects (6%) mentioned that they would check for such information. However, when the Author's Name is available, subjects would be somewhat interested (TES =8, AES =0.26, SD=0.82) to see the Author's Contact Information included in the Web page and even more interested to see the Author's Credential (even if it is just as simple as doctor [Dr.]).

Table 6-16. The element scores regarding Author's Name, Credential, and Author's Contact Information

	N	TES	AES	Std. Deviation
Author's Name	31	-26	-.84	.523
Author's Credential	31	13	.42	.765
Contact Information	31	8	.26	.815
Valid N	31			

The subjects also had similar responses when they were asked about the importance of author's information to be included in a health information Web page (Table 6-17).

Table 6-17. The element scores for Author's Name and Credentials based on their given importance rates

	N	TES	AES	Std. Deviation
Author's name	31	-15	-.48	.677
Author's Credential	31	20	.65	.608
Valid N	31			

6.2.1.4.2 Provider Information (Items 4-12, 13, 14, 5-5, and 5-6)

The vast majority of the subjects would care about the provider's information (TES=26, AES=0.84, SD=0.52) in a Web page, and a slightly smaller number believe in its high importance (TES=21, AES=0.7, SD=0.55). (Table 6-18) In addition, there was strong agreement (TES=-25, AES=-0.8, SD=0.5) that the health information provided by governmental Web sites is always reliable. This rate of trust reached to 100% (TES=31, AES=1.0, SD=0.00) when the provider of such information is the subject's own university. Although, the subjects' interest toward governmental or university Web sites would imply the subjects' interests toward the usefulness of an element providing such information (for instance in a search engine).

Table 6-18. The element scores regarding Provider elements and the two provider-related elements

	N	TES	AES	Std. Deviation
Provider	31	26	.84	.523
Governmental Web site	31	25	.81	.477
University Web site	31	31	1.00	.000
Provider (Importance)	31	21	.68	.541
Valid N	31			

6.2.1.4.3 Update (Item 5-15)

The results showed a fairly positive opinion regarding the update information (the date a Web page was created or last updated). (TES=14, AES=0.45, SD=0.8) The subjects mainly agreed that they (in questionnaire, it was people [of their peers]) would notice or care about the update information within the Web pages (Table 6-19).

Table 6-19. The element scores for Update Information

	N	TES	AES	Std. Deviation
Update Information	31	14	.45	.768
Valid N (listwise)	31			

6.2.1.4.4 User rating as control element (items 4-16 and 5-9 and 5-11)

Most participants thought User Rating information to be helpful (TES=19, AES=0.6, SD=0.7), but fewer believed it would be important for a health information Web page (TES=9, AES=0.3, SD=0.6). (Table 6-20) In comparison, a majority rated Number of Visitor to be of low importance for a Web page (TES=-8, AES=-0.26, SD=0.7).

Table 6-20. The element score regarding User Rating and the Number of Visitors

	N	TES	AES	Std. Deviation
User Rating	31	19	.61	.715
User Rating (Importance)	31	9	.29	.588
Number of visitors (Importance)	31	-8	-.26	.729
Valid N (listwise)	31			

6.2.2 Home task (Free descriptions)

Seventeen subjects returned their free description forms: each included three suggested health topics with a link (to a consumer health Web site of their preference) and a description for each.

6.2.2.1 Health topics

Every subject in Phase I submitted three questions which in their opinion were the most common health concerns of students (of their age) on Campus. A total of 93 health concerns were suggested in a ranked order of importance (1 to 3) (See Appendix 10 for examples). To extract the health topic, we followed the same two-step approach as with Phase 0. The only difference was that in this Phase, we had to convert the subjects' informal expressions to explicit health topics. For instance, we converted a question form concern such as "What are the symptoms of depression?" to "Depression" as the health topic of concern (subtopic analysis, such as "Symptoms of Depression" was out of this study's scope). We had a few cases such as "Stress causing sleepless nights, ways of dealing with stress" in which more than one topic, with the same rank of importance, were suggested. In such cases and only if the topics were reasonably different, new records were created to include the additional topics e.g., one for "Stress" and one for "Sleepless Nights;" but with the same original rank.

A proximity judgment (approximation) was made to group the similar keyword and choose representative keywords (from the same group and for the same group). As result, fourteen categories of health topics were extracted, and the occurrence of each was calculated. Figure 6-8 shows the fourteen topics in their frequency order of occurrence.

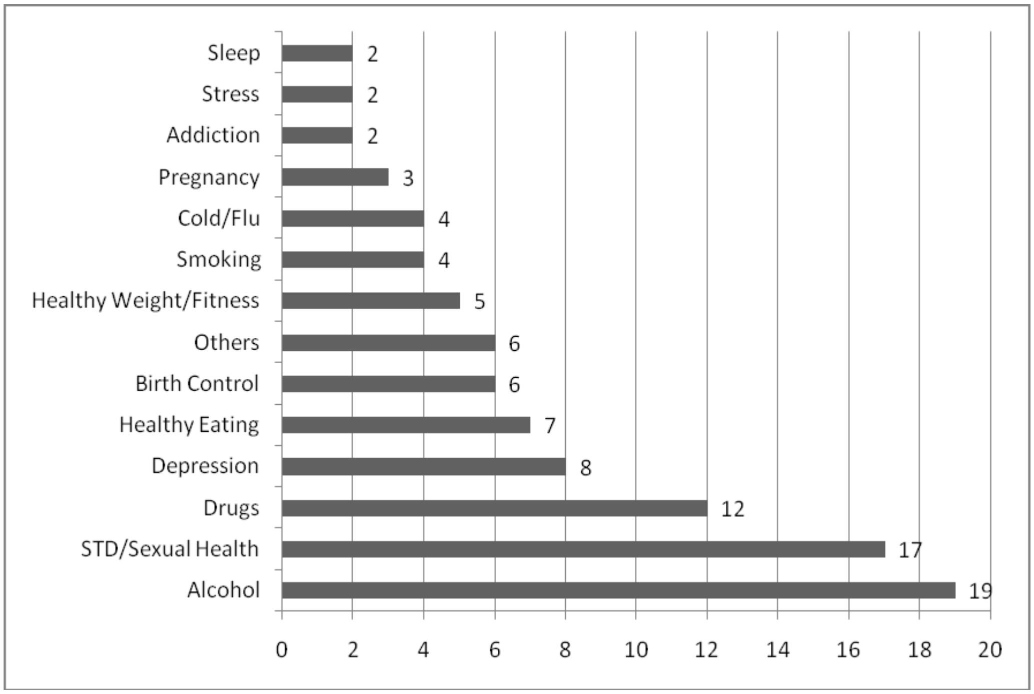


Figure 6-8. Health topic categories suggested by student subjects sorted according to their frequency of occurrence

Two further steps were taken as well. First, the topic score for each topic was calculated (using the formula explained earlier), and the topics were sorted based on their overall topic scores which represented both occurrence and their accumulated adjusted ranks. The second step was to consolidate the similar health topics categories to eliminate duplications and low score topics. For instance, categories such as alcohol, drugs, addictions, and smoking were joined together as one main category of “Alcohol & Drugs.” Figure 6-9 shows the five final health topic categories which resulted from the above steps as well as their calculated topic scores. In this list, “Alcohol & Drugs” was the most frequent concern suggested by students followed by “Sexual Health” and its subcategories (e.g., STI/STDs, Safe sex, Birth Control), Others (e.g., Sleep, Cold & Flu, Cough, Headaches, etc), Healthy Eating/Weight, and Stress & Depression.

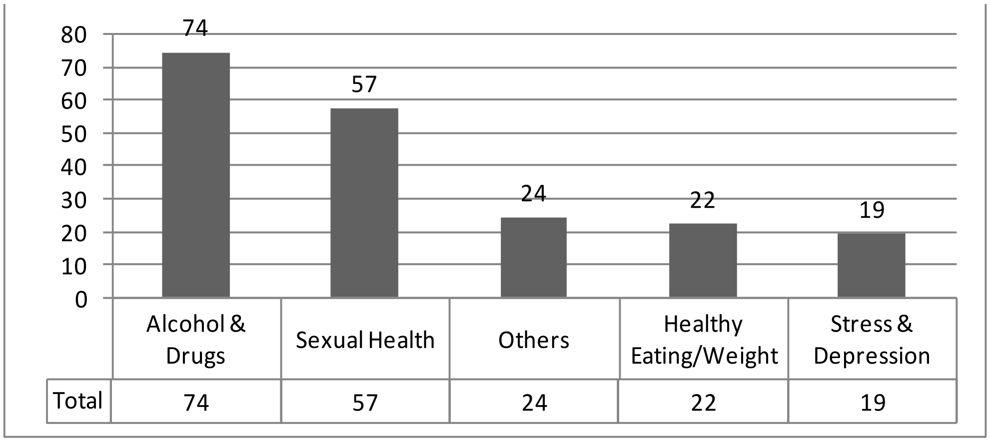


Figure 6-9. Final five combined categories of popular topics suggested by student subjects sorted based on their topic scores

6.2.2.2 Web Site Description Analysis

A total of 51 Web site descriptions were collected. Each description was a paragraph or two regarding the prominent elements or characteristics of one of the subject-preferred Web sites/pages. Table 6-21 shows an example of one of the descriptions submitted by students regarding a safe drinking Web page.

Table 6-21. A Web page description submitted by a Phase I subject

This web page is pretty well organized and has an easy system to allow you to calculate what your blood alcohol level is. Other web pages I found had a lot more complicated ways to calculate it, but this one takes most of the guess work out of calculating it for you. It's a simple way to know if you have drunk too much.

To analyze the descriptions, we merged all the descriptions into one big chunk of text, scanned the content (words, phrases, sentences) for any reference to a knowledge element or characteristics of the Web sites. We recorded each occurrence as a viewpoint expression (in the viewpoint database) and associated with the related knowledge element (except the ones related to Web sites' characteristics) in the association database in a supporting relation of negative to positive type. We associated each statement with a tag that could best represent the knowledge element or characteristic of focus in that expression (based on the investigator's judgment). For instance, the statements in the above description were associated with “Easy to Use”/”Organization” (as characteristics), and “SCS Guides/Tools” (as knowledge elements). There were also cases in which one expression was associated with more than one tag in which case a new record was added to include the additional tag occurrence (but with the same statement). Finally, we treated both positive and negative references to an element or characteristic as one occurrence. For instance, if the statement said (an example from the actual descriptions), “*The only drawback is that it doesn't have links to specific topics so you may have to scan the page for a couple of seconds if you're looking for something really specific,*” it still emphasizes the importance of a clickable table of contents within the page.

We extracted 270 statements associated with 20 different tags in three main categories of Knowledge Elements (related to content, such as FAQs or related topics), Characteristics (attributes of Web page/site, such as credibility or usefulness), and Design Features (software and design related features, such as colors, styles or search features). One statement was found irrelevant to either category and was discarded (but saved in the database). The remaining results were then transferred to a pivot table for categorical calculations. Overall, 134 occurrences of the Knowledge Element category, 119 occurrences of Characteristics, and 16 occurrences of Design Features were recorded. Table 6-22 shows the results for the preferred knowledge elements. TES for each element reflects its total frequency of occurrence, while AES represent the average occurrence per description (in a scale of -1 to +1). For convenience of analysis (and to avoid less important complexities), we did not analyze the distribution and average based on each subject and assumed each submission to be a unique set of descriptions.

Table 6-22. The element scores for the knowledge elements suggested across the students' descriptions of their recommended health Web sites

Knowledge Element	TES	AES
Description / Introduction	38	0.7
Subtopics	32	0.6
SCS Guides/Tools	16	0.3
Related topics / Online Resources	15	0.3
Provider	15	0.3
Table of Contents	14	0.3
FAQs	4	0.1
Local Services	4	0.1
Target Audience	4	0.1
Contact/Ask a Pro	3	0.1
Related Media	3	0.1
Update	1	0.0

Table 6-23 demonstrates the results for Web sites' characteristics and design features of interest by the student subjects. To choose the tag's label (or the characteristics' wording), we strove to choose the keywords that were frequently used either across the subjects' expressions (such as informative or useful) or used by the subjects during the think aloud browsing task.

Table 6-23. The list of identified tags with their frequency of occurrence

Web Site's Characteristics	Frequency of Occurrence
Ease of Use/Organization	36
Informativeness	33
Usefulness	17
Credibility/trustworthiness	15
Reader Friendliness	11
Overall Interest	7
Design Features	16
Software Feature	7
General Appeals	9

6.2.3 CHEKES-II

Looking at the additional viewpoints elicited and associated we revised both the knowledge elements and the health topics in CHEKES-I set. Table 6-24 demonstrates a summary of the subjects' viewpoints regarding the knowledge elements of health Web sites. As shown, the Provider and Update elements were of high interest for the Phase I participants whilst the attitude toward Author was the least. It was concluded that an Author element, if used, should include an Author's Credential, but not necessarily the Author's Contact Information. In addition, looking into the Web site descriptions and the feedbacks received during the interview session, we realized that the subjects would consider Contact Information as composite Author/ Provider's Contact Information through which they could ask their health-related questions (ask a pro) or more help (such as hotlines). The knowledge elements suggested within the Web site's descriptions can particularly be used in indexing, where an optimum description of the resource is required to direct the user to the right resource of their preference. For instance, Target Audience, a new element suggested by the subjects, although it is not normally included in the health Web pages, can be potentially used to highlight the resources that are particularly written for students (or the individuals of their age group). In addition, frequent use of descriptive / introductory phrases and sentences, summarizing the main points of the related Web pages for an external audience, plus the evidence of their frequency within the Web sites (explained earlier in section 6.1.1.18), caused such information to be labeled as a separate element (Introduction). Finally, most elements of high interest to students were the ones that already existed in CHEKES-I. In such cases, the increased number of supporting viewpoints reflects the particular importance of those elements.

Table 6-24. Summary of the Phase I subjects' viewpoints regarding various knowledge elements, including the related scores

Knowledge Element	N	TES	AES
Questionnaire			
Provider	31	26	0.84
Update Information	31	14	0.45
Author's Credential	31	13	0.42
Author's Contact Information	31	8	0.26
Author's Name	31	-26	-0.84
Importance rating			
Author's name	31	-15	-0.48
Author's Credential	31	20	0.65
Description			
Description / Introduction	51	38	0.7
Subtopics	51	32	0.6
SCS Guides/Tools	51	16	0.3
Related topics / Online Resources	51	15	0.3
Provider	51	15	0.3
Table of Contents	51	14	0.3
FAQs	51	4	0.1
Local Services	51	4	0.1
Target Audience	51	4	0.1
Contact/Ask a Pro	51	3	0.1
Related Media	51	3	0.1
Update	51	1	0

The health topics suggested by student subjects were mainly related to four combined categories of Alcohol & Drugs, Sexual Health, Healthy Eating/Weight, and Stress & Depression. The four health topics categories were already available in CHEKES I with a slight difference of wording. There were also a few others that were not frequent enough to constitute separate categories (and thus were categorized under "Others").

Table 6-25 shows the final elements included in CHEKES-II. The bold items are the ones that have been recognized as re-emphasized according to Phase I results. The italicized bold items are the ones newly added in Phase I. We have also underlined the elements that have received negative responses regarding their inclusion.

Table 6-25. CHEKES-II Element Set

Knowledge Elements	Author, **Provider**, **Last Update**, **Contact Information**, Title, ***Introduction***, **Local Services**, **Online Resources**, **Table of Contents**, Terms, **Related Topics**, Parent Topic, **Related Media**, **Related SCS Tools**, **FAQ**, Accreditation, Glossary, Related News
Heath Topics	**General Health/Common Illnesses**, Mental/Emotional Health (**Stress & Depression**), **Alcohol & Drugs**, **Sexual Health & Relationship,** Nutrition & Fitness (**Healthy Eating/Weight**), Healthy Lifestyle, Women's Health, Others, Skin Health, Men's Health, Travel Health,

6.3 Phase II

Phase II was aimed at eliciting the feedbacks (as well as the original viewpoints) of the student subjects (Primary Users 2 Group) regarding the variety of knowledge elements and health topics suggested by the exemplar Web sites, local health professionals, and their peers on Campus. In this phase, the participants compiled and rated a hierarchy of health topics and designed a STD Web page by choosing and rating elements from a Multi-scale questionnaire.

6.3.1 Multi-scale Element Questionnaire

All nineteen subjects participated in a co-design approach in which they reviewed and rated the importance and usefulness of seventeen metadata and content elements (fifteen CHEKES-II Elements plus two Control Elements) to be included in an example STD Web page being designed. The design step for each element was accomplished immediately after the rating (and before moving to the next element). The subjects were allowed to change their rating anytime throughout the co-design process (even after it ended).

To analyze the result, we used the same three-level approach as with Phase I and converted the five-level ranking into the three-level scale of -1 to +1. The only difference was that here, as explained in Chapter 5 (Section 5.3.2.1.3), the subjects would rate not only the importance of the elements (i.e., how important an element is to be included in a health Web page) but also the elements' perceived usefulness (i.e., how useful the provided information would be if it were included in a health Web page).

6.3.1.1 Knowledge elements

Table 6-26 ((a) and (b)) shows the results of subjects' rating for CHEKES-II elements. As demonstrated, the subjects had varying supporting viewpoints on both the importance and usefulness of almost all CHEKES-II elements, except Author and Terms. Sorting the elements in terms of their importance, the spectrum begins with Self-care Tools, Provider Local Help (services), and Table of Contents as the most important and ends with Introduction, Glossary, and Terms as the least important elements. The subjects had slightly different viewpoints regarding the usefulness of the elements, rating Table of Contents, Local Help, and Self-care Tools as the most useful and Last Update, Author, and Terms as the least useful. Author and Terms was rated by most subjects as useless despite rating it as reasonably important.

Table 6-26. Analysis of importance and useful rating of the CHEKES-II elements

a) Importance

Elements (Importance)	N	TES	AES	Std. Deviation
TOC	19	18	0.95	0.229
Self-care tools	19	18	0.95	0.229
Provider	19	17	0.89	0.315
Local Help	19	16	0.84	0.375
News	19	15	0.79	0.419
FAQ's	19	12	0.63	0.597
AV	19	11	0.58	0.769
Author	19	10	0.53	0.697
Last Update	19	10	0.53	0.697
Related topics	19	10	0.53	0.513
Online Resources	19	9	0.47	0.697
Introduction	19	7	0.37	0.761
Glossary	19	6	0.32	0.749
Terms	19	4	0.21	0.918

b) Usefulness

Elements (Usefulness)	N	TES	AES	Std. Deviation
TOC	19	17	0.89	0.315
Self-care tools	19	17	0.89	0.315
Local Help	19	17	0.89	0.315
News	19	16	0.84	0.375
FAQ's	19	16	0.84	0.375
Related topics	19	14	0.74	0.452
Online Resources	19	14	0.74	0.562
AV	19	12	0.63	0.684
Glossary	19	7	0.37	0.761
Introduction	19	6	0.32	0.582
Provider	19	4	0.21	0.855
Last Update	19	3	0.16	0.834
Author	19	-8	-0.42	0.607
Terms	19	-10	-0.53	0.772

6.3.1.2 User rating and Accreditation

User rating as control element was neither rated (overall) as an important nor as a useful element for a health Web page (AES=-0.3 and -0.2), though the opinions were somewhat polarized on the usefulness (SD=0.9). (Table 6-27) HON (Boyer, Selby et al., 1998; Boyer and Geissbuhler, 2005) as the most common available accreditation tool for health Web pages received varying responses. At the first, not a single subject was aware of such tool, logo or information. After providing appropriate explanation regarding HON and its goals, 8 out of 19 subjects provided appropriate rating based on the provided description whilst the other 11 provided written feedback (See examples at Appendix 11). Overall, as was the case with Terms, the subjects' opinion could be interpreted as considering HON to be an element of minor to low importance, depending on their prior familiarity with the tool.

Table 6-27. The element scores for User rating and HON

	N	TES	AES	Std. Deviation
User Rating (Importance)	19	-6	-.32	.749
User Rating (Usefulness)	19	-4	-.21	.918
HON (Importance)	9	4	.44	.882
HON (Usefulness)	8	-3	-.38	.744

6.3.1.3 Co-design artifacts

The Web pages designed by the student subjects in Phase II represented the range of elements they rated as Somewhat Important, Important or Very Important. However, two things are worth noting: first, the Contact Information element was not included in the element evaluation but was made available in the co-design pane. Almost all the subjects used the Contact Information element as a link button in the top bar. In addition, the First Creation Date was made available as a design choice for update information to be included in the Web page, and it was used by only two subjects.

6.3.2 Health Topics

This step was the final health topic analysis to determine the conclusive topic categories and instances that best represents the health topics of overall preference for the student health Web site. In this step, 19 student subjects were given an oppotunity to manipulate (relocate, remove, add, reword) the suggested eight main categories and 42 health topics (aggregated from the topic analysis in Phases 0 and 1) as well as to rate their importance using a five-level of scale (Very Important to Not Important At All). Due to the frequency of students' confusion in rating the main categories versus the contained topics, we excluded the main topics (early in the phase) from the importance rating. In addition, due to the infrequency of occurrence, we did not analyze the rare instances of relocation, removal, or rewording. There were no major requests to change the main categories. The only frequent suggestions were requests to change Common Symptoms as one main category label, but the subjects could not suggest a clear substitute to be included. Finally, one topic (Stress) had occurred in duplicate (by mistake) in two main categories. We calculated the results separately for each category. Once again, the topic score was calculated based on a scale of 1 (the least important) to 3 (the most important)

Overall, a total of 74 health topics were collected, including the 32 new health topics suggested by the subjects. Within the health topics, STD received the highest score of 57 (=19*3), meaning that absolutely all the participants rated the topic as the most important topic, followed by Stress, and Depression with very close scores (56). In contrast, topics such as Family Planning and Self Defense received a topic score of 1, meaning that it was rated of low importance even by the single subject suggesting it.

6.3.3 CHEKES-III

During Phase II, student subjects were given several opportunities to share their level of interest regarding each of the CHEKES-II elements and topics. They were also engaged in a co-design process in which they saw the Web page they had designed containing the elements they had suggested and had opportunities to modify their opinions. As explained earlier, the subjects showed various levels of interest in almost all the elements. However, their prominent lack of familiarity with accreditation tools suggested a removal of Accreditation as an element. In addition, they showed the least interest in the Terms and Author element, although the overall opinion would not suggest a permanent removal of these elements.

The two elements of Title, Contact Information were also preserved in the CHEKES-III set. The element Title was not part of the multi-scale questionnaire, but its inclusion in a Web page was considered desirable (All the Phase II subjects included the title in the Web page they designed). The element Contact Information was also not part of the questionnaire but was preferred to be included in the page design by all but one of the subjects (it was available in the design pane). Two elements of User Rating and First Creation Date were not part of CHEKES-III but were included in Phase III evaluation as control elements.

The health topics shown in Appendix 12 are the final candidate topics of for the CHEKES-III set, including five main categories of Common Symptoms, Common Illnesses, Sexual Health, Mental Health, and Healthy Lifestyle. However, only three topics of high scores (but not necessarily the highest three) for each category were selected as the topic menu to be shown in the prototype. As the high scoring topics were in very tight competition, the decision about the choice of three topics (for the prototype) was made at the discretion of the investigator assisted by the student helpers. For instance, we bypassed suicidal thoughts because of its negative connotations and chose the next topic, which was addiction. The only major exceptions were:

1- the substitution of infectious diseases with Infectious Mononucleosis, which was referred to by the subjects as Mono (the only other occurrence of a Common Illnesses category) to avoid the confusion with Cold/Flu(also types of infectious diseases),

2- renaming Nutrition to Healthy Diet (as was suggested by the subjects in Phase I), and

3- renaming Common Symptoms to "About Your Symptoms" to make it appear more engaging.

Table 6-28 (below) shows the final topic menu for the prototype Web site.

Table 6-28. The final list of Level 1 and Level 2 topics to be appeared in the prototype Web page

- **About Your Symptoms**
  - Cough
  - Fatigue
  - Abdominal Pain
- **Common Illnesses**
  - Cold & Flu
  - Allergies
  - Mono
- **Mental Health**
  - Stress
  - Depression
  - Addiction
- **Healthy Lifestyle**
  - Healthy Diet
  - Fitness
  - Alcohol & Drugs
- **Sexual Health**
  - Men's Health
  - Women's Health
  - Birth Control
  - STI/STDs

The final CHEKES-III elements are listed in Table 6-29. In the next step, Evaluation group subjects did evaluate various aspects of this list as a set through three different tasks.

Table 6-29. CHEKES-III Element Set

Knowledge Content Elements	Title, Author, Provider, Last Update, Contact Information, Introduction, Local Services, Online Resources, Table of Contents, Terms, Related Topics, Parent Topic (or Topic Category), Related Media, Related SCS Tools, FAQ, Glossary, Related News
Health Topics	Appendix 12

6.4 Phase III

The main objective of the analysis tasks in this phase was to elicit data we needed to answer the research questions we asked in Chapter 4. This phase specifically addresses the last two research objectives we outlined in Chapter 1, which are:

- To evaluate the reactions of the users to the knowledge requirements specified in regard to their quality
- To evaluate the usability and usefulness of the specified elements in supporting the design of a KIEHA prototype

In this section, we only describe the data obtained. In Chapter 7 (Discussions), we will discuss these in more details and answer our research questions.

6.4.1 Multi-scale Questionnaire

We computed the related means and variance of the given rating (by the Phase III subjects) to each of the fifteen CHEKES-III elements. We also combined the rating values for each of the three pairs of sub-elements related to the same CHEKES-III element, including Author's Name AND Author's Credential, SCS Tools AND SCS Guides, Contact Information AND Ask Pro. The results will be discussed below under four dimensions of Importance, Usefulness, Credibility, and Overall Interest.

6.4.1.1 Perceived Importance

Table 6-30 shows the means and standard deviation of the subjects' perceived importance regarding all fifteen CHEKES-III elements. The results of the individual elements show an absolute agreement among all subjects on the five elements of Provider, Local Services, TOC, Glossary, and A/V to be of high importance. In contrast, Terms, Author, SCS Tools, and Related News had been perceived as the least important elements. Overall, the set of CHEKES knowledge elements has received an average importance level of 2.81 with an standard deviation of 0.5.

Table 6-30. The perceived Importance of CHEKES-III Elements in a scale of 1(the least important) to 3 (the most important)

Element	N	Mean	Std. Deviation
Provider	8	3.00	.000
Local Services	8	3.00	.000
TOC	8	3.00	.000
Glossary	8	3.00	.000
A/V	8	3.00	.000
Online Resources	8	2.88	.354
Last Update	8	2.88	.354
FAQ	8	2.75	.463
Related Topics	8	2.75	.463
Contact Information	8	2.69	.458
Intro	8	2.63	.744
Related News	8	2.50	.926
SCS Tools	8	2.44	.904
Author	8	2.25	.707
Terms	8	2.25	.886
CHEKES SET	144	2.81	.506

6.4.1.2 Perceived Usefulness

The majority of CHEKES-III elements were perceived as useful information but not following the same order as their importance level (Table 6-31). The subjects rated Local Services, Related Topics, TOC, and News as the most useful elements, while rated Terms, Provider, Author, and SCS Tools as the least useful. Compared to the importance table, the usefulness dimension of Provider and Online Resources were in greatest contrast. Finally, CHEKES-III elements as a set has been perceived to provide highly useful information (Mean=2.70, SD=0.56).

Table 6-31. The perceived Usefulness of CHEKES-III Elements by the Phase III participants in a scale of 1 (Useless) to 3 (Useful)

Element	N	Mean	Std. Deviation
Local Services	8	3.00	.000
Related Topics	8	3.00	.000
TOC	8	3.00	.000
News	8	3.00	.000
Glossary	8	2.88	.354
Last Update	8	2.88	.354
A/V	8	2.88	.354
Intro	8	2.75	.463
FAQ	8	2.75	.463
Online Resources	8	2.75	.463
Contact Information	8	2.69	.372
SCS Tools	8	2.500	.6547
Author	8	2.438	.6232
Provider	8	2.38	.744
Terms	8	2.00	.926
CHEKES SET	144	2.70	.562

6.4.1.3 Credibility

The Phase III subjects had strong agreement (SD=.000) that including Provider, Last Update, Terms, and Online Resources elements would make a Web page look credible (Table 6-32). In addition, Author information would follow Online Resources and is in tight proximity with TOC. In contrast, elements such as SCS Tools, FAQ, and Local Services were believed not to notably affect the credibility of a Web page. Finally, the subjects have determined the CHEKES set to increase the credibility of a Web page that contains them (Mean=2.60, SD=0.73).

