A Taxonomy of Factors to Promote Quality Web-Supported Learning[1]

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Abstract: This paper reports on a case study of the e-learning production unit at the University of Pretoria, South Africa. Phase 1 of the study, completed in 2003, was the design and development of a process-based quality management system for web-supported learning (WSL) using a basic ISO 9000 approach (University of Pretoria, 2003). The second phase, reported in this paper, investigated what factors directly affect the quality of the web-supported learning opportunities (products) produced.

A taxonomy of critical success factors for quality web-supported learning was derived from a comparative analysis of the literature. It was refined and validated by critical colleagues within the case study. It has three components:

- underlying assumptions and exogenous factors;
- refined taxonomy of factors in six categories;
- graphic interpretation based on Ingwersen's (1996) model of information retrieval.

The taxonomy emphasizes the dynamic nature of the teaching and learning process and non-negotiable factors such as staff and student training, technical support, accessibility and reliability of the technology.

Introduction

The term *e-learning* embraces a variety of electronic delivery media, for example web-supported, multimedia, interactive television, virtual classrooms, video conferencing, etc. This study focuses on *web-supported learning (WSL)*, as a subset of e-learning. The term *web-supported learning* is preferred over *web-based learning (WBL)* since the learning model under consideration in this study is a blended one, including varying components of contact time and other delivery media.

The domains of quality assurance and web-supported learning are extremely topical, yet they seldom overlap (Reid, 2003). The purpose of this study was to diminish this gap by applying quality assurance principles to the ADDIE (analysis, design, development, implementation and evaluation) model of instructional design, in order to promote consistency and continuous improvement in an e-learning support unit at a higher education institution.

This investigation is based on a case study at the University of Pretoria, South Africa, in which a process-based quality management system (QMS) for web-supported learning was designed and

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developed in 2003 (University of Pretoria, 2003; European Quality Observatory, 2004; Fresen, 2005). In phase 1, the process-based ISO 9000 approach was applied to the instructional design *process*. This overall process was subdivided into 12 'boxes', steps or *procedures*, each with inputs, outputs, roles and responsibilities and supporting documents such as checklists, standards, policies, pro-formas etc.

The implication of phase 1 was that such an in-depth self-evaluation exercise (i.e. 'improving the way we do things around here') should lead to improved web-supported learning opportunities (*products)* for students. Phase 2, reported in this paper, investigated teaching and learning aspects of the web-supported products developed and implemented by the e-learning production unit. The outcome was a taxonomy of critical success factors which contribute to improving the quality (effectiveness) of web-supported learning in a blended learning model.

Methodology

The research question for this study was:

What factors[2] promote quality web-supported learning?

The primary research method was a literature review which identified and analysed studies of two types: those which present classic benchmarks, indicators and principles for quality web-supported learning (IHEP, 2000; Barker, 1999; Chickering & Ehrmann, 1996), and those that identify criteria for exemplary or promising courses (Graf & Caines, 2001; Confrey, Sabelli & Sheingold, 2002). Twigg (2001) confirms that the IHEP study is particularly meaningful and useful. Yeung (2002) applied the IHEP study to investigate factors contributing to quality assurance of web-based learning in Hong Kong. In South Africa, Herman (2001) and Bezuidenhout (2004) conducted similar studies based on the IHEP study, at the University of Stellenbosch and the Central University of Technology respectively.

Details of the studies mentioned above are given by Fresen (2005). The comparative analysis produced an initial taxonomy of factors which contribute to the quality of web-supported learning, based on six categories: institutional, technology, lecturer, student, instructional design and pedagogical factors.

Since the initial taxonomy was synthesized, additional studies on quality issues relating to instructional technologies emerged, both from database searches and from the bibliographies of other papers. These additional studies were analysed in order to corroborate or extend the initial taxonomy and are also described in some detail by Fresen (2005). The additional studies analysed were Applebee, Dearn, Donnan, & Kiley (2003), Alley (2000), Foreman, Nyatanga & Rich (2002), Herrington, Herrington, Oliver, Stoney & Willis (2001), Lorenzo & Moore (2002), Oliver (2001), Oliver (2003), Waddel & Byrne (2003) and Zhao (2003).

