A conceptual object-oriented model to support educators in an outcomes-based environment
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A conceptual object-oriented model to support educators in an outcomes-based environment

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DECLARATION

I, Rudi Gerhard Harmse, hereby declare that –

• The work in this dissertation is my own original work.
• All sources used or referred to have been documented and recognised.
• This dissertation has not been previously submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised education institution.

Rudi Harmse
ABSTRACT

The introduction of outcomes-based education (OBE) in South Africa has led to a new learner-centred approach with an emphasis on the outcomes that the learners need to achieve. With this learner-centred focus has come a greater need for record keeping. It is now necessary to track each learner’s progress towards the attainment of the learning outcomes. This progress is tracked in relation to assessment standards that are defined for every learning outcome. These assessment standards define the results expected of learners at certain stages in their development.

The new OBE system has emphasised accountability and this is expressed in a requirement to keep evidence to justify the assessment results given. The large numbers of learners and the increased managerial demand of OBE cause problems to educators who may find themselves unable to keep track of the learners’ progress under such conditions.

This dissertation investigates the structure of the new OBE system as well as its assessment and evidence requirements. From this the features required from a support system for educators in an OBE environment are determined. The supporting processes needed to enable these features to be implemented, as well as the storage requirements of such a system are identified.

In addition to OBE, the field of Computer Integrated Learning Environments (CILEs) and Intelligent Tutoring Systems (ITSs) are investigated and useful details identified are added to the requirements for an OBE support system.

The dissertation then presents an object-oriented conceptual model of the items that need to be stored in order to allow the features of an OBE support system to be implemented. The relationships between these items are also indicated in this model.
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CHAPTER 1:
INTRODUCTION

1.1 INTRODUCTION

Outcomes-based education (OBE) in South Africa has caused a renewed look at the need for ensuring that learning takes place and that every learner has the chance to progress. This requires a certain degree of knowledge regarding the progress of individual learners and to provide for their educational needs.

This dissertation will attempt to highlight the needs of a computer system for supporting assessment in an OBE environment and to define a conceptual model which will provide for the storage needs to serve as a foundation for the development of systems intended to provide support in an OBE environment.

This chapter provides a brief background, followed by a problem statement and the objectives of this dissertation. The methodology followed is also discussed and an overview of the chapters is provided.

1.2 BACKGROUND

The increased demand for affordable, quality educational opportunities and the rate of scientific and technological change make it necessary to cater for larger numbers of students in an efficient and cost-effective manner. In addition a fundamental issue for teaching is the effect of individual differences on the efficiency and effectiveness of learning (Chizmar and Williams, 1996). The design of teaching materials may, unconsciously, reflect the styles and preferences of the designer or lecturer (Sadler-Smith, 1996). This may be different to that of at least some of the learners.
The introduction of an outcomes-based education (OBE) system in South Africa, with its emphasis on record keeping, has also increased the requirements to know what each learner can and cannot do. The structure of OBE in South Africa has undergone some changes since implementation, but in the current draft form for the school curriculum there are general outcomes defined that are cross-curriculum. In addition to this, there are different learning areas, which contain a number of learning outcomes, specifying what competence is required of the learner. These learning outcomes are too general to serve as a practical guide to teaching and assessment. There are therefore assessment standards defined for each learning outcome to define the knowledge and skills that need to be demonstrated at each level in a qualification in order to be considered as having mastered the particular learning outcome at that level.

In OBE the curriculum is defined in terms of these learning outcomes and assessment standards. The progress of the individual learners is tracked in relation to these outcomes and assessment standards. With large numbers of learners, it can be difficult for the educator to keep track of the progress and problems of each learner as the course progresses.

Intelligent tutoring systems (ITS) attempt to address some of these issues (Kaplan & Rock, 1995; van Biljon, Janse Tolmie & du Plessis, 1999). ITSs attempt to help the learner progress from the current level of accomplishment to a higher level by keeping track of the learner’s behaviour and using this to gain insight into the current state of the learner’s knowledge and abilities. The information that the ITS has gathered regarding the learner is then used to adapt the instruction in order to assist the learner to progress (Siemer, 1997). Many of these ITSs are programmed with alternative learning strategies, which they then apply and monitor the success of these. The outcomes of these attempts are then stored in a student model, which is used to guide future choices (Woolf, 1996; Rosas, Nussbaum, Strasser & Csaszar, 1997; Siemer, 1997; Angelides & Paul, 1999).

Although the field of Intelligent Tutoring shows a lot of promise, these systems are widely acknowledged as having many shortcomings. The most notable of these is the
limits of current artificial intelligence systems and the lack of flexibility of these systems (Patel & Kinshuk, 1997; Siemer, 1997). Gordon (1997) states that it is yet to be proven that, computers are better at imparting knowledge than other teaching techniques. He also contends that a real danger of the use of computers for delivering the instruction is sidelining of the educator. This has real dangers, as the educator (lecturer) is a very important part of the learning equation.

Computer systems are good at storing and processing information, but lack innovative and adaptive abilities. These shortcomings are especially relevant in fields where the content matter changes often, as ITS systems are unable to adapt quickly enough. Humans on the other hand, are more flexible and adaptive, but they have problems storing large amounts of information accurately.

1.3 PROBLEM STATEMENT

Having to teach large numbers of learners, with varying levels of technological exposure, makes it very difficult for an educator to have the necessary information about the progress of each individual learner. This lack of detailed, timely information prevents an educator from providing the individualised diagnosis and help that is so important in the promoting of skill acquisition.

Without this information the educator would also not be able to assess whether the learners are meeting the stated outcomes and would therefore be unable to function effectively in an outcomes-based environment.

The educator therefore requires an information system, which can provide the necessary representation of learner skills in order to provide meaningful feedback to learners regarding their progress, as well as allowing for the taking of appropriate and timely corrective action. These are requirements of outcomes-based education. This information is also required for final reporting.

In addition, the learner should also have access to the information contained in such a system. This would enable them to evaluate their own learning and to find help for any
gaps in their knowledge and any misconceptions they may have.

1.4 OBJECTIVES

The first objective was to determine the information needs resulting from the adoption of an outcomes-based education system in South Africa. In particular the formative assessment requirements in this regard were of interest.

The second objective was to determine the requirements of a system, which will provide the informational and managerial support, to provide for effective monitoring of learner skill acquisition in an outcomes-based course.

Thirdly, a conceptual model of the storage requirements of such a support system was to be developed.

1.5 METHODOLOGY

A literature study of outcomes-based education (OBE) was conducted. This covered the general principles of OBE, as well as its expression in South Africa. This included a study of its historical development in South Africa, as well as more recent changes that are taking place to identify the general needs of a support system. Further, the assessment needs within this environment was studied, to determine the particular needs that exist with regard to assessment.

As intelligent tutoring systems (ITSs) attempt to address some of the general education needs that had been identified, a literature study into the field of ITSs was conducted and this provided some more criteria for the storage requirements of the support system.

Due to the relatively new and changing nature of OBE in South Africa, it was decided to provide a general model, which could provide a structure within which further research could take place and a platform on which further research could build. Jeffers (1982)
defines a model as a representation of the relationships between formally defined quantities or qualities. The model developed here describes the relationships between various objects that are required to provide for the central storage requirements of an educator support system. The reason for using conceptual models is to reduce ambiguity and because they represent the essential details, while avoiding details that would detract from the essential elements.

Jeffers (1982) states that modelling starts with a careful definition and bounding of the problem to be solved. This was accomplished by the literature study into firstly OBE in general, then assessment in particular. From these studies the essential requirements were identified. These requirements consisted of general design guidelines, which should be adhered to. There were also general educational needs and supporting processes, which needed to be placed in context. In addition to these specific storage requirements were identified. The role of ITSs were also investigated.

All of these needed to be placed in context, in order to provide a clear delineation and bounding of the storage requirements being modelled. This was accomplished by providing a framework, which shows how integrated learning support environments can be developed, defining the role of the learners, educators, artificial intelligence systems, communication systems and storage.

The changes in the structure of OBE in South Africa, coupled with the fact that these changes were still in draft form at the time of the completion of this dissertation, limited the implementation and testing options available. This was therefore left for a future study, once the full impact of the new changes to the OBE implementation has been determined.

1.6 LIST OF CHAPTERS

Figure 1.1 provides an overview of the structure of this dissertation. In particular it shows the relationship between the chapters.
Chapter 2: SYSTEMIC CHANGES IN SOUTH AFRICAN EDUCATION
This chapter looks at the development of a systemic approach to education and training in South Africa and its expression in the outcomes-based National Qualifications Framework (NQF) and the South African Qualifications Authority (SAQA). In the process of doing so, general systems theory, as well as the learning cycle and learning styles are briefly looked at. The general nature of OBE is also covered, first in general, then in South Africa in particular. This chapter concludes with a list of design requirements of an OBE support system.

