AN INVESTIGATION INTO THE REQUIREMENTS
for an e-Learning System

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Keywords: Learning environment, Distance learning, e-Learning, Web-based Technology, SSM, CPTM, Requirements, Activities, Persona, Viewpoints, Business model.

Abstract: The learning environment where students of the same age group learn together instructed by a teacher, was developed over the years and is known today as the traditional classroom. This traditional classroom may be changed by using the latest Web-based technology to replace and/or support the learning process. These new learning environments are accessible using the Internet as the main communication medium and by other remote means such as CD-ROM, and video. Many aspects of the current use of these new technologies reflect an approach to teaching and learning reminiscent of the "programmed learning" training material of the 1970s. This paper uses Soft Systems Methodology (SSM) to construct a Consensus Primary Task Model (CPTM) to analyse the requirements for a distance or e-learning system. In conducting the analysis, we investigate the alternative methods proposed for the construction of a CPTM.

1 INTRODUCTION

Since the early days of education, people have searched for appropriate ways to spread and share their knowledge with their peers. In the 18th and 19th centuries, Jewish pupils used to study in small basements instructed by the community Rabbi. This study environment used to be called the *'Heder'* ('The Room'). The pupils used to study the Bible and gained reading and writing skills.

According to Dr. Katz, Director of the School of Education at Bar-Ilan University, The study of the evolution of communication technology has considerably influenced the development of distance learning. Katz (Katz, 2001) categorises the stages of the development of distance learning as three generations: **First generation**: utilising traditional printed material and communications via mail and telephone. **Second generation**: audio recordings, radio and television broadcasts. Both first and second generation Distance Learning delivery systems were designed primarily to produce and distribute learning materials as efficiently as the technology of the day permitted without any attention being focused on the lack of interactive communication between students and teachers.

Third generation: includes interactive video, email, and world wide web (www) technologies, learning activities via these Distance Learning systems has been redefined to include teacher-student interaction. Interactive video-conferencing or interaction by way of on-line Internet-based instructional and learning packages offer one-to-many tuition in which teachers and students are able to communicate synchronously thereby solving instructional and learning problems in real time. This may transport the student to a new cognitive environment which motivates and stimulates the student (Katz, 1998, 2000, 2001).

This evolution of the learning environment and methods has arisen in response to technology. We are unconvinced that the development has taken place in a systematic way, through an analysis of the requirements of the basis of the needs of various *stakeholders* in the learning system. In general, requirements elicitation is a complex and difficult task, and there is evidence (see for example the British Computer Society survey "IT Projects: Sink or Swim", January 2000) that failure to get the requirements right is clearly associated with the failure of IS/IT projects. In this context, failure may include lack of user acceptance.

Y. Sofer Y. and B. McIntosh S. (2004).
AN INVESTIGATION INTO THE REQUIREMENTS - for an e-Learning System.
In *Proceedings of the Sixth International Conference on Enterprise Information Systems*, pages 233-237
DOI: 10.5220/0002604202330237

A number of stakeholders, with different viewpoints, can be identified in considering learning systems. Their views may be surmised, and having been identified will impact the perception of *purpose* of the system to be designed. For example:

The "learner" has some motivation to learn, but may be assumed to wish to do so at minimum cost in time and effort.

The instructor may seek to transfer knowledge in the most effective and efficient way.

The employer may wish to reduce costs by delivering learning remotely, avoiding travel costs and loss of production.

The infrastructure owner may wish to minimise communications overhead.

The material owner may wish to protect intellectual property rights.

Because the various stakeholders have different views of the purpose of the system, requirements elicitation implies the need to consider an appropriate methodology. A methodology according to Dr. Brian Wilson is a description of *how to think about* the process of analysis prior to doing it. The methodology can be described as a set of guidelines which simulate the intellectual process of analysis (Wilson, 2001).