Table 6-32. The perceived Effects of CHEKES-III Elements on Credibility of a Web Page in a scale of 1 (Does not affect credibility) to 3 (Make it more credible)

Element	N	Mean	Std. Deviation
Provider	8	3.00	.000
Last Update	8	3.00	.000
Terms	8	3.00	.000
Online Resources	8	3.00	.000
Author	8	2.81	.530
TOC	8	2.75	.707
A/V	8	2.63	.744
Glossary	8	2.50	.926
Contact Information	8	2.50	.463
News	8	2.50	.756
Related Topics	8	2.50	.756
Intro	8	2.50	.756
Local Services	8	2.38	.916
FAQ	8	2.25	1.035
SCS Tools	8	2.063	.7289
CHEKES SET	144	2.60	.732

6.4.1.4 Overall interest

As shown in Table 6-33, the subjects had absolute agreement in their overall interest regarding nine CHEKES-III elements (SD=0.000): Provider, Local Services, FAQ, Related Topics, Online Resources, TOC, Glossary, A/V, and Introduction/Description, and they had a reasonably high interest in four others: Last Update, News, Contact Information, and SCS Tools. The two elements of least interest were Terms and Author (Mean=2.25-2.50), although the opinion highly vary on Terms (SD=0.886).

Table 6-33. The Overall perceived Interest in CHEKES-III Elements by the Phase III subjects in a scale of 1 (would not like it) to 3 (Would like it very much)

Element	N	Mean	Std. Deviation
Provider	8	3.00	.000
Local Services	8	3.00	.000
FAQ	8	3.00	.000
Related Topics	8	3.00	.000
Online Resources	8	3.00	.000
TOC	8	3.00	.000
Glossary	8	3.00	.000
A/V	8	3.00	.000
Intro	8	3.00	.000
Last Update	8	2.88	.354
News	8	2.88	.354
Contact Information	8	2.625	.4432
SCS Tools	8	2.63	.694
Author	8	2.500	.4629
Terms	8	2.25	.886
CHEKES SET	144	2.81	0.566

6.4.1.5 CHEKES-III Elements: User Rating and Creation Date as Control Elements

As shown in Table 6-34, with the exception of one factor (Overall Interest toward User Rating), the subjects rated all the other elements reasonably lower than the CHEKES-III elements. No single CHEKES-III element received a mean of less than 2.0 in any of the four dimensions being evaluated.

Table 6-34. The subjects' rating regarding User Rating and Creation Date as the two control elements

	N	Mean	Std. Deviation
User Rating: Overall Interest	8	2.38	.916
User Rating: Usefulness	8	1.63	.518
User Rating: Importance	8	1.50	.926
User Rating: Credibility	8	1.75	1.035
Creating Date: Overall Interest	8	1.38	.744
Creating Date: Usefulness	8	1.25	.463
Creating Date: Importance	8	1.13	.354
Creating Date: Credibility	8	1.63	.916

6.4.2 Google Simulation

Every participant in Phase III had evaluated the ten selected links (in terms of relevance, trustworthiness, and overall quality) using both Google and Simulated Google's index results. They also ranked the three first links they would choose as worthiest to click. After they ranked the links given by Google and Simulated Google, the subjects were shown the actual Web pages corresponding to those links. Then, they were asked to assess the relevance and overall quality of the Web pages and also to rank the best three they actually prefer.

We first re-ordered the responses for all the links/sites to hold the same order (as the order of Web sites on simulated Google questionnaire was set to be different from the ones with actual Google). It was then determined whether or not the changes induced by Simulated Google had been positive toward selecting the right Web site (right is determined by the subject) as compared to Google. In other words, if the subjects were to actually rank the Web sites by visiting and scanning through them, would they be more likely to choose the Web sites they ranked as best in Google or the ones with Simulated Google? To answer this question, we created a score, we called *click score*, which represents the subjects' level of intention to click on a Web site's link when asked to rank the links they would prefer to click on. Links of higher click scores were the ones that received overall higher click ranks by the subjects. To calculate the click score, we first reversed the link click rank (1, 2, 3 to 3, 2, 1) and considered that as the click score for that link. We also calculated the *Actual*

Page Visit Score for each of the ten Web sites related to the ten links in Google and Simulated Google. To compute actual page visit score, we simply reversed the Web site's ranks given by the subjects. We then calculated the mean of all the scores for each link in the three tests. Therefore, we computed three overall scores for each link: Google Click Score, Simulated G Click Score and Actual Page Visit Score. Finally, we performed a Pearson Correlation test to examine the correlation between the click scores in Google and Simulated Google and the scores by the Actual Page Visit, which is shown in Table 6-35.

Table 6-35. Correlations between Web sites' Actual Page Visit (APV) Scores and the Click Scores by Google (G) and Simulated Google (SG)

		G Click Score	SG Click Score	APV Score
G Click Score	Pearson Correlation	1	.086	.395
	Sig. (2-tailed)		.814	.259
	N	10	10	10
SG Click Score	Pearson Correlation	.086	1	.713(*)
	Sig. (2-tailed)	.814		.021
	N	10	10	10
APV Score	Pearson Correlation	.395	.713(*)	1
	Sig. (2-tailed)	.259	.021	
	N	10	10	10

* Correlation is significant at the 0.05 level (2-tailed).

As shown in the above table, the scores of Actual Page Visit are significantly correlated ONLY with the click scores from Simulated Google and NOT from Google.

6.4.3 Prototype Testing

We first extracted the results from the suggested health topics. As explained in Chapter 5, every Phase III subjects suggested three health topics (a total of 24 topics) that in their opinion are very important to be in a student/university health Web site. Table 6-36 shows the results. Comparing this to Appendix 12 (the CHEKES-III health topics list) and Table 6-36 (the list of health topics appeared in the prototype's health topic menu), we found all the health topics recognized as important by the subjects already existing in CHEKES-III.

All but one (Pregnancy Options) were the topics that were presented in the prototype (as the important health topics). All but four (Pregnancy Options, Alcohol and Drug Abuse, Gym, Eating, Mental Illnesses, and Immunization and Vaccination) were in the exact same wording with CHEKES-list. However, those differences are minor, e.g., Eating had appeared as Nutrition or Healthy Diet, or Gym as Fitness.

Table 6-36. The list of health topics suggested by Phase III subject as the most important health topics for a university health Web site

STD	Nutrition	Health lifestyle	Nutrition
Pregnancy Options	Stress and Depression	Alcohol and Drug Abuse	Mental Illnesses
Immunization and Vaccination	STD	Sexual Health	STD
Flu	Gym	Depression	Birth Control
STD	Eating	Birth Control	Depression
Stress	Safe Sex	STD	STD

In addition, as explained in Chapter Five, we built a health Web page based on the CHEKES III elements and asked the Phase III subjects to compare it with two other Web sites, TH (TeenHealth.org Web site) and UO (the Health Web site on the University of Ottawa), both from our list of exemplar Web sites in Phase I. Once again, it is emphasized that all three Web sites were built based on the same design features and main content.

To analyze the results, we performed a paired t-test between the Campus-HITS Web site and each of the other two (TH and UO) to compare the subjects' given rating regarding the seven different characteristics of the Web sites. Table 6-37 illustrates the t-test between the Campus-HITS Web site and Teen Health. As shown, the improvement was significant (at 0.01 level) only in three out of the seven aspects (i.e., Topic Wealth, Ease of Use, and Overall Quality). For the others, although there was improvement, however they were not significant.

Table 6-37. Paired sample t-test of rating given to Campus-HITS (CH) as compared to Teen Health (TH)

	N	Mean (TH)	Mean (CH)	t	Sig (2-tailed)
Professional Look	8	4.13	4.75	2.376	.049
Content Organization	8	4.25	4.63	1.158	.285
Topic Wealth	8	3.88	5.00	3.211	.015
Informativeness	8	3.38	3.75	1.000	.351
Visual Appeal	8	4.00	4.38	1.158	.285
Ease of Use	8	3.50	4.75	3.416	.011
Overall Quality	8	3.75	4.75	3.742	.007

A comparison was also made between Campus-HITS and UO. As demonstrated in Table 6-38, significant improvements (at 0.01 level) are detectable in four of the seven aspects: Content Organization, Topic Wealth, Ease of Use, and Overall Quality. The subjects also found the Campus-HITS Web site to have a significantly stronger visual appeal when compared to the University of Ottawa site.

Table 6-38. Paired sample t-test of rating given to Campus-HITS (CH) as compared to University of Ottawa (UO)

	N	Mean (UO)	Mean (CH)	t	Sig (2-tailed)
Professional Look	8	4.13	4.75	1.655	.142
Content Organization	8	4.00	4.63	3.667	.008
Topic Wealth	8	3.25	5.00	5.000	.002
Informativeness	8	3.75	3.75	.284	.785
Visual Appeal	8	3.63	4.38	3.813	.007
Ease of Use	8	3.25	4.75	2.728	.029
Overall Quality	8	3.13	4.75	3.274	.014

Supporting data to the above comparison was the final part of the Phase III questionnaire in which the subjects were asked to rank the three Web sites based on all seven aspects. As shown in Table 6-39, the Phase III participants have recognized Campus-HITS Web site being reasonably to absolutely superior (1.4 to 1.0) in all the seven variables used.

Table 6-39. The average ranking given to each of the three Web sites for the seven quality factors

Web sites	Topic Menu	Ease of Use	Content Organization	Overall Quality	Informativeness	Professional Look	Visual Appeal
CH	1.4	1.0	1.0	1.0	1.3	1.4	1.1
TH	2.4	2.4	2.5	2.4	2.4	2	2.5
UO	2.3	2.6	2.5	2.6	2.4	2.6	2.4

To compare the ranking given to the Web pages, we also computed the sum of the Web site's score for each category (by reversing the rank given (1, 2, 3 to 3, 2, 1)) and ran a paired t-test between Campus-HITS and each of other two sites. As shown in Table 6-40, the differences were significant.

Table 6-40. Paired sample t-test of ranking given to Campus-HITS as compared to Teen Health and University of Ottawa

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Campus-HITS - Teen Health	9.286	1.604	.606	7.803	10.769	15.3	6	.000
Pair 2	Campus-HITS - University of Ottawa	10.429	2.070	.782	8.514	12.343	13.3	6	.000

We will discuss the evaluation results in more depth in Chapter 7.

Chapter 7: Discussion

In this chapter, we will We will discuss the results from Chapter 6 to answer the research questions we asked in Chapter 4 (and Chapter 1) in order to evaluate the framework we proposed. We will also compare the results from each step to some related studies and discuss the potential areas of contribution by our research. Finally, we will discuss some of the limitations that might have affected the study's results.

7.1 Evaluating the framework

In this chapter, we discuss the results, presented in Chapter 6, based on their contribution(s) to answer the research questions. In addition, we broaden the discussion to include:

- Demonstrations of the qualitative aspects of the requirements data, which was used as basis of reasoning to choose the final specifications
- Comparisons of the results obtained with the related research

7.1.1 Questions 1 and 2: Evaluating practicality and usability of the framework

The first and second researchs question we asked were the following

- Can we develop requirements engineering techniques and methods that can accommodate multiple viewpoints, support traceability and requirements change over time?
- Can we use such requirements engineering methods as the basis to specify the quality knowledge requirements of an eHealth application?

In Chapter 4, we conceptually discussed the capability of our framework in accommodating multiple viewpoints, and supporting traceability and requirements change. Here, we discuss the contributions of those features in specifying our knowledge requirements specifications (CHEKES-III). To discuss this, we chose Author's Name as an example element the inclusion of which (in CHEKES-III) was justified through our framework. The reason for this selection was that the viewpoints regarding the inclusion of Author's Name, as compared to other elements, were rather dispersed. Hence, we found the element particularly a good candidate for demonstrating the capabilities of our framework in resolving viewpoints conflicts.

7.1.1.1 Author's Name: Should it be included or not?

To specify the knowledge elements in our set of knowledge requirement specifications (CHEKES-III), we elicited and analyzed the related knowledge requirements from a variety of sources and calculated the overall momentum toward the inclusion of the elements suggested. The momentum toward a particular element is equal to the average element score or AES for that element as we described in Section 6.1.3.2. Therefore, it represents the overall nature (minus to plus) and occurrence of the related associated viewpoints.

Author's Name as an element was primarily suggested by some of the exemplar Web sites. According to our telescopic framework, we used such normative viewpoints as the primary basis of our element set. We created an association (in the association database) between the Author's Name and CHEKES set with an association role of "Element-Element set" and started associating all types of related viewpoints from various sources. Throughout Phase 0 to Phase II, we elicited the viewpoints of 74 sources of requirements (18 Web sites + 6 Local professionals + 31 Primary Users 1 + 19 Primary Users 2) and examined their level of support for such inclusion, using a scale from -1 to +1. We recorded the associations for all the viewpoints and calculated the overall momentum. Figure 7-1 shows the summary of results for all the viewpoints. As illustrated, the overall slightly negative (-0.2) momentum suggests exclusion of Author's Name from the final requirements specifications.

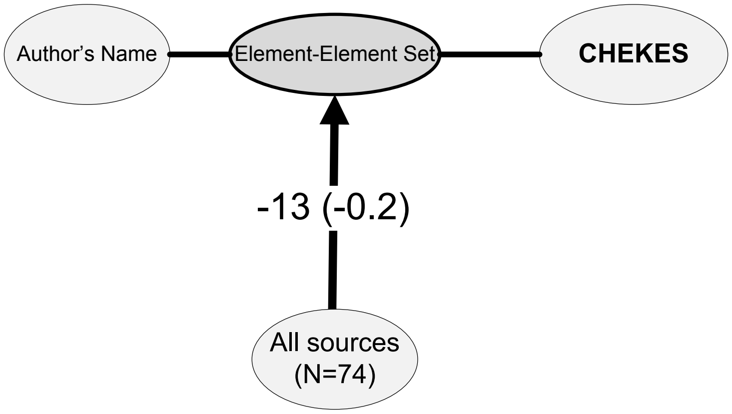


Figure 7-1. The overall momentum of the requirements sources' viewpoints regarding the inclusion of Author's Name in CHEKES set. -13 shows the total score of the viewpoints (i.e., TES), whereas -0.2 shows the average momentum among all the viewpoints (i.e., AES)

However, three particular features of our framework helped us decide otherwise. First, the traceability feature of our framework, made possible with metadata, helped us check the validity of the momentum by tracing back the specification and locating the roots of such momentum. We analyzed which source and with what precise rating supported or opposed the inclusion. Using the traceability feature, we traced the viewpoints back to their sources. Figure 7-2 shows the same inclusion for the Author's Name traced back one level down to its source.

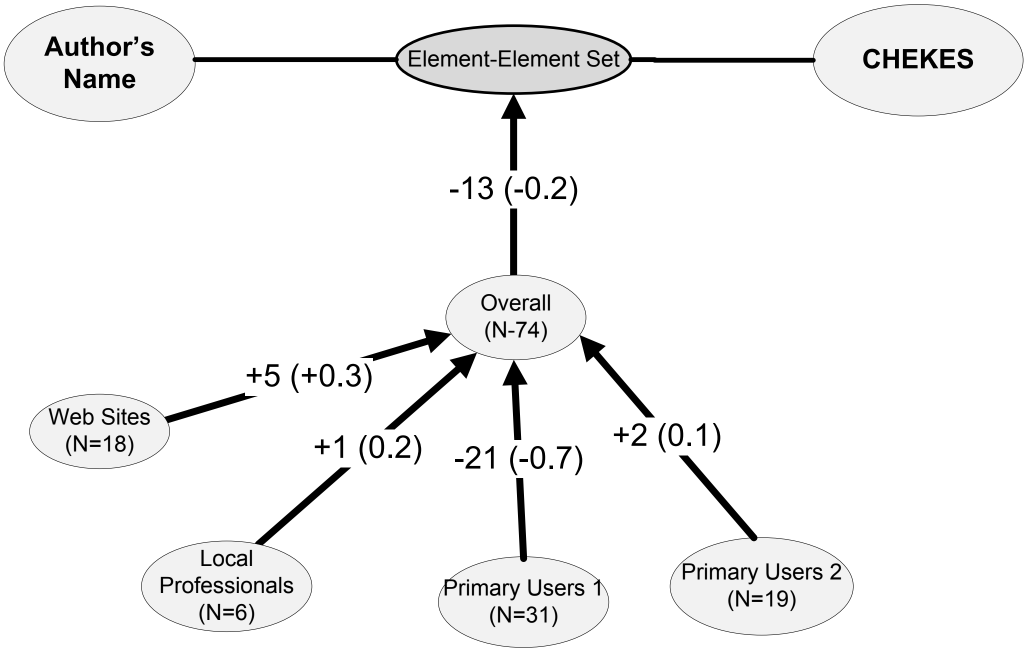


Figure 7-2. A knowledge requirement map illustrating the diversity and momentum of the supporting viewpoints for Author's Name

As we have demonstrated, the above more detailed view of the requirements knowledge map (i.e., the topic map) shows that the sub-momentums from all the sources are similarly slightly positive, except for the primary users from Phase I (who also contributed a greater number of viewpoints). Therefore, a question could be raised as to why the viewpoints of the primary users in Phases I and II should be so different, acknowledging that they were both from the same population. It might have happened, for example, that the disparity had been caused by a misunderstanding or misinterpretation of the requirements engineer during the transformation (and association) process. If so, the transparency of requirements path in TDM-KREM could help us in this matter.

We traced the viewpoints of both Primary Users 1 and 2 back to their original viewpoints' expressions to check the validity of the requirements transformation. We have illustrated the results in Figure 7-3.The requirements association map reveals three points. As shown, the major cause for negativity of sub-momentum for the primary users in Phase I has been caused by a questionnaire item asking them whether they usually look for the Author' s Name when they browse health Web pages. In that questionnaire, we were measuring the overall attitude of the primary users toward some selected knowledge elements. The majority, or roughly 90% of these subjects strongly disagreed or disagreed that they usually look for the Author's Name. However, there are various possible interpretations for this:

1- They do not usually look for such information because they would not perceive the Author's Name to be important. Therefore, disagreement should be interpreted as negative viewpoint regarding the inclusion.

2- They do not usually look for Author's Name, but they do look for it sometimes or very occasionally. Therefore, the disagreement should be considered as neutral viewpoint regarding the inclusion.

3- Not looking may not be necessarily relevant to the subjects' perception of the importance of the Author's Name.

To avoid such confusion, we used triangulation. To triangulate the results, we elicited the subjects' viewpoints, regarding a particular element, through various questionnaire items, scale or tasks.

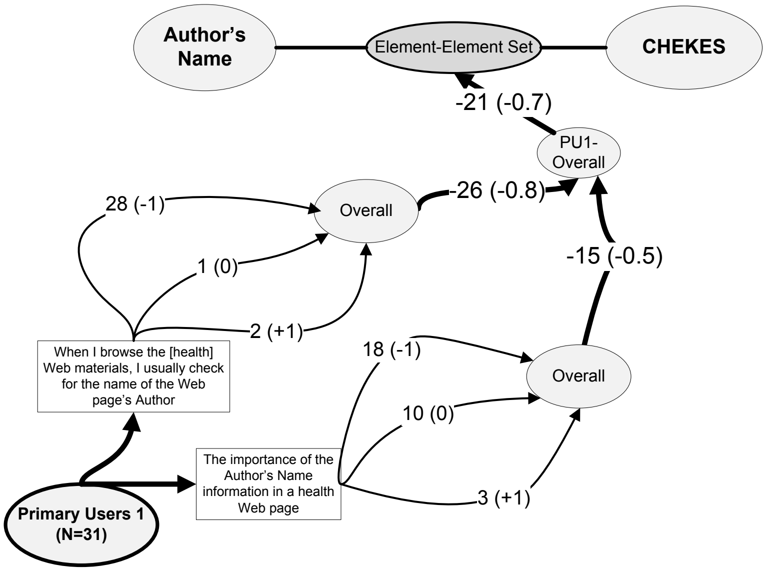


Figure 7-3. A deeper view of the knowledge requirements map showing the original viewpoint expressions of the requirements sources in Phase I (regarding Author's Name)

For the Primary Users 1, we used a second questionnaire instrument, which asked them how important they perceive the Author's Name information in a health Web page (in general) to be. As shown, 18 subjects perceived the Author's Name to be unimportant (~60%). In addition, ten others rated the importance as somewhat important (or neither important nor unimportant) and only three perceived the information to be important. Therefore, the sub-momentum of the Primary Users 1's viewpoints (-21 (-0.7) indicates their overall attitude toward the Author's Name as a piece of knowledge in a health Web page, not being checked by them very often and not being perceived as important. However, such attitude could not explicitly reflect objection to the inclusion of the Author's Name. According to the telescopic feature, as explained in Chapter 4 (Section 4.5.2), all the elements of normative viewpoints (i.e., the viewpoints of local to international health and eHealth professionals) will be included in the requirements specifications unless there is reasonable evidence of dislike (or objection) from the primary users of knowledge content.

In Phase II, we tailored the aggregated viewpoints one level forward, consistent with our telescopic approach. We narrowed down the Phase 0-I viewpoints, using a method similar to common WinWin approaches (Boehm, Egyed et al., 1998; Gruenbacher, 2000). To do this, we used the co-design approach to check whether the primary users explicitly include or exclude the Author's Name information in a health Web page being designed.

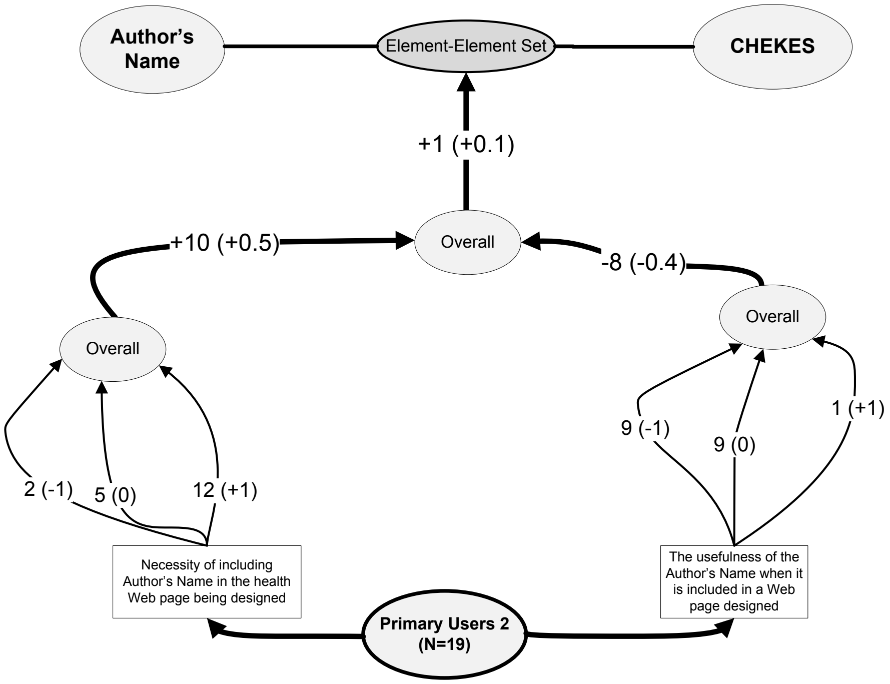


Figure 7-4. Another deeper view of the knowledge requirements map showing the original viewpoint expressions of the subjects in Phase II (regarding Author's Name)

As our scheme shows (Figure 7-4), during the co-design task, we asked the Primary Users 2 (i.e., the Phase II participants) about the importance of including the Author's Name element in the Web page they would design, in a five-scale from 1 (Not Important At All) to 5 (Very Important). To complete the task, the subjects were given three examples of Author's Name information and were asked to drag and drop their choice into the Web page they would design. As demonstrated, twelve subjects (~65%) considered the inclusion important and included the element in the Web page. Another five subjects rated the element as Somewhat Important, but all chose to include the element in the page. Only two subjects preferred not to include the element at all and rated the element as Not Important At All. Therefore, considering the element scores, we had +10 (+0.5) score of supporting viewpoints toward the inclusion (or +15 if we include the subjects with neutral viewpoints who included the element during the co-design). In the next step, we asked the users to rate the usefulness of including the Author's Name information (for their peers) for their peers. As shown, the vast majority considered the Author's Name to be useless or only somewhat useful (neither useless nor useful), for an average element score of -0.4. This attitude of the Phase II subjects was consistent with the attitude of the Phase I subjects regarding the importance of the Author's Name (-0.5). Overall, our telescopic framework suggests a +10 momentum from the primary users toward the inclusion of Author's Name in a health Web page. In other words, similar to a WinWin approach, we considered the last round of viewpoints tailoring as the determining phase toward the inclusion. Therefore, we included the element in CHEKES-III. However, the sub-momentums of attitude toward the overall usefulness and importance of such element (by the primary users) plus the fairly neutral normative viewpoints of the exemplar Web sites and the local professionals may suggest that such information is an element of fairly low value. Such value would help the requirements engineer to sort the specifications based on their values.

The element value can be enhanced using additional information. Our metadata-based framework allows us to enhance the usability/usefulness of the knowledge elements as well. In the study conducted, the study of knowledge elements and health topics were primarily limited to a simple three level reasoning of inclusion-neutral-exclusion. Therefore, we did not intend to investigate, for example, how the knowledge elements selected should be presented considering the variety of possible choices available for each. For instance, we did not study whether the provider information should be presented in form of a visual logo or a simple textual note or whether it should include only a brief title of the provider's organization or detailed information including the type of organization and affiliations. However, we included a complementary element for the Author's Name as an example.

We raised a question as to whether a complementary knowledge element such as Author's Credential could enhance the Author's Name if the elements are included together (as was suggested by all the exemplar Web sites presenting Author's Name). We elicited all the viewpoints regarding this enhancement and associated the results as viewpoints supporting the association of Author's Credential with Author's Name with an association role of "Complementary element – Element." As demonstrated in Figure 7-5, regardless of whether we consider the gross momentum of +0.6 or take only the Phase II results as the determining Phase (+0.8) into account, the results suggest a developer can enhance an Author's Name with information on the Author's Credentials.

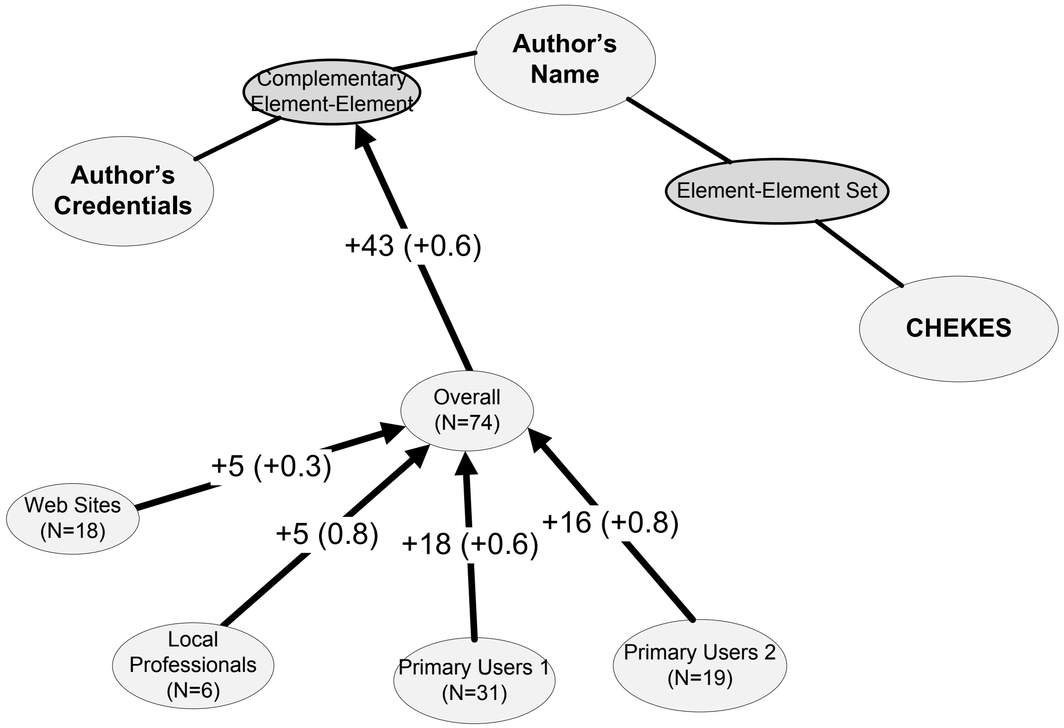


Figure 7-5. A knowledge requirements map demonstrating the level of support for the Author's Credential across the sources (in Phase 0-II)

A third feature of our framework is that each element in the element set (CHEKES) has a comparable dynamic value (average element score (AES)). (Table 7-1) The reason for this dynamicity is the evolving nature of the supporting viewpoints. For example, it was shown that corresponding score (AES) for Author's Name evolved along with the evolution of related viewpoints throughout the research, in both quantity and quality. As shown in Table 7-1, we have sorted the CHEKES-III elements and their average element scores (we called here *element inclusion momentum*), based on the results from Phase II. Such a ranked list can tell a developer how to build knowledge content that reflects such order of knowledge requirements. In addition, by updating the element inclusion momentum over time, throughout the lifecycle of the application, the developer can update the KIEHA knowledge content based on the latest rank of the knowledge elements.