Chapter 3: ASSESSMENT OF LEARNING
A central issue in OBE is the assessment of learning. Here the topic of assessment is first covered in general, before the particular assessment requirements of an OBE environment is covered. Finally, this chapter concludes with a list of design requirements of an OBE support system with regard to assessment and feedback.

Chapter 4: COMPUTER INTEGRATED LEARNING ENVIRONMENTS
The general components of a computer integrated learning environment are covered...
in this chapter. The role of ITSs is also covered and some additional design principles for the support system are identified.

**Chapter 5: AN OBE SUPPORT SYSTEM**
This chapter presents a framework for the development of an integrated learning environment, which defines the role of the different role-players. This is followed by the presentation of a conceptual model of the storage required in the form of objects and their relationships.

**Chapter 6: CONCLUSION**
This final chapter provides an overview of the dissertation. It takes a final look at how the conceptual model provides the base on which OBE support systems can be developed. This chapter also provides some final comments and looks at problems experienced and future research opportunities, before concluding the dissertation.
CHAPTER 2:

SYSTEMIC CHANGES IN SOUTH AFRICAN EDUCATION

2.1 INTRODUCTION

Systems thinking is a formal management science discipline that deals with systems. It focuses on the parts the system is made up of and the way these parts interact with each other. A systemic educational system has emerged in South Africa making use of a National Qualifications Framework (NQF) and built on the principles of outcomes-based education (OBE).

This chapter gives a brief introduction to systems thinking, followed by a brief discussion on the learning cycle and some of the effects that learning styles can have. This is followed by a look at the management of learning.

After these introductory sections, the development of a systemic education policy system in South Africa is traced, from its roots before the 1990s through to its culmination in the South African Qualification Authority (SAQA) and the National Qualifications Framework (NQF).

This leads into a discussion on outcomes-based education (OBE). Different possible approaches to OBE are highlighted. This is followed by a brief overview of OBE as implemented in the South African school system. The proposed revised curriculum framework of 2001 is also covered.

Finally this chapter concludes with a summary of the requirements identified within this chapter, which would have relevance for the design of an instructional support system within an OBE environment in South Africa.
2.2 SYSTEMS THINKING

Systems thinking is a formal management science discipline that deals with whole systems, their interconnected parts and the interaction of those parts (Fingar, 1996). Any group of interconnected parts that can only function correctly if all the parts are present, functional and connected in the proper way is a system. If something is made of a number of parts and it does not matter how the parts are arranged, it is not a system, but a heap (Ballé, 1994). The parts of a system rarely provide adequate information about the system if viewed in isolation, but a system can provide valuable information about the functions of each of its components (Davies, 1973).

Ballé (1994) describes the attempt to improve systems by studying and improving the individual parts of a system as an attempt to make a horse run faster by teaching each leg the most efficient movement. Even though each leg may function perfectly, when the horse tries to gallop it will not get far, because there will be no co-ordination. The systems approach avoids this danger by focussing on the interrelationships between parts, for example, on how the horse’s legs relate to each other and back to the horse. In systems thinking complexity is managed by focusing on the interfaces and boundaries of components, their connections and arrangements, and their capabilities to provide a result which is greater than the sum of the parts (Fingar, 1996).

Osborne (1996) states that viewing training as an open system provides insights into the management of the training process. When an instructional offering is viewed as an open system the resources needed are the inputs, the way these resources are used form the process and the results of the education are the outputs (Mende & Curtis, 1997). Osborne (1996) divides these into means (inputs and processes – resources and how they are used) and ends (the results of the training on the trainee, organisation and society).

While the term feedback is used for normal two-way communication, it has specific meaning when used in terms of a system and is one of the major concepts in systems thinking (Ballé, 1994; Fingar, 1996). Senge (1993) defines feedback as a
reciprocal flow of influence. He emphasises that every influence is both cause and effect, therefore nothing is ever influenced in just one direction.

Rather than thinking in terms of a simple cause and effect (Figure 2.1), systems thinking takes a circular causality into account. This is called a feedback loop (Figure 2.2), whereby A affects B, which in turn affects A again.

![Figure 2.1: Cause and effect: if A then B](adapted from Ballé, 1994, p 45).

![Figure 2.2: Feedback loop: A affects B, and B affects A](adapted from Ballé, 1994, p 45).

Representations based on systems thinking frameworks are built on the interactions between parts. Instead of one-way causal statements the system is built using a series of feedback loops. The concept of feedback allows a causal structure to be linked to dynamic behaviour. If a system shows a consistent behaviour pattern, feedback loops allow the identification of structural reasons for the behaviour and the means to act upon feedback structures to modify the behaviour (Ballé, 1994).

The educational process can be viewed as a system that includes teaching and learning activities. These activities are tied together via various feedback loops. The educational process does not only consist of teaching and learning, however, but
also includes other functions relating to course management. These functions include assessment, admission, quality assurance, direction and support (Tait, 1997).

In the systems approach the educator is not only seen as a learning resource, but also as a manager of learning resources. This “teacher-manager” must be able to balance and reconcile the task needs of the curriculum with the, often conflicting, personal and group needs of the learners.

Of central importance in any educational system, are the learners and their learning, therefore learning will be considered more closely in the following section.

### 2.3 LEARNING

This section provides a brief overview of learning by first looking at the learning cycle and then at how the different learning styles affect the learning cycle.

#### 2.3.1 The learning cycle

The learning cycle is represented in Figure 2.3. This represents a model of learning consisting of four stages (Sadler-Smith, 1996; Tait, 1997):

i. Concrete experience;

ii. observations of and reflections on the experience;

iii. the formulation of abstract concepts based on the reflections concerning the experience; and

iv. the testing of the implications of the new concepts in new situations. (This involves practice and planning of future learning through experimentation.)

It can be seen from Figure 2.3 that the learning cycle involves a feedback loop, whereby the results of previous learning drives subsequent learning experiences.

![Figure 2.3: The learning cycle (from Sadler-Smith, 1996)]
The learners themselves are engaged in this process and are the ones who are experiencing it.

2.3.2 Learning styles

Many learners prefer to have information presented to them step by step in a linear form, while other learners find learning easier when they can see the whole to begin with so they can arrange the various parts into a pattern that makes sense to them (Harris & Bell, 1990). The first type of learner is often called serialist and the second type holist. Many learners are able to switch from one style to another, often according to the structure of the current learning, while other learners can only operate in one of the styles.

Another way of classifying learners is in terms of their strengths and weaknesses for each stage of the learning cycle. This leads to the following learning styles (Harris & Bell, 1990; Sadler-Smith, 1996):

- Activists: People who involve themselves in experience are called activists. These persons tackle problems by brainstorming and move on when the excitement fades.
- Reflectors: These are cautious and thoughtful people who prefer to consider all possibilities before making any decisions. Their actions are based on observation and reflection.
- Theorists: These are people who integrate their observations into logical models after analysis and strive for objectivity.
- Pragmatists: These are practical people who want to apply new ideas immediately and get impatient with an overemphasis on reflection.

A completely effective learner has characteristics of all four learning styles. This is however rare, often one of the styles will dominate, while the others are present to a lesser degree (Harris & Bell, 1990; Sadler-Smith, 1996). Although the validity of this classification of styles had not yet been proven, they do nonetheless provide a good platform for planning learning activities.
2.4 TEACHING AND MANAGING IN SYSTEMS THINKING

There are two roles that educators can take. They can either manage learning resources, or act as learning resources themselves. An educator creates a learning environment appropriate for realising the learning objectives. When educators teach in the classroom, they are basically saying that they are the most appropriate resource available. In some cases this may be appropriate, but educators should also focus on the management of the learning environment in order to provide the best learning opportunities to the learners and should only teach if this is the most appropriate method for learning. The educational community has come to realise that the role of academic institutions is to be places of learning, not merely of instruction. The educational mission is not instruction, but to produce learning in every learner, by whichever means works for that individual learner (Chizmar and Williams, 1996).

Since the time and resources available to lecturers is always limited, they should naturally concentrate on doing the work that flows most directly from their role as managers of learning resources.

To see more clearly the management task of the lecturer, it is useful to consider the work done by an educator in terms of the four management functions of the traditional viewpoint (Hellriegel & Slocum, 1993): Planning, Organising, Leading and Controlling.

![Figure 2.4: The management cycle.](image-url)
These four functions form a cycle of interrelated activities, which together define the area of an educator's professional competence and expertise. These functions do not only involve things to be done, but also decisions to be taken.

