Chapter 2 Literature review

Chapter guide

2. Literature Review

2.1 Information requirements

In designing a Web replacement for lectures, one first has to evaluate the information required by the student so that s/he can understand the subject sufficiently well to be able to solve problems associated with the subject, *with a minimum input from the lecturer*. In the current study the complexity of the information requirement was exacerbated by the students being faced with two new technologies: the Web browser and the Logo programming environment. Fortunately, they had already become reasonably adept at using different software packages in completing assignments during the computer literacy component of their course.

Before looking into the information requirement for the course, the link between information and knowledge will be examined.

> *...knowledge is structured integrated information and information is fragmented knowledge...* (Brookes, 1981 as cited in Todd, 1999)

2.2 Creating knowledge from information

> *In order to extract, integrate and use information, the cognitive system must develop ways of representing the available information. ... a representation is an encoding of selective information about an external event; it does not encode all possible information available. What gets selected for encoding is a function of the organism's present interests and abilities.* (McShane, 1991:17)

In the following sections the views of a variety of researchers and philosophers on the meaning of, as well as the link between, information and knowledge will be discussed.

2.2.A The Brookes equation

Brookes (1975 and 1977 as cited in Ingwersen, 1992:31) developed a pseudo-mathematical[1] relationship between a knowledge structure[2], *K(S)* and new information, *I* to yield a new knowledge structure.

$$K(S) + I = K(S + \Delta I) \qquad (1)$$

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[1] The term **pseudo**-mathematical is used as none of the variables are measurable.

[2] Knowledge or cognitive structures are the categories and concepts on which a person's (or machine's) model of the world is based (Ingwersen, 1992:229)

In words, the new knowledge structure is the old knowledge structure *plus* a portion (ΔI) of the new information at hand, which has been assimilated. The form of the Brookes equation used here is after Ingwersen, 2000a. The author prefers this form to that originally proposed by Brookes (1975)

$$K(S) + I = K(S + \Delta S) \qquad (1a)$$

as equation 1a implies a synonymity between knowledge and information, whereas the author believes that these are separate entities, as will be discussed in subsequent paragraphs.

A problem with equation (1), found by Brookes' detractors (Ingwersen, 2000a) is that the reverse equation is also implied

$$K(S + \Delta I) = K(S) + I \qquad (2)$$

This means the new knowledge structure could devolve back to its original state. In order to show that knowledge gained is never lost (Ingwersen, 2000a), Brookes formulated a one way relationship

$$K(S) + I \rightarrow K(S + \Delta I) \qquad (3)$$

It is a moot point as to whether information added to a knowledge structure is always retained. It is common knowledge that humans possess both short- and long-term memories. With short-term memory, information is definitely lost from a knowledge structure after a period of time. This means equation (2) should hold for short- term memory in humans. However, one would expect that the relationship (3) should hold for a machine's knowledge structure.

Brookes (1980) noted that the amount of information, ΔI accommodated into the knowledge structure would not necessarily be the same for different knowledge structures, given the same information, I. This means that different people (*i.e.* different knowledge structures) will accommodate different amounts of the same given information.

Brookes' equation also clearly supports Piaget's primary learning mechanisms of assimilation and accommodation of new information:

> *...Assimilation is the process by which new information is interpreted in the light of existing cognitive structures; accommodation is the process by which cognitive structures change in the light of new information.* (McShane, 1991:41)
> *... the mechanisms of assimilation and accommodation serve as a filter between cognitive structures and new information. They act continually over time to modify existing cognitive structures.* (*ibid.*:42)
>
> *Brookes' equation presents a dynamic picture of a person's knowledge undergoing change. It is a conceptualization of the fundamental transformation*

> *that characterizes information and its effect in the mind. It is an expression of what happens in the mind when people are exposed to information and do something with this information.* (Todd, 1999)

As Brookes (1975) stated, "it will take a long time" to understand the equation. This is because there are no consistent definitions of the variables, nor can these variables be measured in any way.

In the next section, Brookes' equation and the concepts of assimilating and accommodating information is discussed in more detail to show their relationship to learning.

2.2.B Assimilating and accommodating information: learning

As mentioned in the previous section, Brookes' equation states that not all information received is processed (Brookes, 1980). Furthermore, a piece of information may be interpreted differently, depending on the current state of the recipient (or the context in which the information is received), resulting in different changes to his or her knowledge structure (Ingwersen, 1996). Also, as no two people can have the same knowledge structures, they will interpret new information differently and so assimilate different amounts (ΔI from the Brookes equation) of the new information. People are continually constructing or interpreting new experiences and by so doing are transforming their prior knowledge into new knowledge (Crebbin, 1999). This processing of information to construct new knowledge is **learning** (Gagné & Glaser, 1987).