Table 7-1. A scored list of CHEKES-III elements showing their varying momentum of inclusion (IEM)

Elements	EIM
Title	1.00
Contact Information	0.95
TOC	0.95
Self-care tools	0.95
Provider	0.89
Local Help	0.84
News	0.79
FAQ's	0.63
AV	0.58
Author	0.53
Last Update	0.53
Related topics	0.53
Online Resources	0.47
Introduction	0.37
Glossary	0.32
Terms	0.21

Except for Title, we followed a similar approach for all elements as with the Author's Name to make the final judgment. We found the inclusion of Title too trivial to be researched.

7.1.1.2 Comparison

We compared our element set with some major element sets of quality health information identified across studies. This comparison was aimed at demonstrating the validity of the element set (or requirements specifications) developed. A wide variety of element sets has been introduced in the health informatics literature as indicators of quality health information. In this dissertation, we claim that the set of knowledge elements specified through a TDM-KREM framework is the set of elements that is essential for "quality" health knowledge content. Therefore, we believe that such a set can be used as quality criteria to assess the health information content provided to all the primary users in the same population. Here, we test the generalizeability of our element set.

We identified two main groups of relevant literature. We described each group, chose a representative study from each group, and compared the suggested element sets to CHEKES-III. The first group includes a broad variety of guidelines, literatures and organizational publishing policies that have listed a series of both knowledge elements and attributes that characterize a quality health information Web site/page. Obviously, we could not compare our results to all of the 300 quality element sets identified by only one of the related systematic reviews. We found a practical approach was to compare our results to the synthesized results of the three available systemic reviews, aggregating the quality factors of all. The first review was Eysenbach et al.'s review of 79 empirical quality studies (regarding online health information) (Eysenbach, Powell et al., 2002). We found Eysenbach's study one of the most comprehensive reviews in this area as it summarized the results from 79 related studies. Eysenbach's list of elements have also been used as the basis in several further quality studies such as Bernstam et al. (2005). The second review was by the Picker Institute Europe, conducted by Coulter et al.: it reviews six of the most well known quality rating tools such as Health On the Net (Boyer, Selby et al., 1998), DISCERN (Charnock, Shepperd et al., 1999), and the European Commission (2002). The third was the systemic review of Bernstam et al. (2005), in which the authors reviewed 273 distinct instruments of quality assessment for online health information and finally selected eight as the quality element set that can be used by health consumers to assess the quality of health information Web pages.

To make the comparison, we first extracted all the quality elements (available in element tables) from the selected reviews and sorted them on a data matrix. We then removed all the irrelevant quality criteria from the matrix. For instance, we discarded vague characteristic-related criteria such as Balanced Evidence, Accuracy, and Reliability or design-related features such Internal Search Engine Present. In addition, we excluded the criteria with no clear meaning, such as "Higher-rank Higher quality". We have listed the rest in Table 7-5 and included the related elements from CHEKES-III for comparison.

As demonstrated, CHEKES-III includes all the elements summarized across the three studies except two. We did not include First Creation Date and References, because of their low rate of occurrence across the literature. In addition, First Created was used as a control element in both Phase II and Phase III and never received any interest from the primary users (rather it was rated as "Too Much Information" by many of the Phase III subjects). CHEKES-III also includes Terms as a general element for all policies, disclaimers and sponsorship information. However, as explained earlier in this chapter, more details of what should be included under each element were not researched in this study. Finally, CHEKES-III suggests six more elements that have not been included in any of the three studies. One more thing worth noting is that when we actually reviewed the quality element sets in some of the literature reviewed in the above three studies, we realized that some of the six CHEKES-III elements had been included. However, such elements were somehow ignored or discarded in the process of reviews by the authors. For instance, Frequently Asked Questions has been mentioned in the AMA guideline but has not been included in Bernstam et al.'s final list (AMA was one of the finalists in the Bernstam et al. study).

Table 7-2. Comparison table of the quality elements identified by the three systemic reviews and the CHEKES-III elements

Elements	Eysenbach et al	Coulter et al	Bernstam et al	CHEKES-III
Date of creation disclosed	X	X		
Date of last update disclosed	X	X	X	Last Update
External links provided	X	X	X	Online Resources
Internal links provided				Related Topics
Disclosure of ownership	X	X		Provider
Feedback mechanisms provided	X	X		Contact Information
Terms/Policies/Disclaimers/Copyright	X	X	X	Terms
Description of editorial process	X	X		Terms
Disclosure of advertising	X	X		Terms
Disclosure of sponsorship	X	X		Terms
Disclosure of authorship	X	X	X	Author
Authors' credentials disclosed	X	X	X	Author
References provided	X	X		
Graphics and multimedia present	X	X		A/V
Frequently Asked Questions				FAQ
Related health news				Related News
Self-care tools and guides				SCS Tools/Guides
Local health services and Help lines				Local Services
Description/Introduction				Introduction
Glossary of the medical terminology				Glossary
Topics included				TOC

The second group of quality-related studies is a series of large-scale studies/projects aimed at creating an XML/RDF based metadata element set to sort, index, and filter the health information Web sites. The most prominent representatives of these are MedCERTAIN (Eysenbach, Kohler et al., 2001), Quatro (Archer, 2005), and MedIEQ (Mayer, Karkaletsis et al., 2006). All these projects have been funded by programs of the European Union such as Safer Internet Programme (SIP). To compare the elements, we compare our elements to MedIEQ as the latest study of this type. As Mayer et al. describe, their study has continued the work of previous projects as an initiative to advance the related state of the art. Once again, non-relevant elements (such as URI) were excluded. Table 7-6 shows the results.

Table 7-3. A comparison of knowledge elements in MEDIEQ (excluding the four non-relevant elements) and CHEKES-III

MedIEQ	CHEKES-III
Author	Author
Author's Contact Information	Contact Information
Last Update	Last Update
Topic Keywords	TOC (Table of subtopics)
Quality Seals	-
Virtual Consultation	Contact Information (Ask a Pro)
Advertisement	-
-	A/V
-	FAQ
-	Related News
-	SCS Tools/Guides
-	Local Services
-	Introduction
-	Provider
-	Terms
-	Online Resources
-	Related Topics

As shown, CHEKES-III contains all the MedIEQ elements except two, Quality Seals and Advertisement. We excluded the Quality Seals or Accreditation from our list as we found our primary users unfamiliar with even the most known types of such seals (HON). HON is one of the accreditation tools used by MedIEQ to rate the quality of a health Web site. We did not include Advertisement, as it is rather a negative indicator of health Web site quality. However, in our telescopic approach, we based our element set on the elements that exist within the exemplar Web sites or are recommended by local professionals (positive quality elements). Therefore, advertisement as an element of very low frequency of occurrence across the exemplar Web sites was not included.

A main shortcoming of the previous quality-related studies from the literature was their lack of supporting evidence. We did not come across many studies that demonstrated a relationship between the viewpoints of the actual stakeholders of health information, particularly consumers, and of the element set being defined (i.e., the element set is not traceable). Even if elements are recommended by qualified professionals, only a few studies demonstrate explicit support on the usability and usefulness of such elements by the primary users of such applications. In addition, there is hardly any evidence provided in the literature which supports the validity of the defined elements for differentiating a quality Web site from non-quality Web site in such a way that selected quality pages would better satisfy the knowledge needs of target individuals as compared to non-quality pages. For example, none of the student health Web sites we viewed contained Author's Name or Creation Date, and few of them contained other elements such as Update or Quality Seals. Therefore, such Web sites would be most probably be filtered out by the indexing tools based on such quality elements.

A contribution of this dissertation is the proposed framework allows the inclusion of elements to be transparently substantiated with a balanced range of viewpoints including those of health and eHealth professionals and the consumers. As shown above, although the CHEKES-III elements were the result of a small-scale short-term study with its own natural limitations (we will discuss this later in the chapter), the wealth of the elements was reasonably comparable (if not superior) to the summary list of elements recommended by related systematic reviews as well as with those from large-scale quality-rating projects. Therefore, it is expected that our framework could improve further quality knowledge design by promoting and enabling rational and multi-viewpoint requirements engineering.

7.1.2 Question 3: the Primary Users' perception regarding the specifications

The third question we asked was:

> How will the primary users of an eHealth application perceive the quality of knowledge elements selected for inclusion using the proposed requirements engineering framework? Specifically, will they recognize those elements as pieces of knowledge that,
>
> a. are required in the application,
>
> b. contain useful information,
>
> c. make the application look credible, and
>
> d. match their overall interest?

To answer the research question, we calculated the overall average of responses for each of the five evaluation factors (necessity of inclusion, usefulness, effect on credibility of the Web page, overall interest, and informativeness) in the CHEKES set. Table 7-4 presents the results. The table shows that CHEKES elements, as a set, have been recognized by the subjects as pieces of knowledge that are:

1. reasonably necessary to be included in the Web page (Mean=2.8, SD=0.5),
2. contain useful information (Mean=2.7, SD=0.5),
3. make the health Web page look credible (Mean=2.6, SD=0.7),
4. and match their overall interest (Mean=2.8, SD=0.6).

Table 7-4. The overall ratings of the Phase III participants regarding CHEKES elements as a set on the five selected measures

CHEKES Set	N	Mean	Std. Deviation
Overall Importance of inclusion	144	2.8	0.5
Overall Usefulness	144	2.7	0.5
Overall Effects on Credibility	144	2.6	0.7
Overall Interest	144	2.8	0.5
Overall Informativeness	144	2.5	0.6

In addition, we asked the participants to rate the Informativeness (the wealth of information provided) of a health Web page when it includes the CHEKES element. Informativeness or sufficiency of information as a measure was not part of the element dimensions in our research question, as we only included the factor as an additional measure suggested by both Aladwani and Palvia (2002) and De Wulf et al. (De Wulf, Schillewaert et al., 2006) in their questionnaire items. The results show that the CHEKES set, if included in a health Web page, would make the Web page informative (Mean=2.5, SD=0.6). The result was slightly lower than the other four dimensions. A possible rationale was that our level 2 and level 3 of our three-level informativeness scale (Could be Informative and Informative) were not precisely defined. For instance, it is hard to say whether an Author's Name or Provider's Information is "Informative" or "Could be Informative." In addition, our main intention of including informativeness was to identify whether a knowledge element would bring too much information in a health Web page. Of the 144 cases of informativeness rating in Phase III, only fourteen were "Too Much Information" from which seven were related to the control elements of First Created and User Rating.

Furthermore, we examined three more aspects of our results. We tested to determine whether the four measures we used to evaluate the elements can predict the satisfaction level (Overall Interest) of a subject rating those elements. We performed a bivariate two-tailed Pearson Correlation test and sorted the results in Table 7-5 (below). As shown, Usefulness, Importance, and Informativeness are statistically correlated with Satisfaction at a significant level (at 0.01). However, Credibility of an element may not be a predictor of the subject's interest in the knowledge provided by that element. For instance, Author's information has been ranked as one of the top element affecting the credibility of a Web page. However, that seemingly positive property cannot predict the overall interest of the subjects in the element. The table of results regarding Overall Interest (Table 6-33) shows Author's information as one of the least interesting knowledge elements. This is in accord with our findings regarding the overall attitude toward Author's information as we discussed earlier in this Chapter. Credibility only correlates with Importance, meaning that the elements which make the Web page look credible are identified as important to be included in the health Web page. This also justifies why the Phase II subjects preferred to include the element in the Web page despite overall negative perception regarding the element.

Table 7-5. Correlations between Satisfaction and four other dimensions of knowledge elements evaluation

		Satisfaction	Informativeness	Usefulness	Importance	Credibility
Satisfaction	Pearson	1	.557(**)	.654(**)	.610(**)	.051
	Sig. (2-tailed)		.000	.000	.000	.540
	N	144	144	144	144	144
Informativeness	Pearson	.557(**)	1	.589(**)	.513(**)	.010
	Sig. (2-tailed)	.000		.000	.000	.906
	N	144	144	144	144	144
Usefulness	Pearson	.654(**)	.589(**)	1	.514(**)	-.017
	Sig. (2-tailed)	.000	.000		.000	.836
	N	144	144	144	144	144
Importance	Pearson	.610(**)	.513(**)	.514(**)	1	.229(**)
	Sig. (2-tailed)	.000	.000	.000		.006
	N	144	144	144	144	144
Credibility	Pearson	.051	.010	-.017	.229(**)	1
	Sig. (2-tailed)	.540	.906	.836	.006	
	N	144	144	144	144	144

** Correlation is significant at the 0.01 level (2-tailed).

We also examined whether we can recommend the four dimensions we suggested in our research question as scale to evaluate the knowledge elements. To test the reliability of such a scale, we determined a Cronbach's Alpha. As evident at Table 7-6, it seems that if Credibility were discarded, the three others (Importance, Usefulness, and Overall Interest) would make a reliable scale to evaluate knowledge elements.

Table 7-6. Contributions of Four Evaluation Dimension if Used as Scale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Overall Interest	7.98	1.883	.590	.471
Usefulness	8.09	1.901	.478	.528
Importance	8.10	1.502	.624	.394
Credibility	8.19	2.175	.114	.803

7.1.3 Question 4: Support for quality eHealth application design

The fourth research question we asked was

- Will the knowledge requirements specified using the proposed framework support the design of quality knowledge content for an eHealth application?

We then asked two specific questions:

1. Will these specifications, if used as the basis of design, improve the quality of an exemplar search engine in such a way that it helps the users choose the health resources they actually prefer?
2. Will these specifications, if used as the basis of design, improve the quality of an exemplar health Web site in terms of ease of use, wealth of health topics, content organization, and overall quality?

We discuss the answers in the following sections.

7.1.3.1 Improving the quality of an exemplar search engine

In our research question, we wondered whether the requirements specified, when used as the basis of design, will improve the quality of an exemplar search engine in such a way that it helps the users choose the health resources they actually prefer. We considered a search engine (or an indexing method) “better” if it could provide index information regarding the relevance, trustworthiness and overall quality of a resource such a way that the user is able to choose the same resource as they would if they had access to the full resource content. We, therefore, assumed that the subjects would be more likely to click on a link (i.e., choose a resource) if they found it more relevant to what they were looking for, more trustworthy and of a better overall quality as compared to other links in the list with less comparable values.

To test our hypothesis, we computed two scores for each link included in the interfaces: **Link Score** and **Interest to Click Score**. Link score represents the overall perceived value of a link (in the search results) for a particular participant. Interest to Click Score simply reflects the attitude of the participant toward clicking a link in the search results. To calculate the link score for link ***l*** and for participant ***p***, we used the formula shown in Table 7-7.

Table 7-7. Formula to calculate the link score

$$LS_p^l(Link\ Score) = R_p^l(Relevance) + T_p^l(Trustworthiness) + O_p^l(Overall\ Like)$$

LS_p^l=Link score for link l by participant p
R_p^l=Adjusted relevance rate for link l by participant p
T_p^l=Adjusted overall trust rate for link l by participant p
O_p^l= Adjusted overall interest rate for link l by participant p

As shown, to calculate the link score for a particular participant (and for a particular link), we reversed the participant's given rating for relevance, trustworthiness, and overall quality, and computed their sum as the link score. To calculate the interest to click score, we simply reversed the given rating for the interest to click and considered that as the interest to click score (ICS) for that link (***l***) as perceived by participant ***p***. To test our hypothesis, we ran a Pearson Correlation between the link score and the desire to click score in the participants' responses to both Google and Simulated Google. Tables 7-8 (a) and (b), show the SPSS results for both. As demonstrated, link score and interest to click scores are significantly correlated (at 0.01 level). In other words, the links of better overall rating (i.e., better Link Scores) are more likely to be pursued (clicked) by the subjects.

Table 7-8.

(a) Correlation between the subject's Interest to Click a Link, Web Site Rank, and Link Score in Google

		Google Interest to Click	Google Link Score
G Interest to Click	Pearson Correlation	1	.670(**)
	Sig. (2-tailed)		.000
	N	80	80
Google Score	Pearson Correlation	.670(**)	1
	Sig. (2-tailed)	.000	
	N	80	80

** Correlation is significant at the 0.01 level (2-tailed)

(b) Simulated Google

		SG Interest to Click	SG Link Score
SG Interest to Click	Pearson Correlation	1	.803(**)
	Sig. (2-tailed)		.000
	N	80	80
SG Link Score	Pearson Correlation	.803(**)	1
	Sig. (2-tailed)	.000	
	N	80	80

** Correlation is significant at the 0.01 level (2-tailed).

To compare both interfaces in helping the subject make “better” informed decisions, we granted the subjects access to the full version of resources (the health Web sites). We asked the subjects to rank the first three Web sites/pages that they would consider the best and accumulated the given rank for each of ten Web sites. Then, we used the Pearson Correlation formula to determine which interface would help the subjects choose the health Web pages they actually like to use. As we showed, in 6.4.3, only the results from Simulated Google were significantly correlated with the results from Actual Page ranking. Evidence for that was the similar selection of FD (familydoctor.org), GC (Government Canada), and UW (the health Web site of Western Washington University) as the top three Web sites in both the subjects’ actual page ranking and also in Simulated Google (and in the same order). In other words, Simulated Google helped the subjects choose the Web sites they would actually perceive to be the best in terms of relevance, and overall quality.

We found few papers that have investigated the potential contribution of metadata in enhancing the health resource indexing methods or the health search engines. Of eighteen health/medical search engines listed by Can and Baykal (2007) none is based on metadata as its sole indexing method. In addition, search engines such as WRAPIN (the search engine by the Health on the Net Foundation), although they claim (Gaudinat, Ruch et al., 2006) to have quality elements as the basis of their indexing and retrieval methods, are disappointing in practice. In an actual retrieval, for instance, WRAPIN, it only shows the quality seals of the links listed. Even Healia, (Eng, 2006) as one of the latest and most sophisticated consumer health search engines, only uses metadata to filter the content based on target audience (age, gender, and race), reading level, and quality seals. However, the original index includes only the health Web sites that have been already approved according to some criteria.

We believe that a rational use of metadata, as enabled by TDM-KREM, has the potential to improve the indexing methods of online health resources. As shown above, we only used TOC (list of subtopics), Provider information, and the Target Audience. Target Audience was not a knowledge element to be included in CHEKES, but was suggested by some of the Phase I subjects. Our results showed that adding only three pieces of metadata information enabled the consumers to choose the Web sites they actually liked. A superior feature of our method is that it does not filter the online health resources and thus does not objectively exclude the health Web sites or pages with content possibly useful for consumers (but with low quality rating). Therefore, it actually empowers the health consumers by providing awareness and helping them make decisions (rather than making decisions for them).

7.1.3.2 Improving the quality of exemplar health Web sites

In our second specific question, we asked: Will the requirements specified, if used as the basis of design, improve the quality of an exemplar health Web site in terms of ease of use, wealth of health topics, content organization, and overall quality?

In the prototype testing conducted, we focused on two types of evaluation approaches, element/topic-level and holistic. In our discussion of the answer to the first research question, we compared our element set to elements of some quality criteria across the literature reviewed and concluded that our set of knowledge elements was reasonably comparable (if not superior) to those elements. A limitation of that evaluation was that the participants evaluated each element separately, although they were instructed to imagine its use in a health Web page. However, a computer-based knowledge artifact such as a health Web site or page as a whole is a composite product of various underlying components including knowledge content, software features and graphical attributes, compelling a comprehensive, holistic evaluation that involves the totality of the quality and not simply the presence or absence of a knowledge element.

Considering that the focus of this dissertation is the quality of knowledge content, we strove to minimize the variation of the software and graphical features of the three health Web sites studied by choosing a single design template. In addition, we endeavored to equalize the main subject-specific content of all three sites by using an external piece of relevant STD content for all three. Therefore, we presumed that the final Web sites were only different in their knowledge content in terms of the hierarchy of the health topics and the knowledge elements used.

To evaluate the health topics, we used an approach similar to the one by Fang and Holsapple (2007). A difference here was that instead of asking the users to find some specific topics, we asked them to locate the health topics that, in their opinion, were the most important (for a student health Web site). However, as we did not want their opinions to be affected by the health topics listed in our hierarchy, users were asked to submit the topics before being granted access to the Web sites. As shown in Figure 7-6, all the health topics (but one) which have been recognized as “the most important for a university health Web site” were directly available in the health topic menu (a match rate of 96% (23 of 24)). We also totaled the frequency of each health topic’s occurrences across the subjects and showed the results as momentum value toward that health topic. This momentum was then examined against the momentum of the CHEKES-III health topics of their equivalent and a comparison table was produced (Table 7-9). The table shows that the topics of high interest by the subjects were also the topics of highest momentum in our topic set.

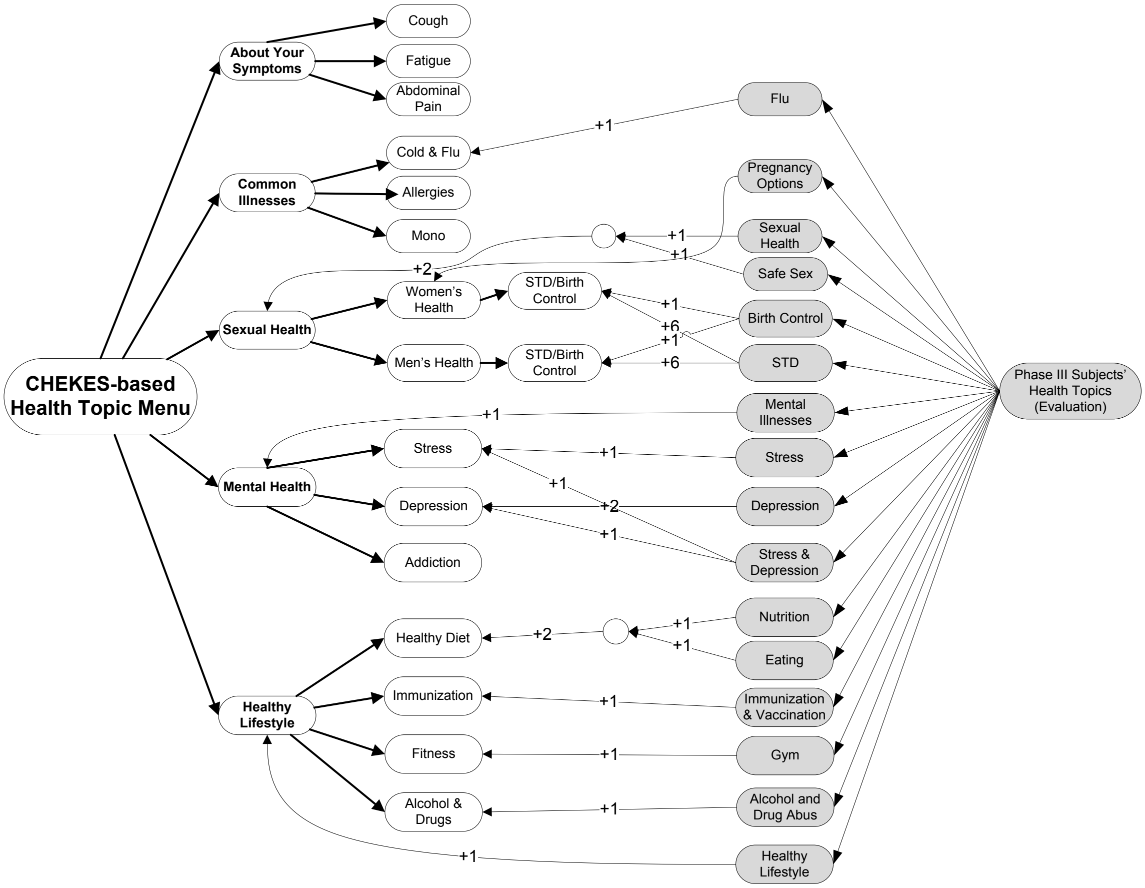


Figure 7-6. A comparison of the wealth of health topics in our prototype's health topics menu and the related frequency of the health topics suggested by the Phase III subjects

Table 7-9. A comparison of the CHKES-III topics scores and the frequency of health topics suggested by the Phase III subjects

Health Topic	Topic Score	PIII Scores
STDs/HIV	57	6
Depression	56	3
Stress	56	2
Nutrition and Fitness	55	3
Birth control	55	2
Alcohol	55	1
Drugs	53	1
Colds & Flu	53	1
Travel Health & Immunization	42	1
Pregnancy	16	1

The findings were valuable for us to assess the comprehensiveness/completeness level of the knowledge content we specified. Eysenbach et al., in their study of criteria for quality health information, report comprehensiveness or completeness as one of the six dimensions of quality commonly defined as “proportion of a priori–defined elements covered by a Web site.” (Eysenbach, Powell et al., 2002) Somewhat similarly, in our context, we would consider a quality health Web site as a Web site that covers a great ratio of high priority topics or elements identified by all the viewpoints of health information provision. The TDM-KREM approach allowed us to summarize this wealth of topics in CHEKES-III, and our evaluation confirmed that the topics collected were valid representatives of health topics of high priority to the primary users interviewed. Hence, the knowledge content created (based on CHEKES-III) can be considered reasonably comprehensive/complete.

A second approach we took to examine our hierarchy was to evaluate its holistic aspect. To test this, we used two measures used by Fang and Holsapple: Ease of Use and Satisfaction. We asked the participants to tell us if it was easy for them to locate the health topics of their interest and whether the topic menu was the type of menu, they would prefer to see in a health Web site. As summarized in Table 7-10, the subjects rated the Campus-HITS (CH) health topic menu as significantly easier to use and as satisfying their interests (95% and 99% confidence level) as compared to the two other health Web sites. In the final ranking, the participants ranked Campus-HITS as the superior Web site (Average Rank=1.0 and 1.4) in both these aspects.

Table 7-10. *t*-test measurement of variance for ease of use and overall satisfaction between Campus-HITS prototype (CH), Teen Health (TH), and University of Ottawa (UO)

Ease of use	Sig (2-tailed)
CH-TH	0.03
CH-UO	0.00
Overall Satisfaction	
CH-TH	0.01
CH-UO	0.02

Therefore, we conclude that our framework and our approach to viewpoint elicitation, approximation, and aggregation were successful in tailoring the list of health topics (suggested by various viewpoints) into a hierarchy that is perceived as easy to use by and matches the interests of the primary users.

The next test concerned the evaluation of the holistic aspects of knowledge elements. Because the knowledge element set we specified was quantitatively richer than the average wealth of elements of the health Web sites, we were concerned that the primary users would perceive such a large volume of knowledge in a Web page as too much information. And if not, we wondered whether the subjects would consider the content more informative than the other Web sites. No subject perceived the content provided too much information. In fact, they ranked Campus-HITS to be the most informative Web site of the three (average rank CH=1.4 TH=2.4 UO=2.4).