2.4.1 Planning
Planning in education includes identification and analysis of the educational needs (Sadler-Smith, 1996). This is where the work of establishing the learning objectives is done (Hellriegel & Slocum, 1993). These need to be precise and clear objectives, as they are important in driving the rest of the process. During this process the educator takes on the role of identifier or evaluator as well as a diagnostic role (Osborne, 1996). The educator identifies the needs of the learners in order to plan future learning experiences (Osborne, 1996; Sadler-Smith, 1996). This does not happen in isolation, but is based on an evaluation of the results of previous learning activities. This ensures a feedback loop, which enables the educator to respond appropriately to the effects the planned interventions are having on the learner. This aspect is more related to the controlling function, but it feeds directly into the next planning cycle, thereby completing the feedback loop required for effective management. This is why it is mentioned here.

2.4.2 Organising
Although this stage does involve some planning aspects, it involves mostly the organising function. At this stage, the educator acts in a designer/planner role (Osborne, 1996). The actual educational interventions are designed, planned and organised at this stage (Osborne, 1996; Sadler-Smith, 1996). This involves the arranging and relating of the learning objectives in such a way that the learning objectives will be attained in the most effective and efficient way possible (Hellriegel & Slocum, 1993).

2.4.3 Leading
During this stage the planned learning activities are implemented and its effects are monitored (Osborne, 1996; Sadler-Smith, 1996). During this phase, the educator is mainly involved in the motivation, encouraging and inspiring of learners to allow them to attain the objectives most effectively (Hellriegel & Slocum, 1993). This encompasses the educators leading function. The leading function includes the
provision of feedback in response to the findings of the control function. This is the role of formative assessment, which is discussed in Chapter 3.

2.4.4 Controlling

During this phase, the educator fulfils the controlling functions (Sadler-Smith, 1996). This is when the educator decides whether the organising and leading functions are successfully meeting the set objectives. If these objectives are not met, then the educator should assess and regulate the situation. (Hellriegel & Slocum, 1993; Sadler-Smith, 1996).

During the cycle or process described above, the educator functions as manager of the overall cycle or system, performing different roles or functions at different stages. The purpose of this management is to ensure that the instructional system meets its objectives of promoting and enabling appropriate learning.

In South Africa various changes have taken place in education. The following section looks at a few of the historical developments with regard to South African curriculum policy.

2.5 AN HISTORICAL PERSPECTIVE ON CURRICULUM POLICY IN SOUTH AFRICA

Until the 1990s South African education was characterised by a centralised curriculum policy system which, according to Jansen (1999) has been described as authoritarian, prescriptive, context blind and discriminatory, as well as Euro-centred, racist and sexist.

The main characteristic of this policy system was that curricula were regularly devised for all schools based on a school subjects approach (Van Wyk & Mothata, 1998). These curricula were then introduced into schools with different resource levels and therefore produced different results in these different contexts. This led to a situation that, the institution where the qualification was obtained, was more important than what the qualifying students actually knew and could do (SAQA:
Strategic Support Unit, 2000).

2.5.1 Before 1990

During the 1980s, the pressures for reform led to the Department of Manpower, through the National Training Board (NTB), embarking upon a number of initiatives. The most noteworthy of these was the restructuring of the apprenticeship system into a competency-based modular training system run by autonomous industry training boards in order to replace the declining time-based apprenticeship system (SAQA, 2001a). According to Kraak (1999) this was based on narrow interpretations of skill and cost-minimising approaches to human resource development. The proposals that emanated from these initiatives were narrowly focussed on apprenticeship to the exclusion of basic education, which was seen as a point of access to the skill training. The unions found this unacceptable, as it would exclude many workers in South Africa, due to their lack of basic education.

At the same time during the period 1985-1990 “People’s education” started to represent a radical new pedagogic alternative (Kraak, 1999). This alternative represented a call for democratising education, giving a high level of education to all learners, bridging the gap between theory and practice and the development of critical thinking. These ideas were imprecisely conceptualised and open to multiple interpretations and manipulation.

Simultaneously with the above initiative, the Department of Education initiated its own process of policy discussion (SAQA, 2001a).
The key principle differences between People’s education and Apartheid education are summarised in Table 2.1.

<table>
<thead>
<tr>
<th>Political Project:</th>
<th>Apartheid Education</th>
<th>People’s Education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used to impose policies of separate development.</td>
<td>An egalitarian project of social transformation.</td>
</tr>
<tr>
<td></td>
<td>It resulted in racially (and regionally) differentiated access to education.</td>
<td>A central demand was equal access to education for all.</td>
</tr>
<tr>
<td>Curriculum Framework:</td>
<td>A curriculum based on rigidly defined schools subjects with the purpose of transmitting the state-determined syllabus through rote learning and without questioning.</td>
<td>A curriculum opposed to rote-learning and based on critical thinking, independent work and integrated studies, aimed at equipping students to question and reveal the underlying causes of social inequality.</td>
</tr>
<tr>
<td>Role of Learner:</td>
<td>Learner acted upon; little control of learning process; learners were selected, assessed graded and often excluded from future learning processes.</td>
<td>The pedagogy was learner centred; student-paced learning; continuous assessment.</td>
</tr>
<tr>
<td>Role of Teacher:</td>
<td>The teacher was subservient to the dictates of the state; tasks prescribed by an imposed syllabus.</td>
<td>Teacher professionalism encouraged; teachers to play a key role in curriculum development.</td>
</tr>
<tr>
<td></td>
<td>Content-centred learning.</td>
<td>Process-led learning; the emphasis was on group work, participatory pedagogy; independent thinking and student inputs into the learning process.</td>
</tr>
<tr>
<td>Role of Community:</td>
<td>Community had little power in determination of school policy.</td>
<td>Community involvement in school management and curriculum was strongly emphasised.</td>
</tr>
</tbody>
</table>

Table 2.1: The key features of People’s Education compared with Apartheid Education (adapted from Kraak, 1999, p. 23).

2.5.2 Early 1990s

During the early 1990s the government started work on establishing a new Education policy. There was growing realisation that all levels of stakeholders, from the Unions to Education and Training providers needed to be involved in this process.

In April 1994 the discussion document on a National Training Strategy Initiative (NTSI) was published. This initiative originated with the reconstructed NTB, which had for the first time contained representatives from the progressive trade unions and
The significance of the NTSI was that it was the first multiparty stakeholder forum, which included both the ANC/COSATU alliance and government departments to formally propose the creation of an integrated Education and Training system (Kraak, 1999; SAQA, 2001a). According to Jansen (1999) the NTSI document was probably the most significant policy document of the time and was the root of what was only later to be called outcomes-based education in South Africa. This NTSI document was one of the foundational documents for the SAQA Act (RSA, 1995).

The NTSI argued for a paradigm shift from thinking of education and training as separate entities to thinking of learning as a lifelong process. According to Kraak (1999) this was expressed in terms of:

- **A National Qualifications Framework** as the nucleus of the strategy, allowing for a lot of different qualifications from a range of Education and Training pathways;
- a **governance structure** which would focus on achieving the NTSI objectives;
- a set of **financial incentives** to encourage investments in Education and Training; and
- **a National Economic Development Plan** to link Education and Training to socio-economic planning.

### 2.5.3 SAQA and the NQF

A lot of the recent education legislation in South Africa is founded on two pillars: outcomes-based approaches to learning and a national qualifications framework (NQF). The approaches taken in South Africa have been strongly influenced by similar movements in other countries. This section will look more closely at the NQF, while the next section takes a closer look at OBE. The reader should bear in mind that (according to the SAQA website): "*The NQF is a social construct, whose meaning has been and will continue to be negotiated by the people, for the people.*" (SAQA, 2001b).

The role of SAQA is the establishment of standards, quality assurance systems and management information systems in support of the NQF (DOE, 2001). This includes
ensuring that the standards and qualifications that are registered on the NQF are internationally comparable and consistent across the different providers.

South Africa’s NQF is a systemic framework that is meant to combine education and training into a single integrated system organised around the notion of learning outcomes (SAQA: Strategic Support Unit, 2000; DOE, 2001a). It provides for multiple entry and exit points and promotes mobility of learners and transferability of credits. It does this by defining rules of access from one qualification to another. This includes recognition of prior learning in order to facilitate access to, as well as mobility and progress within education, training and employment (SAQA, 2001a). The scope of the NQF is from the end of compulsory schooling through to post-doctoral research in higher education and training (SAQA: Strategic Support Unit, 2000).

In their overview document on the NQF, SAQA summarises the NQF as follows: "In short, the NQF is the set of principles and guidelines by which records of learner achievement are registered to enable national recognition of acquired skills and knowledge, thereby ensuring an integrated system that encourages life-long learning." (SAQA, 2001a).