According to Mayer, Steinhoff, Bower and Mars (1995) as well as Harp and Mayer (1998), in order for a learner to construct *a coherent mental representation* (knowledge) from information presented, s/he must use the processes *selecting*, *organising* and *integrating* to evaluate the information.

- *Selecting*: relevant information is extracted;
- *Organising*: links are made between the selected pieces of information;
- *Integrating*: links are made between the new information and prior knowledge.

Only once this process has been completed can it be said that knowledge has been created and learning has taken place.

In order to create knowledge, people need to do more than passively access information, they need to do something with the information (Alexander, 1995). Ingwersen (1992:33) feels that by interacting with information, a person may become aware of a lack of knowledge[1] and thus be forced into searching for new information to overcome this deficiency. Information is thus something which affects and transforms the recipient's state of knowledge when perceived (Ingwersen, 1996).

In the next section, the use (and misuse) of the words information and knowledge will be discussed.

2.2.C Information and knowledge: synonymity

From the previous arguments it can be seen that while most authors accept that information is not, in itself, knowledge, information is required to extend existing knowledge. According to Brookes (1975) "knowledge is the summation of many bits of information which have been organised into some sort of coherent entity". Some authors, however, seem to regard the terms as being interchangeable:

> *...Think of a teacher writing Pythagoras's theorem on a blackboard and asking the students to copy it down. This is using the blackboard for knowledge. The teacher could as easily have got the students to turn to a page in their textbook that contains the same knowledge.* (Tiffin & Rajasingham, 1995:62)

What the students are looking at here is not knowledge, but information. Their brains need to do something with this information (in this case Pythagoras's theorem) so that it can be added to their existing knowledge structures. Ingwersen (1996) sums this up well:

> *The author's text, including titles, captions, headings or cited works are representations of cognitive structures* [of that author] *intended to be communicated as information objects.*

Unfortunately, the interchangeability of the terms *information* and *knowledge* is exacerbated by dictionary definitions. (See, for instance, the Online-Dictionary.) A more pertinent dictionary definition for information is *facts or news* (Collins Plain English Dictionary, 1996:329).

Belkin (1975) discusses the difficulty in defining information and states that it depends strongly on the context in which the word is used. Saracevic (1999) in his essay on Information Science asks the question "What is 'Information' in Information Science?" and answers it by saying "We don't know". He goes on to say

> *Information is a basic phenomenon. For all basic phenomena - energy or gravity in physics, life in biology, justice in jurisprudence - the same "we-don't-know" answer applies.*

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[1] Also referred to as an *anomalous state of knowledge* (Dervan & Nilan, 1986; Ingwersen, 1996)

He believes that Information Science is the communication of "human knowledge records", where a knowledge record is a "content bearing object".

Perkins on the other hand states categorically "What is knowledge? Knowledge is information..." (Perkins, 1986: 2). This is the opposite view to that discussed above, and, in the opinion of the author, just as incorrect. Knowledge is created from information, but to create information from knowledge requires a verbal articulation of that knowledge *by the person in possession of the knowledge.* Crebbin (1995) takes this even further in saying that "it is not always possible for someone to interpret and reconstruct knowledge into a form which can be understood by others" (*i.e.* it is not always possible for someone to recreate information from the knowledge s/he may possess). Shulman (1987) has similar views to Crebbin from his work with teachers, "teachers themselves have difficulty in articulating what they know and how they know it".

Crebbin (1995 and 1999), in developing a definition of knowledge from constructivist learning theories, states that "knowledge does not exist outside people". She feels that the belief that knowledge exists and has meaning beyond human construction, needs to be challenged (Crebbin, 1995).

2.2.D Information and knowledge in the computer industry

The use of the words information and knowledge in the computer industry is widespread. A term such as *Information Technology Department* is used to describe people doing hardware, software and network support. Generally, these people have nothing to do with information other than to provide the medium on which it is digitally stored or transported. However, the *technology* in *information technology* is the key concept and most of the work that the technology does, revolves around information (capture, storage, retrieval and transmission). Thus, using *information technology* as a global description for the computer industry is perfectly legitimate. According to Tanner (1992), the current usage of the term *information technology* implies the electronic handling of information, whether that information is numbers, pictures, sounds or other forms as well as a mixture of these. However, Davenport (1997:24-26), from an Information Science perspective, feels that the people in these fields are more concerned with technology and have very little to do with information. He feels that even corporate librarians are becoming more concerned with technology than the information which they are expected to deliver.

A term used incorrectly in the computer industry is *Knowledge Engineering*. In trying to find a definition for this term, the author did a search using the Google search engine (http://www.google.com) and came up with more than 30 000 hits. Of the more than 50 sites visited, only the Coventry University's Knowledge Engineering Management Centre (KEMC) tried to define *Knowledge Engineering*:

> *What is Knowledge-Based Engineering (KBE)?*
>
> *We haven't seen a perfect definition yet, but here's the best we've found, "A computer system that stores and processes knowledge related to and based upon a constructed computerised product model".* (KEMC, Coventry University 1999).