Furthermore, we wondered if the subjects would perceive the manner in which the information had been organized on the page (into different knowledge elements) as reasonably better than the way the other two sites were organized. Ultimately, all the subjects agreed that they liked the way the information was organized in the Campus-HITS Web site (Mean=4.5, SD=0.5). However, the variance was only significant between Campus-HITS and the University of Ottawa Web site. The subjects ranked Campus-HITS as being the superior Web site in the area of information/content organization (Average Rank CH=1.0 TH=2.5 UO=2.5).

In the last step, we evaluated whether the prototype built satisfied the overall needs of the primary users' representatives. We also included two other measures, professional look and visual appeal. We examined whether the users' level of satisfaction would affect their perceptions regarding the credibility (or what students often call professional look) of the Web site. We also included visual appeal as a control measure.

As shown in Table 7-11(a), the phase III participants' satisfaction with Campus-HITS Web site was significantly better than with the other two Web sites. The participants had a strong consensus that the CH Web site was the best of the three Web sites (Average Rank=1.0). For the two other factors, the results varied in separate rating (a), but in the final ranking, the primary users ranked Campus-HITS as the superior Web site on Professional Look and Visual Appeal.

Table 7-11. The Phase III results regarding overall satisfaction

a) the significance of variance (using *t*-test),

Overall Satisfaction	Sig (2-tailed)
CH-TH	0.007
CH-UO	0.014
Professional Look	
CH-TH	0.049
CH-UO	0.142
Visual Appeal	
CH-TH	0.285
CH-UO	0.007

b) Average ranking for the Web sites on the three factors of Satisfaction, Professional Look and Visual Appeal

Web sites	Overall Satisfaction	Professional Look	Visual Appeal
CH	1.0	1.4	1.1
TH	2.4	2	2.5
UO	2.6	2.6	2.4

Various conclusions can be derived from the above results. One conclusion is based on the model of satisfaction/pleasure by De Wulf et al. (2006). De Wulf et al., in their study of pleasure as the measure of Web site success, demonstrate the results of their empirical research and suggest factors such as commitment, trust, and satisfaction to be all related with pleasure. According to their model, content, content organization, and technology are the three dimensions of a Web site, which affect the joy of use in primary users. Thus, the level of joy experienced determines the level of satisfaction, trust, and commitment to the content. Our results support this relationship in the domain of health information Web sites. Although we did not alter the technology aspect of the Web site (such as software and design features), the results show that a change in the wealth of health topics and knowledge elements (and not the actual written content) can cause significant changes in the subjects' level of satisfaction with the Web site. In addition, this satisfaction also affected the subjects' perception regarding the credibility of the Web site: Campus-HITS was considered to have the superior professional look among all three sites. Therefore, as De Wulf et al. suggest, it can be expected that such a positive level of satisfaction with a health Web site will increase the users' commitment or loyalty to the content.

A second conclusion was made regarding the contribution of the knowledge elements specified toward awareness and health behavior change. We proved that the knowledge elements and topics we specified using our framework matched the personal needs of the primary users. Therefore, according to the Elaboration Likelihood Model (Petty and Cacioppo, 1986), we expected the primary users to process such information more effectively as compared to non-tailored knowledge. In addition, we expected a knowledge artifact based on such a tailored set to receive greater attention (Kreuter and Holt, 2001) and thus produce a higher level of satisfaction. The results show that our expectations were valid. The achieved user satisfaction indicates the success of the tailoring approach we developed, and thus prove the effectiveness of our framework. Therefore, in summarizing the above viewpoints, including the model of satisfaction by De Wulf et al., we conclude that the knowledge requirements specification produced, if used as a basis in a knowledge artifact such as a health Web site, will result in greater comprehension of the content, greater commitment to the content, and greater likelihood of behavior change.

The final issue is the unexpected variance of the Web sites in their visual appeal. One explanation is that although we made every effort to minimize the visual differences (See Figure 7-7), we violated the consistency in few cases. In Campus-HITS Web site, we included some of the suggestions of the Phase II participants regarding their preferred positions and formats for various pieces of information. For instance, we had several ways to present Online Resources in the page (within the text, in a side box, or as a simple link). We decided to follow the suggestions by the majority of subjects and used side box. For the other two Web sites, we allowed their original format of elements to appear in the test. For example, University of Ottawa Web site, included Online Resources within the text, and Teen Health Web site had a simple link to a separate page containing Online Resources information. Our rationale was that keeping the information (regarding knowledge elements) in their original formats would make comparisons more valid. However, there is a possibility that such variations have been responsible for the differences of perceptions (regarding the visual appeal). Nonetheless, we would not perceive such changes as justification for the great differences in satisfaction levels. Rather, we believe that the overall satisfaction induced by the combination of factors such as richness of knowledge wealth, availability of health topics of interest, and ease of use has caused an overall satisfaction that has also affected the participants' opinion regarding the visual appeal. This is supported by the result of a Pearson correlation test between all these factors (Table 7-12). Therefore, while we do not deny the message of the studies (Tractinsky, Katz et al., 2000; Lindgaard and Dudek, 2003) substantiating that "What is beautiful is usable," we would also propose the possibility that "Quality content is beautiful."

Table 7-12. Pearson Correlation between all the six variable of the Web site quality

		Organization	Topic Wealth	Visual Appeal	Ease of Use	Overall
Organization	Pearson Correlation	1	.699(**)	.702(**)	.701(**)	.671(**)
	Sig. (2-tailed)		.000	.000	.000	.000
	N	24	24	24	24	24
Topic Wealth	Pearson Correlation	.699(**)	1	.581(**)	.820(**)	.755(**)
	Sig. (2-tailed)	.000		.003	.000	.000
	N	24	24	24	24	24
Visual Appeal	Pearson Correlation	.702(**)	.581(**)	1	.712(**)	.813(**)
	Sig. (2-tailed)	.000	.003		.000	.000
	N	24	24	24	24	24
Ease of Use	Pearson Correlation	.701(**)	.820(**)	.712(**)	1	.835(**)
	Sig. (2-tailed)	.000	.000	.000		.000
	N	24	24	24	24	24
Overall	Pearson Correlation	.671(**)	.755(**)	.813(**)	.835(**)	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	24	24	24	24	24

** Correlation is significant at the 0.01 level (2-tailed)

7.2 Summary by Research Questions

We summarize our discussions of the answers to the research questions (based on the general research questions from Chapter 1).

1- **Can we develop requirements engineering techniques and methods that accommodate multiple viewpoints, support traceability and requirements change over time?** Yes. In Chapter 4, we conceptually demonstrated the capability of our framework in accommodating (or supporting) the above three features. Early in this chapter, we presented how the proposed framework accommodated 74 viewpoints of requirements regarding an example element (Author's Name). It was also shown that how a particular specification/element in the final specifications could be rooted to its sources of supporting viewpoints, and thus demonstrated its traceability. Finally, we showed the corresponding score for a specific element evolved over time, and after each iteration of viewpoint update, and hence demonstrated the framework's support of requirements change.

2- **Can we use such requirements engineering methods as the basis to specify the quality knowledge requirements of an eHealth application?** Yes. In Chapter 6 and also this chapter, we demonstrated how the methodology proposed helped us develop the knowledge requirements specifications. Earlier in this chapter, we compared our final specifications (or element set) with a variety of the quality element set available across the literature. In our comparison, we found our element set including not only the majority of elements specified in the competing quality element sets, but also additional elements that could help the user better comprehend the knowledge content provided (e.g., Frequently Asked Questions). In addition, our requirements specification includes the health topics of preference by the primary users, which is missing in the competing quality sets.

3- **How will the primary users of an eHealth application perceive the quality of the knowledge elements specified using such a requirements engineering process?** Our results showed that the primary users perceive the specifications as pieces of knowledge that are necessary to be included in a health Web page (as an example of KIEHA), contain useful information, make the health Web page look credible, and match their overall interest. We, therefore, concluded that they perceive the specifications as quality knowledge elements of an eHealth application.

4- **Will the knowledge requirements specified in this manner (i.e., using the proposed framework) support the design of quality knowledge content for an eHealth application?** Yes. We demonstrated that the use of specifications as the basis of design could improve the quality of an exemplar search engine in such a way that it helps the users choose the health resources they actually prefer. We also showed that an exemplar Web site could be significantly improved in terms of ease of use, wealth of health topics, content organization, and overall quality when it uses the specified knowledge elements. Therefore, our framework supports the design of quality eHealth application.

7.3 Limitations

Several limitations might have affected the quality of this research. We did not include the research literature and standard documentations and guidelines as sources of requirements. A particular advantage of using a telescopic approach, as described in Chapter 4, is its emphasis on reasonable completeness of requirements information. This is particularly important as it addresses the fair distribution or representativeness of all related requirements stakeholders, what otherwise can result in over attention to specific stakeholders (one of the five topic risks of requirements engineering (Lawrence, Wiegers et al., 2001)). However, we did not include research literature for two reasons. First, in our design we strove to include only the sources which explicitly shared the same (or reasonably similar) context as our application domain i.e., a similar problem frame (Jackson, 1994). However, to check the context similarity in the literature, we had to systematically review the abstracts (as well as the full text of a few) of all seemingly relevant pieces of literature retrieved. Early in our research, we used the query suggested by Eysenbach et al. (2002) in their systematic review as a basis and developed a query relevant to our specific context ((satisfaction OR pleasure OR quality OR usability) AND (information OR education OR advice OR knowledge OR promotion OR Health) AND (internet OR web OR ehealth OR “e-health” OR website OR Web site OR www)). The results encompassed 5365 abstracts. We found a literature review of this volume required more generous number of resources and more time than were available to us. The second reason was that the research literature contained viewpoints of varying validity ranging from conceptual or futuristic visions to the findings of studies with rigorous methodologies. This variety compels a requirements engineer to appraise and rank the requirements viewpoints based on some explicit criteria. Creating such appraisal criteria was beyond the scope of our framework. Nonetheless, we strove to compare our results to several relevant studies in our discussions of answers to the research questions.

We limited our variability analysis scale to a simple three-level scale (-1, 0, +1). We used this scale to classify all the requirement viewpoints into three explicit classes: opposing, neutral, or supporting. In addition, we compromised the five-level rating for consistency. One may argue that real world viewpoints do not often fit such an abstract scale and usually involve a great deal of fuzziness, ambiguity and uncertainty. This is absolutely correct. However, we would argue that requirements engineering is principally sought to resolve such human-nature issues by some reasonable abstraction, so that the results would be usable, for instance, by a Web page designer who would be free to include some and exclude some others. Therefore, the discussion should rather focus on the choice of abstraction levels; the more there are, the better they represent the original viewpoints. We chose three for the convenience and simplicity of the analysis efforts required. We also believe that the traceability and updateability features of our framework allow a subsequent investigator to revise the analysis methods by being able to access the original viewpoints and the associations made anytime throughout the lifecycle of an application.

Another limitation may concern the scalability of the approach we demonstrated in this dissertation. Due to our limited access to commercial applications allowing Topic Map development, we compromised our requirements representation to include a combination of manual and automated data analysis methods using Microsoft Access and Excel. One may argue that there is no evidence that such methods could apply to larger knowledge requirements engineering projects. We have two rationales to believe otherwise. First, our framework is based on Topic Map and RDF as the current top Web-based knowledge representation languages. Both of these languages are designed to virtually organize and map the entire Web knowledge. We have not come across any proof regarding a limitation of this technology in terms of handling topics and associations. Second, in our research, we gathered a large volume of viewpoints (74 distinct sources) that was enormous when compared to many of the requirements engineering approaches reported in the current literature. For the health topics alone, we collected approximately 600 related viewpoints. Therefore, we believe that the framework demonstrated, even if only applicable to projects of the same scale, can still contribute to a broad range of eHealth application design projects.

Furthermore, we agree that, as Petrasch (1999) suggests, requirements specifications in general should not only list the elements and characteristics of quality design to be included, but also emphasize the characteristics of non-requirements, whose absence is vital for quality to happen. Although our framework was open to both positive and negative suggestions, our selection of the sources for normative needs was biased toward sources of quality design - the exemplar Web sites. Therefore, we could not have elicited the elements of content that impede quality, such as advertisements. Further research is required to evaluate the impact of such potential shortcomings.

Finally, the methodology we presented in our research design was a compromised version of a full TDM-KREM framework aimed principally at answering the research questions we asked. Therefore, there were a variety of minor limitations due to unavailability of resources and time constraints. For instance, our study was limited by the fact that only one requirements engineer performed all the viewpoint transformation, approximation, and aggregation, all of which can be affected by the level of skills of the human researcher performing them. Another example was our decision to ignore a portion of the qualitative data we collected throughout the study. For instance, we could analyze the verbal viewpoints of the subjects when they were searching for quality health Web sites, or we could evaluate the Web pages they designed during the co-design tasks for additional elements. In all the cases, we strove to minimize the potential effects on the quality of our research.

Chapter 8: Conclusions

> *There are two main strategies we can adopt to improve the quality of life. The first is to try making external conditions match our goals. The second is to change how we experience external conditions to make them fit our goals better.*
>
> Mihaly Csikszentmihalyi, 1990

This chapter provides some conclusive notes, an overview of the contributions made by this dissertation, and some recommendations for future research.

8.1 Concluding Summary

In this research, we emphasized the role of health informaticians as health knowledge requirements engineers and proposed a telescopic dynamic metadata-based knowledge requirements engineering methodology (TDM-KREM) to be used as a basis for related research and practices. The framework proposed in this dissertation enables a multi-viewpoint elicitation, analysis and aggregation of knowledge requirements in such a way that a balanced view of the knowledge stakeholders' viewpoints is captured and included in the final reasoning of the requirements specifications. In addition, the framework is based on the latest metadata-based models of knowledge representation on the Web, Topic Map, and RDF to ensure the universal usability of the requirements knowledge. This choice of knowledge representation enables traceability of the requirements specified by associating them with their supporting viewpoints in a transparent chain of associations. In addition, the cardinality and temporality features of viewpoint and association enable regular updates of the knowledge requirement allowing such procedure to be pursued throughout the lifecycle of the knowledge-intensive application.

We also evaluated the TDM-KREM framework through a four-phase study design during which we demonstrated the practicality and effectiveness of our framework in specifying the knowledge elements and topics of student health Web sites. The results showed that the knowledge elements and health topics specified using the TDM-KREM framework did match those of the primary users' preferences very strongly. Our findings also proved that such elements, if used as basis to index and retrieve online health resources, could help users choose the resources that actually match their interests. Finally, our data showed that such a set of specifications (CHEKES-III), if used in a design of a knowledge-intensive eHealth applications, for example a health Web site, could result in the satisfaction of the application users.

8.2 Contributions to Knowledge

The research we presented in this dissertation has made several contributions to the field of health informatics, health promotion, and requirements engineering.

8.2.1 Health informatics

1. **A Knowledge requirements engineering framework**: Building knowledge artifacts is a foundational task in health informatics. However, as Musen (2002) emphasizes, original methodologies are missing in the field of health informatics to address its particular needs. Our research has made methodological contributions to the field of health informatics in that it expanded the scope of requirements engineering to the field of knowledge and knowledge artifact design. The methodology proposed in this dissertation can be used as the basis to practice requirements engineering in two practical ways:
    a. A health informatician can use the data set defined in this dissertation for viewpoints, associations and sources as a basis to build a relational requirements database. He then can follow the procedure we demonstrated in this dissertation to identify the sources, elicit the viewpoints, analyze them, and to specify the knowledge requirements.
    b. In a more sophisticated way, one can start building requirements database by using a Topic Map editor (e.g., Ontopia Omnigator at www.ontopia.net/omnigator). In this case, the topics and association roles defined in this dissertation can be easily adopted to build a Topic Map directly on the Web. This would allow a team of knowledge researchers/developers to specify knowledge requirements for a particular context remotely, collaboratively, and over time.
2. **A methodology to build quality assessment criteria to assess online health resources**: In Chapter 1, we pointed to a shortcoming of the existing quality criteria lacking evidence of support from the related stakeholders. In this dissertation, we demonstrated that quality criteria (as an element set) can be built using the framework proposed in such a way that each element could be rooted to its supporting viewpoints. We also showed that the rationale used to substantiate the inclusion of each element would guarantee its acceptance by the Primary Users. Therefore, the investigators can confidently adopt our methodology to build new quality elements that are usable and useful for a wide spectrum of users.

3. **Delivering a quality element and topic set**: This dissertation has delivered an element and topic set that was comparable to the prominent elements of quality available across the literature. A superior feature of the element (and topic) set developed is that it includes content comprehension elements that help the users understand the knowledge provided more effectively. For instance, our results specified Frequently Asked Questions as a knowledge element that can boost comprehension of knowledge content in a health Web page. In addition, the element set produced included health topics, the inclusion of which was found crucial for the primary target users. Therefore, the research made a contribution by expanding the notion of quality knowledge element set to include topics and content comprehension elements. More particularly, the element set can be used as a basis to direct further design of health knowledge content targeting adolescent consumers or more specifically university students.
4. **Introducing new scales**: This dissertation has introducing two scales,
    a. a four-factor scale (Importance, Usefulness, Effect on Credibility, and overall interest) to evaluate knowledge elements and
    b. another four-factor scale (Relevance, Trustworthiness, Overall Quality, and Desire to Click) to evaluate the result of an health resource index.

   We measured the reliability of both scales and found both reliable. Therefore, this research has provided health informaticians with tools to reliably evaluate the inclusion of any knowledge element (into an application content) or the quality of an online resource index (such as a health search engine).
5. **Practical examples of quality improvement**: this research demonstrated two practical examples of quality improvement based on quality elements specified,
    a. improving quality of an exemplar search engine (Google) by using a selected set of specified knowledge elements, and
    b. improving quality of two exemplar health Web sites (Teen Health and University of Ottawa Health Web Site).

In both case, we measured the compared improvement perceived by the primary users of such application throughout an experimental design. Throughout the experiment, we endeavored to minimize the cross-effects of other application variables such as software or graphical features by using a generic template for all. We also kept the subjects (Evaluation Group) blind in terms of differentiating the modified from original application. The result in both cases showed significant improvement. Therefore, this research contributes to the field of eHealth application design in two ways: First, it indicates a positive relationship between the use of evidence-based knowledge elements (specified using the proposed framework) and the significant improvement achieved. Second, it demonstrates how such achievements can be made in a research lab with limited funding and in the short term.

8.2.2 Health Promotion/Education

1. **Effective health information tailoring methodology**: Our research has provided a knowledge provision framework that is based on the existing models of health behaviour change. Using this framework, health educators and health promotion researchers could reasonably specify not only the health topics of high interests to health consumers, but also the exact elements of knowledge the users prefer. Such tailoring of health knowledge would be expected then to boost awareness and behavior change, the two goals of health promotion.

2. **Specifying the health knowledge needs of adolescent consumers**: This dissertation has particularly specified the knowledge elements and topics of preference by adolescent consumers. The results are significant in two ways:

    a. This research highlights the particular health knowledge needs of adolescent consumers in a ranked element set. For instance, it shows that Sexual Health and Mental/Emotional Health and their subtopics are the most important topics for this group. Such ranking helps the health educators in the community to prioritize their resources. In addition, the ranked list emphasizes the fact that such ranking may evolve over time and thus should be updated often to address the most current knowledge needs of such consumer groups.

b. The research has delivered an element and topic set which have been supported by a variety of viewpoints regarding the knowledge needs of adolescent consumers. The results also showed satisfaction of the primary users with the final specification. There are two particular contributions here. The research substantiated that an early inclusion of the normative viewpoints is necessary for an effective tailoring of requirements. Our results showed that many elements of the final specifications were only suggested by the normative viewpoints. However, the research showed that the viewpoints of adolescent consumers are particularly important in sorting and filtering such viewpoints and direct the specifications to match their preferences.

8.2.3 Software/Requirements Engineering

1. **Software Engineering and quality design**: The fact that every software design must accommodate viewpoints of its stakeholders is unquestionable. Every software designer may claim that he or she consulted at least one of the stakeholders in the particular context of software he or she designs. However, this research particularly emphasized the totality of requirements viewpoints being crucial to achieve quality. We emphasized and accommodated three aspects of viewpoints to achieve totality in our proposed framework:

    a. diversity of the individuals being consulted which must represent the entire spectrum of stakeholders relevant to the software,

    b. quantity of representatives for every type of stakeholders, which must be determined based on their level of influence or use, and

    c. evidence from exemplar examples of software that represent the viewpoints of related stakeholders for competition software in a holistic view.

We also demonstrated the empirical achievement of quality software as result of such accommodation. We therefore believe that such a framework can be used as a basis for further quality design. Furthermore, our research advances the new field of evidence-based software engineering (Kitchenham, Dyba et al., 2004; Dyba, Kitchenham et al., 2005). Evidence-based software engineering (EBSE) encourages evidential design, which was also a focus in this research. We believe that this dissertation can address the main shortcoming of the EBSE approach, which was lack of a practical methodology.

2. **Advancing viewpoint-based requirements engineering methods**: The research has made contributions to the field of requirements engineering in that it advances the current framework of viewpoint-based requirements engineering. The contributions are particular in the following areas:
    a. The research introduced and demonstrated the use of Web-based metadata (particularly Topic Map) in requirements representation and analysis. The use of Web-based metadata enables:
        i. convenient management of requirements data in a broad variety of applications supporting markup language (such as XML editors),
        ii. rationality and transparency of the requirements transformation and reasoning, and
        iii. accommodation of requirements change.
    b. This dissertation introduced the notion of dated & ranked requirements specifications. The proposed framework annotates every requirement with two stamps, a dynamic score that represents its latest level of supporting viewpoints, and the last update, which is the date the requirements specifications were last updated. This not only helps a requirements engineer to monitor the evolving value of each requirement but also allows him or her to set an expiry date for every specified requirement, so that the old requirements are flagged to be examined for their continued validity.

3. **Inform quality Web design**: The proposed framework can now be used by organizations, authorities, and individuals considering the design or adoption of a Web-based knowledge provision/education application. The methodology proposed in this dissertation can help them select the most suitable set of knowledge for their audience. The evaluation approach demonstrated in this research can also be employed by developers of informational/educational Web sites to discover the relative strengths and weaknesses of the knowledge content they provide, in terms of supporting viewpoints, and as compared to competing designs.

8.3 Future Research

Future research is recommended in the following areas:

1- **A comprehensive knowledge elements study**: The scope of research we presented in this dissertation was limited to determine the need for presence or absence of some knowledge elements. However, users' input could be sought to identify their specific preferences regarding the quality of information associated with each element. For example, as we demonstrated in Chapter 7 (Section 7.1.1.1), a complementary element such as Author's Credential could enhance the usability of Author's Name as an element. Therefore, we recommend further research to study the possibilities of other complementary elements that could enhance the specified elements. The results of such research are then expected to inform the knowledge developers not only in terms of WHAT elements to include but also on HOW to include them; so that the results would maximize quality.

2- **A holistic knowledge requirements engineering**: The scope of KIEHA application in this research was limited to the application's knowledge content. However, in reality a KIEHA application such as a health Web site include several other components of design that also directly or indirectly affect the quality of the knowledge presented. For instance, a broad variety of presentation styles, design artifacts, and software features might contribute to overall usability of the content being provided. Hence, research is recommended to expand the scope of the knowledge requirements engineering approach presented in this dissertation to identify and include such factors. Such research is then expected to cover the entire spectrum of the factors that might possibly affect the quality of a KIEHA application and thus achieve a higher level of quality.

3- **Expand the scope of evaluation**: In our evaluation of the design improvements, we focused on the user-perceived measures of quality. The results of such evaluations, even though show user satisfaction, lack several other aspects of quality pursued in standard usability evaluations. For example, although we measured the compared the satisfaction of the subjects with the health topic menu we created, we would need evidence from a usability testing to claim that the topic menu was more efficient, in terms of time taken to find a specific health topic. Prospective researchers are recommended to broaden the scope of evaluation to include comprehensive measurements of content quality (e.g., usability testing).

4- **Knowledge provision to professionals**: Research is recommended to investigate the usability of the proposed framework in the area of knowledge provision to professionals. For example, a researcher may apply the knowledge requirements engineering method we presented in this dissertation to specify the knowledge elements of a generic practical clinical guideline. In addition, such research could also identify the medical topics of high priority by the related professionals and update them over time to address the most current topics. We foresee a clinical guideline designed in such an evidence/viewpoint-based manner to satisfy knowledge needs of the concerning health professionals.

5- **The variation of element and topic set across consumer groups**: The scope of primary users in this research was limited to a consumer group of a particular age and education level. Therefore, the specified element and topic set might not necessarily be generalized to all other groups of consumers. Further research is recommended to study the possible variations of consumer preferences and thus variations of element and topic sets across different consumer groups (e.g., in terms of age and education level). Such research could also examine the possibility of developing a general set that could fulfill the health knowledge needs of public in general.

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Glossary

A/V (As knowledge element)

See Related Media

Accreditation (As knowledge element)

See Quality Seal

Author (As knowledge element)

The individual(s) who created or directly contributed to a Web page's subject-specific content, such as editor(s) or reviewer(s), and even illustrator(s)

Breadcrumb

See Parent Topic

Campus-HITS

Campus Health Information Tailoring Service

CHEKES

Campus-HITS Knowledge Element Set (See also Campus-HITS)

Contact Information (As knowledge element)

Information on how to communicate with the provider of an application for comments, concerns, and questions

Creation Date (As knowledge element)

The date a piece of content, such as a Web page, was first created (also called First Created).

Data

Component of a message e.g., a character, symbol or something that simply exists and has no significance beyond its existence (in and of itself) (See also Information)

eHealth Application

Application providing health services and/or information through the Internet and related technologies

eHealth

A field of health informatics that is closely related to Public Health Informatics and Consumer Health Informatics and concerns health information services provided through the Internet and related technologies

End Users

See Primary Users

FAQ

See Frequently Asked Questions

First Created (As knowledge element)

See Creation Date

Frequently Asked Questions (FAQ) (As knowledge element)

A set of common questions (usually gleaned from the particular audience of a particular Web site) and answers (from the provider or author(s)) with respect to the topic of concern in a Web page

Glossary (As knowledge element)

Any definitional information regarding the terms used within an application content in order to make the content more accessible/understandable to the audience.

Health Promotion/Education

The provision of information and/or education to individuals, families, and communities for the purposes of awareness and to improve their behavior

Health Topic

See Knowledge Topic

HIDDEL

Health Information Disclosure, Description and Evaluation Language

Information

Data that has been given meaning by way of relational connection with other data

KIEHA

Knowledge-intensive eHealth Application

Knowledge

Appropriate human-made collection of information, such that its intent is to be useful (See also Data, Information)

Knowledge Element

Any set of information pieces of an application content that share similar purpose(s). For example, “Provider” as knowledge element refers to any piece of information that identifies the organization, association, company, etc. officially responsible for the content of application (e.g., a Web site) including its purpose.

Knowledge Requirement

Viewpoint of requirements stakeholders regarding the knowledge content of an application

Knowledge Requirements Engineering

A method of requirements engineering that is specialized to specify the knowledge requirements of an application

Knowledge Requirements Specifications

The final set of knowledge requirements (See Knowledge Requirement) selected to be included in an application content.

Knowledge Topic

Any topic of concern in an application content, ranging from main topic categories to subtopics. When health knowledge is the knowledge concern, the knowledge topic is called “health topic.”

Last Update (As knowledge element)

The date a piece of content, such as a Web page, was last modified/updated.

Local Help (As knowledge element)

See Local Services

Local Services (As knowledge element)

Any piece of information within an application content (e.g., a health Web page) on how to find or access local related professional facilities offering relevant services, including the descriptions of the services offered (also called Local Help).

Main User

See Primary User

MedCERTAIN

Certification and Rating of Trustworthy and Assessed Health Information on the Net

MedIEQ

Quality Labeling of Medical Web Content Using Multilingual Information Extraction

Metadata

Data about data or information about information. For instance, the information regarding the author for a piece of content, i.e., Author Information, is a piece of metadata.

NATURE

Novel Approaches to Theories Underlying Requirements Engineering

Online Resources (As knowledge element)

Links to (or information on how to access) other resources offering relevant information

Parent Topic (As knowledge element)

The category that a Web page's title (or topic) belongs to. For example, a Web page with the title or main topic of "How to Prevent STD" belongs to the general category of "Sexually Transmitted Diseases." Parent Topic is also called Breadcrumb or Topic Category.

Primary Users

Individuals who will primarily use an application (also called main user, target users, or end users).