The question of which methodology to choose is itself problematic. It must reflect characteristics of the problem, scope and compass of the methodology and the skills and knowledge of the analyst, among other considerations A valid first question to ask is, is the situation considered as a 'soft' or a 'hard' problem? Wilson indicates that the design of a piece of a software to meet a given specification is a 'hard' problem whereas the specification of information requirements to meet business needs is a 'soft' problem particularly if the needs as specified by potential users. He states that the assumption upon which Soft Systems Methodology (SSM) is based is that:

Whatever the nature of the organisations, assume that the individuals within it are pursuing purposeful activity.

Individuals may well be pursuing different purposes, but they are not acting randomly. This means that providing we can identify their purposes and accommodate them, we should be able to alleviate the problem of competing viewpoints.

2 THE ARGUMENT

According to Dr. Owston (Owston, 2000) the growth of Web-based courses over the last several years has been extraordinary. Despite the widespread adoption of this new technology by educational institutions, it seems that we know very little about Web-supported pedagogy. Owston (Owston, 1997) cautions that before embracing the innovation of this new technology we need to be able to answer three questions:

(1) Does the Web increase access to learning?

(2) Can the Web promote improved learning?

(3) Can increased access and improved learning be attained without increasing the costs of education?

Owston indicates that unless we have evidence of satisfying these criteria we may be doomed to promoting just another educational bandwagon (Owston, 2000).

On the question of access, Owston suggests that each of us may have a different interpretation of what 'access to learning' means, although most will agree that it means making education more attainable for more people. Owston suggested that this implies an increase in the availability of educational opportunities for those unable to attend formal classes (i.e. school, university, corporate training etc) because of cultural, economic, or social barriers. According to Owston, Web-based educational methods can break down these barriers.

Owston suggests, however, that although the Web breaks down the long-standing physical and temporal barriers of access to education, it can create new kinds of barriers for students. These include shortages of computer hardware, malfunctions of hardware, skills difficulties and bandwidth problems.

Owston suggests that there are promising indications that the Web is a viable means to increase access to education. Evidence on how it can promote improved learning is not as readily available. In fact, there is debate in the instructional design literature about whether there are any unique attributes of media that can promote improved learning (Clark, 1983, 1994; Kozma, 1991, 1994).

Owston suggests that the issue becomes further complicated when the Web is used as a 'tool for learning', as opposed to a medium for delivering pre-determined content, which requires the users to gain the skills needed to use the tool; this may cause new barriers as mentioned above.

With regard to the cost of education, Owston suggests that there are three main areas of cost for a Web based course:

(1) Hardware and software - includes the Internet connection itself and all necessary computer hardware and Web related software required for delivering as a course.

(2) Course development - includes planning the course content and suitable pedagogy for developing the Web resources associated with the course.

(3) On-going course support – includes posting new materials and removing dated materials, verifying the validity of the links, improving the layout and design, adding functionality and uses of new technology.

Based on these assumptions, we can define a purpose for a Web-based learning environment, offering efficient, effective learning and reducing the cost of education. Using an appropriate methodology, we can derive system requirements.

3 SELECTING SSM AS THE METHODOLOGY

The terms '*hard*' and '*soft*' are used frequently in explanations of the Soft Systems approach, but first we need to make clear the distinction between the two. The terms are essentially comparative ones and are used to distinguish between methods of examination that address clearly defined problems (techniques) and others that are used when the problem is not clear at the outset. Here a preliminary investigation is required to *identify* and *select* the problem to be solved. The latter type of examination applies to situations that are regarded as *unstructured* or *soft*, inevitably involving people working as individuals or groups towards some organisational or other goal (Patching, 1990). This is illustrated in Figure 1.