On the same page, they define *Knowledge Management*:

> *What is Knowledge Management?*
>
> *The systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest. Knowledge management helps an organization to gain insight and understanding from its own experience. Specific knowledge management activities help focus the organization on acquiring, storing and utilizing knowledge for such things as problem solving, dynamic learning, strategic planning and decision making. It also protects intellectual assets from decay, adds to firm intelligence and provides increased flexibility.* (*ibid.)*

Reading these two definitions, in the light of the earlier discussion, it should be clear that *information* should be the descriptive noun used in these subjects, rather than *knowledge*. Unfortunately, *Knowledge Engineering* is widely accepted in the computer industry, so it is highly unlikely that a semantic argument against its use is going to change matters. Ingwersen (2000b) sums up the source of this semantic error by noting that knowledge engineering is an abbreviated form of knowledge **representation** engineering, where the "representation" element has, unfortunately, disappeared. This is supported by Bunderson and Inouye (1987) who state that "Knowledge technology includes those methods and mechanisms that mankind has evolved for the *acquisition* of knowledge or expertise from one or more human masters, and the *representation* of that knowledge in appropriately usable form." [italics in original].

Another example, stemming from the concept *Knowledge Engineering*, where knowledge is used instead of information

> *...She admitted that it prevented her from making recreational use of the Web while at work, but noted that the slow speed really did get in the way of doing her job, which was becoming increasingly knowledge- and research- based.*
>
> *...*
>
> *Expectations will rise, and need to be matched by the company system if the culture of the true knowledge worker is to be successfully nurtured. ...* (Honeyball, 2000).

The use of the word knowledge instead of information by academic institutions, publications and dictionaries, unfortunately lends legitimacy to the concept that information is knowledge. Martin (1998) sees a shift in the term "knowledge worker" to "information worker" since the publication of Parat's report (1977 as cited in Martin 1998) on *The Information Economy* for the US Department of Commerce.

It would appear that the confusion between knowledge and information in the computer industry is a result of Machlup's book *The Production and Distribution of Knowledge in the United States* (1962). In both this book and the 1980 follow-up, he maintains that knowledge is a marketable commodity in that it can be produced and sold. He defines "knowledge as anything that is known by **somebody** and the production of knowledge by which **someone** learns something **he** or **she** has not known before, even if **others** have". (Machlup, 1980: 7). In keeping with the view given in a preceding paragraph, emphasis has been placed on words in Machlup's own definition which shows that knowledge is something personal. Machlup goes on to include *disseminating* and *communicating* in his definition of knowledge production (*ibid.).* Machlup does allude to the difference between information and knowledge (*ibid*: 8), but refuses to accept these differences. He states that "...in these ordinary uses of the word, all information is knowledge" (*ibid*: 9).

2.2.E Philosophical views on information and knowledge

According to Popper (1968:4) neither observation nor reason can be described as a source of knowledge. This statement cannot go unchallenged. Without observing (not only visually) the information (in all forms) with which we are bombarded each day, we cannot add to our existing knowledge. Similarly, without thinking and reasoning about that information, links to our existing knowledge **cannot** be made. Thus, observation and reasoning are fundamental to increasing our existing knowledge. Popper does, however, state that knowledge cannot start from nothing, but is advanced by the modification of earlier knowledge (*ibid*:28). Yet how is this modification of knowledge achieved? It **must** come from some external stimulus.

De Lange (2000) has looked into the roots of the words information and knowledge in order to extract the historical meanings. Interestingly enough, those meanings are as relevant today as they were centuries ago. He goes on to define knowledge as "the whole of all acts of conscious thinking" and information as "a collection of abstract forms represented (carried, coded) by any artifact outside the human mind" (*ibid.).*

Gorman defines knowledge as "Distinctions and connections organized for purposes within context" (Gorman, 1999, 2001a). He breaks knowledge into three parts: facts, skill and understandings (Gorman, 2001b) and clarifies these as follows:

- Facts or distinctions are the building blocks for knowing something. These need to be memorized as they usually cannot be deduced. They are retrieved exactly as they were stored. By themselves, they only reflect the past (Gorman 2001c).
- Skills are required to know how to do something
- Connections or understandings are how the facts and/or skills relate to each other within a specific context. These become the models which enable a person to apply "old" knowledge to new situations (Gorman 2001c).

Davenport (1997:5) believes there are three levels of "information" in Information Science, with each successive level becoming more complex. These levels are data, information and knowledge. Davenport's summary of the definitions of data, information and knowledge is most succinct.