The SAQA Act (RSA, 1995) outlines the objectives of the NQF as follows:

- To create an integrated national framework for learning achievements;
- facilitate access to, mobility and progression within education training and career paths;
- enhance education and training quality;
- accelerate the redress of unfair discrimination of the past in education, training and employment opportunities; and
- to contribute to the personal development of each learner as well as the social and economic development of the nation.

The National Standards Body (NSB) regulations specify a number of requirements for registered qualifications. These include the following (SAQA, 2001a):

- It should represent a planned combination of learning outcomes. These outcomes must have a defined purpose and should be intended to provide qualifying
learners with applied competence and a basis for further learning.

- Integrated assessment should be incorporated to ensure that the purpose of the qualification is achieved. The assessment should include a range of formative and summative assessment methods. These include things like portfolios, simulations, workplace assessments, as well as written and oral examinations.

The notion of applied competence suggests a broadening of the behaviourist notions of knowledge usually associated with outcomes and competence models (SAQA, 2001a). Applied competence suggests that foundational competence, practical competence and reflexive competence are all needed to accomplish a task meaningfully in a real world context. Foundational competence is an understanding of what is being done and why it is being done. Practical competence is a demonstrated ability to do a particular thing, while reflexive competence is the demonstrated ability to integrate or connect performance with an understanding of the performance in order to learn from the actions and to be able to adapt to change and unforeseen circumstances (SAQA, 2001a).

The NQF is not a curriculum framework and therefore its primary focus is not how the outcomes are achieved (SAQA: Strategic Support Unit, 2000). It forms part of a systemic definition of the new South African education system uniting the different forms of education and training into a single structure. According to Kraak (1999) the ideas of an integrated system and an NQF are deeply imprinted in the legal statutes of governance. South Africa would therefore appear to be firmly committed to a systemic approach to Education and Training.

Outcomes-based education in South Africa is a central aspect of the NQF. The qualifications and standards registered in the NQF are described in terms of the learning outcomes that the qualifying learner is expected to demonstrate (SAQA, 2001a). The commitment to an outcomes-based approach was re-iterated by the minister of education in his response to the report of the review committee on Curriculum 2005 (Asmal, 2000). The following section will look more closely at what is meant by the term outcomes-based education.
2.6 OUTCOMES-BASED EDUCATION

According to Malcolm (1999) the traditional curriculum in North America, Australia and South Africa was geared towards matriculation, universities and employment. This curriculum was essentially academic and was structured around disciplines used at universities. This was even true at primary school level. Malcolm (1999) notes that this system has failed, stating that, of the students who started together, only 20-30% matriculate in the minimum time. This system acted more as a selection and sorting mechanism for competitive entry to university or employment, than as education. This system also faced criticism from industry that even the successful students are not satisfying the needs of the workplace.

This section contains a general discussion of outcomes based education and this includes a look at different approaches and interpretations.

2.6.1 What is OBE?

According to Siebörger (1998) outcomes-based education is an approach to teaching and learning which stresses the need to be clear about what learners are expected to achieve. The educator states beforehand what performance is expected of the learners. This is an outcome. The role of the educator is to help the learner achieve the outcomes stated in the curriculum and the learner’s task is to attain what the outcome expects.

Inputs are the experiences from which the learner learns, while outcomes are the result of learning. Outcomes-based education makes a distinction between the two, because “what the teacher teaches is not necessarily what students learn” (Malcolm, 1999, p. 80). Even though this would not seem to be a great revelation, it is in fact contrary to the tradition of behavioural objectives, where the objective promises that for the same input for all students, it is expected that the same outcome will be attained by all students.

The advantage of separating inputs from outcomes is that this allows the educator to acknowledge inputs to learning from other sources. The learners themselves can
bring more input into the learning situation. Different inputs can lead to the attainment of the same outcome and a single input may lead to the attainment of more than one outcome. Thus the educator can use multiple single inputs or multidimensional inputs that will enable the different learners to attain the same general outcomes.

This puts emphasis on what the learners should know and be able to do, as well as sharing curriculum control between the government and educational institutions. Educators can make full use of local knowledge to design the most effective inputs to attain the outcomes, while providing a means of balancing similarities and differences in curriculum across the country. The prescribed outcomes form the common framework, while the inputs allow local variations.

According to Kraak (1999), the heart of outcomes-based education and training systems is the demonstration of competence in terms of criteria which are established by the relevant education and training authority. Instead of the government prescribing inputs through syllabuses and recommended texts, they prescribe the outcomes and leave the design and selection of inputs to the educators.

The curriculum inputs and assessment have to be designed to suit the students involved and this needs to be done at the point of contact. The educator is directly responsible for the design of the curriculum and especially assessment. These responsibilities make the knowledge and professional skills of the educator important.

Outcomes-based education argues for assessment that measures and reports on many dimensions of performance rather than reducing the achievement to a single score. A particular performance has to be analysed in relation to relevant outcomes and the learning that is demonstrated. Tests are still important assessment tools, but they are analysed in relation to specific outcomes. The record keeping and reporting is accordingly much more complex than in traditional education. A small number of dimensions of performance is sensible and leads to a focus on broad competencies and concepts (Malcolm, 1999).
In summary, the three most significant advantages of outcomes-based education are (Siebörger, 1998):

- The same outcome can be used in different types of education. The assessment criteria and types of assessments used may vary, but the learners should achieve the same outcome.
- It is easier to combine different units and modules to form qualifications if they are outcomes based.
- Prior learning can be recognised on the basis of outcomes already achieved. This also allows learners to more readily progress at their own speed.

### 2.6.2 Different models of OBE

Education is changing in many countries to an emphasis on broad competencies and moving management responsibility and accountability to the schools. Most of these countries have stayed with a government-defined syllabus and resources (input), while only a small number have chosen outcomes-based models (Malcolm, 1999).

Malcolm (1999) did a comparative study on different OBE models. Malcolm also used comparisons of the American and Australian models as being illustrative of the main types of approaches to OBE. This section will make extensive use of his comparison.

**Transformation vs. Knowledge and skills**

There are differences in the way outcomes are chosen in different countries, with some relying heavily on local consultation, while others are defined on a governmental level and handed down. There are also differences in how outcomes are stated and some issues of definition. Some forms of OBE intend to make learners into certain types of people (e.g. USA) while others stick with knowledge and skills (e.g. Australian). Some contradictions within the systems make this apparent distinction more confusing. For example, according to Malcolm (1999), Spady advocates that outcomes define what a learner should be, but insists that behaviour or performance is sufficient definition of learning. On the other hand the Australian policy is based on what students should know, but is based on constructivist definitions of learning which come much closer to assessing the belief systems of the learners.
Learner progress

Another area of difference is in when outcomes are reached and how a learner progresses. One of the foundational assumptions of OBE is that all students can learn. This idea can be interpreted in two ways.

One way is the claim of early behaviourists that anyone can be taught anything given good teaching and sufficient time. In this view, the outcomes are exit outcomes and a student is defined as either having demonstrated an outcome or not having demonstrated it. This idea is basically based on the ability to redo the test at a later stage and this is the approach taken by Spady (as referenced in SAQA, 2001a), who is considered the main proponent of OBE in the USA (SAQA, 2001a). In these models the attainment of outcomes is through a network of instructional units, each having its own prescribed achievements. A student does not move to the next unit unless the current one is mastered.

Another view focuses on increments of progress rather than standards of achievement. In this view learning is seen as a process, with successful learning being measured by improvement in standard rather than the standard itself. This is value-added education where each learner is considered to have a right to some form of progress. The Australian model is such a model, in that it expects different learners to be operating at different levels and that a particular learner may be operating on more than one level at the same time. The educators therefore design activities that cross levels, with learners reaching forwards to new levels, while relating back to previous levels. By working together with learners at other levels the learners see their activities as part of a bigger development (Malcolm, 1999). In this model students do not master one level before moving on to the next. The educator’s task is not to decide whether a learner has mastered a particular level, but to decide which level best describes the learner’s progress.

While the USA models allows the learner to retake the test in order to “never fail” the Australian model states that there always has to be an outcome. If a learner completes a task, it must surely demonstrate something, even if it is not at the level intended. This outcome must be mapped onto the set of outcomes and levels. Both
of these approaches to OBE remove the time constraint on achieving a particular standard.