The updated and extended taxonomy is presented in Table 1. Critical colleagues within the case study were asked to reflect on and refine the taxonomy for purposes of triangulation and verification. The refined taxonomy, which answers the research question, is given in Tables 2

[2] The word 'factor' is used throughout in the ordinary everyday sense of the word, such as 'characteristic' or 'aspect'. No statistical *factor analysis* is implied or intended.

and 3. In order to provide a visual synthesis and interpretation of the taxonomy, it was mapped onto Ingwersen's (1996) cognitive model of information retrieval (Figures 1 and 2).

Extension and Refinement of the Initial Taxonomy

According to Miles & Huberman (1994), the first step in data analysis is data reduction. The original taxonomy was highly descriptive, using synonymous words or phrases to clarify the nuances in various factors. This promoted validity in comparing and classifying items identified in the primary sources. The wording of items in the taxonomy was subsequently reduced, focusing on single words or phrases to list the factors succinctly[3] (see Table 3). Discussion of concepts such as 'communication', 'learning styles', 'collaborative learning' amongst other factors listed, may be found in the literature on instructional design and web-supported learning (for example, Chickering & Ehrmann, 1996, Gagné, 1985, Gery, 1987, Reeves, 1993).

Most of the additional relevant studies published since 2000 corroborated factors already in the initial taxonomy. Ten additional factors that were not in the initial taxonomy were identified:

- community and empathy (Waddel & Byrne, 2003) *[lecturer factor]*;
- layout and presentation (Herrington et al., 2001) *[instructional design factor]*;
- appropriate bandwidth and download demands (Herrington et al., 2001) *[technology factor]*;
- learner-centered environment (Herrington et al., 2001) *[pedagogical factor]*;
- currency of learning resources and content (Applebee et al., 2003; Herrington et al., 2001) *[pedagogical factor]*;
- usability (Alley, 2000; Foreman et al., 2002) *[instructional design factor]*;
- multiple learning paths (Alley, 2000) *[pedagogical factor]*;
- reusable learning objects (Oliver, 2001) *[instructional design factor]*;
- reusable learning designs (Oliver, 2001) *[instructional design factor]*;
- student selection and entry into courses (Oliver, 2003) *[institutional factor]*.

The ten additional factors were added to the initial taxonomy and are indicated in Table 1 in *italic* text.

Table 1: *Extended taxonomy of critical success factors identified from the literature*

Institutional factors	**Technology factors**
Technology plan	Appropriate use
Infrastructure	Reliability
Student consultation	Accessibility
Institutional programme evaluation	IT support and training for lecturers
Organisational change	IT support and training for students
Student selection and entry into courses	*Appropriate bandwidth and download demands*
	Management of student data
Lecturer factors	**Student factors**
Interaction with students	Communication

[3] If not stated, adjectives such as 'effective', 'appropriate', 'optimal' are implied in the reduced list.

Feedback to students Professional training Evaluation of teaching competence Academic background *Community and empathy*	Time management Self directed learning Client expectations Critical thinking Motivation Problem solving Client satisfaction
Instructional design factors	**Pedagogical factors**
Group learning Engagement Higher cognitive levels Learning resources Learning materials Interactivity Standards Course evaluation Inclusivity Student motivation Modular chunks Use of media Use of images, graphics, animation Complete learning package *Layout and presentation* *Usability* *Reusable learning objects* *Reusable learning designs*	Learning outcomes High expectations Assessment strategies Diversity Clearly stated expectations Self reflection Non-threatening environment Research methodology Relevance of content Accuracy of content *Currency of content and learning resources* Continuous improvement Educationally significant goals Adaptable, sustainable, scaleable *Learner-centered environment* *Multiple learning pathways*

Table 1 reflects the first attempt to answer the research question by listing factors to promote the quality of web-supported learning in six categories. The taxonomy was corroborated and refined by critical colleagues in two case analysis meetings. The critical colleagues confirmed the importance of all the factors listed in Table 1. Various suggestions were made in terms of rewording, merging and adding to the list of factors, based on their experience.

In synthesizing such a taxonomy, it is impossible to list *all* critical success factors for quality web-supported learning. It is inevitable that other researchers will suggest additional factors. In attempting to be as comprehensive yet as succinct as possible, earlier research listed separately two types of basic factors (Fresen & Boyd, 2003):

- underlying *assumptions* which must be in place before quality web-supported learning can even be contemplated;
- *exogenous* (external) factors, which are important for quality web-supported learning, yet are beyond the control of e-learning practitioners.

The critical colleagues agreed with listing underlying assumptions and exogenous factors

separately. These factors are listed in Table 2, reflecting the suggestions and consensus of the critical colleagues. The resulting refined taxonomy of critical success factors for quality web-supported learning is presented in Table 3.