Table 2.2.e.1 *Data, Information and Knowledge* (from Davenport, 1997:9)

Data	Information	Knowledge
Simple observations of states of the world • Easily structured • Easily captured on machines. • Often quantified • Easily transferred	Data endowed with relevance and purpose • Requires unit of analysis • Need [*sic*] consensus on meaning • Human mediation necessary	Valuable information from the human mind. Includes reflection, synthesis and context • Hard to structure • Difficult to capture on machines • Often tacit • Hard to transfer

In the light of the above definitions, Davenport has a rather tongue-in-cheek view of the concept knowledge management:

> *For years, people have referred to data as "information"; now they have to resort to the high-minded "knowledge" to discuss information - hence the current boom in "knowledge management".* (Davenport, 1997:8).

In spite of this and saying that "data, information and knowledge are not interchangeable concepts" (Davenport, 1998:1), Davenport misuses the word *knowledge* in discussing knowledge transfer:

> *Knowledge transfer involves two actions: transmission (sending or presenting knowledge* [information][1] *to a potential recipient) and absorption by that person or group. If knowledge* [information] *is not absorbed, it has not been*

[1] The author has included [information] in the quotation to signify where he feels that Davenport has used *knowledge* incorrectly.

> *transferred. Merely making knowledge* [information] *available is not* [knowledge] *transfer.* (Davenport, 1998:101).[1]

Davenport goes on to say:

> *Even the transmission and absorption together have no useful value if the new knowledge does not lead to some change in behaviour, or the development of some new idea that leads to new behaviour.* (*ibid.*).

2.2.F Working definitions of information and knowledge

The following table sums up the preceding arguments. These definitions will be used, to qualify the terms given, in the rest of this document. From *knowledge* and *information*, working definitions for *learning* and *teaching* are also proposed.

Table 2.2.f.1 *Working definitions*

Knowledge[2]	• Skills which enable a person to solve problems. • Stored facts which allow a person to understand a problem or situation.
Information	The medium by which knowledge is transferred between people. It may be verbal, written, an action to be copied or a combination of these.
Learning	Making links between information presented and existing knowledge to create new knowledge.
Teaching	Assisting a learner in creating new knowledge from information presented.

It should be noted that Bloom *et al* (1956) have a far more complex structure for knowledge. They also separate intellectual abilities and skills from knowledge, which conflicts with the preceding arguments. In this study, intellectual abilities and skills are considered as part of knowledge.

From the definitions given in table 2.2.f.1, information requirements for Web-based teaching can be developed.

[1] This quotation is nothing other than a reformulation of the Brookes equation (section 2.2.A).

[2] This definition of knowledge are loosely based on Gorman's views (2001a).

2.3 Information requirements for Web-based teaching

> *When authors advocate a particular approach to teaching (or learning), only rarely do they make explicit their view of what constitutes valid knowledge, of how it is created, shared or reproduced.* (Candy 1991:262).

Before the requirements for Web-based teaching can be addressed, it is necessary to define the role of the teacher and the role of the learner in the teaching/learning process.

2.3.A The role of the teacher

> *Teaching can be thought of as events, external to the learner, designed to support internal learning processes* (Gagné, 1987).

The teacher should be a subject expert, and being a subject expert means that the teacher would have converted information on the subject into usable knowledge. In teaching that subject, the teacher presents his or her knowledge to the learner. However, to the learner, this is not knowledge, but information[1]. A good teacher will realise this and try to facilitate making the required links between the learner's existing knowledge and the new information presented (Gagné & Glaser, 1987; Copley, 1992 as cited in Tam, 2000). Most of the theories of learning revolve around making these links (*e.g.* Bloom's Taxonomy of Learning[2] and Gagné's Learning Events[3]). Unfortunately, in most tertiary[4] teaching situations, the teacher has even less regard for the process by which the learner is expected to accommodate new information with his or her existing knowledge. These tertiary level teachers have usually forgotten what is difficult and what is easy for students (Bransford *et al*, 1999:32). A teacher's subject knowledge needs to be tempered with pedagogical knowledge as well (Shulman, 1987; Bransford *et al*, 1999:33).

More often than not, the learner is coached, by the teacher, to pass an examination (Fox, 1983; de Bono, 2000: 6; Johnston, 2000; Kantrowitz & McGinn, 2000; Schank, 2000; Shea, 2000). In cases such as these, the learner gains no knowledge, and the information that had been absorbed during the coaching/cramming session is soon lost. (equation 2 in section 2.2.A). Assessments usually measure factual knowledge which seldom asks the student when, where and why that knowledge should be used (Bransford *et al*, 1999:37).