**Behaviourist vs. Constructivist**

There are differences in what the different models consider learning, as some are firmly rooted in behaviourist positions where outcomes must be performances and not thoughts, understandings or mental processes. In this view what happens in the head helps learning, but the behaviour is the outcome and the thing that is assessed (e.g. USA). Other models (e.g. Australian) view learning in a much more constructivist way. The learning takes place in the mind and expresses itself in many ways, performance being one of these ways. In this view what happens in the mind is a complex combination of cultural, social and personal factors. Because the learning takes place in the mind, assessment is achieved by inference, not measurement. In these models the performances are not seen as measures of learning, but rather as clues about what and how learners think. The educator, therefore, uses the various sources as evidence for the inferences made to satisfy the requirement for public accountability.

**Culminating performance vs. Continuous assessment**

The different models also differ on their view on continuous assessment. Some models are focussed on culminating performances, so continuous assessment is a series of exit performances leading up to the culminating performances. These models make a distinction between the performance and any learning activities, which are considered practice. The final performance and not the practice is what matters. In others, like the Australian system, continuous assessment includes the information that the educator assembles while observing the students at work. This is a natural part of teaching, especially when the learning is through projects and tasks as is often the case in programming subjects. These formative assessments become part of the summative judgements about the level of achievement. There is less of a distinction between teaching/learning and assessment/performance. In the Australian model what a learner demonstrates during the learning as well as in the final performance is considered authentic assessment.
Homogenous groups vs. Heterogeneous groups

The models also differ in the way learners are grouped and promoted. The ideal in all the models is that no learner should wait around or spend time relearning something already known. In Spady’s approach, according to Malcolm (1999), the student should move on to the next station as soon as they have mastered the current one.

There are three options:

- **Individualised instruction, especially computer based.** Groups may be formed where appropriate, but the emphasis is on the individual and classes and grades are irrelevant.

- **Learners may work in whole class groups, but loops of enrichment and corrective action are available.** According to Malcolm (1999) this is the common approach in the USA. The educator teaches the whole class, then conducts the assessment. Those who need additional work move into the corrective pathway, while others move into an enrichment pathway.

- **Learners may be assigned to groups in such a way that they are always with their peers in achievement.** The learners work in groups, but as soon as a learner demonstrates the required learning, the learner moves on. The composition of the groups change often, and as a learner may progress at different speeds in different aspects, the learner may be in several different groups in one week.

The emphasis in all of these is that the individual learners move efficiently through the course without regard to belonging to any group. Malcolm (1999) states that the most common version in the USA is the second one, but that this approach is very difficult to manage, as the needs of the additional paths can become too much to manage. This is especially so if any learners fail to reach the outcome after a second try and need to do another corrective cycle.

In the Australian model the recommended strategy is to teach in such a way that two or three levels are covered. This allows every learner in a class to work at his or her own level. Work groups are usually formed flexibly with learners at different levels working together. In this model learners are seldom streamed into different groups based on achievement. The needs of the learners at different levels within a class...
can also place demands on the educator’s time in this model, however.

Clockwork vs. Organism

According to Malcolm (1999) educators can be divided into two groups based on whether they view the world as clockwork or an organism. These two views can be traced back to the ancient Greeks. Plato is the source of a clockwork view, while Aristotle took a view of the world as an organism. As these different views explain the differences in the models as well as leading to different interpretations and therefore implementations of the same models they will be shortly discussed here.

The world as clockwork is the view that God made the world as a giant machine and then stood back. As surely as the turning of cogs and levers in a machine, the world’s future was predictable, because it had been designed according to quantifiable laws. In education, the clockwork view finds expression in bureaucratic management, behaviourist learning theories, logical positivism and content-centred curriculum (Malcolm, 1999).

The view of the world as an organism is that the seed becomes the tree. God does not make the tree complete; creation is within. The tree that results depends not only on the seed, but soil, wind and rain, birds, lightning, elephant breaking branches, etc. The eventual tree cannot be predicted because its environment shapes it. The tree in turn shapes the environment by affecting the wind, purifying the air, providing food for particular animals, etc. The tree and the world are connected. In education this view finds expression in organic management, constructivist learning theories, post-modernism and learner-centred curriculum.

In organic management every worker is presumed to be creative and purposive, with ideas on getting the job done. The task of management is to draw on the knowledge of the worker and to support the growth of individuals and the organisation as a whole. Similarly, in constructivist learning theories the educator helps the learner to build their knowledge and skills, bringing together the different aspects of the learner’s experience and relating it with the classroom experiences. These include the learner’s prior knowledge, hopes, other learners and the community. Knowledge is not seen as objective truth, but as subjective. This view contains the post-
modernist views that there is not a single truth or separation between learner and learned. The curriculum is not delivered from an external source, but is interpreted and created through the interaction of educators and learners.

2.7 OBE IN SOUTH AFRICA

The NQF sets a systemic framework for organising the education and training system around the learning outcomes, from the end of compulsory schooling through to post-doctoral research in higher education and training. Curriculum 2005 is the curriculum that has been developed within an outcomes-based education framework and is currently being implemented in schools. Learners, who follow Curriculum 2005 and demonstrate the learning outcomes that it identifies, will achieve a General Education and Training Certificate (GETC). This is a qualification registered at Level 1 of the eight-level National Qualifications Framework. (SAQA: Strategic Support Unit, 2000).

Curriculum 2005 (C2005) contains the basic distinction between inputs and outcomes, with the schools being responsible for designing inputs to suit the nationally defined outcomes. The policy also provides guiding principles for the curriculum design and is learner centred. The Revised National Curriculum Statement defines outcomes-based education as "an activity-based and developmental process encompassing what learners learn and are able to do at the end of the learning process." (DOE, 2001b).

The main design features of C2005 was the critical outcomes, 66 specific outcomes, range statements, phase and programme organisers, assessment criteria, performance indicators and expected levels of performance (DOE, 2001b). According to Malcolm (1999) the framework of C2005 and the critical outcomes it defined were similar to that used in Ontario.

As a result of the review process of C2005 (C2005 Review Committee, 2000), this design was changed in the draft Revised National Curriculum Statement (DOE, 2001b). This Revised National Curriculum Statement strengthens and consolidates C2005 by simplifying and streamlining its main design elements, while
simultaneously ensuring that the learning expectations are clearly spelt out at each grade. It has been reduced to three main design features: Critical and developmental outcomes, learning outcomes and assessment standards. The learning outcomes are similar to the 66 specific outcomes of C2005, but they have been reduced in number. The range statements, phase and programme organisers, assessment criteria, performance indicators and expected level of performance have been replaced by assessment standards (DOE, 2001b).

SAQA has established assessment regulations and criteria for assessors (SAQA, 2001c). The task of these assessors is to determine if the learners involved have indeed attained the outcomes required for the relevant levels. The registration criteria is meant to ensure that those who make decisions about the competence of learners have the requisite knowledge, skills and experience for the specified NQF registered standards and qualifications to make such a judgement. In the case of the school curriculum this occurs at the end of Grade 9 and is where the result of the school curriculum fits onto the NQF as the General Education and Training Certificate (GETC), which must meet the Level 1 requirements of the NQF. This GETC for compulsory schooling is a whole qualification based on exit-level outcomes and is set out in the document: *Qualifications Framework for GETC for Compulsory Schooling* (DOE, 2001c), which is one of the 10 documents that the Revised National Curriculum Statement consists of.

Assessing outcomes is part of the whole structure of the NQF (Siebörger, 1998). All outcomes have to be designed to reflect the critical outcomes specified by SAQA in order for them to be linked to the NQF. Aspects of assessment will be further discussed in the next chapter. As has been mentioned before, the GETC qualification on the NQF is a whole qualification with exit outcomes, which occur at the end of a ten-year school curriculum (Grade R and grades 1-9). This is further divided into three phases: Foundation, Intermediate and Senior. This corresponds to benchmarking performance using the assessment standards at Grades 3, 6 and 9 (DOE, 2001b).

The levels in the original framework are too far apart to be used as descriptions of the
learner’s achievements. This was found to be problematic (C2005 Review Committee, 2000) and is the reason for the introduction of Assessment standards in the revised curriculum statement, which describes the level at which learners should demonstrate achievement of the learning outcomes, at a specific grade (DOE, 2001a; DOE, 2001b). As this is closely tied to assessment, it will be discussed further in the following chapter.

In summary, Table 2.2 provides some basic definitions related to outcomes-based education and training (OBET) in South Africa, as well as some expanded definitions which addressed some criticisms of traditional OBET.