Table 2: *Underlying assumptions and exogenous factors forming the foundation of the taxonomy*

Underlying assumptions	**Exogenous factors**
• ICT infrastructure; • information literacy of clients[4]; • basic computer literacy of clients; • positive attitude of lecturers; • commitment and motivation of clients; • sound advice, support and consultation to lecturers with respect to instructional design and educational practice; • sound instructional design practice; • sound teaching and learning practice; • commitment to continuous improvement.	• quality of the institutional learning management system; • stability of national telecommunications infrastructure; • class size; • work load of clients; • recognition and incentives for lecturers.

The refined taxonomy presented in Table 3 should be read with the understanding that the underlying assumptions listed above are taken as given and that the exogenous factors are acknowledged.

[4] "Clients" include lecturers and students

Table 3: *Resulting taxonomy of factors to promote quality web-supported learning*

Institutional factors	**Technology factors**
Technology plan Student selection and entry into courses Student consultation Institutional programme evaluation Change management Standardisation of information design and dissemination	Appropriate use of technology Reliability Availability 24/7 Accessibility (Inclusivity) System training for clients IT support for clients Appropriate bandwidth and download demands Management of student data
Lecturer factors	**Student factors**
Interaction / facilitation Frequent feedback Academic background Evaluation of teaching competence Community and empathy	Communication Time management Self directed learning Critical thinking Problem solving
Instructional design factors	**Pedagogical factors**
Usability: • Modular chunks • Use of media	Learning outcomes, goals, expectations Flexible learning package Assessment strategies
• Use of images, graphics, animation • Layout and presentation • Standards • Accessibility **Learning principles:** • Collaborative learning • Interactivity • Engagement • High expectations • Higher cognitive levels	Learning styles Learner-centered learning environment Content and learning resources: relevance, accuracy, currency Adaptable, sustainable, scaleable, reusable Self reflection

Various factors were suggested by the critical colleagues, for example the importance of standardised dissemination of information, on an institution-wide basis. This factor refers to the importance of standardising the *information design* of all applications that influence web-supported learning, for example the user interface of campus portals, access to library reference pages etc. Another suggestion was to subdivide the instructional design factors into two subsections, *usability* and *learning principles*.

Further modifications agreed upon were that the term *inclusivity* should be re-worded as *accessibility* and moved to *technology* factors. The current connotation of the word *accessibility* includes access to technology for persons with learning and/or physical disabilities (Brown,

2004). Similarly *diversity* was reworded as *learning styles*, which is intended to include equity issues as well as social, cultural and gender sensitivity. The term *organisational change* was replaced with *change management*, a term more widely used in the field of education innovation.

Ingwersen's (1996) Cognitive Model of Information Retrieval

One of the critical colleagues suggested that the taxonomy in Table 3 could be meaningfully mapped onto Ingwersen's (1996) cognitive model of information retrieval (IR) interaction. The benefit of such a mapping is that it provides a practical and holistic interpretation of the complex issues involved in synthesizing factors to promote quality web-supported learning. Ingwersen's model is presented in a simplified form in Figure 1 and discussed below the figure. The mapping of the categories in the taxonomy (Table 3) onto Ingwersen's model is given in Figure 2.