Further, in attempting to use software to disseminate [educational] information, the software developer seldom does a needs analysis of the user, nor, in fact, is any kind of detailed analysis of the user done. This usually results in the failure of the software to

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[1] contrary to the view expressed by Tiffin & Rajasingham (1995) discussed in a previous section
[2] Bloom *et al* (1956)
[3] Gagné (1965)
[4] Tertiary education refers to higher or post-secondary education.

facilitate learning (Draper, 2000). The failure is often as a result of the software being driven by technology rather than the educational needs of the student (Draper, 1998). In order to develop successful educational software, the teacher needs to work closely with the developer. This is to make sure that not only are the subject requirements met, but also those of the user. Needless to say, the teacher **must** also understand the needs of his or her students (Galusha, 1997) and should also have a good grasp of the capabilities (and limitations) of the technology to be used (Kaufmann & Thiagarajan, 1987).

In order for a teacher to develop a successful Web-based learning environment, her or she needs to critically examine his or her teaching practice and develop it accordingly. (Saarenkunnas *et al*, 1999). Web-based teaching does not rely on Web-based instruction only, it also needs the more traditional forms of contact teaching (*ibid.)*. The teacher should also take the views of the learners, about the role of Web-based teaching, into account when designing courses. This could prevent "cultural insensitivity"[1] to, as well as "misempowerment"[2] of, the learners (Lê & Lê, 1999).

To analyse his or her teaching practice, a teacher needs a set of guidelines on which to base his or her analysis. Such a set of guidelines from Shulman (1987) is given in Table 1.3.1. Shulman bases his model on classroom evaluations of successful teachers.

Table 2.3.A.1 *A model for pedagogical reasoning and action* (Shulman, 1987)

Comprehension	Of purposes, subject matter structures, ideas within and outside the discipline
Transformation	• Preparation: critical interpretation of texts, structuring and segmenting, development of a curricular repertoire, and clarification of purpose • Representation: use of a representational repertoire which included analogies, metaphors, examples, demonstrations, explanations, and so forth • Selection: choice from among an instructional repertoire which includes modes of teaching, organizing, managing, and arranging • Adaptation and tailoring to student characteristics: consideration of conceptions, preconceptions, misconceptions and difficulties, language, culture, and motivations, social class, gender, age, ability, aptitude, interests, self concepts, and attention
Instruction	Management, presentations, interactions, group work, discipline, humour, questioning and other aspects of active teaching, discovery or inquiry instruction, and the observable forms of classroom teaching
Evaluation	• Checking for student understanding during interactive teaching • Testing student understanding at the end of lessons or units • Evaluating one's own performance, and adjusting for experiences
Reflection	Reviewing, reconstructing, reenacting and critically analyzing one's own and the class's performance, and grounding explanations in evidence
New comprehensions	• Of purposes, subject matter, students, teaching and self • Consolidation of new understandings, and learnings from experience

[1] This could be racial or economic factors preventing the learner from successfully using the medium.
[2] The learner might not want to use the medium.

Before looking at the role of the learner, consider these words in closing this section on the role of the teacher,

> *...But what must concern the academic teacher is not so much the information retrieved by the student, but the use of that information - the transformation wrought by the student to render it as knowledge.* (Laurillard, 1993:126).

2.3.B The role of the learner

Students need to seek meaning and understanding from the information they interact with in order to gain knowledge (deep learning) rather than merely memorising facts for later recall in an examination (shallow learning) (Alexander, 1995).

The majority of students are unable to make connections between what they are learning and how knowledge they gain will be used. This is because of the way in which they process information (Anon., 2001b). Students need to learn when, where and why to use information received as well as how to recognise meaningful patterns in the information in order to develop an understanding (knowledge) of the subject matter (Bransford *et al*, 1999:38).

The learner needs to apply some form of cognitive strategy in order to solve given problems. If applied successfully, the cognitive strategy should lead to mastery of the subject matter (Fleming, 1987). Learners need to think about and discuss their own approach to learning, and be willing to explore alternatives (Candy, 1991:296). However, many learners regard this as

- a waste of time,
- the teacher avoiding his or her responsibility,
- not what they had come to learn (Baird & Mitchell, 1986 as cited in Candy, 1991:297).

Nonetheless, for learners to be able expand their knowledge, they need to become autonomous, and to become autonomous learners, they need to think about learning itself (Candy, 1991:298,299). A common misconception is that a person becomes autonomous on becoming an adult. This is rarely the case, as discussed by Steyn (1998). The student needs to be convinced that he or she needs to become an independent lifelong learner (Forsyth, 1998:20).

As the teacher usually sets specific deadlines for tasks in Web-based courses, students are responsible ensuring that they complete their tasks within these deadlines (Passerini & Granger, 2000). Learners need to take control over their learning rather than having a teacher control it for them. Figure 2.3.b.1 shows a hypothetical continuum showing how teacher/learner control of learning varies. On the left is teacher dominated control, with very little scope for learner control, as is found in a school classroom. On the right a point is reached where the learner controls almost everything which he or she wishes to learn. This point would be reached by a person truly capable of independent study (Candy, 1991:8-19). This point is seldom achieved, but for Web-based learning, one would hope that the learner falls at least into the right half of the continuum.