<table>
<thead>
<tr>
<th>The Basic Definition</th>
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<tbody>
<tr>
<td><strong>An outcomes-based model:</strong></td>
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<tr>
<td>Outcomes:</td>
</tr>
<tr>
<td>The contextually demonstrated end products of the learning process.</td>
</tr>
<tr>
<td><strong>Unit Standards:</strong></td>
</tr>
<tr>
<td>Nationally agreed (and registered) statements of specific outcomes and their associated performance or assessment criteria together with administrative and other necessary information. Unit standards are the smallest measure of a prescribed assessment.</td>
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<tr>
<td><strong>Credits:</strong></td>
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<tr>
<td>They are the recognition that a learner has achieved a unit standard. Credits may be accumulated until conditions have been met for the award of a qualification.</td>
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<tr>
<td><strong>NQF levels:</strong></td>
</tr>
<tr>
<td>They are the positions on the NQF where national unit standards are registered and qualifications awarded. They are arranged to signal increasing complexity in learning and to facilitate meaningful progression routes along career and learning pathways.</td>
</tr>
<tr>
<td><strong>A qualification:</strong></td>
</tr>
<tr>
<td>A planned combination of learning outcomes which has a defined purpose and which is intended to provide qualifying learners with applied competence and a basis for further learning. May or may not be made up of unit standards.</td>
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<table>
<thead>
<tr>
<th>The Expanded Definition</th>
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<tbody>
<tr>
<td><strong>Globalisation and the need for expanded underpinning knowledge:</strong></td>
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<tr>
<td>As a consequence of globalisation, workers require broadened skills that go beyond the narrow task dimensions of routinised work. Workers now need to be multiskilled and adaptable in the face of change. They need to understand and participate in the management of work roles and production systems, taking responsibility for contingencies, quality control, innovation and flexible responses to new product demands – competencies which are impossible to develop in narrow competency-training systems.</td>
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<tr>
<td><strong>The iceberg metaphor:</strong></td>
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<tr>
<td>This symbolises the importance of seeing performed competency (the tip of the iceberg) as being underpinned by a much larger foundation of knowledge and understanding (the submerged structure of the iceberg).</td>
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<tr>
<td><strong>Exit level outcomes:</strong></td>
</tr>
<tr>
<td>The outcomes that are to be achieved by a qualifying learner at the point which he or she leaves the program leading to a qualification.</td>
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</table>
Critical cross-field outcomes: These are cross-curricula, broad outcomes that focus on the capacity to apply knowledge, skills and attitudes in an integrated way. Included are:
- problem-solving skills;
- teamship;
- self-responsibility;
- collecting and analysing information skills;
- communication skills;
- technological and environmental literacy;
- developing macro vision;
- learning skills;
- citizenship;
- cultural and aesthetic understanding;
- employment-seeking skills; and
- entrepreneurship.

Rules of combination: They set out how many credits from various categories and fields – fundamental, core or specialised courses – must be accumulated in order to award a particular qualification.

Learning Area Statements: These specify the learning area and its defining features.

Learning Outcomes: These specify the sequence of core concepts, content and skills to be taught and learnt in each learning programme at each grade level.

Assessment Standards: They describe the level of knowledge and skills expected and the range for each of the learning outcomes for each grade level.

Applied competence: This is the ability to put into practice in the relevant context the learning outcomes acquired in obtaining a qualification.

Integrated assessment: A form of assessment which permits the learner to demonstrate applied competence and which uses a range of formative and summative assessment methods such as portfolios, simulations, in situ workplace assessments, as well as written and oral examination.

Table 2.2: A conceptual toolkit for OBET.
(Adapted from Kraak, 1999 and expanded using Siebörger, 1998 as well as SAQA, 2001a and C2005 Review Committee, 2000.)

The curriculum policy in South Africa will continue to evolve as the policy is adjusted as a result of the review process into the current implementation of C2005. As part of this review process, the review committee has made a number of recommendations in their report to the minister of education (C2005 Review Committee, 2000; DOE, 2001a). Some of the findings of this report include:

- There is support for C2005 but the levels of understanding vary. Most teachers’ understanding of C2005 is considered to be shallow. They found unnecessarily complex language and confusing terminology to be a problem.
- The committee found problems in the structure and design of C2005 and recommended some changes. Too many learning areas led to insufficient time spent on mathematical and language skills. In this regard they recommended the reduction of learning areas. This suggestion has been turned down by the Minister of Education, on the grounds that the relevant learning areas are too important (Asmal, 2000). There has, however, been an increase in the time given
They also found the C2005 design structure to be strong on integration, but weak on conceptual coherence. It was found that range statements, performance indicators and expected levels of performance failed to provide for progression as intended. This was largely due to curriculum designers attempting to avoid prescribing content.

- There are problems with assessment. Too much time is spent on managing and administering assessment, leaving minimal time for classroom work.

It is this last problem which prompted the need for a support system for OBE. The next section lists some requirements for an OBE support system.

### 2.8 DESIGN REQUIREMENTS FOR AN OBE SUPPORT SYSTEM

This chapter examined the characteristics of the OBE system implemented in South Africa. From this certain requirements for a system that would aim to support educators in the day to day tasks of managing learning can be identified. This section summarises these design requirements for an OBE support system.

#### 2.8.1 General design principles

- In order to manage the complexity, there should be a focus on the interfaces and boundaries of components, together with their connections and arrangements. By focussing on the interrelationships between these parts, co-ordination can be ensured.

#### 2.8.2 Features needed by an OBE educator support system

- The educator is directly responsible for the design of the curriculum and especially assessment. An OBE support system should therefore assist the educator in fulfilling this responsibility.

- The educator has to arrange and relate the learning objectives in such a way that the learning objectives can be attained in the most effective and efficient way possible. These objectives are stated in terms of learning outcomes in an OBE environment. The support system should allow these learning outcomes to be
effectively communicated to all the learners.

- What the learners need to achieve must be clearly stated and the performance expected of the learners must be specified in advance. Emphasis is on what the learners should know and be able to do.

- The goal is not instruction, but producing learning in each individual learner. This means the effect of learning interventions on each individual learner should be the focus. The education should be learner centred. It is the responsibility of the educator to identify the needs of the learners and to plan future learning experiences based on these needs. The support system should provide facilities to enable the educator to identify these needs and to plan accordingly.

- There should not be a particular time constraint on achieving a particular standard or outcome, therefore the support system should assist in the tracking of learner attainment of outcomes.

- The educator should use various sources as evidence for the inferences made to satisfy the requirements for public accountability. It would be beneficial if a support system could assist in managing these sources of evidence in order to satisfy the accountability requirements.

- A distinction is made between the experiences from which learners learn and the outcomes, which are the results of learning. Different inputs can lead to the attainment of the same outcome and a single input may lead to the attainment of more than one outcome. Input to learning from other sources needs to be acknowledged. Prior learning can be recognised on the basis of outcomes already achieved. This means that the support system should keep track of the outcomes attained by the individual learners, as well as the assessments that have taken place.

### 2.8.3 Supporting processes needed in the model

- The educator needs to be able to manage the different learning resources.

- It needs to be possible to keep track of the different learning styles and preferences of the learner.

- The educator should be assisted with identifying the needs of the learners in order to plan future learning experiences.

- The educator should be able to arrange and relate the learning objectives in such
a way that the learning objectives are attained in the most effective and efficient way possible. This is done in terms of the learning outcomes and assessment standards.

- Outcomes-based education argues for assessment that measures and reports on many dimensions of performance rather than reducing the achievement to a single score. A particular performance has to be analysed in relation to relevant outcomes and the learning that is demonstrated.

- Different types of both formative and summative assessments should be catered for. This should include the capability to handle things like portfolios, simulations, workplace assessments, as well as written and oral examinations. This is discussed in further detail in Chapter 3.

- Tests are still important, but need to be analysed in relation to the learning outcomes and assessment standards.

- The amount of the educator’s time taken to cater for the needs of the learners at different levels within the class should be minimised.

- The amount of time spent on managing and administering assessment should be kept to a manageable level.

2.8.4 Storage requirements

- There should be a planned combination of learning outcomes. These outcomes must have a defined purpose and should be intended to provide qualifying learners with applied competence and a basis for further learning.

- Assessment standards that describe the level at which learners should demonstrate achievement of the learning outcomes at various points during the course should be stored to guide the learning and assessment. This, together with their relationship to learning outcomes and learning areas define the curriculum.

- Each individual learner’s learning style and preferences should be recorded.

- There should be a record of past and planned learning interventions for each learner.

- The progress of each learner should be recorded in terms of the learning outcomes and assessment standards.

- There should be a record of the evidence used to assess the learner’s progress.

- Each assessment done should be recorded. This assessment should not be in
terms of a single score, but should be recorded in terms of the assessment standards.

- There should be a distinction between the learning experiences, assessment evidence and the actual learning that has taken place.
- A learner-centred view should be catered for.
- A record needs to be kept of available learning resources.
- Different types of assessment should be catered for.

### 2.9 CONCLUSION

This chapter provided an overview of the systemic changes that have occurred in South African education. This included an overview of OBE and its intended context in South Africa. The chapter concluded with a summary of design requirements for an OBE support system that can be identified from the nature of the new educational policy.