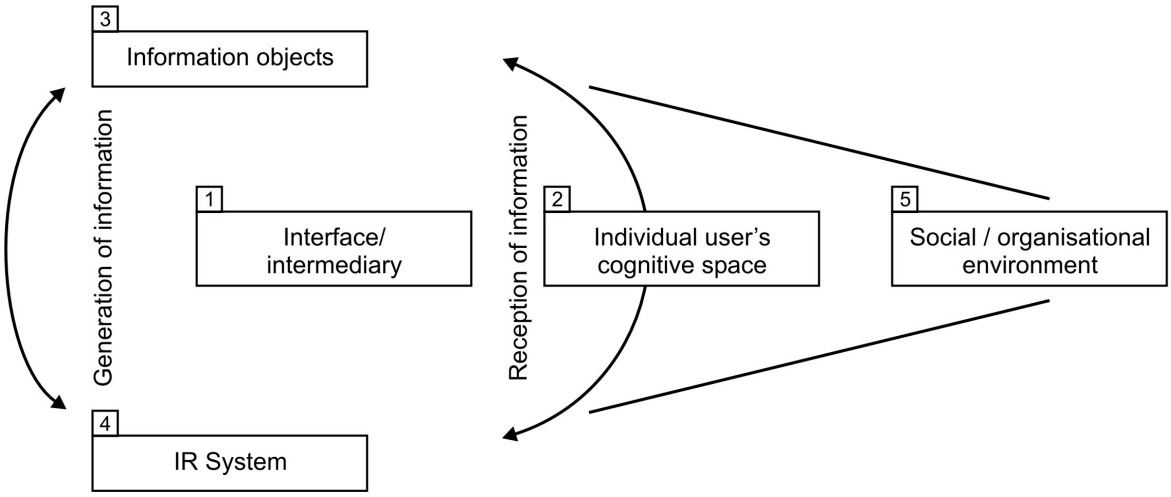

Figure 1: Simplification of Ingwersen's (1996) cognitive model of IR interaction.

The details of Ingwersen's model, such as particular items in each section and the flow of transformation, influence, interaction and communication between items are excluded from Figure 1, in order to simplify the concepts and to enable a mapping with the taxonomy.

In Figure 1, the interface, or intermediary (1) may be human or a computer. In the context of this study, it would be the computer providing access to web-supported courses (this maps onto *technology factors* in the taxonomy). The individual user (2) is the client, namely the student or lecturer participating in web-supported teaching and learning situations (this maps onto the *lecturer* and *student factors*). The information objects (3) are the web-supported learning products that the student is engaging with, including content, resources, learning activities etc. These learning opportunities are based on the *instructional design* and *pedagogical factors* that need to be considered in designing and developing quality web-supported learning products. The information retrieval system (4) is the *institutional infrastructure* to enable either information retrieval or in this case, web-supported learning. The social or organizational environment (5) includes institutional and exogenous factors, as well as the underlying assumptions that are required for quality web-supported learning. For example, underlying assumptions such as positive attitudes, motivation, class size and incentives for lecturers are part of the social and organisational environment.

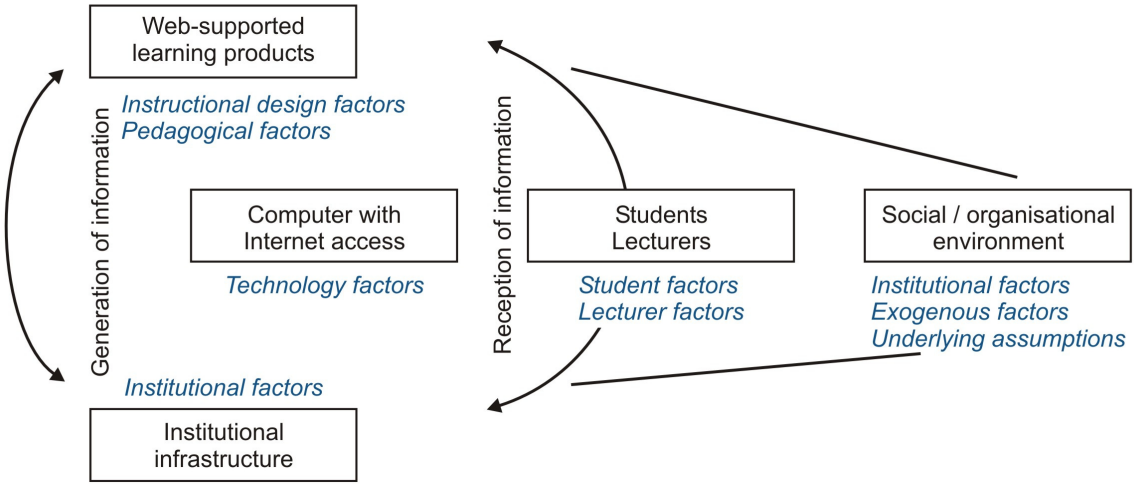

Figure 2: Graphic interpretation of the taxonomy for quality web-supported learning, mapped onto Ingwersen's (1996) cognitive model of IR

Figure 2 presents the categories of the taxonomy for quality web-supported learning mapped onto Ingwersen's (1996) cognitive model for IR, as interpreted in the foregoing discussion. In Figure 2, the categories of the taxonomy are indicated in italic text. *Institutional factors* appear twice, since they appear to map naturally onto both the *institutional infrastructure* and onto the *organisational environment*.