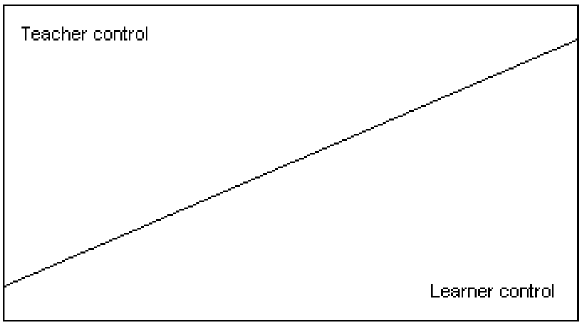

Figure 2.3.b.1 *Hypothetical teacher/learner control continuum* (after Candy, 1991:10)

The figure also shows that as the teacher surrenders control over what is being learned, the learner must accept a corresponding amount of control of his or her own learning (Candy, 1991:9). This seldom occurs with undergraduate students. Steyn (1998) feels that undergraduate students should be treated as developing learners rather than adult learners. However, with Internet-based learning, the learner **must** take more control of his or her learning (Forsyth, 1998:32). A further problem often found is that undergraduate learners lack the motivation for on-line coursework found in adult learners (Irani, 2000). This lack of motivation for on-line learning is usually caused by the learning expectations ingrained in the student by the passive manner in which information is received in the school classroom (Åkerlind & Trevitt, 1995).

To sum up this section on the role of the learner, consider the following from MacFarlane (1995):

> *Students will have to learn how to manage their own learning processes to an unprecedented degree... to swim in a sea of information, to use the rich resources of a supportive learning environment, to self pace and self structure their own programmes of learning* (MacFarlane, 1995 as cited in Ward & Newlands, 1998).

2.3.C The role of the medium of delivery

Technology-based teaching procedures must take into account characteristics of the learner, such as maturity and knowledge status (Gagné, 1987) as learning is highly dependent on the prior knowledge of the learner (Reigeluth, 1983 as cited in Fleming, 1987). It should also try to match the learner's cognitive strategies with the task at hand by

- assuming the learner knows, and will use, the correct strategy,
- reminding the user of a known strategy,
- building a strategy into the teaching procedure (Fleming, 1987).

Much of the educational material available on the Web does not live up to expectations since most of this material is in the form of electronic page-turners or an electronic book with some search and indexing facilities (Cronjé, 1997; Forsyth, 1998:13). However, it is often easier and quicker to get an answer to a question by consulting a reference book than by using a search engine to scour the Web (Basch, 1999). Students often prefer the portability (and readability) of a book or printed notes over a network dependent computer terminal (Harmon & Jones, 1999). In spite of these misgivings, the Web does allow relatively easy access to information (Forsyth, 1998:13.).

Arnold (1997) prefers using the Web to deliver his course notes and references as it allows him the flexibility to make rapid changes to the course content and reference material in the light of students' responses to preceding lectures and assignments. All the students then have immediate access to the changes without having to wait for a reprint of the updated edition of the course guide.

In spite of its appeal as a delivery mechanism, the Web still contains many unknowns as a tool for learning, both in terms of the expectations of the learner and what can or cannot be done with the technology (Hill, 2001). As the Web is not appropriate in all situations in education, Harmon and Jones (1999) have proposed five levels of Web use for educators to use as a tool in deciding how, or indeed whether, to use the Web in their courses. Table 2.3.c.1 shows these levels with a short description of how Web usage varies in the different levels.

Table 2.3.c.1 *Levels of Web use in education* (after Harmon & Jones, 1999)

Level	Web usage
0	No Web use.
1	*Informational* Web use: usually administrative, including information such as the syllabus, course schedules and contact information. Frequent use of the Web is not necessary.
2	*Supplemental* Web use: provides an addendum to core content of a course, and usually includes course notes and handouts on the Web. Frequent, but not necessarily daily access to the Web is required.
3	*Essential* Web use: most of course content is placed on the Web. Students cannot successfully complete the course without accessing the Web.
4	*Communal* Web use: face-to-face and on-line interactions occur, with course content being provided in either medium. Students generate on-line course content themselves.
5	*Immersive* Web use: all course content and interactions occur on-line.

In addition to the levels of Web use outlined in Table 2.3.c.1, Harmon and Jones have also identified eleven factors that influence whether Web-based instruction should be used (*ibid.*). In Table 2.3.c.2 these factors are listed with a brief description of how each factor influences the choice of Web-based instruction.