Provider (As knowledge element)

The organization, association, company, etc. officially responsible for the composition and content of an application's, e.g., a Web site

Quality Seal (As knowledge element)

An endorsement of content quality by an external accreditation body, such as a quality logo or a quote of approval

Quality

The totality of features and characteristics of an application that bear on its ability to satisfy stated or implied needs.

QUATRO

Quality Assurance and Content Description project

RDF

Resource Description Framework

Related Media (As knowledge element)

Any type of audio, video, image, or flash file that contains relevant subject-specific content and promotes comprehension of the topic of concern in a Web page

Related News (As knowledge element)

Any piece of information outlining the latest news regarding the topic of concern in a Web page

Related SCS Tools/Guides (As knowledge element)

Any type of self-care tool, such as quizzes, if-then charts, games, and educational media (e.g., picture series, flash-based presentations), that promotes the ability of users to provide self-care or make better-informed decisions about their health.

Related Topics (As knowledge element)

Links to other content pages within the application domain that contains relevant information

Requirement Source

Source of information regarding the viewpoints concerning content or design requirements of an application, such as related individuals, standard documentation, an exemplar application, or literature

Requirements Engineer

Qualified individual(s) who practice(s) requirements engineering

Requirements Engineering

The branch of software engineering concerned with the real world goals for, functions of, and constraints on application/software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior, and to their evolution over time and across application/software families

Requirements Stakeholder

Person or organization who influences or is potentially impacted by an application

Requirements Viewpoint

Expression or statement holding a viewpoint of a requirements source regarding an application design or content

SCS

Self Care Support

Simulated Google

A modified version of Google interface that includes metadata information

SQL

Structured Query Language

Subtopics

See Knowledge Topic, Table of Contents

Table of Contents (As knowledge element)

The set of headings or subtopics the information regarding which are provided within a page of content (as a set of links, buttons, or as a menu)

Target Users

See Primary Users

TDM-KREM

Telescopic Dynamic Metadata-based Knowledge Requirements Engineering Model

Terms (As knowledge element)

Any set of information regarding legal/official disclosure, terms, and notices regarding the content of a Web site/page. It is also used as general term for all related information such as “terms and conditions,” ”privacy policy,” “disclaimer,” “sponsorship,” and “disclosure of purpose.”

Title (As knowledge element)

For an eHealth application, it refers to the title of a content page (or a series of pages). For example, “How to prevent STD” can be a page title for a Sexual Health Web site. The title of a health information Web page refers to or represents the main health topic (See Knowledge Topic) the information regarding which is provided within that page

Topic Category

See Parent Topic

Topic Map

An ISO-certified language to represent the knowledge topics on the Web using three components of Topics, Association, and Occurrence

Update

See Last Update

URI

Universal Resource Identifier

URL

Universal Resource Locator

Viewpoint

See Requirements Viewpoint

WRAPIN

Worldwide online Reliable Advice to Patients and Individuals

XML

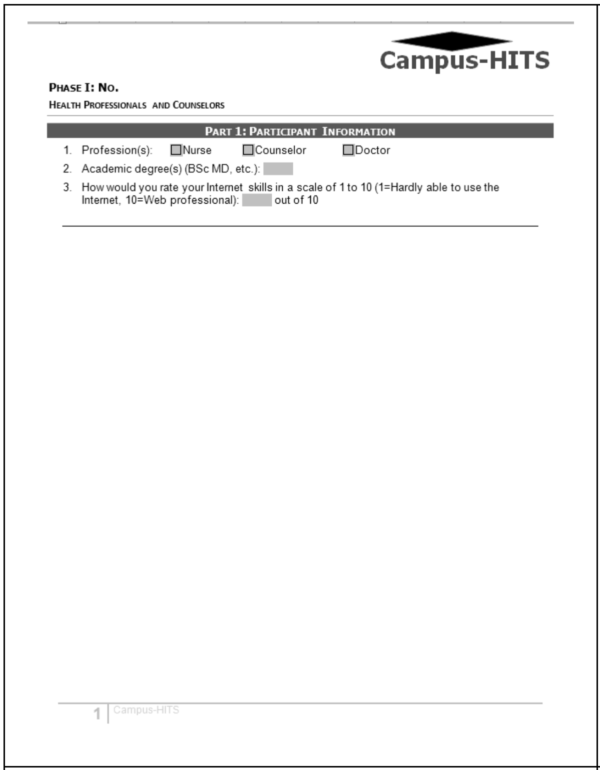
Extensible Markup Language

Appendix

Appendix 1: The list of selected exemplar Web sites (and their URLs for Phase 0)

MedlinePlus	http://www.nlm.nih.gov/medlineplus/sexuallytransmitteddiseases.html
Familydoctor.org	http://familydoctor.org/165.xml#6
MedicineNet	http://www.medicinenet.com/sexually_transmitted_diseases_stds_in_women/article.htm
Mayoclinic	http://www.mayoclinic.com/health/chlamydia/DS00173/DSECTION=1
Teen Health	http://www.kidshealth.org/teen/sexual_health/stds/std.html
Canada Health Portal	http://chp-pcs.gc.ca/CHP/index_e.jsp/pageid/4005/odp/Top/Health/Youth/Sexuality/Sexually_Transmitted_Infections
Health Canada/CHN	http://www.hc-sc.gc.ca/iyh-vsv/diseases-maladies/chlamyd_e.html
BC Health Guide	http://www.bchealthguide.org/kbase/topic/symptom/stdis/cys.htm
Canadian Teen Health	http://www.sexualityandu.ca/teens/sti.aspx
Sexuality and You	http://www.chebucto.ns.ca/health/TeenHealth/sexualhealth/stis/stis.htm
University of Princeton	http://www.princeton.edu/uhs/ih_Q_A_sexual_health.html#sti
Stanford	http://vaden.stanford.edu/library/sexualHealthAndSTIs.html
University of Wisconsin	http://www.uhs.wisc.edu/display_story.jsp?id=681&cat_id=38
University of NY	http://www.nyu.edu/shc/promotion/stis.html
University of Harvard	http://huhs.harvard.edu/HealthInformation/STIs.htm
University of Toronto	http://www.utoronto.ca/health/healthtips/stiinfo/stiinfo.htm
University of McGill	http://www.mcgill.ca/studenthealth/boutique/sti/
University of Ottawa	http://www.uottawa.ca/health/information/sex.html
University of Calgary	http://www.ucalgary.ca/wellnessguide/physical/STI.html
University of Victoria	http://health.uvic.ca/self-help/sexually-transmitted-diseases.html

Appendix 2: Phase 0 Questionnaire for health professionals



Campus-HITS

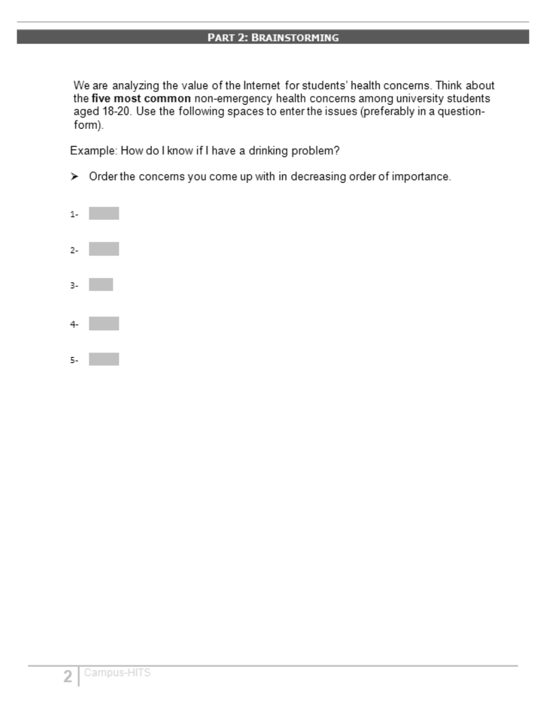
PHASE I: NO.

HEALTH PROFESSIONALS AND COUNSELORS

PART 1: PARTICIPANT INFORMATION

1. Profession(s): ☐Nurse ☐Counselor ☐Doctor
2. Academic degree(s) (BSc MD, etc.):
3. How would you rate your Internet skills in a scale of 1 to 10 (1=Hardly able to use the Internet, 10=Web professional): out of 10

1 Campus-HITS



PART 2: BRAINSTORMING

We are analyzing the value of the Internet for students' health concerns. Think about the **five most common** non-emergency health concerns among university students aged 18-20. Use the following spaces to enter the issues (preferably in a question-form).

Example: How do I know if I have a drinking problem?

➢ Order the concerns you come up with in decreasing order of importance.

1-

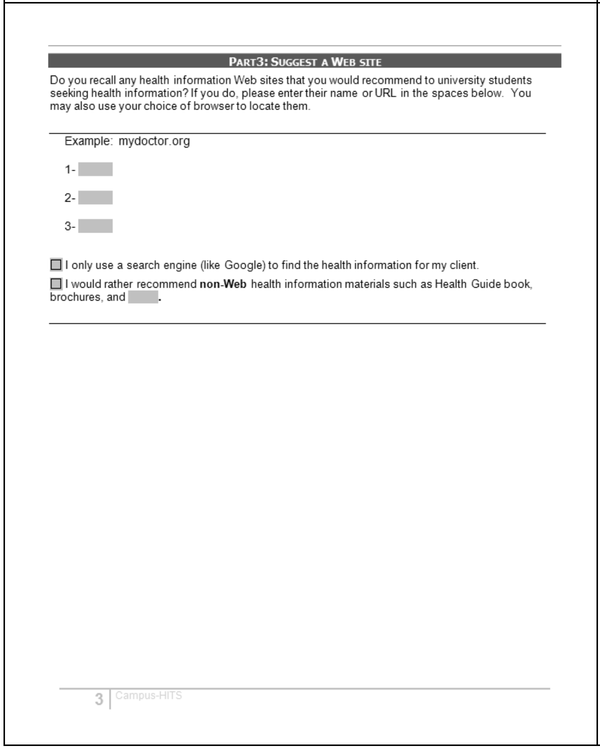
2-

3-

4-

5-

2 Campus-HITS



PART3: SUGGEST A WEB SITE

Do you recall any health information Web sites that you would recommend to university students seeking health information? If you do, please enter their name or URL in the spaces below. You may also use your choice of browser to locate them.

Example: mydoctor.org

1-

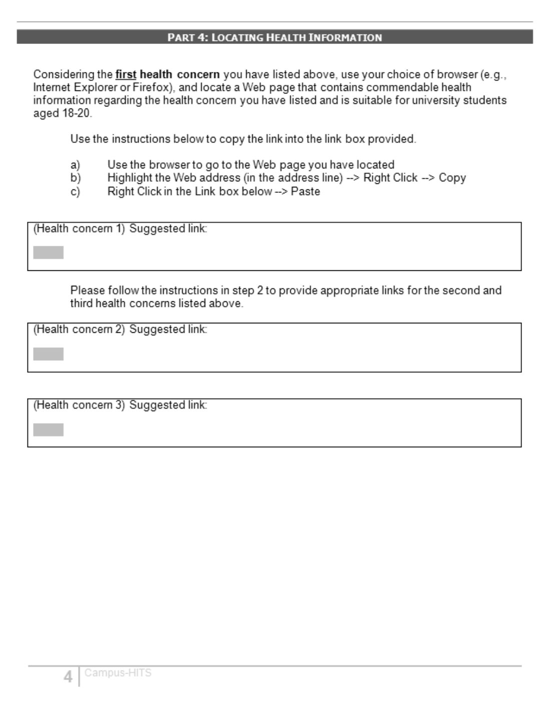
2-

3-

☐ I only use a search engine (like Google) to find the health information for my client.

☐ I would rather recommend **non-Web** health information materials such as Health Guide book, brochures, and **.**

3 Campus-HITS



PART 4: LOCATING HEALTH INFORMATION

Considering the **first health concern** you have listed above, use your choice of browser (e.g., Internet Explorer or Firefox), and locate a Web page that contains commendable health information regarding the health concern you have listed and is suitable for university students aged 18-20.

Use the instructions below to copy the link into the link box provided.

a) Use the browser to go to the Web page you have located
b) Highlight the Web address (in the address line) --> Right Click --> Copy
c) Right Click in the Link box below --> Paste

(Health concern 1) Suggested link:

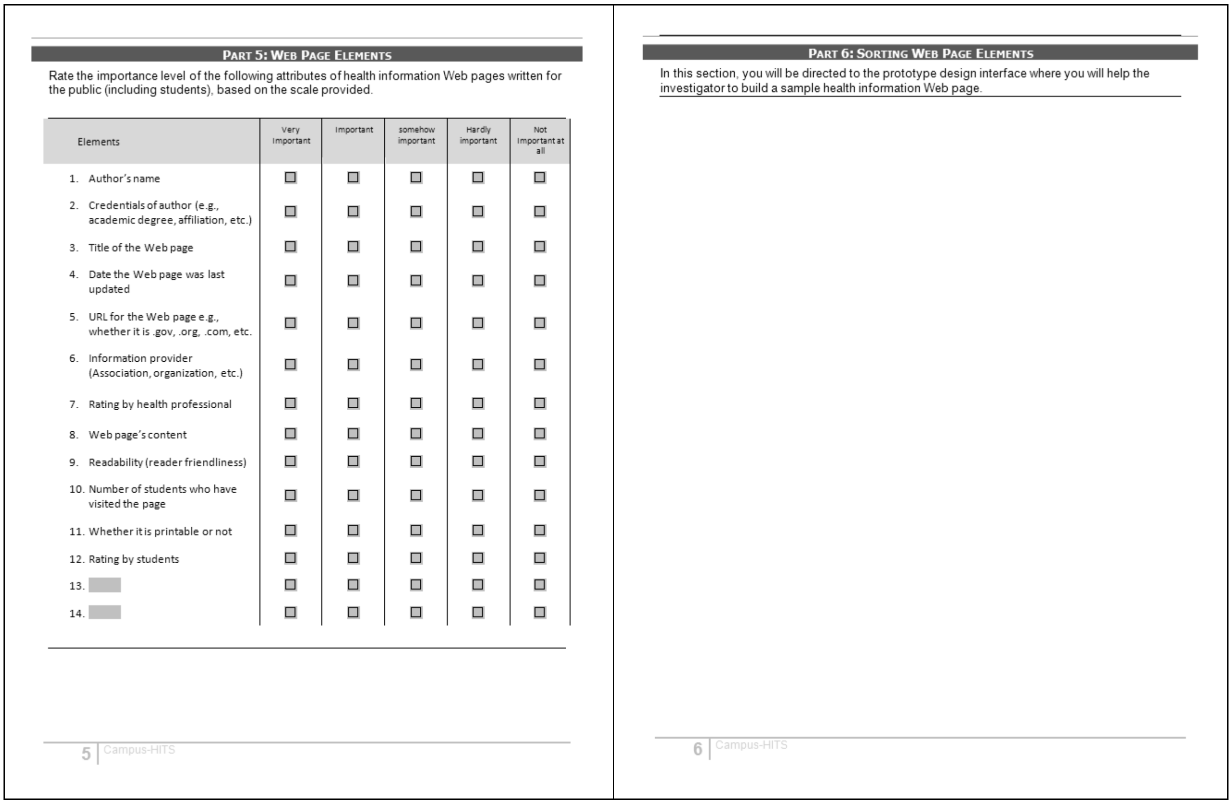
Please follow the instructions in step 2 to provide appropriate links for the second and third health concerns listed above.

(Health concern 2) Suggested link:

(Health concern 3) Suggested link:

4 Campus-HITS

Appendix 2- continued



PART 5: WEB PAGE ELEMENTS

Rate the importance level of the following attributes of health information Web pages written for the public (including students), based on the scale provided.

Elements	Very Important	Important	somehow important	Hardly important	Not Important at all
1. Author's name	☐	☐	☐	☐	☐
2. Credentials of author (e.g., academic degree, affiliation, etc.)	☐	☐	☐	☐	☐
3. Title of the Web page	☐	☐	☐	☐	☐
4. Date the Web page was last updated	☐	☐	☐	☐	☐
5. URL for the Web page e.g., whether it is .gov, .org, .com, etc.	☐	☐	☐	☐	☐
6. Information provider (Association, organization, etc.)	☐	☐	☐	☐	☐
7. Rating by health professional	☐	☐	☐	☐	☐
8. Web page's content	☐	☐	☐	☐	☐
9. Readability (reader friendliness)	☐	☐	☐	☐	☐
10. Number of students who have visited the page	☐	☐	☐	☐	☐
11. Whether it is printable or not	☐	☐	☐	☐	☐
12. Rating by students	☐	☐	☐	☐	☐
13.	☐	☐	☐	☐	☐
14.	☐	☐	☐	☐	☐

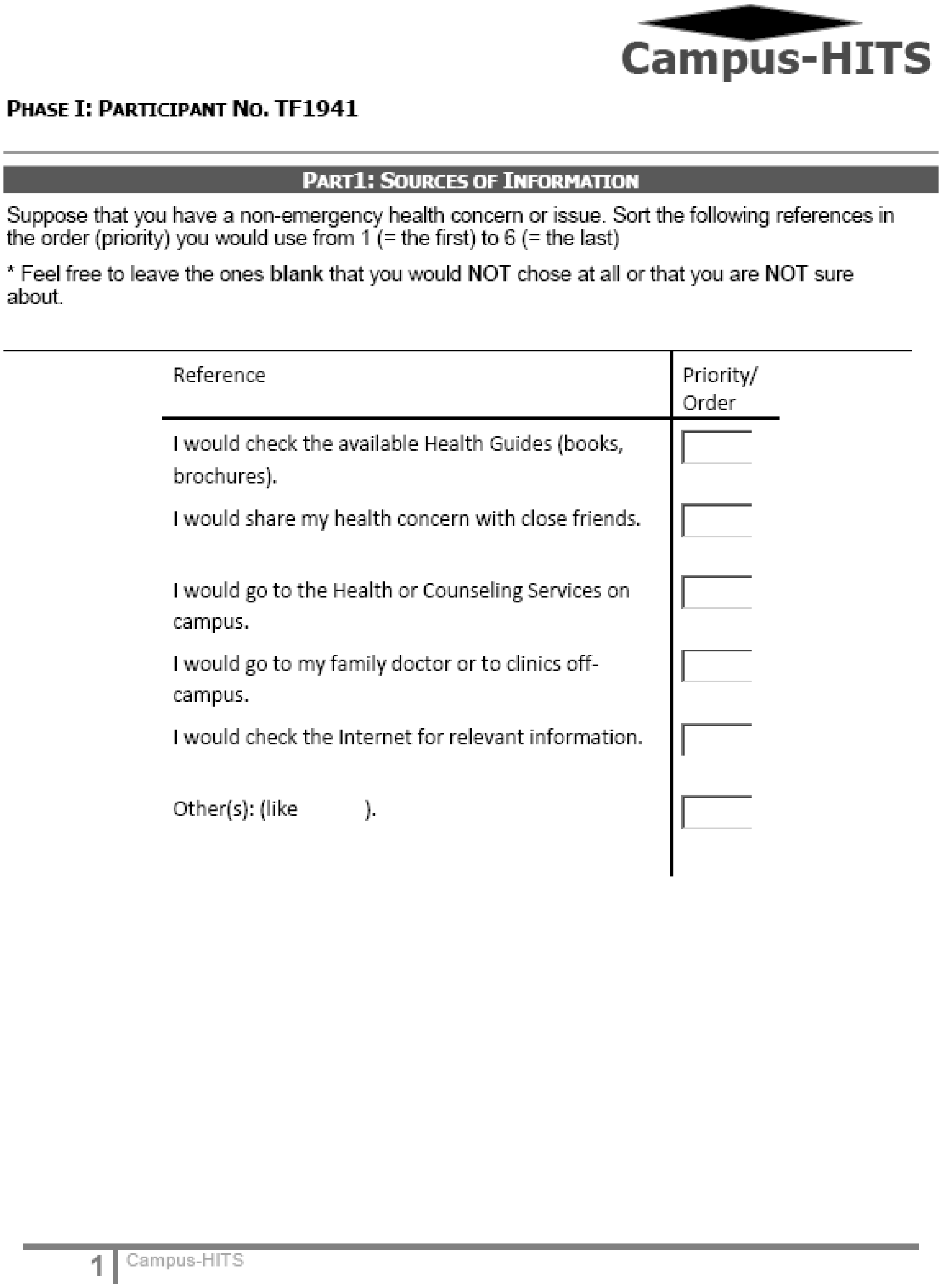
5 Campus-HITS

PART 6: SORTING WEB PAGE ELEMENTS

In this section, you will be directed to the prototype design interface where you will help the investigator to build a sample health information Web page.

6 Campus-HITS

Appendix 3: Phase 1 Questionnaire for Student Participants



Campus-HITS

PHASE I: PARTICIPANT NO. TF1941

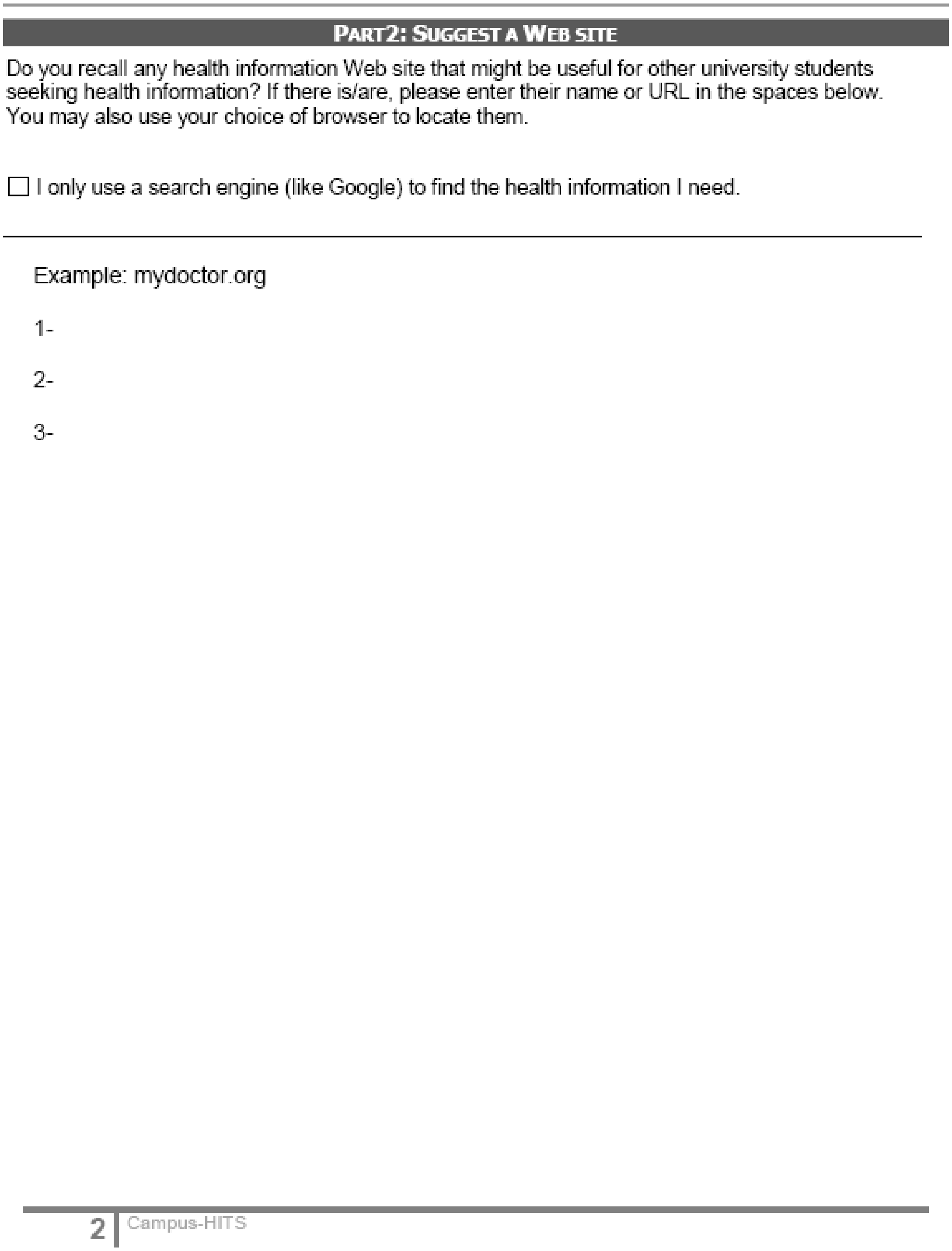
PART1: SOURCES OF INFORMATION

Suppose that you have a non-emergency health concern or issue. Sort the following references in the order (priority) you would use from 1 (= the first) to 6 (= the last)

* Feel free to leave the ones **blank** that you would **NOT** chose at all or that you are **NOT** sure about.

Reference	Priority/ Order
I would check the available Health Guides (books, brochures).	☐
I would share my health concern with close friends.	☐
I would go to the Health or Counseling Services on campus.	☐
I would go to my family doctor or to clinics off-campus.	☐
I would check the Internet for relevant information.	☐
Other(s): (like).	☐

Appendix 3- continued



PART2: SUGGEST A WEB SITE

Do you recall any health information Web site that might be useful for other university students seeking health information? If there is/are, please enter their name or URL in the spaces below. You may also use your choice of browser to locate them.

☐ I only use a search engine (like Google) to find the health information I need.

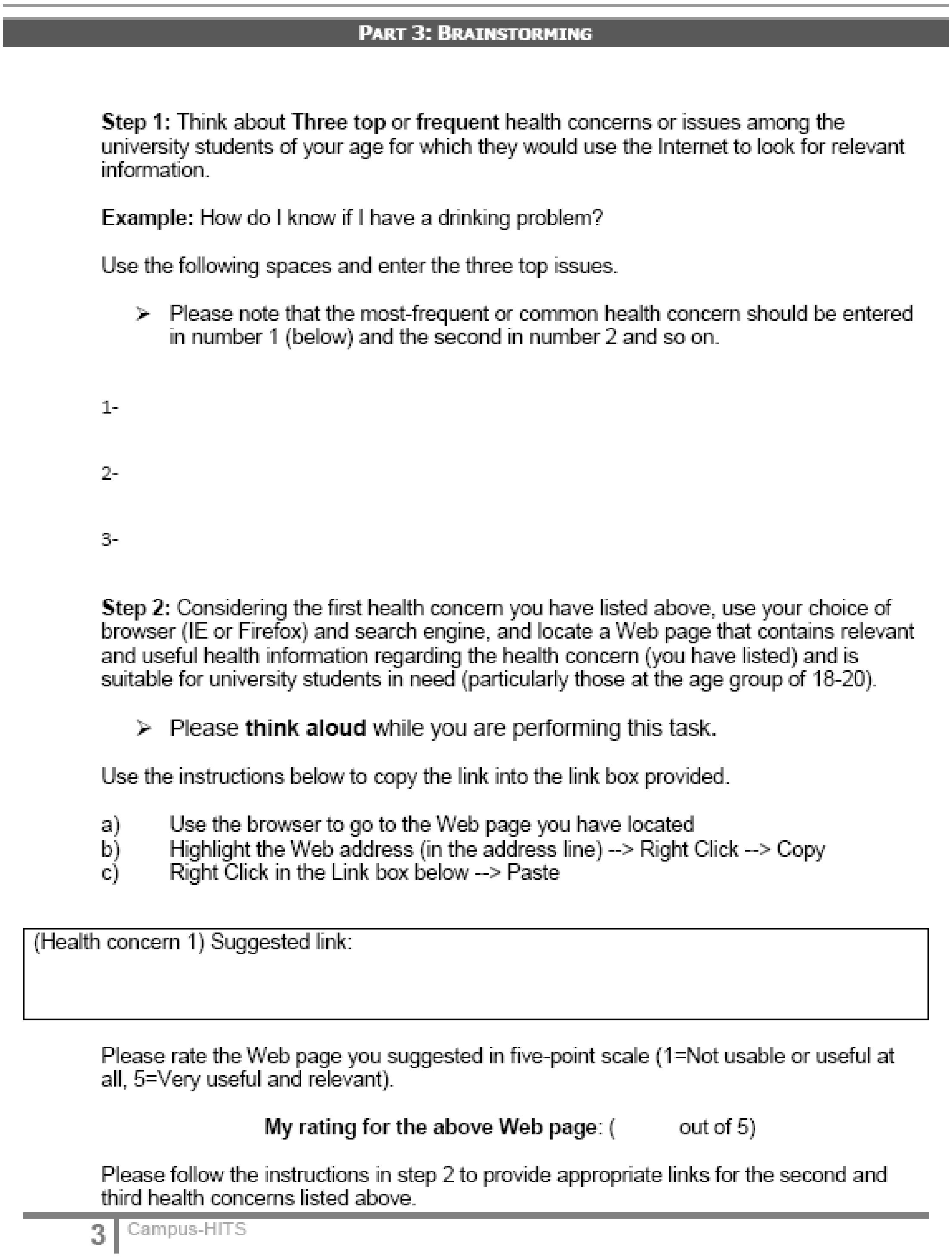
Example: mydoctor.org

1-

2-

3-

Appendix 3- continued



PART 3: BRAINSTORMING

Step 1: Think about **Three top** or **frequent** health concerns or issues among the university students of your age for which they would use the Internet to look for relevant information.