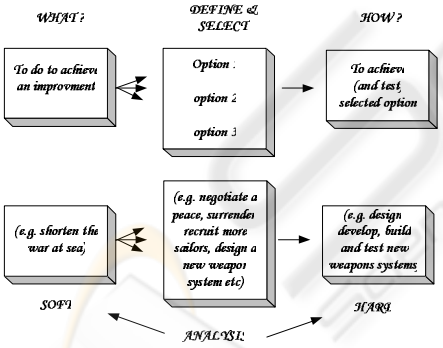

Figure 1: The Soft/Hard Division (Checkland and Scholes, 1999)

Checkland (Checkland, 1999) describes the use of SSM in relation to '*problem-solving*'. He argues that '*Real-world problems*' are more of a case of '*perceptions of problems*', this means that any problem can be perceived differently by different individuals or groups. Furthermore, Checkland states that: "a fixed element in every problem situation will be the existence of the role of 'problem owner', occupied by those who perceive the problem. A second fixed element will be the role, of the would-be problem solver, the occupants of which wish to tackle the perceived problem(s)."

SSM is concerned with defining *what* problem(s) needs to be solved, clarifying the problems that exist as a prerequisite for defining the options for improvement. These raise the questions that the designed system should give an answer to.

4 ROOT DEFINITION

According to both Checkland and Wilson, the Root Definition (RD) is a way of trying to capture the sense (root) of the *purpose* to be served. Like differential equations, RDs do not exist in reality but represent a precise framing of the system's purpose, achieved with the participation of available stakeholders. The equivalent in real-world terminology might be business objectives, mission statement, specifications etc.

The next stage is to define the area of concern more precisely (i.e. to synthesise the 'Root Definition' (Checkland, 1999)). That will lead us towards a well defined statement about the area of concern, its activities and components. This may represent a minimum that can be agreed in terms of the domain of the real activity. It will offer people who have an interest in the system the opportunity to see what they are agreeing on and what has been left out. As suggested by Checkland, the Root Definition used as a statement of purpose in SSM can be validated in terms of the mnemonic "**CATWOE**" (Checkland and Scholes, 1999). This is illustrated below.

According to the assumptions identified earlier, we can define a Root Definition representing one view of a learning system:

"*A client owned system to provide appropriate training to trainees by using the Internet as the main communications medium and learning environment, to provide an effective and efficient training solution to allow trainees to take a course anywhere at any time in order to reduce the training costs, while maintaining the privacy of the system and complying with training policy and directives, and while learning from the operation of the total system*".

Customer: Not stated (payer of training costs)
Actor: Trainees
Transformation: Untrained trainees → appropriately trained trainees
Weltanschauung: Using the Internet as the main communication medium to deliver effective and efficient training will reduce the training costs

Owner: Client
Environment: Internet; training policy and procedures

Using this RD allows us to develop a model of the activities that the system must logically do, if it is to be the system described in the RD. The words in the RD allow us to make an initial assessment of the likely subsystems in the overall model, with a view to facilitating the development of a full model at a relevant level of detail. The following candidate subsystems:

- Provide effective and efficient training
- Assess training (needed to assure effectiveness)
- Comply with the client's training policy and procedures
- Assess the cost of training (necessary in order to reduce costs)
- Maintain privacy
- Maintain knowledge base
- Monitor and control the system's performance (required by systems theory)

5 GUIDANCE AND METHODS OF CONSTRUCTING THE SYSTEM'S CPTM

The Consensus Primary Task Model (CPTM) reflects an accommodation of stakeholders' viewpoints. Each viewpoint may give rise to different ideas on the transformation carried out by the system, and different "Weltanschauungen"[1], or beliefs that underlay the purpose of the system.

The four methods for the construction of the CPTM are:

A. mission-statement: this is the most defensible method since the starting point is a 'definition of purpose' arrived at by personnel in the situation itself. The drawback of this method is that it uses only one RD. As we saw from our root definition earlier, even this suggests seven subsystems models to consider. Using this method for construction will not result in a model offering sufficient detail, which will lead us to a CPTM model of limited utility.

B. W-decomposition: this is the most difficult method to be used since the combination of the resultant W-dependent models has to be based upon a well-specified non-contentious RD and model.