Table 2.3.c.2 *Factors influencing the desirability of Web use in education* (after Harmon & Jones, 1999)

Factor	**Description**
Distance	This refers to the geographical proximity of the teacher and students. Under certain circumstances, teachers and students in close proximity can benefit from online instruction.
Stability of material	How often does the course material need to be updated? Web-based material can be rapidly updated and is immediately available.
Need for multimedia	If a course requires the use of multimedia, this can be easily incorporated into Web-based material, providing the student has sufficient bandwidth in his or her access to the Web.
Need for student tracking	Is it necessary to keep records of student interaction with and progress through the course? Web server-based software is available for record keeping.
Number of students	The higher the level of Web usage, the lower the number of students a teacher can manage. Using Web-based instruction to boost student numbers, when classroom space is at a premium, is a mistake.
Amount of interaction	Here, the interaction is amongst students and the teacher, not with the software. This becomes very important in Web use levels 4 and 5 in Table 2.3.c.1, where E-mail, chat rooms and bulletin boards would supply the interaction.
Social pressure to use Web	Although not really pedagogically valid, social pressure is one of the driving forces behind using the Web as an instructional tool. Educational institutions could lose credibility for not having Web-based offerings amongst their products.
Need for online reference	Reference sites, which are regularly updated, may be useful as an adjunct to course material.
Infrastructure	An institution must have the network capability and servers to supply a satisfactory data throughput. It also needs support personnel to maintain the technology.
Comfort levels	Students with no background in technology-based learning require significant amounts of training in order to cope with a Web-based course.
Access	This refers to whether the student has access to both the Internet and the necessary hardware.

Harmon and Jones have extended their arguments to show how the factors outlined in Table 2.3.c.2 affect the level of Web usage outlined in Table 2.3.c.1 (*ibid.*). The issue of "Number of students" has been examined by Irani (2000). She reported that many universities in the USA were looking to increase student numbers by 30-40% over the next ten years by offering on-line courses to relieve the pressure on campus facilities. She questions whether undergraduate students will be able to cope this medium of course delivery (*ibid.*).

According to Wijekumar (2001), creating an on-line course requires more than putting course notes on the Web. It requires time and effort from people with skills ranging from subject matter experts to instructional designers and programmers. She feels that currently, much of the material available being created is driven by tools built into "Web-based course and development systems" rather than educators with teaching and learning at heart (*ibid.*). Lê and Lê (1999) take this even further. They feel that the students themselves should be included in the design process when constructing on-line course material (*ibid.*, Saarenkunnas *et al*, 1999). Web-based courses seldom rely solely on the Web as the sole form of instruction. Traditional forms of teaching, such as lectures and tutorials, are also used (Saarenkunnas *et al*, 1999).

The so called Clark-Kozma debate (Clark, 1994; Kozma, 1994) centres around whether, in a learning activity, the delivery medium plays a role in any learning which takes place. An issue of the journal *Educational Technology Research and Development* was devoted to this debate (Ross, 1994). According to Clark, the learning activity (and learning) is independent of the delivery medium. To him, the teaching method is important. He uses an analogy of a truck delivering groceries. Regardless of what type of truck is used, the groceries will be delivered (Clark 1983 as cited in Clark, 1994 and Kozma, 1994). Kozma on the other hand feels that the medium of lesson delivery is important and does influence learning (Kozma, 1994). Depending on the topic, presentations in different media can influence the learning outcome. He cites two specific examples in which measured differences in learning outcomes were found, which could be directly attributable to the medium used. However, Russell (2002) has more than three hundred references in his "no significant difference" database. In these references researchers have found that technology-assisted teaching has not produced significantly different outcomes to classroom-based teaching.

"...the *learning activity* and not the technology or the medium in which it is used, is the key to improved outcomes..." (Housego and Freeman, 2000).

2.4 Web-based teaching as aid in disadvantaged communities

2.4.A Cultural and language issues

The failure of students to pass their grades in higher education can more often than not be ascribed to a mismatch between what students have learned in their home cultures and what is expected of them in the university culture (Bransford *et al*, 1999:225). In order for such students to create new knowledge, they need a great deal of assistance making links between their existing knowledge and the new information they receive on a daily basis (*ibid.*:224). This is of critical importance when technology-assisted teaching is being considered. A generic teaching method, such as found in Web-based courses, could fail by not taking into account cultural and language differences amongst learners (Lê & Lê, 1999).

2.4.B Political and economic issues

Education is a political and economic phenomenon and failure to take into account the financial constraints under which schools are forced to operate often lead to the downfall of new teaching practices (Morgan, 1987). A factor often overlooked when implementing such new practices, especially when technology is involved in the new practice, is maintenance (and the cost of the maintenance) of the new system (*ibid.*; Galusha, 1997). A limitation of the Internet is the increasing complexity of the technology required to access it. Implicit in this increasing complexity is an increase in the cost of being able to access the information available on the Internet (Forsyth, 1998:18). Before poor countries can capitalise on new technologies, they need to increase the number of people with the high-level skills required by these technologies (Elliot, 2001).