Example: How do I know if I have a drinking problem?

Use the following spaces and enter the three top issues.

- Please note that the most-frequent or common health concern should be entered in number 1 (below) and the second in number 2 and so on.

1-

2-

3-

Step 2: Considering the first health concern you have listed above, use your choice of browser (IE or Firefox) and search engine, and locate a Web page that contains relevant and useful health information regarding the health concern (you have listed) and is suitable for university students in need (particularly those at the age group of 18-20).

- Please **think aloud** while you are performing this task.

Use the instructions below to copy the link into the link box provided.

a) Use the browser to go to the Web page you have located
b) Highlight the Web address (in the address line) --> Right Click --> Copy
c) Right Click in the Link box below --> Paste

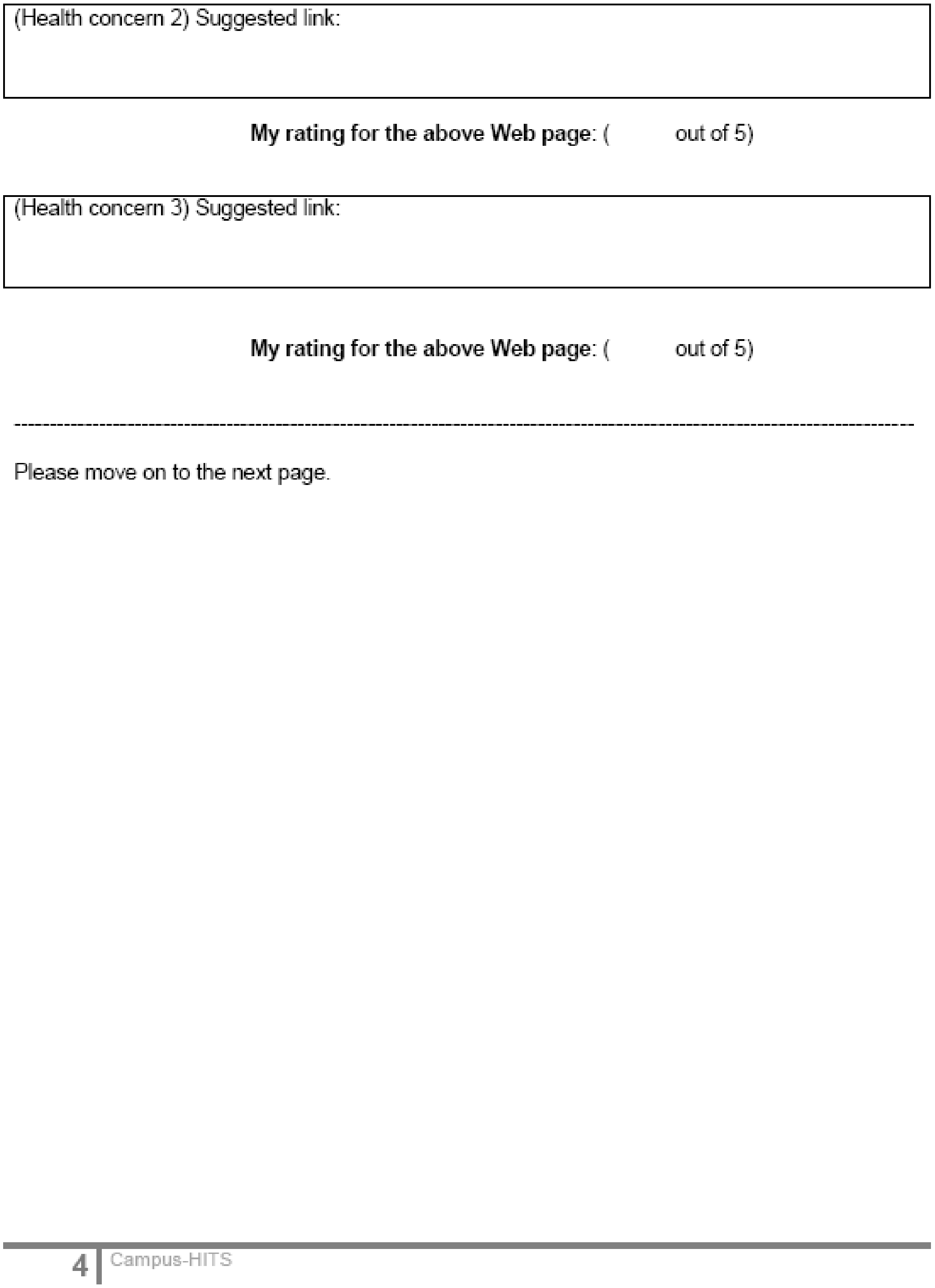
(Health concern 1) Suggested link:

Please rate the Web page you suggested in five-point scale (1=Not usable or useful at all, 5=Very useful and relevant).

My rating for the above Web page: (out of 5)

Please follow the instructions in step 2 to provide appropriate links for the second and third health concerns listed above.

Appendix 3- continued



(Health concern 2) Suggested link:

My rating for the above Web page: (out of 5)

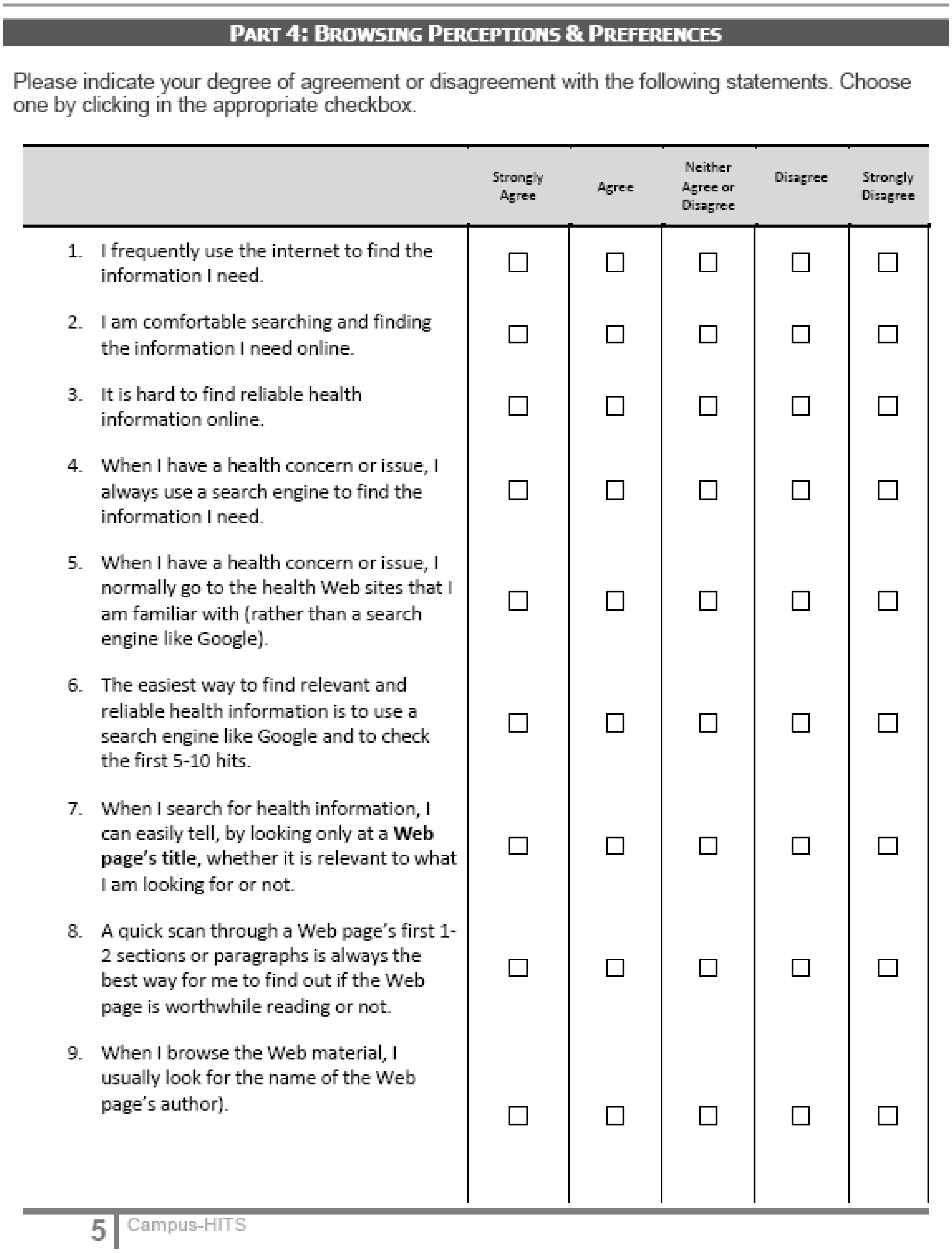
(Health concern 3) Suggested link:

My rating for the above Web page: (out of 5)

Please move on to the next page.

4 Campus-HITS

Appendix 3- continued

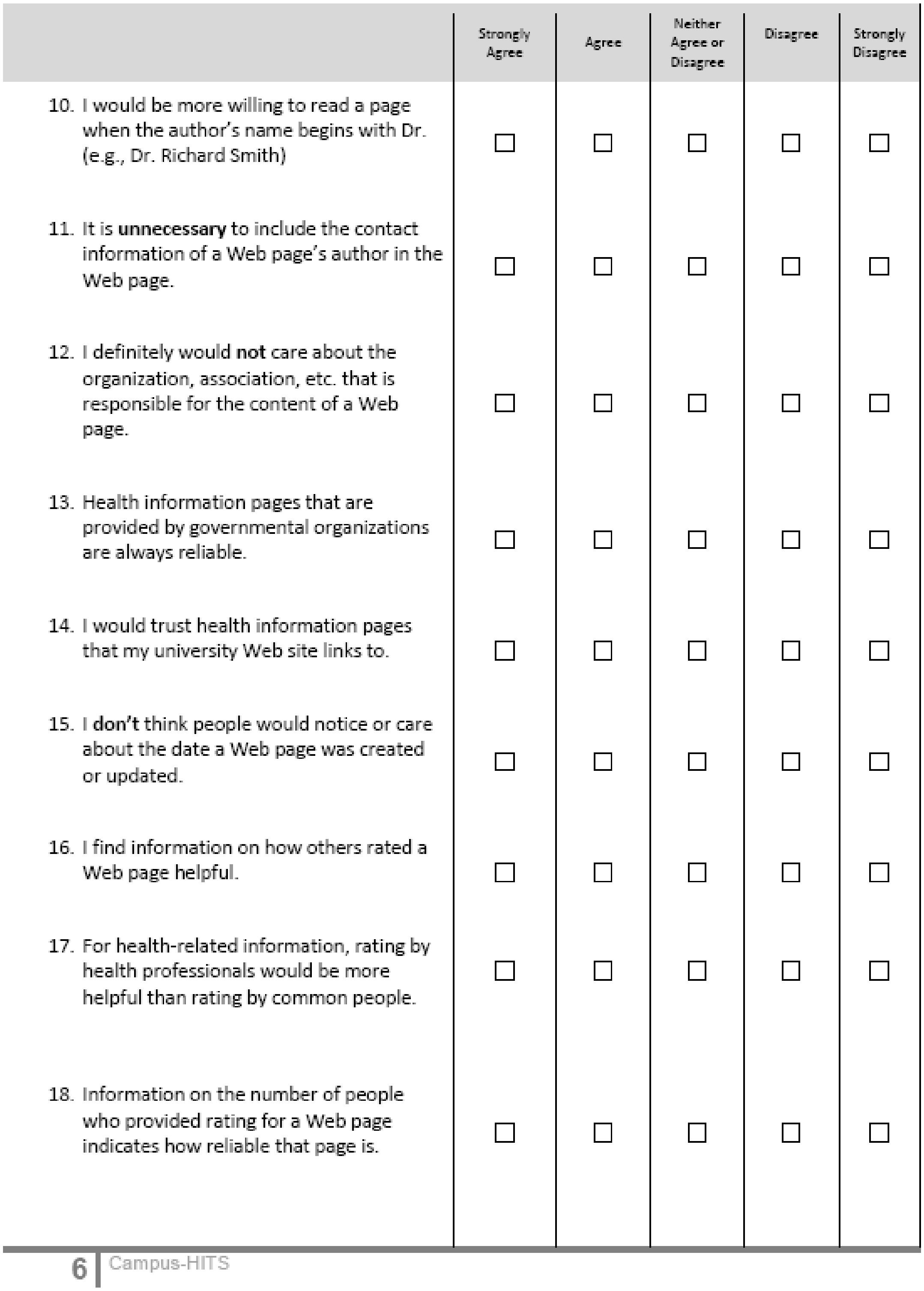


PART 4: BROWSING PERCEPTIONS & PREFERENCES

Please indicate your degree of agreement or disagreement with the following statements. Choose one by clicking in the appropriate checkbox.

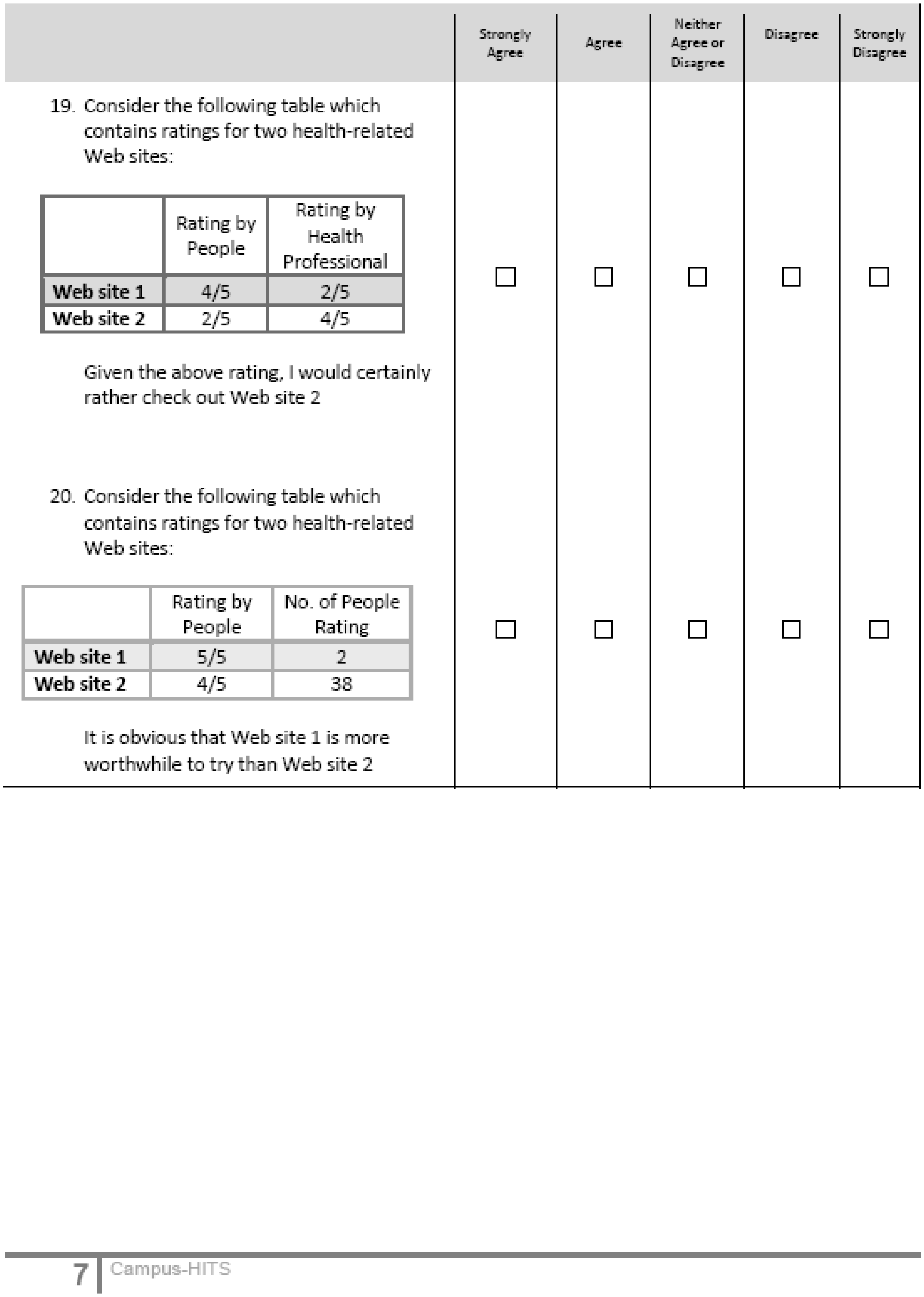
	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
1. I frequently use the internet to find the information I need.	☐	☐	☐	☐	☐
2. I am comfortable searching and finding the information I need online.	☐	☐	☐	☐	☐
3. It is hard to find reliable health information online.	☐	☐	☐	☐	☐
4. When I have a health concern or issue, I always use a search engine to find the information I need.	☐	☐	☐	☐	☐
5. When I have a health concern or issue, I normally go to the health Web sites that I am familiar with (rather than a search engine like Google).	☐	☐	☐	☐	☐
6. The easiest way to find relevant and reliable health information is to use a search engine like Google and to check the first 5-10 hits.	☐	☐	☐	☐	☐
7. When I search for health information, I can easily tell, by looking only at a **Web page's title**, whether it is relevant to what I am looking for or not.	☐	☐	☐	☐	☐
8. A quick scan through a Web page's first 1-2 sections or paragraphs is always the best way for me to find out if the Web page is worthwhile reading or not.	☐	☐	☐	☐	☐
9. When I browse the Web material, I usually look for the name of the Web page's author).	☐	☐	☐	☐	☐

Appendix 3- continued



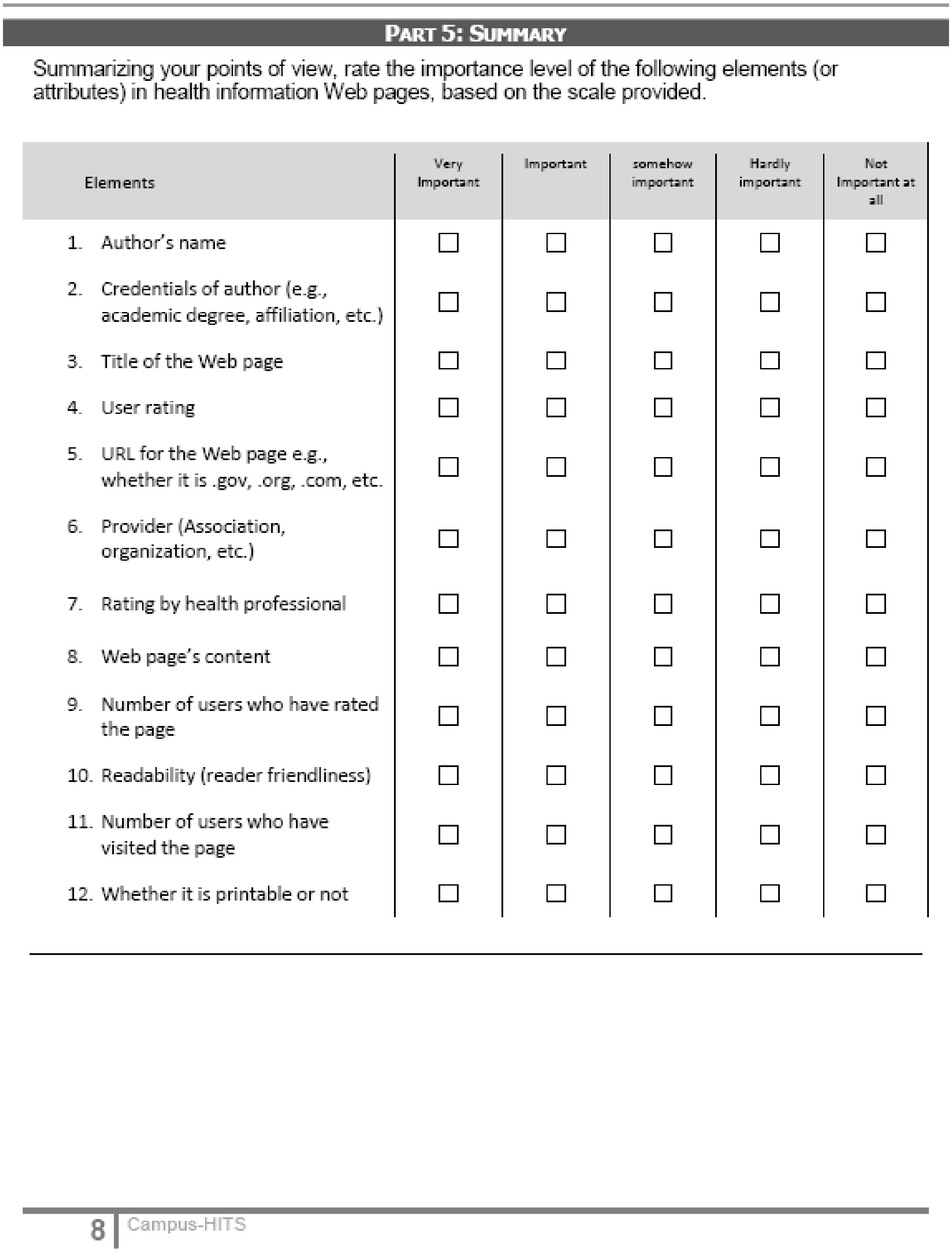
	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
10. I would be more willing to read a page when the author's name begins with Dr. (e.g., Dr. Richard Smith)	☐	☐	☐	☐	☐
11. It is **unnecessary** to include the contact information of a Web page's author in the Web page.	☐	☐	☐	☐	☐
12. I definitely would **not** care about the organization, association, etc. that is responsible for the content of a Web page.	☐	☐	☐	☐	☐
13. Health information pages that are provided by governmental organizations are always reliable.	☐	☐	☐	☐	☐
14. I would trust health information pages that my university Web site links to.	☐	☐	☐	☐	☐
15. I **don't** think people would notice or care about the date a Web page was created or updated.	☐	☐	☐	☐	☐
16. I find information on how others rated a Web page helpful.	☐	☐	☐	☐	☐
17. For health-related information, rating by health professionals would be more helpful than rating by common people.	☐	☐	☐	☐	☐
18. Information on the number of people who provided rating for a Web page indicates how reliable that page is.	☐	☐	☐	☐	☐

Appendix 3- continued



<table>
<tr><th></th><th>Strongly Agree</th><th>Agree</th><th>Neither Agree or Disagree</th><th>Disagree</th><th>Strongly Disagree</th></tr>
<tr><td>19. Consider the following table which contains ratings for two health-related Web sites:
<table>
<tr><th></th><th>Rating by People</th><th>Rating by Health Professional</th></tr>
<tr><td>Web site 1</td><td>4/5</td><td>2/5</td></tr>
<tr><td>Web site 2</td><td>2/5</td><td>4/5</td></tr>
</table>
Given the above rating, I would certainly rather check out Web site 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>20. Consider the following table which contains ratings for two health-related Web sites:
<table>
<tr><th></th><th>Rating by People</th><th>No. of People Rating</th></tr>
<tr><td>Web site 1</td><td>5/5</td><td>2</td></tr>
<tr><td>Web site 2</td><td>4/5</td><td>38</td></tr>
</table>
It is obvious that Web site 1 is more worthwhile to try than Web site 2</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
</table>

Appendix 3- continued



PART 5: SUMMARY

Summarizing your points of view, rate the importance level of the following elements (or attributes) in health information Web pages, based on the scale provided.

Elements	Very Important	Important	somehow important	Hardly important	Not Important at all
1. Author's name	☐	☐	☐	☐	☐
2. Credentials of author (e.g., academic degree, affiliation, etc.)	☐	☐	☐	☐	☐
3. Title of the Web page	☐	☐	☐	☐	☐
4. User rating	☐	☐	☐	☐	☐
5. URL for the Web page e.g., whether it is .gov, .org, .com, etc.	☐	☐	☐	☐	☐
6. Provider (Association, organization, etc.)	☐	☐	☐	☐	☐
7. Rating by health professional	☐	☐	☐	☐	☐
8. Web page's content	☐	☐	☐	☐	☐
9. Number of users who have rated the page	☐	☐	☐	☐	☐
10. Readability (reader friendliness)	☐	☐	☐	☐	☐
11. Number of users who have visited the page	☐	☐	☐	☐	☐
12. Whether it is printable or not	☐	☐	☐	☐	☐

Appendix 3- continued

PART 6: POSTINGS

Please read the following story and follow the instructions:

In Summer 2006, a UVic student decided to create a Web site (i.e., a Weblog) for students to allow them to post and share their cool and useful health-related links (to Web pages, audio/video, animation and other types of resources). He also wanted everyone to write the description in such a way that other students would be encouraged to click on the link and check it out. And, to make it more interactive, he planned to add a rating feature so that all students and also the doctors/nurses/counselors on campus could rate the posted links.

The following is one of the postings. Please take the time to read through the posting. After you are done, proceed to the next section.

Enjoy the party and get back home safe

This is a great page. It has a calculator that you can use it to estimate just how little alcohol (e.g., in a party) it takes to put you on the "wrong side of the law". It is reliable because it is provided by the police department at the University of Oklahoma. Anyway, if you want to enjoy your party without being caught by the Friday night cops or if you care about your health or safety, use this calculator. It has also lots of other cool stuffs about BAC (blood alcohol content) such as how you would expect to feel or what would be happening in your body if you are on a certain level of BAC.
By the way, just read the first two sections, the rest are useless. This page is easy to read and I found the content very useful, at least to me.