C. Wider-system Extraction: this method is relatively easy to use once a wider-system model has been derived. In our case we offer an economic/effective online training system delivered remotely using the Internet Technology. Our main aim is to reduce the training costs on the one hand and on the other hand to offer an efficient and effective training process. To use the Wider-system Extraction method of construction we should examine the system Ws. In our case these are the other methods of training (i.e. learning from books and etc.); as this is not our main purpose we will not use this method.

D. Enterprise Model Assembly: this is the method most widely used by Dr Wilson in his consulting and has proved the most acceptable from the client 'buy-in' point of view. Of course, the client must have some initial appreciation of the status and purpose of the models being generated so that acceptance can be pursued. The method, apart from being based upon a very simple generic model of any enterprise, is an appropriate method, given widely differing Ws. With a little practice, it is a relatively easy method, but relies on the ability to construct a logically defensible conceptual model from a set of RDs (Wilson, 2001).

Wilson argues that in a model of an enterprise there will be a set of activities which represents its core purpose, **T**–Core Transformation. There will be other activities which facilitate, or support, this process-**S**–Support. Since the enterprise is bound by the limitations of its environment[2], other activities must exist which link its activities to the environment -**L**–Linking, providing opportunities to use the Internet Technology and other remote methods. Finally in a managed enterprise there will activities of planning, monitoring and control to enable it to survive in a changing environment – **P,M,C**–Planning, Monitoring and Controlling (in this case, making sure that the online training solution is effective and efficient) (Wilson, 2001).

6 CONCLUSIONS

The main purpose of modelling a system using this approach is to derive as wide a range as possible of the system's functional and non-functional

[1] Weltanschauung – German word, described by Checkland and Wilson as world-view or viewpoints of the system.

[2] In a "Human Activity System (HAS)", the assignment of a boundary is a subjective matter. Wherever the boundary is considered to be, an "open" system exchanges information with its environment.

requirements, reflecting the differing views of relevant stakeholders.

The list of activities and their logical relationships derived from the system's CPTM allow us to investigate the system's functional and non-functional requirements. Choosing the appropriate way of constructing the CPTM has an impact on the utility of the resulting model, because of the different assumptions underlying the approach. Analysing the activities represented in the CPTM, will give us the basis of the list of functions that the system will be required to support, and should meet the expectations of the stakeholders considered in the analysis.

7 FURTHER WORK

In this research paper we have used Dr. Wilson's Enterprise Model in order to construct the system's CPTM. A number of unfinished questions were raised during that process and require further investigation and work. While the CPTM addresses "what" the system has to achieve, it remains an open question "how" to carry out each activity. This question raises concerns about the non-functional requirements, which are to some extent ignored in the approach we have used.

One of our main concerns was the importance of the system's End-user. For consideration is what the End-user seeks in the system. One of the proposed solutions can be the use Cooper's idea of the *Persona* (Cooper, 1999) to describe the system's user. The *Persona* is an elastic imaginary user that has identity (i.e. name) and will be addressed by name (i.e. David) and not as 'User'. As David is determined by his set of characteristics we will be able to know what David seeks in the system and build a solution dedicated to David and his colleagues. This will be approached by building a Business Model that will indicate:

The need for the proposed solution (market)

The market sector for which the solution will be aimed at (David and his colleagues).

The second question relates to information analysis. The CPTM provides a list of the necessary system activities, which we regard as functional requirements. Analysing those requirements will give us a list of Software based Functions that the system needs to support, which will lead to 'Data Requirements' which can be divided into:

Performance data (i.e. how do we know how well we are doing each activity)

Operational data (i.e. what information do we need in order to carry out the activity)

In terms of the development of an on-line learning system, we believe that our approach will lead us to a defensible set of functional requirements. We propose to carry out the necessary further analysis and implement the design arrived at. With respect to our consideration of the candidate approaches to the development of a CPTM, we need to justify our confidence in the enterprise assembly approach by constructing the CPTM using alternatives, and determining whether there is any substantive difference in the resulting models.

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