2.4.C The digital divide

Students need training in the technical issues of using computers and the Internet (Galusha, 1997). Students lacking these skills can be hampered in their efforts to complete a distance course. "If distance learning is to be successful, technical barriers must be made a non-issue" (*ibid.*) (see also "Comfort levels" in Table 2.3.c.2). On the other hand, if teachers are not motivated to use the technology then any Web-based teaching initiatives will not reach expected outcomes (Bohlin, 1999). Arnold (1997) asks whether it is always appropriate to compel students to commit themselves to technology-based learning as transformations of this nature are usually met with resistance. This resistance to technology-based learning is rarely acknowledged and even more rarely addressed by educators and education administrators (Åkerlind & Trevitt, 1995).

Furthermore, an aspect of the digital divide seldom discussed is the challenge of providing Internet access in all communities (Anderson, 2001). Generic services which supply only basic HTML Web services are inadequate to meet educational needs (*ibid.*). The cost involved in supplying (and receiving) high quality Internet services may be beyond the budget capabilities of many disadvantaged communities (*ibid.*).

2.4.D South African issues

One of the biggest problems in South African education is that of teacher skills. Many mathematics and science teachers in Black communities have not studied the subjects they teach beyond the senior school year (TELI, 1996; Pretorius, 2001a). In order to overcome this, in-service training programs for teachers have been implemented at many tertiary institutions.

However, there is very little motivation for teachers to improve their qualifications, nor for that matter is there any reason for university graduates to become teachers. A language teacher with a Masters degree (and more than 10 years appropriate experience) can, at best, expect to earn R80 000 per annum (with no fringe benefits), at one of the better schools in Pretoria (Nel, 2001). In the first three years that the BSecEd(Sci) (a course to train secondary school science teachers) was offered as a degree at the University of Pretoria, not a single Black student had enrolled (Nordhoff, 2001). With the poor return on investment on university studies for teachers, this is hardly surprising. O'Malley (2001) feels that some of the donations from the private sector and overseas sources, which are currently used for building new schools and repairing "old" ones, should be used for increasing the standards of teacher professionalism. However, without increasing the salaries of teachers, the standard of teaching will not improve. This problem is not unique to South Africa, as it has also been noted in the United States Government's Web-based Education Commission Report (WBEC, 2000: 6 & 7).

In 1996, the South African government compiled a report on using technology as a teaching and learning aid in education. This report, known as the Technology-Enhanced Learning Initiative (TELI), examined advantages and disadvantages of various forms of technological aids in teaching as well as how these aids could be implemented in South African education (TELI, 1996 &1997). An important finding was that the teacher remained the key to successful provision of education, regardless of the technological aid being used (TELI, 1996). Using technological aids in education is usually more expensive than in an equivalent face-to-face situation (*ibid.*). Schrecker (1998) concurs with this and goes on to say that technology does not save money by lessening the need for teachers and classrooms. It requires a high capital investment as hardware, software and support staff have a built-in obsolescence which needs to be continually upgraded.

In 1997, the TELI team gave themselves five years in which to implement the initiative (TELI, 1997). At the time of writing (November, 2001), no noticeable progress in its implementation has been seen (as can be deduced from the writings of Pretorius in the *Sunday Times* during 2001), in spite of the R71 million budget requested in 1997 (TELI, 1997). This maybe an indication of the difficulty surrounding a project of this nature.

The Information and Communications Technology (ICT) report (Departments of Education and Communications, 2001) as well as the TELI discussion document (TELI, 1996) see the delivery of services, such as electricity, water and telephone connectivity, to the poorer communities as fundamental to the implementation of any technology-based teaching initiative. However, the introduction of technological aids to teaching may widen the gap between the urban and rural areas (TELI, 1996).

In closing this section on Web-based teaching in disadvantaged communities, consider the following:

> *Educational technology has not yet produced promised changes in our schools and our workplaces...* (Estes & Clark, 1999).

2.5 Conclusion

In this chapter working definitions of information, knowledge, learning and teaching have been developed from arguments in the literature as well as from the views of several academics. Information and knowledge are not synonymous, but rather, like teaching and learning, separate, related concepts.

From these working definitions, the information requirements for successful teaching via the Web have been developed. Web-based teaching requires more than merely converting course notes into Web pages. It needs more work than normal face-to-face lectures *in addition to* some face-to-face contact between the lecturer and the student. Using Web-based teaching to increase student numbers without increasing lecturing staff is also not feasible as these students require more attention (not less) than their classroom-based counterparts. Harmon & Jones (1999) tools for evaluating the desirability of Web use in education should be followed carefully before implementing Web-based modules.

Finally, issues concerning Web-based teaching in disadvantaged communities have been examined. These show that care should be taken in not further marginalising the disadvantaged communities with the introduction of technology that can be neither afforded by those communities nor supported within them.