Posted by Julia on Sept. 23, 2006

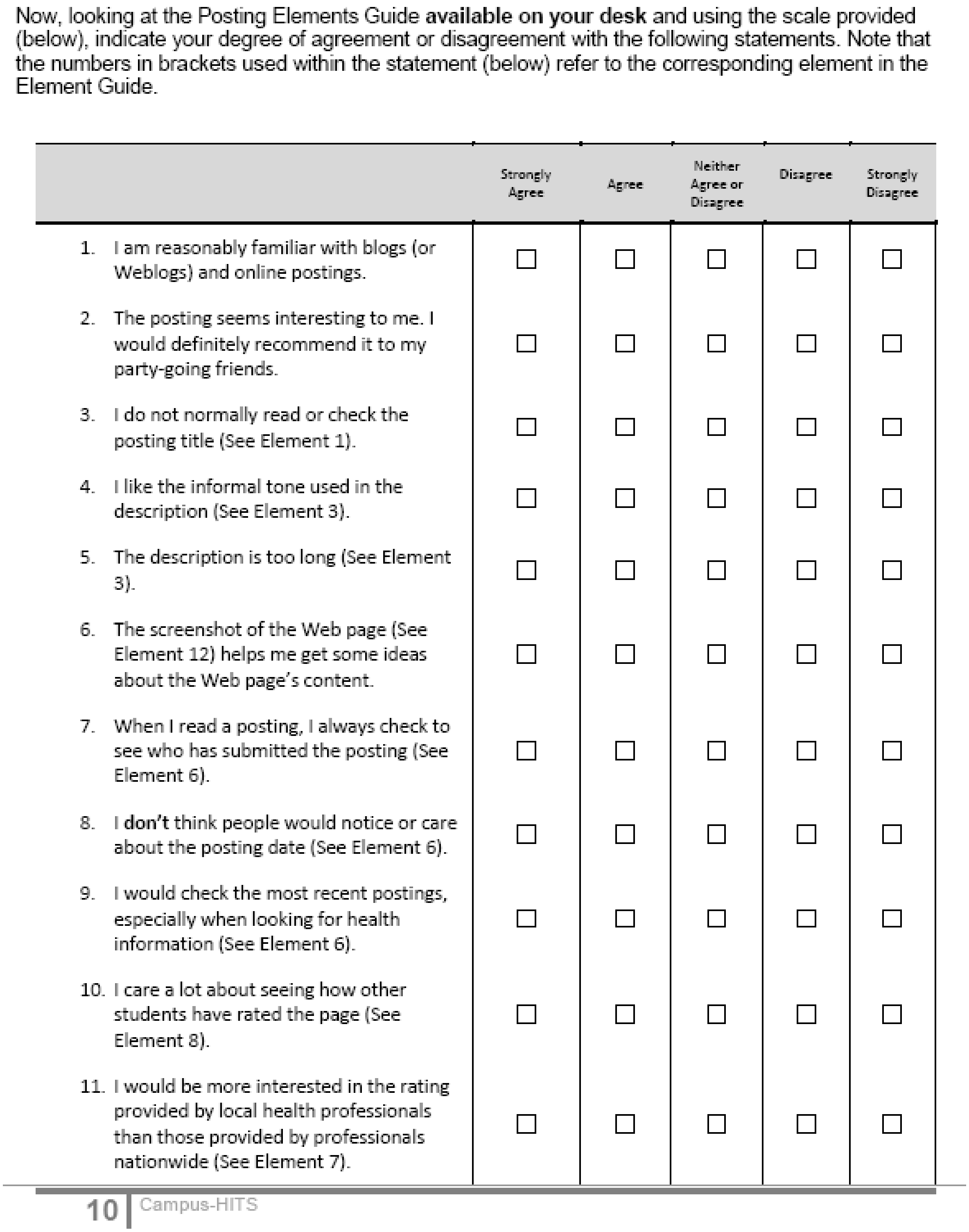
Rating by students: ★★★★⯪ (67 ratings)

Rating by health professionals: ★★⯪☆☆ (8 ratings)

How much is too much?

Author: Richard M. Hamilton

Appendix 3- continued

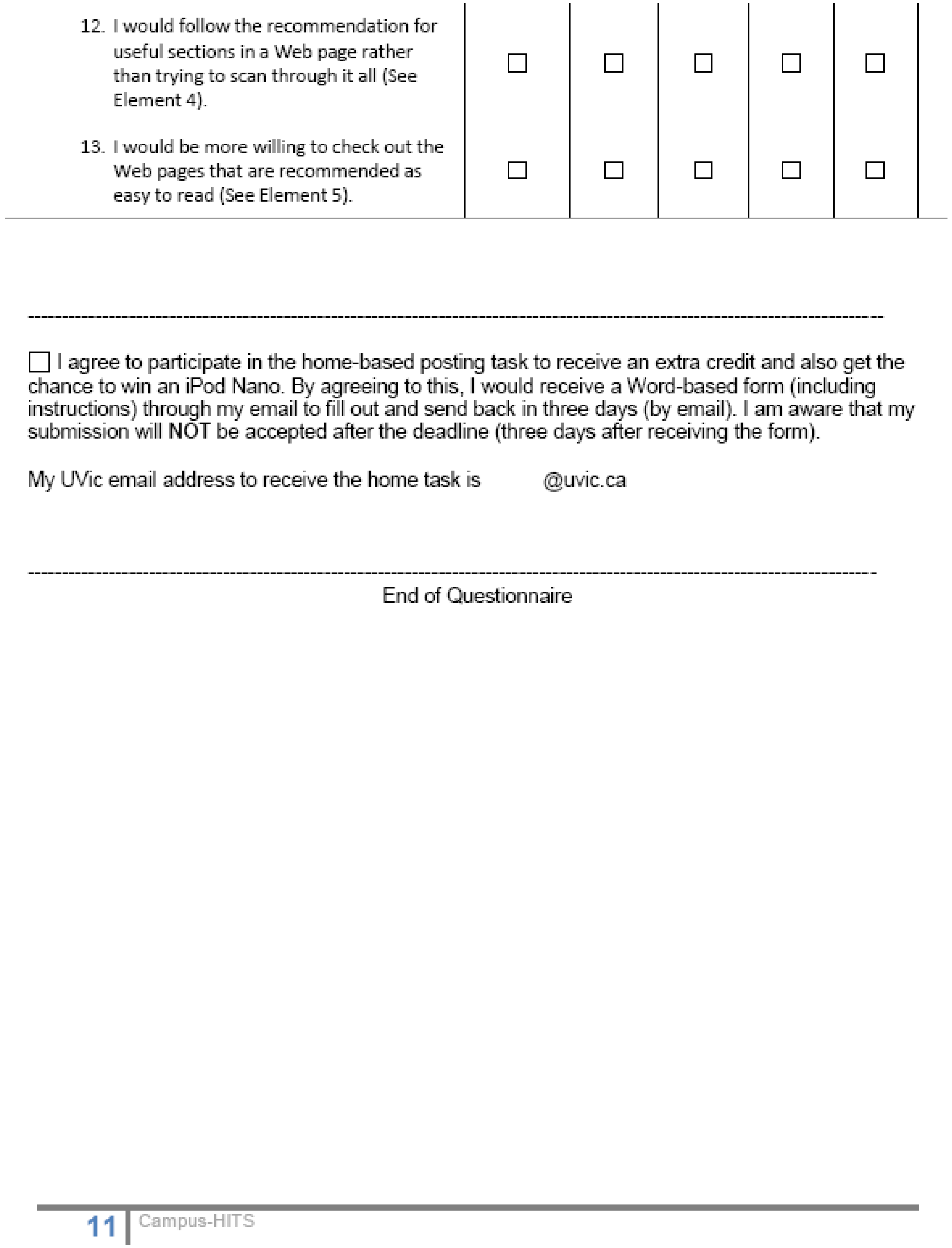


Now, looking at the Posting Elements Guide **available on your desk** and using the scale provided (below), indicate your degree of agreement or disagreement with the following statements. Note that the numbers in brackets used within the statement (below) refer to the corresponding element in the Element Guide.

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
1. I am reasonably familiar with blogs (or Weblogs) and online postings.	☐	☐	☐	☐	☐
2. The posting seems interesting to me. I would definitely recommend it to my party-going friends.	☐	☐	☐	☐	☐
3. I do not normally read or check the posting title (See Element 1).	☐	☐	☐	☐	☐
4. I like the informal tone used in the description (See Element 3).	☐	☐	☐	☐	☐
5. The description is too long (See Element 3).	☐	☐	☐	☐	☐
6. The screenshot of the Web page (See Element 12) helps me get some ideas about the Web page's content.	☐	☐	☐	☐	☐
7. When I read a posting, I always check to see who has submitted the posting (See Element 6).	☐	☐	☐	☐	☐
8. I **don't** think people would notice or care about the posting date (See Element 6).	☐	☐	☐	☐	☐
9. I would check the most recent postings, especially when looking for health information (See Element 6).	☐	☐	☐	☐	☐
10. I care a lot about seeing how other students have rated the page (See Element 8).	☐	☐	☐	☐	☐
11. I would be more interested in the rating provided by local health professionals than those provided by professionals nationwide (See Element 7).	☐	☐	☐	☐	☐

10 | Campus-HITS

Appendix 3- continued



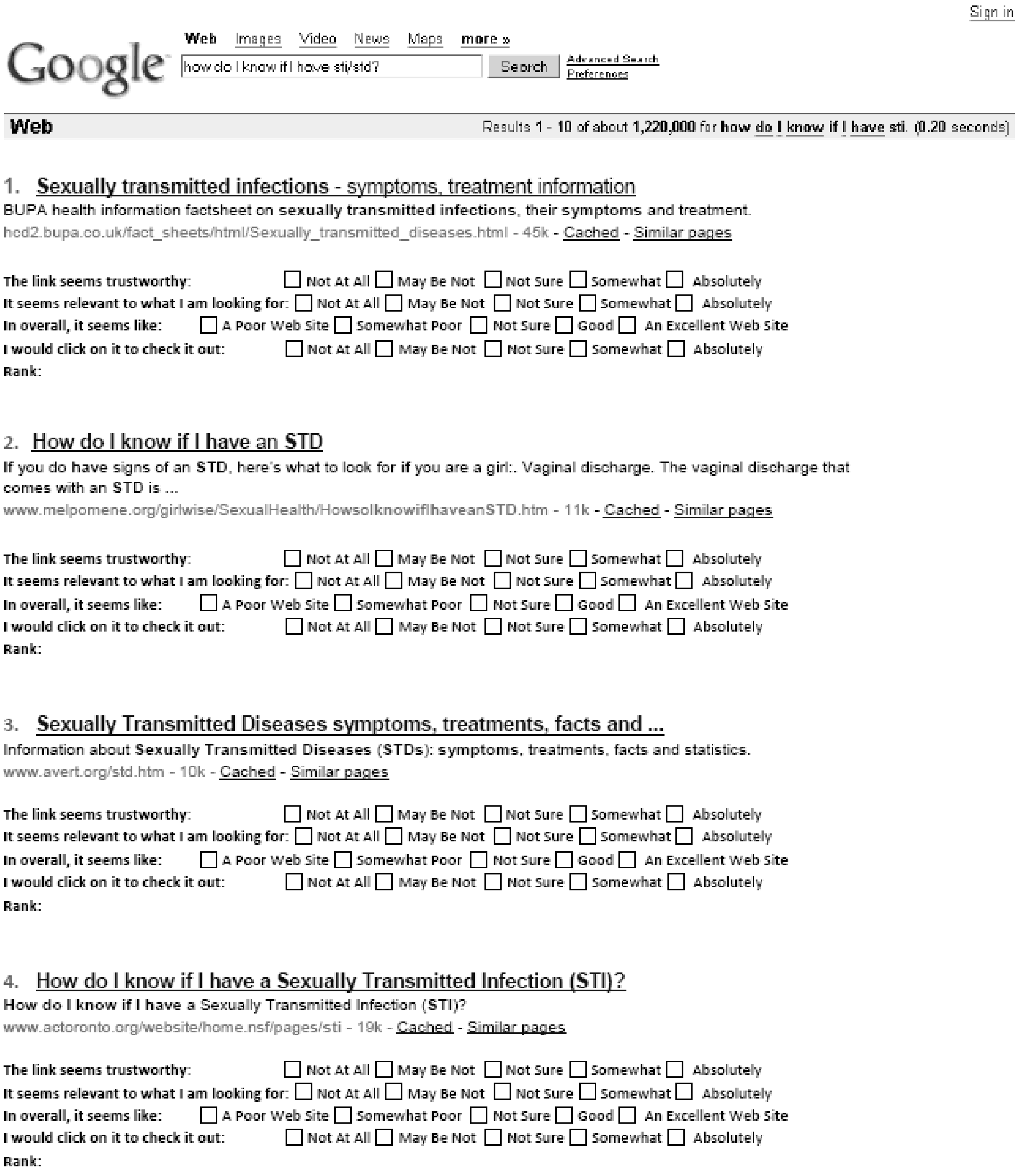
12. I would follow the recommendation for useful sections in a Web page rather than trying to scan through it all (See Element 4).	☐	☐	☐	☐	☐
13. I would be more willing to check out the Web pages that are recommended as easy to read (See Element 5).	☐	☐	☐	☐	☐

☐ I agree to participate in the home-based posting task to receive an extra credit and also get the chance to win an iPod Nano. By agreeing to this, I would receive a Word-based form (including instructions) through my email to fill out and send back in three days (by email). I am aware that my submission will **NOT** be accepted after the deadline (three days after receiving the form).

My UVic email address to receive the home task is @uvic.ca

End of Questionnaire

Appendix 4: Google Interface enhanced with questionnaire items (Phase III)



how do I know if I have sti/std?

Web Results 1 - 10 of about **1,220,000** for **how do I know if I have sti**. (0.20 seconds)

1. **Sexually transmitted infections** - symptoms, treatment information
BUPA health information factsheet on **sexually transmitted infections**, their symptoms and treatment.
hcd2.bupa.co.uk/fact_sheets/html/Sexually_transmitted_diseases.html - 45k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

2. **How do I know if I have an STD**
If you do **have** signs of an **STD**, here's what to look for **if** you are a girl:. Vaginal discharge. The vaginal discharge that comes with an **STD** is ...
www.melpomene.org/girlwise/SexualHealth/HowsoIknowifIhaveanSTD.htm - 11k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

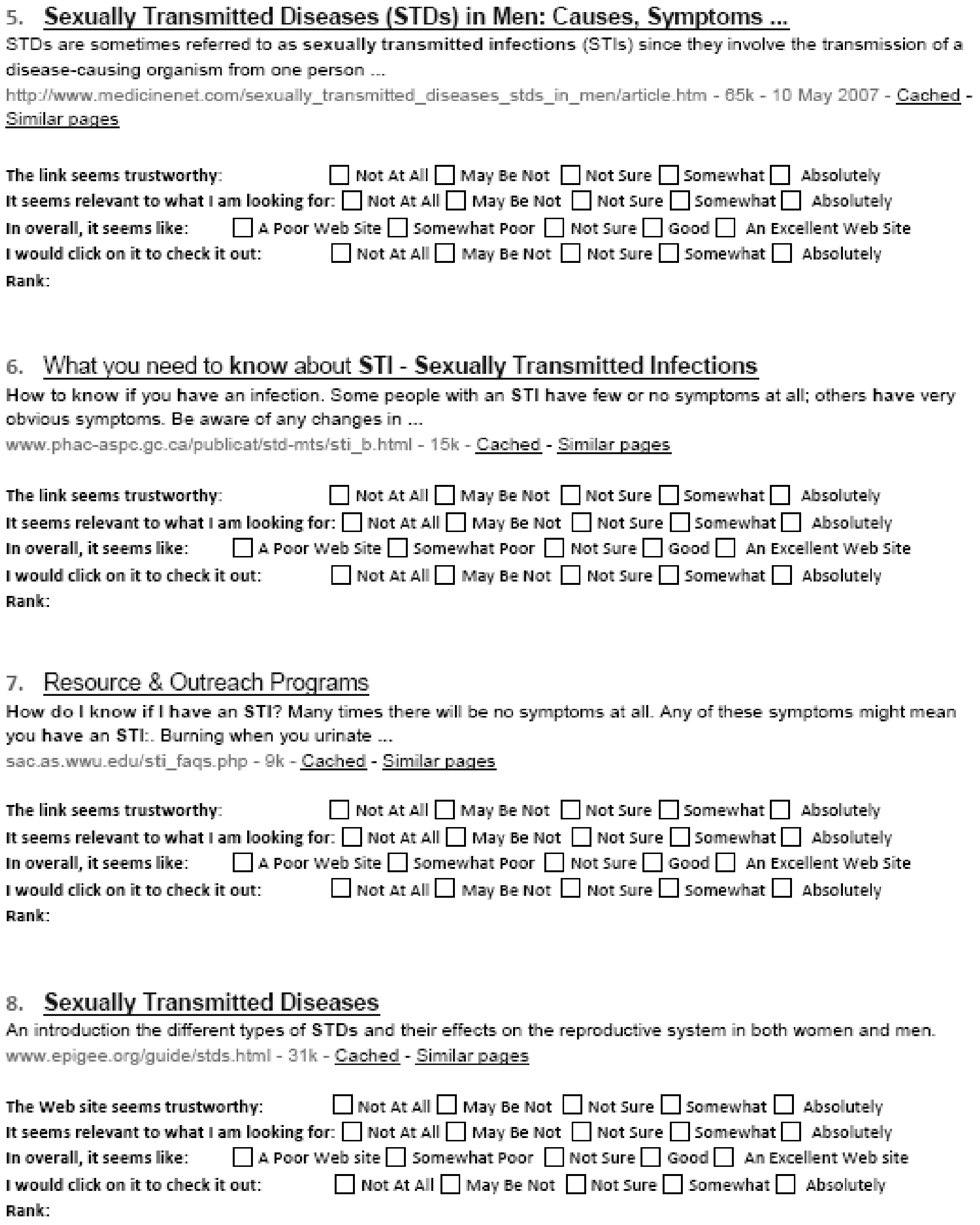
3. **Sexually Transmitted Diseases** symptoms, treatments, facts and ...
Information about **Sexually Transmitted Diseases** (**STDs**): symptoms, treatments, facts and statistics.
www.avert.org/std.htm - 10k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

4. **How do I know if I have a Sexually Transmitted Infection (STI)?**
How do I know if I have a Sexually Transmitted Infection (**STI**)?
www.actoronto.org/website/home.nsf/pages/sti - 19k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

Appendix 4 - Continued



5. **Sexually Transmitted Diseases (STDs) in Men: Causes, Symptoms ...**
STDs are sometimes referred to as **sexually transmitted infections** (STIs) since they involve the transmission of a disease-causing organism from one person ...
http://www.medicinenet.com/sexually_transmitted_diseases_stds_in_men/article.htm - 65k - 10 May 2007 - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

6. What you need to **know** about **STI - Sexually** Transmitted **Infections**
How to know if you have an infection. Some people with an **STI** have few or no symptoms at all; others have very obvious symptoms. Be aware of any changes in ...
www.phac-aspc.gc.ca/publicat/std-mts/sti_b.html - 15k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

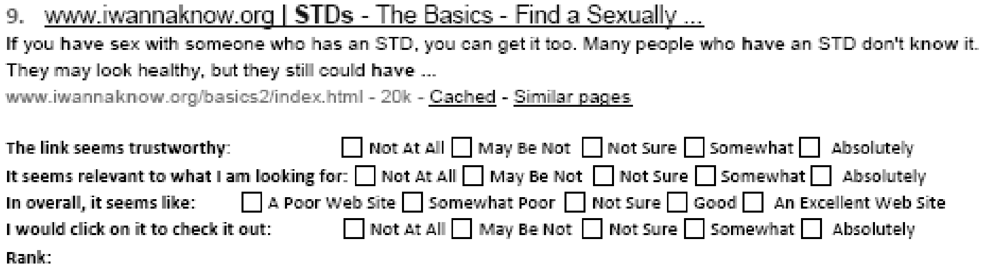
7. Resource & Outreach Programs
How do I **know** if I have an **STI**? Many times there will be no symptoms at all. Any of these symptoms might mean you have an **STI**:. Burning when you urinate ...
sac.as.wwu.edu/sti_faqs.php - 9k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

8. **Sexually Transmitted Diseases**
An introduction the different types of **STDs** and their effects on the reproductive system in both women and men.
www.epigee.org/guide/stds.html - 31k - Cached - Similar pages

The Web site seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

Appendix 4 - Continued

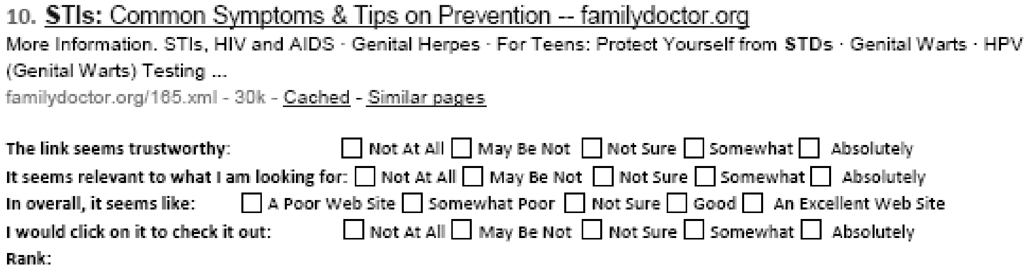


9. www.iwannaknow.org | **STDs** - The Basics - Find a Sexually ...

If you **have** sex with someone who has an STD, you can get it too. Many people who **have** an STD don't know it. They may look healthy, but they still could **have** ...

www.iwannaknow.org/basics2/index.html - 20k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:



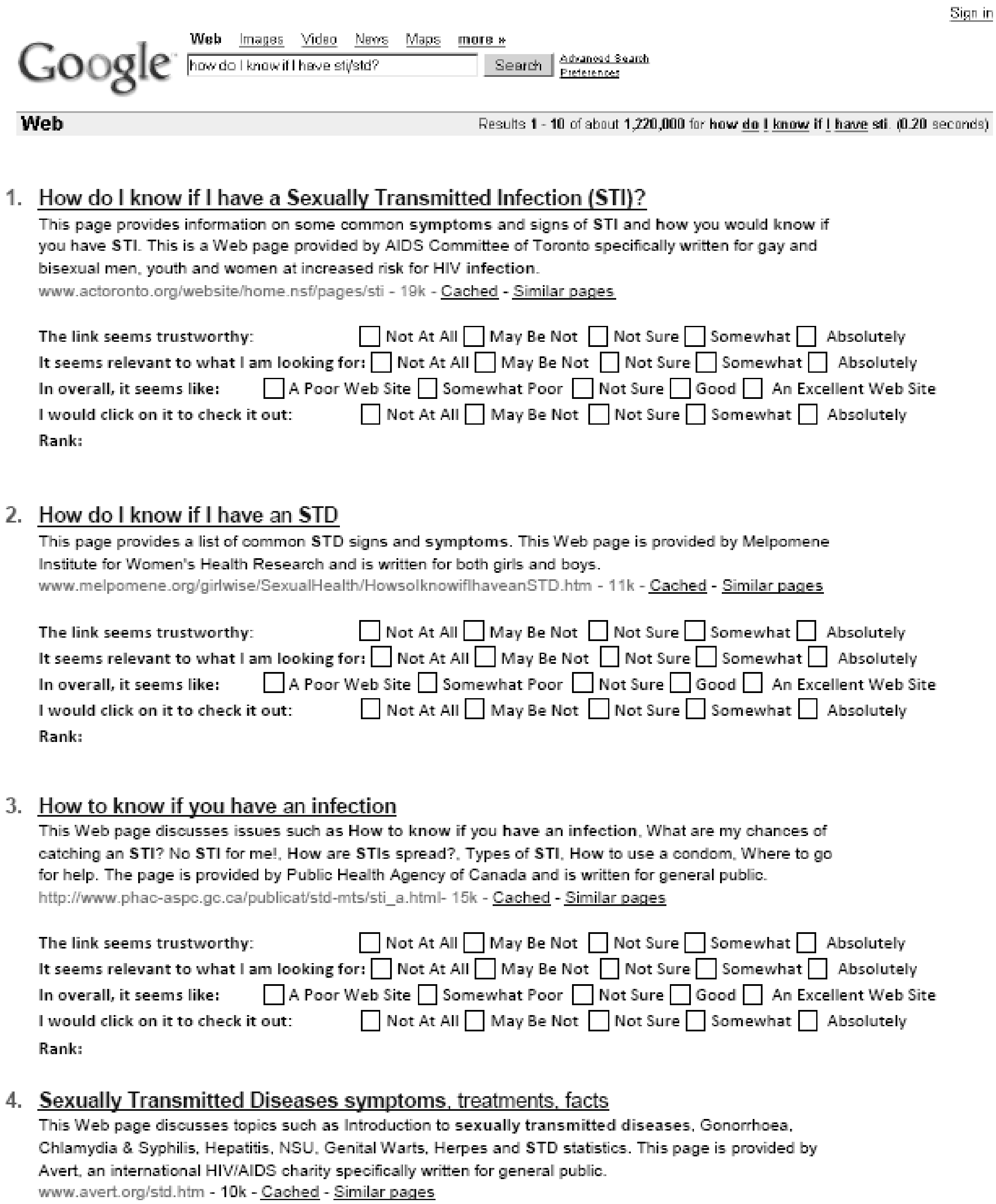
10. **STIs:** Common Symptoms & Tips on Prevention -- familydoctor.org

More Information. STIs, HIV and AIDS · Genital Herpes · For Teens: Protect Yourself from **STDs** · Genital Warts · HPV (Genital Warts) Testing ...

familydoctor.org/165.xml - 30k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

Appendix 5: Simulated Google Interface designed using CHEKES III elements (Phase III)



how do I know if I have sti/std?

Results **1** - **10** of about **1,220,000** for **how do I know if I have sti**. (**0.20** seconds)

1. How do I know if I have a Sexually Transmitted Infection (STI)?
This page provides information on some common **symptoms** and signs of **STI** and how you would know if you have **STI**. This is a Web page provided by AIDS Committee of Toronto specifically written for gay and bisexual men, youth and women at increased risk for HIV infection.
www.actoronto.org/website/home.nsf/pages/sti - 19k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

2. How do I know if I have an STD
This page provides a list of common **STD** signs and **symptoms**. This Web page is provided by Melpomene Institute for Women's Health Research and is written for both girls and boys.
www.melpomene.org/girlwise/SexualHealth/HowsoIknowifIhaveanSTD.htm - 11k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

3. How to know if you have an infection
This Web page discusses issues such as **How to know if you have an infection**, What are my chances of catching an **STI**? No **STI** for me!, How are **STIs** spread?, Types of **STI**, How to use a condom, Where to go for help. The page is provided by Public Health Agency of Canada and is written for general public.
http://www.phac-aspc.gc.ca/publicat/std-mts/sti_a.html- 15k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
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I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

4. Sexually Transmitted Diseases symptoms, treatments, facts
This Web page discusses topics such as Introduction to **sexually transmitted** diseases, Gonorrhoea, Chlamydia & Syphilis, Hepatitis, NSU, Genital Warts, Herpes and **STD** statistics. This page is provided by Avert, an international HIV/AIDS charity specifically written for general public.
www.avert.org/std.htm - 10k - Cached - Similar pages

Appendix 5 - Continued

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

5. **Sexually transmitted infections**

In this Web pages you would find information on, What are **STIs**? Getting help with **STIs**, **Symptoms**, The common **STIs**, Prevention of **STIs**, and Further information. This Web page is provided by BUPA Health Assurance Limited (Insurance Company) and is specifically written for general public.
hcd2.bupa.co.uk/fact_sheets/html/Sexually_transmitted_diseases.html - 45k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

6. **Sexually Transmitted Diseases (STDs) in Men**

This Web pages tells you about, What are **sexually transmitted diseases** (**STDs**)? Gonorrhoea, Chlamydia, Syphilis, ..., Herpes and Conclusion. This page is provided by MedicineNet, Inc and specifically written for men.
http://www.medicinenet.com/sexually_transmitted_diseases_stds_in_men/article.htm - 65k - 10 May 2007 - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

7. **Sexually Transmitted Infections**

This Web page talks about the topics such as Facts on **Sexually Transmitted Infections**, Frequently Asked Questions (FAQs), and Helpful Links. This page is provided by Sexual Awareness Centre of West Washington University (WWU) and is written for students at WWU.
sac.as.wwu.edu/sti_faqs.php - 9k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site
I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
Rank:

Appendix 5 – Continued

8. **Sexually Transmitted Diseases**

This Web page provides information on Human Papilloma Virus, Herpes Virus, Hepatitis, …, Rare **Infections**, and Make No Mistake. This page is provided by Hearthstone Communications Ltd. and is written for general public.

www.epigee.org/guide/stds.html - 31k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

Rank:

9. **STDs** - The Basics

This Web pages provides you information regarding Find an **STD**, Prevention, **Symptoms**, Testing, Treatment, and Links. This Web page is provided by American Social Health Association (ASHA) and is written for teenagers and young adults.

www.iwannaknow.org/basics2/index.html - 20k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

Rank:

10. **STIs:** Common **Symptoms** & Tips on Prevention

This Web page discusses various topics such as, What are **sexually transmitted infections**?, Am I at risk for having an **STI**?, Should I be checked for **STIs**? What else should I do to prevent **STIs**?, …, and Should I use a spermicide to help prevent **STIs**?. This is a Web page provided by American Academy of Family Physicians and is written for general public.

familydoctor.org/165.xml - 30k - Cached - Similar pages

The link seems trustworthy: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

I would click on it to check it out: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely

Rank:

Appendix 6: Evaluation (computer-based) form designed for the phase III participants to evaluate the ten different links used in Google and Simulated Google interface (Phase III)