Thus the answer to the research question in this study is provided by the *taxonomy of factors for quality web-supported learning*, which has three components:

- underlying assumptions and exogenous factors (Table 2);
- refined taxonomy of factors, in six categories (Table 3);
- graphic interpretation providing a cognitive summary (Figure 2).

Implications and future research

This paper presents a taxonomy of critical success factors to enhance the quality of web-supported learning opportunities in a blended learning environment in higher education. The taxonomy of factors is organized in six categories: institutional, technology, lecturer, student, instructional design and pedagogical factors. Many of the factors are well established having been synthesized directly or indirectly from the literature, for example, better communication channels between students and lecturers (Chickering & Ehrmann, 1996) and classic instructional design theory (Gagné, 1985; Gery, 1987; Reeves, 1993). Additional factors were identified from more recent studies, for example usability, currency of content and resources, re-usability of learning objects and technical issues such as appropriate bandwidth and download demands[5]. Undoubtedly there are more such studies and more factors to enhance web-supported learning.

[5] This study does not make recommendations for particular technical specifications regarding the provision of high speed internet access. The implication is simply that designs should take existing technical constraints into account.

What this study has not yet done, is to test the taxonomy of factors for quality web-supported learning by applying it in a practical situation[6]. Instructional designers and project managers need guidance in applying the list of factors and deciding which are the most critical ones. The rating of the importance of factors will provide a list of quality improvement priorites, as explained by Pretorius (2004):

> "… results with high importance but low performance become quality improvement priorities and those with high importance and performance can be used as examples of good practice to be disseminated to other locations where delivery in that area is proving to be unsatisfactory. By tapping both importance and performance, institutions can ensure their scarce quality improvement resources are targeted towards what really counts" (Pretorius, 2004, p. 26).

The above concept may be interpreted graphically as shown in Figure 3. It is recommended that future research should apply the taxonomy synthesized in this paper, in order to rate and prioritize the factors.

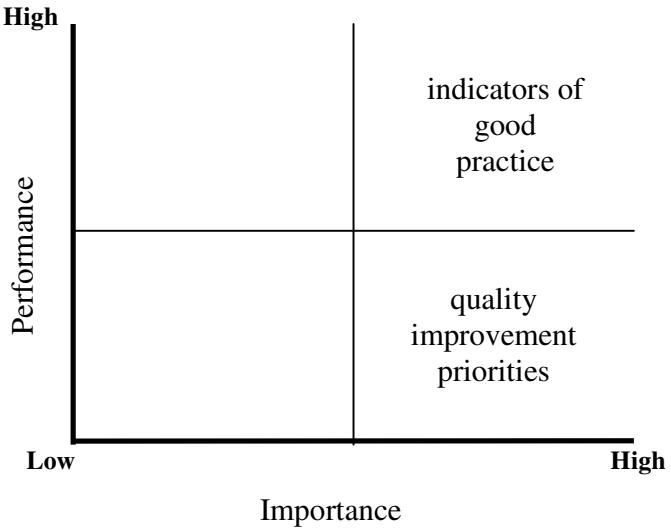

Figure 3: Framework to analyse and rate the importance of the factors in the taxonomy

The use of such a rating framework in evaluating one or two web-supported courses would enable the practical application of the taxonomy, while at the same time promoting the identification of quality improvement initiatives and the importance of summative evaluation in general.

[6] This provides an opportunity for further research.

Conclusion

The web medium offers increased convenience and alternative methods of communication and assessment. There are changing roles for both lecturers and students in learning how to make optimum use of electronic media in order to enhance the learning process. Issues such as change management, accessibility, learner-centered environments and technology access and reliability have an impact on the quality of web-supported learning products.

Few studies appear to present a holistic approach to enhancing quality in web-supported learning, by applying standard quality assurance practice to products, process and client satisfaction measures (see Fresen, 2005). Phases 1 and 2 of this study have attempted to diminish the gap between quality assurance and online learning practices (identified by Reid, 2003). The taxonomy presented in this paper is an attempt to provide a holistic, theoretical basis from which to pursue excellence in web-supported learning.

Another fresh approach in this study was to apply principles of information retrieval (IR) by mapping the categories in the taxonomy onto Ingwersen's (1996) cognitive model of IR interaction (Figure 2). This presents a practical, holistic, graphic interpretation of the taxonomy of critical success factors.

Further research is required in order to apply the taxonomy of factors in a practical situation, in order to identify the most important factors as well as quality improvement priorities.

In order to enhance its generalisability, this study is registered with the European Quality Observatory (2004).

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