Learning outcomes and assessment standards were identified as the tools used to describe the goals of the curriculum. When this dissertation uses the terms goals and objectives, it is used in a general sense and should be understood to be expressed in terms of the learning outcomes and assessment standards in the new South African OBE system. The term objective is not meant to denote a specific narrow educational definition, as is often done to contrast it with outcomes. In this dissertation it simply denotes the intended target.

The importance of assessment of learning was highlighted in this chapter. The assessment of learning and the evidence requirements in an OBE environment will be looked at more closely in the following chapter.
CHAPTER 3:

ASSESSMENT OF LEARNING

3.1 INTRODUCTION

The previous chapter looked at the nature of learning and the systemic changes in the South African education system. The main characteristics of an outcomes-based education system were highlighted and some design requirements for a support system were identified. From this chapter it becomes clear that assessment is an important part of learning and of OBE in particular.

Assessment is not marking or grading, but is the act of measuring the extent of the learning that has taken place. As such, the information gained in this manner can be used to determine whether a learner has successfully completed a section of a course (summative assessment) and/or to provide feedback to the learner and to guide future learning (formative assessment).

From the learner’s viewpoint, the assessment tasks are the true lesson objectives (Rowntree, 1990). This means that irrespective of what aims and objectives (learning outcomes and assessment standards) have been set for the course, if the learners are only assessed on how well they have memorised certain details, then recalling those facts are the real objectives as far as the learners are concerned. It is therefore essential that the methods of assessment relate to the true aims and objectives. An example of how one could fail to do this would be setting out to teach learners how to play a guitar, but ending up by only asking the learner to write an essay about how it is done rather than doing it.

This chapter firstly looks at the theoretical foundations of assessment and then performs a detailed analysis of the practical assessment requirements of outcomes-based education. Finally the chapter is concluded with a summary of the design
requirements for a support system which flows from the assessment needs of OBE.

3.2 WHAT IS ASSESSMENT?

Educators are responsible for helping the learners achieve the instructional objectives designated for their classes. These instructional objectives are that each learner should attain the learning outcomes by being able to demonstrate their mastery of the assessment standards. The purpose of assessment is to determine whether the learners have achieved these objectives (Rowntree, 1990; Cunningham, 1998). According to Siebörger (1998) assessment is similar to evaluation, but assessment is the measurement of the extent of learning in individuals, whereas evaluation is a process by which the effects and effectiveness of teaching are determined. In an evaluation of the progress of a learner, assessment is an important aspect to consider, but the home background of the learner and his or her interests and abilities are also considered. Therefore assessment is simply one aspect of evaluation.

Assessment should not be confused with grading or marking. Although a grade or mark cannot be assigned without assessment it is quite feasible to assess without awarding any marks. According to Siebörger (1998) the word assessment means that one is not only thinking of tests, examinations and written exercises, but also of many other ways of gaining information and giving feedback about the progress of learners.

Fingar (1996) states that feedback, specifically in the form of knowledge regarding the outcomes of learners’ actions, is required for learning to take place. This feedback should be continuous and constructive (DOE, 2001d). It should indicate where the learner’s strengths and weaknesses lie and what developmental needs there are. This feedback should also include the outlining of an action plan on how learners will be supported. Assessment of learning and progress is central to teaching and learning and should form an integral part of teaching and learning (Sutton, 1991; Parkinson, 1994; Cunningham, 1998).

It should be noted that assessment is an activity conducted by humans and is
therefore subject to human judgement (Sutton, 1991). In addition, measuring what a learner knows, understands or is capable of doing is not always easy (Parkinson, 1994). The educator does not always have all the correct information and may therefore not always assess a learner’s work correctly (Siebörger, 1998).

### 3.3 APPROACHES TO ASSESSMENT

Educators are required to make a large number of decisions, often in a short amount of time, based on what is known at the time. Assessment, whether formal or informal, plays an important role in this decision-making (Harris & Bell, 1990). According to Cunningham (1998), assessment is always used to make decisions and if there is no decision to be made, there should be no assessment conducted. Trice (2000) is of the opinion that the term informal assessment has no meaning to an assessment specialist. According to Trice (2000), an assessment must always have some form of standard or formal procedures for it to be considered assessment. It is claimed that informal questioning of learners may be useful to the educator, but that this does not constitute an assessment of learning. This would seem to indicate a narrower definition of assessment than that used by other authors (Harris & Bell, 1990; Sutton, 1991; Parkinson, 1994; Cunningham, 1998). The wider meaning of the term assessment, which includes all forms of assessment whether formal or informal, will be used in this dissertation.

The purpose of educational assessment is not simply to measure what learners have achieved, but also to help learners to achieve more (Siebörger, 1998). Parkinson (1994) states that assessment should be diagnostic (assisting in identifying strengths and weaknesses) and that it should be evaluative. Assessment, which does not motivate learners to learn and tell them what they need to do in order to improve, does not fulfil its educational purpose.

#### 3.3.1 Formative and summative assessment

Educators are not only makers of instructional decisions, but also have to make socio-personal decisions daily (Cunningham, 1998). They, for example, must decide how to react to learner behaviour or determine in which discussion group a particular
learner needs to be placed. A balance must be maintained between the need to treat every learner the same (fairness) and the need to adjust for individual differences.

It has already been stated that an assessment should only be used in the context of a particular decision, which needs to be taken. The form of assessment used should also be appropriate for the type of decision to be taken.

Two main types of assessment, according to the use to which the results will be put to are (Rowntree, 1990; Sutton, 1991; Biggs & Moore, 1993; Parkinson, 1994; Scott, 1996; Melton, 1997; Beaty, 1998; Siebörger, 1998; Trice, 2000; DOE, 2001b):

• Formative assessment; and
• summative assessment.

Trice (2000) identifies a third type called diagnostic assessment. This is the case when the learners’ skills and knowledge are assessed before instruction begins to determine what they already know.

**Formative assessment**

Formative assessment is an ongoing process consisting of both formal and informal assessment by which information about a student’s learning is obtained and used to plan and guide subsequent learning (Harris & Bell, 1990; Sutton, 1991; Parkinson, 1994; Cotton, 1995; DOE, 2001d). This includes the day-to-day decisions that the educator has to make, which have to be based on information gathered by the educator, no matter how informal this gathering of information may have been (Cunningham, 1998). According to Beaty (1998) formative assessment is an essential feature of the learning environment. The information provided by formative assessment should be available at a time and in a form which will enable the learners to develop (Siebörger, 1998). Formative assessment is part of the process of learning, not something separate.

Cunningham (1998) states that formative assessment includes the planning decisions made prior to instruction, based on observations and information assessments, as well as alterations made during instruction.
Formative assessment may have an individual or group focus (Harris & Bell, 1990; Cunningham, 1998). The emphasis for individuals is usually on determining any shortcoming of the learner’s understanding. It provides the learners with feedback on how they are performing and gives them guidance on what they need to do to remedy apparent weaknesses (Cotton, 1995; Melton, 1997). When focussing on groups, the intent is to determine whether the rate at which content is presented should be changed and if a certain topic needs to be repeated.

The mass of detail generated in formative assessment is of use to both educators and learners, but is less useful for those not directly involved in the learning process (Sutton, 1991). This is where summative assessment comes in.

**Summative assessment**

The purpose of summative assessment is to report or place on record what is known about the learners’ abilities and attainments and this type of assessment is usually based on formal assessment procedures (Rowntree, 1990; Sutton, 1991; Parkinson, 1994; Cotton, 1995; Cunningham, 1998; DOE, 2001b). These assessment reports are usually of benefit to outside entities such as other educators, parents or employers (Harris & Bell, 1990; DOE, 2001d). The traditional example of summative assessment is the end of course examination. Here the main objective is to determine what the learners have achieved and not to give feedback that will aid learning. In a pure behaviourist approach learners would be assessed at the end of a programme to determine whether or not they have achieved the set standards (Melton, 1997).

In practice the relationship between formative and summative assessment is more complex. Any act of assessment can be both summative and formative. Although some courses may have no summative assessment, all courses need formative assessment, preferably carried out by someone else in addition to the learner (Rowntree, 1990).

The classification of assessments as either formative or summative is based on the use to which the results of the assessments are put. It is also possible to classify assessments according to how frequently they take place (Siebörger, 1998).
case a distinction is made between continuous assessment and terminal assessment.

3.3.2 Continuous assessment and terminal assessment

Continuous assessment is the use of frequent pauses for assessment during the course. Continuous assessment is not always used formatively, but it is best suited to this. According to the Revised National Curriculum Statement (DOE, 2001b) this type of assessment involves the assessing of different kinds of written and oral work completed for exams and tests. It is intended to be formative and developmental. This continuous work can be collected in a portfolio of the learner's work.