Campus-HITs Phase III: Web Site Evaluation Test

1. Sexually Transmitted Infection

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

2. Sexually_Transmitted Diseases

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

3. Sexually Transmitted Infection

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

4. Sexually Transmitted Diseases

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

5. Sexually Transmitted Infections

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

6. Sexually Transmitted Diseases

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

7. Sexually Transmitted Infections

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

8. Sexually Transmitted Diseases

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

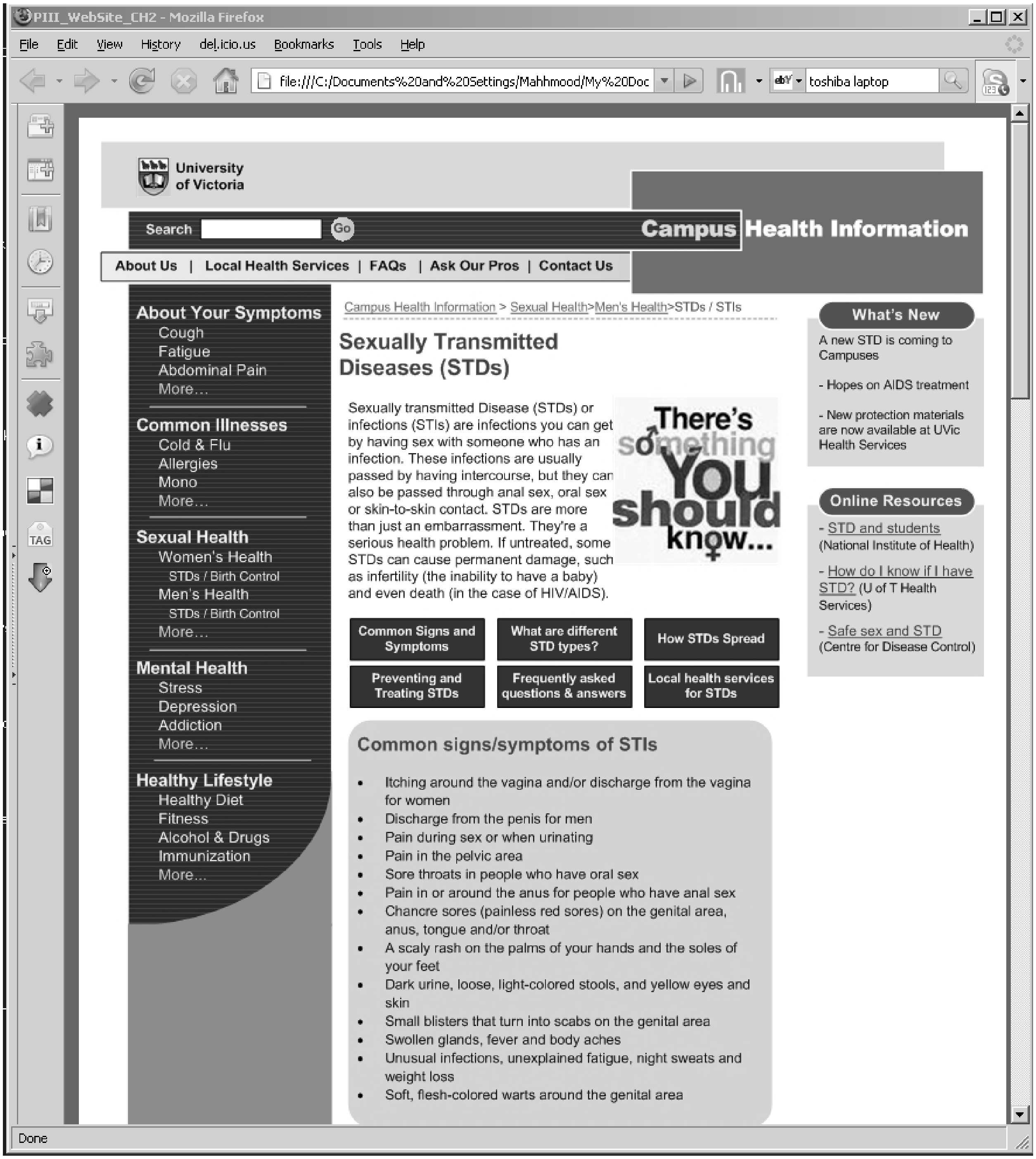
9. Sexually_Transmitted Diseases

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

10. Sexually_Transmitted Infections

It seems relevant to what I am looking for: ☐ Not At All ☐ May Be Not ☐ Not Sure ☐ Somewhat ☐ Absolutely
In overall, it seems like: ☐ A Poor Web Site ☐ Somewhat Poor ☐ Not Sure ☐ Good ☐ An Excellent Web Site

Appendix 7: Campus-HITS generic health Web page (the prototype) designed based on CHEKES III elements



Sexually Transmitted Diseases (STDs)

Sexually transmitted Disease (STDs) or infections (STIs) are infections you can get by having sex with someone who has an infection. These infections are usually passed by having intercourse, but they can also be passed through anal sex, oral sex or skin-to-skin contact. STDs are more than just an embarrassment. They're a serious health problem. If untreated, some STDs can cause permanent damage, such as infertility (the inability to have a baby) and even death (in the case of HIV/AIDS).

Common signs/symptoms of STIs

- Itching around the vagina and/or discharge from the vagina for women
- Discharge from the penis for men
- Pain during sex or when urinating
- Pain in the pelvic area
- Sore throats in people who have oral sex
- Pain in or around the anus for people who have anal sex
- Chancre sores (painless red sores) on the genital area, anus, tongue and/or throat
- A scaly rash on the palms of your hands and the soles of your feet
- Dark urine, loose, light-colored stools, and yellow eyes and skin
- Small blisters that turn into scabs on the genital area
- Swollen glands, fever and body aches
- Unusual infections, unexplained fatigue, night sweats and weight loss
- Soft, flesh-colored warts around the genital area

What's New

A new STD is coming to Campuses

- Hopes on AIDS treatment

- New protection materials are now available at UVic Health Services

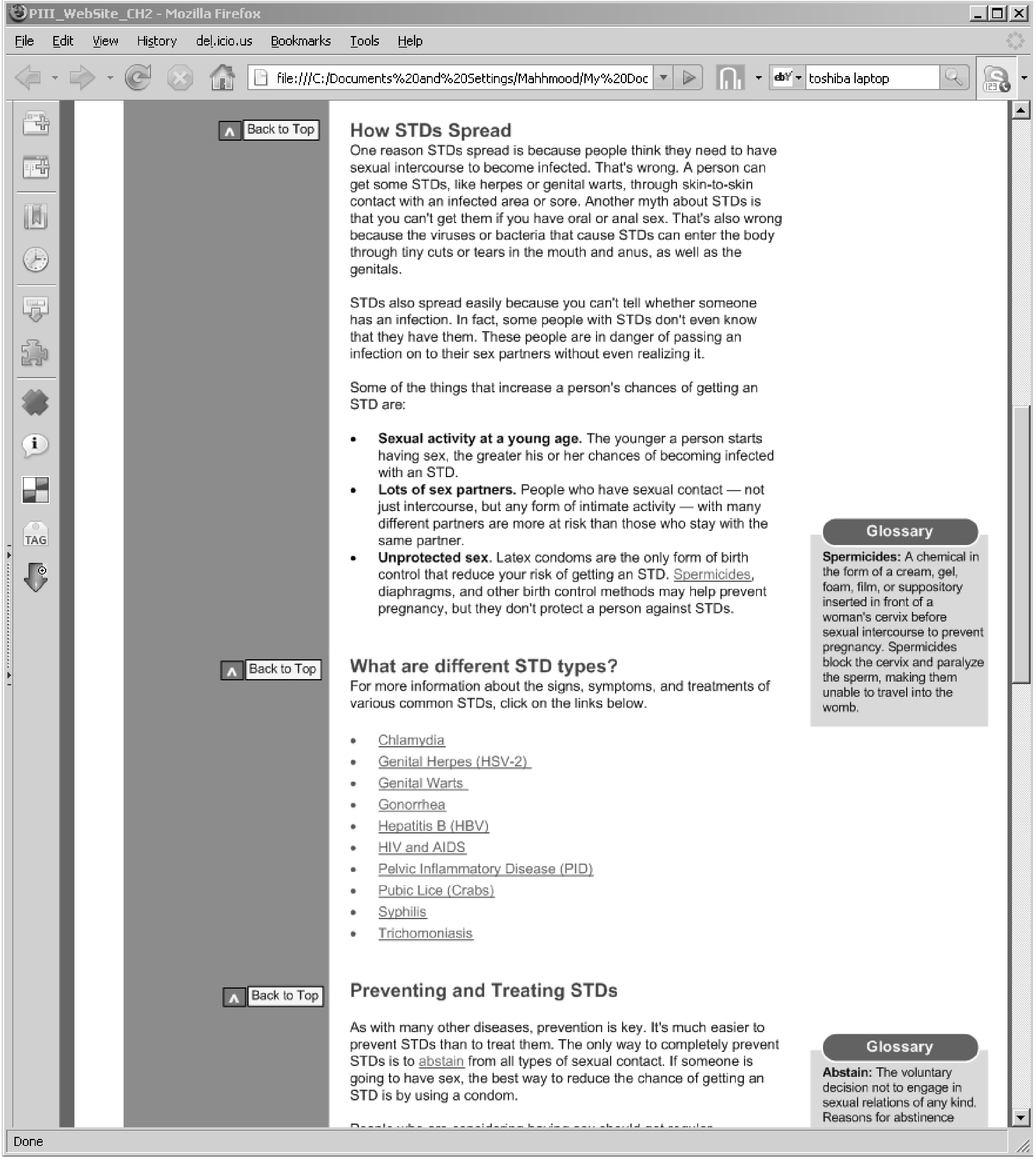
Online Resources

- STD and students (National Institute of Health)

- How do I know if I have STD? (U of T Health Services)

- Safe sex and STD (Centre for Disease Control)

Appendix 7 – Continued



How STDs Spread

One reason STDs spread is because people think they need to have sexual intercourse to become infected. That's wrong. A person can get some STDs, like herpes or genital warts, through skin-to-skin contact with an infected area or sore. Another myth about STDs is that you can't get them if you have oral or anal sex. That's also wrong because the viruses or bacteria that cause STDs can enter the body through tiny cuts or tears in the mouth and anus, as well as the genitals.

STDs also spread easily because you can't tell whether someone has an infection. In fact, some people with STDs don't even know that they have them. These people are in danger of passing an infection on to their sex partners without even realizing it.

Some of the things that increase a person's chances of getting an STD are:

- **Sexual activity at a young age.** The younger a person starts having sex, the greater his or her chances of becoming infected with an STD.
- **Lots of sex partners.** People who have sexual contact — not just intercourse, but any form of intimate activity — with many different partners are more at risk than those who stay with the same partner.
- **Unprotected sex.** Latex condoms are the only form of birth control that reduce your risk of getting an STD. Spermicides, diaphragms, and other birth control methods may help prevent pregnancy, but they don't protect a person against STDs.

Glossary

Spermicides: A chemical in the form of a cream, gel, foam, film, or suppository inserted in front of a woman's cervix before sexual intercourse to prevent pregnancy. Spermicides block the cervix and paralyze the sperm, making them unable to travel into the womb.

What are different STD types?

For more information about the signs, symptoms, and treatments of various common STDs, click on the links below.

- Chlamydia
- Genital Herpes (HSV-2)
- Genital Warts
- Gonorrhea
- Hepatitis B (HBV)
- HIV and AIDS
- Pelvic Inflammatory Disease (PID)
- Pubic Lice (Crabs)
- Syphilis
- Trichomoniasis

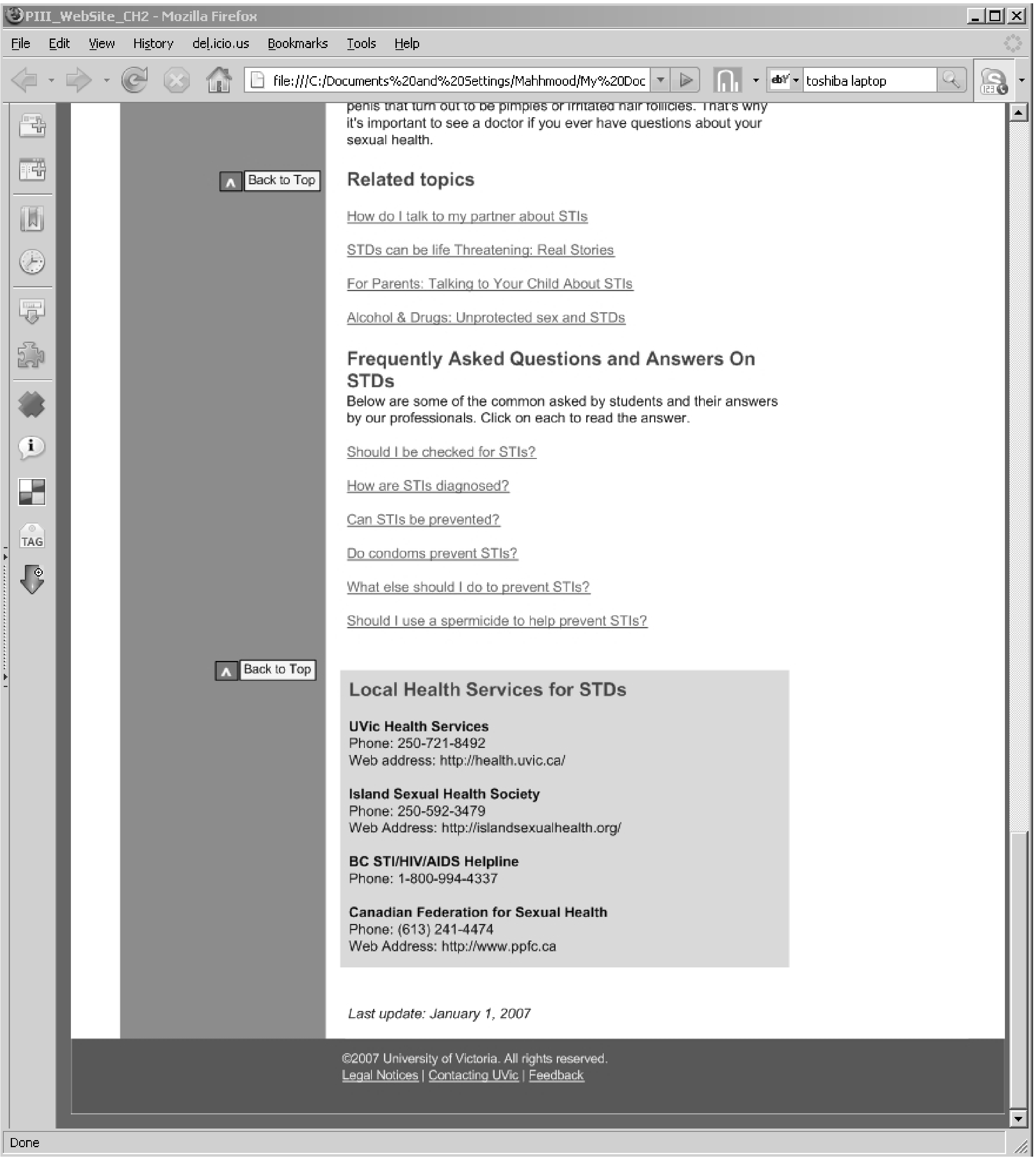
Preventing and Treating STDs

As with many other diseases, prevention is key. It's much easier to prevent STDs than to treat them. The only way to completely prevent STDs is to abstain from all types of sexual contact. If someone is going to have sex, the best way to reduce the chance of getting an STD is by using a condom.

Glossary

Abstain: The voluntary decision not to engage in sexual relations of any kind. Reasons for abstinence

Appendix 7 – Continued



penis that turn out to be pimples or irritated hair follicles. That's why it's important to see a doctor if you ever have questions about your sexual health.

Related topics

How do I talk to my partner about STIs

STDs can be life Threatening: Real Stories

For Parents: Talking to Your Child About STIs

Alcohol & Drugs: Unprotected sex and STDs

Frequently Asked Questions and Answers On STDs

Below are some of the common asked by students and their answers by our professionals. Click on each to read the answer.

Should I be checked for STIs?

How are STIs diagnosed?

Can STIs be prevented?

Do condoms prevent STIs?

What else should I do to prevent STIs?

Should I use a spermicide to help prevent STIs?

Local Health Services for STDs

UVic Health Services
Phone: 250-721-8492
Web address: http://health.uvic.ca/

Island Sexual Health Society
Phone: 250-592-3479
Web Address: http://islandsexualhealth.org/

BC STI/HIV/AIDS Helpline
Phone: 1-800-994-4337

Canadian Federation for Sexual Health
Phone: (613) 241-4474
Web Address: http://www.ppfc.ca

Last update: January 1, 2007

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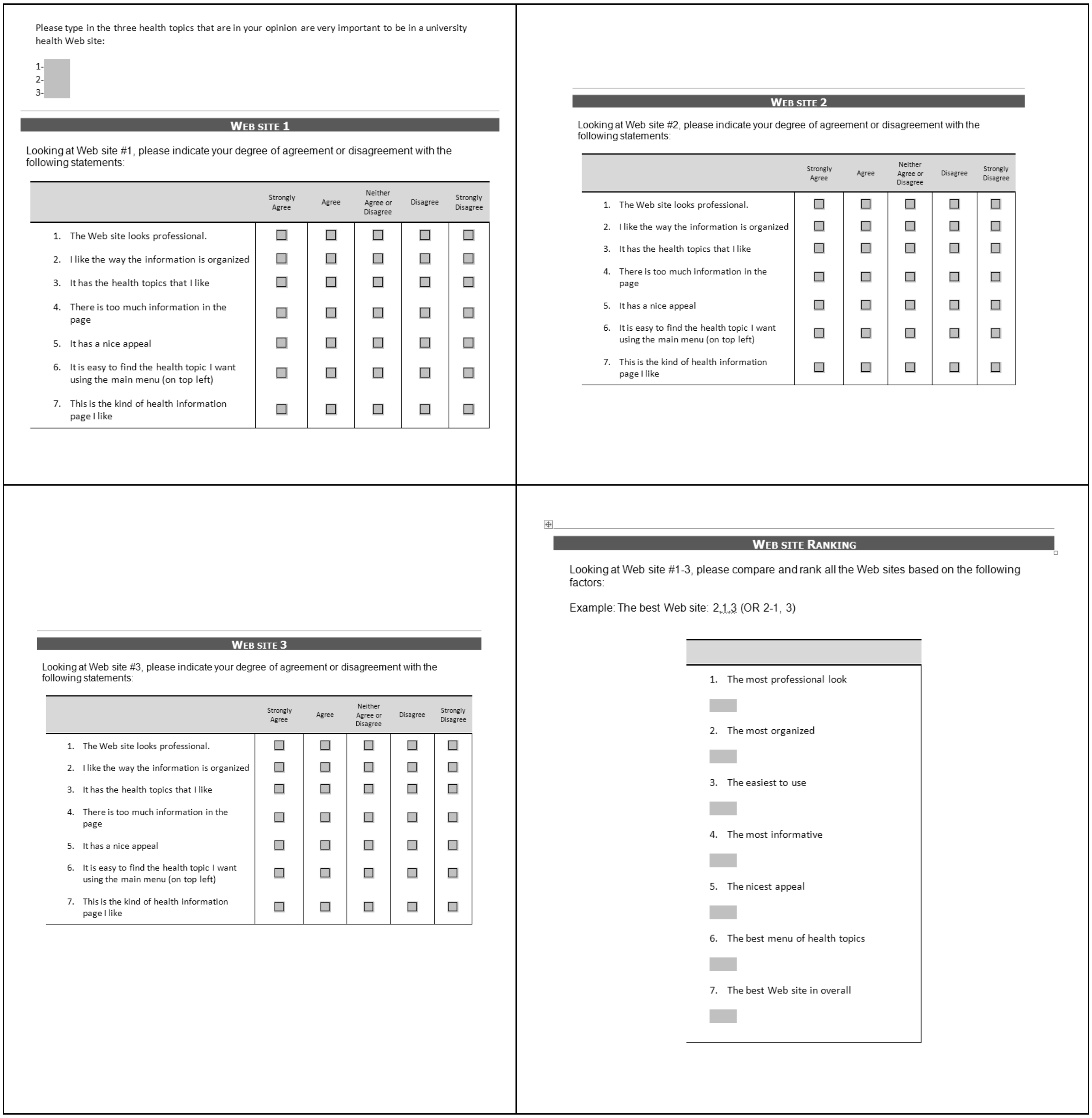
Appendix 8: Questionnaire form to evaluate the three Web sites in Phases III



Please type in the three health topics that are in your opinion are very important to be in a university health Web site:

1-
2-
3-

WEB SITE 1

Looking at Web site #1, please indicate your degree of agreement or disagreement with the following statements:

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
1. The Web site looks professional.	☐	☐	☐	☐	☐
2. I like the way the information is organized	☐	☐	☐	☐	☐
3. It has the health topics that I like	☐	☐	☐	☐	☐
4. There is too much information in the page	☐	☐	☐	☐	☐
5. It has a nice appeal	☐	☐	☐	☐	☐
6. It is easy to find the health topic I want using the main menu (on top left)	☐	☐	☐	☐	☐
7. This is the kind of health information page I like	☐	☐	☐	☐	☐

WEB SITE 2

Looking at Web site #2, please indicate your degree of agreement or disagreement with the following statements:

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
1. The Web site looks professional.	☐	☐	☐	☐	☐
2. I like the way the information is organized	☐	☐	☐	☐	☐
3. It has the health topics that I like	☐	☐	☐	☐	☐
4. There is too much information in the page	☐	☐	☐	☐	☐
5. It has a nice appeal	☐	☐	☐	☐	☐
6. It is easy to find the health topic I want using the main menu (on top left)	☐	☐	☐	☐	☐
7. This is the kind of health information page I like	☐	☐	☐	☐	☐

WEB SITE 3

Looking at Web site #3, please indicate your degree of agreement or disagreement with the following statements:

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
1. The Web site looks professional.	☐	☐	☐	☐	☐
2. I like the way the information is organized	☐	☐	☐	☐	☐
3. It has the health topics that I like	☐	☐	☐	☐	☐
4. There is too much information in the page	☐	☐	☐	☐	☐
5. It has a nice appeal	☐	☐	☐	☐	☐
6. It is easy to find the health topic I want using the main menu (on top left)	☐	☐	☐	☐	☐
7. This is the kind of health information page I like	☐	☐	☐	☐	☐

WEB SITE RANKING

Looking at Web site #1-3, please compare and rank all the Web sites based on the following factors:

Example: The best Web site: 2,1,3 (OR 2-1, 3)

1. The most professional look
2. The most organized
3. The easiest to use
4. The most informative
5. The nicest appeal
6. The best menu of health topics
7. The best Web site in overall

Appendix 9: Cross-tabulated table of health topics suggested by professional participants sorted based on category and topic scores

Combined topics (bold) / suggested topics	Category/ Topic Score
Mental Health & Relationship	28
Stress related concerns due to life and academic pressures	5
Managing stress	5
Dealing with relationship issues	4
Symptoms of anxiety/depression	4
Personal Relationship concerns	3
Dealing with depression	3
Mental Health Issues such as anxiety and depression	3
Life planning concerns - career, life purpose	1
STD & Infectious Diseases	20
sexually transmitted infections	5
Infectious Illnesses	5
STD	4
infectious diseases -mononucleosis	3
Other Infectious Illness	3
Birth Control	17
birth control	8
Contraception	5
I would like to start on some method of Birth Control and be checked for STI's..	4
Healthy Lifestyle	11
I am having trouble sleeping, eating and keeping up with my courses. Can you help me.	5
Health concerns related to sleep, nutrition and exercise	2
Balancing school and the rest of their commitments	2
Nutrition	1
life style concerns	1
Others	10
I've been up all night with fevers, chills and a cough.	3
I fell on the ice and my knee is very painful and swollen.	2
Fatigue	2
rash	1
allergy	1
Gynecological Concerns	1
Alcohol & Drugs	4
alcohol	2
Wellness and associated issues such as drinking, drugs	1
substance use	1
Injuries	3
Sport Injuries and Musculoskeletal disorders	2
Injury	1
Travel Health	2
travel health	1
I will be travelling to Malaysia in May and would like to know what immunizations	1

Appendix 10: Example student health concerns identified by the Phase I participants

- How do I know if I have a STI?
- What are the effects of alcohol on my body?
- How can I minimize my chances of catching the cold/flu?
- What are the consequences of having sex?
- How much alcohol is too much and what are the effects?
- What are the effects and consequences of using drugs?
- When drinking, do students usually combine drugs as well?
- Finding a way to calculate safe amounts of alcohol consumption
- A way of stopping germs to avoid cold and flu
- Ways to stay physically fit with a healthy diet
- What are symptoms, and treatment options of the different kinds of STD's?
- What are the different kinds of birth control and are they available on campus? How much do they cost?
- How much and how often does a student have to drink in order for it to seriously affect their health later on in life?
- Stress causing sleepless nights, ways of dealing with stress
- Explain the effect of drinking now and later
- How to have safe sex?
- What are the symptoms of depression?
- What are some healthy and effective dieting methods?
- What are the most effective birth control pills?
- How do I know if I have a drinking problem and how can I treat it?
- So what's the deal with sexually transmitted disease?
- What are reasonable of safe level of alcohol consumption?
- How can I recognize depression?
- Do I overdrink?
- What am I getting the freshman 15?
- How does alcohol affect your liver?
- What are the short-term effects of cocaine use?
- How is the best way to quit smoking cigarettes?
- What are the symptoms of alcohol poisoning?
- How well do condoms prevent the spread of STI's and pregnancy?
- How do I get rid of common cold/flue?
- How much sleep should I get each night?
- Why do I get frequent headaches?
- What are the symptoms of various STDs?
- Am I pregnant?
- How do i get help quitting smoking?
- How can I reduce stress in my life (especially around exam time)?
- Do I have a sexually transmitted infection?
- What types of birth control and contraceptives are there available for sexual intercourse?
- Do I suffer from depression?

Appendix 11: Some of the subjects' comments regarding the importance or usefulness of HON accreditation tool

I have no idea what it means. I don't think anybody would know about such standards. For the people who know what is means they may look for it, so it would be important to have.
I don't think this is a familiar term.
I am not familiar with what this is. If you included an explanation of what this was it may be useful.
Most browsers would not be familiar with this term.
I believe that myself or other students that I have come into contact with do not know what a HON Code is. For this reason a HON code would not be useful to me.
The students may not understand this term (including me).
never heard of a HON code but now that I know what it is its would be very useful
It is important to show the credibility of the resources used on the website, the information and so on. However, students may not be familiar with "HON Code"
I think UVic Health Services will be good enough in terms of credibility
I do not think the HON code is a recognizable term for most students.
The student would probably be more interested in the information specific to them and wouldn't click on the HON.
Can not see any clear disadvantage to adding the logo (can cause no harm). However if it is included, I would argue that most students would not know what it is or means. They would not consider the fact that it was a hyperlink and simply pass over it as they scrolled down to the information they were looking for.
I do not think the HON Code logo is useful because not a lot of people know what it means.

Appendix 12: Final CHEKES III Health Topics

Main Category/Health Topic	Topic Score	Main Category/Health Topic	Topic Score
Mental Health Issues/Addiction		Common Symptoms	
Depression	56	Fatigue	53
Stress	56	Vomiting & Nausea	52
Alcohol	55	Fever	52
Suicidal Thoughts	54	Headaches	51
Eating Disorders	54	Stress	50
Drugs	53	Eating Disorders	50
Smoking	51	Abdominal Pain	50
Anxiety Disorders	50	Coughs	49
A negative body image	50	Sore Throats	49
Fatigue	49	Diarrhea	49
Attention Deficit Syndrome	48	Sprains, Strains & Sports Injuries	48
Personality disorders	46	Skin Injuries	35
Anxiety	35	Sleepless nights	35
		Acne	33
Safe and Healthy Lifestyle		Runny Nose	20
Stress Management	56	Men's Health/Sexual Health	
Guidelines for alcohol, smoking and drugs	56	STDs/HIV	57
Nutrition and Fitness	55	Birth control	55
Sleep	53	Genital Problems	55
Relationships	45	Women's Health / Sexual Health	
Travel Health & Immunization	42	STDs/HIV	57
Pregnancy	16	Birth control	53
Stomachache	6	Vaginal Problems	52
Common Illnesses			
Colds & Flu	53		
Infectious diseases	53		
Allergies	47		