Terminal assessment refers to the measurement of performance made at the end of a course or unit of study. This form of assessment is usually used summatively. In cases where modules build upon each other, the terminal assessment for each module can also be used formatively.

In recent years, and in particular in higher education, there has been a tendency to move away from once-off summative (terminal) assessment at the end of long programmes (Harris & Bell, 1990; Melton, 1997). This is due to the stress that these once-off assessments place on the students and the risk that they might not do themselves justice under the pressure. The argument is that moving towards continuous forms of assessment is not only less stressful, but also more reliable, because of the wider coverage that may be achieved over a longer period of time.

Melton (1997) warns that there is a risk that assessment carried out during the course of a programme is likely to focus on enabling objectives rather than on the ultimate objectives to be achieved. Careful consideration needs to be given to the relationship between performance assessed on an on-going basis and the ultimate level of performance achieved at the end of the programme.

According to Harris and Bell (1990) continuous assessment should focus on the improvement of the quality and process of learning.

3.3.3 Frames of reference

There are different approaches that can be taken to assessment (Sutton, 1991;
Cotton, 1995; Scott, 1996; Siebörger, 1998; Cunningham, 1998):

- Intuitive grading;
- Reference-to-perfection;
- norm-referenced;
- criterion-referenced; and
- ipsative grading.

**Intuitive grading**

Intuitive grading involves the educator basing grades on what the educator knows about the learner. This method is not recommended by Cunningham (1998) due to the great possibility of bias and difficulty of justifying marks allocated.

**Reference-to-perfection**

Reference-to-perfection grading is one of the most popular methods of grading, even though it is widely criticised in the measurement and evaluation literature (Cunningham, 1998). In this approach the grading is done according to a range of percentages. This method has a long tradition and is easy to implement. For this system to be used effectively there must be an understanding of what a score of 100 represents. In general 100 is intended to refer to a complete mastery of the content area, but in practice it is simply an indication that the student got all the items correct, which is not very meaningful when viewed in absence of information about test difficulty. This type of test is also commonly used with norm-referenced assessment, whereby the learners are compared to each other based on their percentage score in the particular test. In fact most authors cover this type of assessment as one of the ways norm-referenced assessment can take place.

Despite its limitations, reference-to-perfection is frequently used as the basis for assigning grades. Due to differences in test difficulty, the mark distribution may be different from what the educator expects or wants. These marks are then often adjusted, either by adjusting the marks themselves, or by making the subsequent test easier or more difficult. These kinds of adjustments are sometimes criticised on the basis that learners should get the grades they deserve. According to Cunningham (1998) this criticism is misguided, as the reference-to-perfection method does not provide the grade a learner deserves. According to him this is its big promise and
major failing, as there is nothing innately revealing about the percentage of items a learner gets right in a test.

It is clear that Cunningham (1998) is not much in favour of reference-to-perfection, as is demonstrated by his statement that “The reference-to-perfection method of grading continues to be used on a widespread basis, largely out of ignorance. Students demand an explanation of grading policies and get one. It is a grading technique with a long history of use, and one with which students are familiar. Its irrationality does not seem to have deterred its use.” (Cunningham, 1998, p. 156).

**Norm-referenced**

Norm-referenced assessment is an assessment where the learner is compared to other learners or to the “average learner”. The learner is compared against a norm and then the learner is classified according to whether the learner’s performance is above or below the norm. This form of assessment is designed for comparative judgements and is not designed to generate specific information about what an individual learner knows, understands and can do irrespective of other learners (Harris & Bell, 1990; Sutton, 1991; Parkinson, 1994; Cunningham, 1998; Mabry, 1999; Trice, 2000). Additionally, the meaning of a particular grade is of limited use. Norm-referenced tests are not intended to provide detailed information about learner knowledge and skills (Mabry, 1999). For example a C grade can be obtained in many different ways. This means that what one C grade learner knows may be quite different from what another C grade learner knows.

A problem with norm-referenced assessment is that, in any subject area, the knowledge and practice can be divided into what the learner must know, should know and could know (Cotton, 1995). All learners should obtain good marks in the areas they must and should know. This means that the only real differentiation between learners' marks will result from the 'could know' aspects. As there is a fundamental need to spread the learners' marks to obtain a clear rank order, due to statistical problems of reliability if the marks are grouped too closely together, there is pressure to ask trivial questions on topics that are peripheral to the subject (Cotton, 1995; Mabry, 1999).
Another problem with norm-referenced assessment is that it pits learners against each other in a competition, which discourages them from learning from each other and developing team competencies (Mabry, 1999).

**Criterion-referenced assessment**

In order to generate specific information about learning strengths and needs, the learning goals and criteria for success must be stated as precisely as possible (Sutton, 1991). The assessment process is then designed to provide evidence, for each individual learner, that those particular criteria for success have been met. Criterion-referenced assessment measures the learner’s performance against the predetermined expectations (usually some form of list) built into the assessment process (Harris & Bell, 1990; Sutton, 1991; Cunningham, 1998; Siebörger, 1998; Mabry, 1999). This approach requires that a detailed list of what the student is to achieve be developed prior to instruction. This list is constructed in the form of instructional objectives. The learners are assessed by reference against the criteria specified and not against the learners’ previous performance or the performance of other learners. Sometimes the performance criteria are written in the form of a number of levels, which allows the educator to assess the learner’s achievement of the criteria at a certain level (Siebörger, 1998; Mabry, 1999).

The unique characteristic of criterion-referenced assessment is the information provided about what a student has learned. According to Cunningham (1998), the absolute standards provided by criterion-referenced assessment are useful with concrete academic subjects like mathematics. Standards can be easily set and are widely understood and accepted for this kind of subject. Some other subjects are more difficult to quantify with absolute standards (Parkinson, 1994; Cunningham, 1998).

**Ipsative-referenced assessment**

Ipsative-referenced assessment involves a learner’s performance being measured against that same learner’s performance (Sutton, 1991; Cotton, 1995; Cunningham, 1998; Mabry, 1999). It is used to measure individual progress over time and could be very specific or general in nature. In either case any form of norm-referenced judgement is inappropriate, because the only interest is in the development of the
individual learner, regardless of the expectations for other learners. Therefore the same output rendered by different learners would result in different marks being allocated. Cunningham (1998) warns of dangers of this approach and discourages its use. According to Siebörger (1998) ipsative-referenced assessment is seldom used formally, but is often used informally in the classroom. Mabry (1999) states that this type of assessment does not facilitate comparison, whether to other learners or to predetermined criteria.

Siebörger (1998) suggests that the use of ipsative-referenced and criterion-referenced assessment, in addition to the continued use of norm-referenced assessment, can improve assessment.

3.3.4 Differentiation in assessment

The need for differentiation arises from the assumption that learners learn at different rates, to different levels of attainment and in different ways. Even though all learners are not the same, they all deserve equal opportunities to learn and develop, regardless of their differences. This means they should be given equal access to learning opportunities offered and special recognition should be given for their particular strengths and difficulties (Sutton, 1991; DOE, 2001b). No learner should be excluded from any of the learning experiences. Learners may be excluded unintentionally, for example, by using language which is difficult for non first-language learners or by assuming knowledge of events that is not in the sphere of experience of the learner (Sutton, 1991; Parkinson, 1994).

Differentiation in teaching plans involves providing learners with learning opportunities within their extended grasp, so each has equal opportunities to improve. Differentiation in assessment involves structuring assessment tasks that allows each learner the opportunity to demonstrate true proficiency and allow the accurate assessment of the learner’s needs.

Sutton (1991) identifies two approaches to differentiation, which applies to both learning and assessment. These are differentiation by outcome and differentiation by task.
**Differentiation by outcome**

Differentiation by outcome involves offering all learners the same learning experience or assessment task and the differences between learners are recognised in the outcomes of the task. This is very much the traditional approach to education, where learners use the same learning materials, attend the same lectures and write the same exams. Sutton (1991) identifies some problems with this approach with regard to assessment.

As previously discussed, one of the purposes of assessment is to identify individual learner’s progress to date and their learning needs for the future. The task created for assessment may, however, be too complex in wording or structure to allow the learner with a lower attainment, or the less confident learner, to demonstrate their proficiency. A task that feels or sounds too difficult for a learner may cause them to panic or guess wildly. Sutton (1991, p. 22) relates an experience when administering a standardised test for all children in a year group: “I watched a child sit quietly crying onto her test paper, which was just too much for her. For that child, that test gave her no opportunity to show what she could do.”

At the other end of the scale in terms of attainment and confidence, differentiation by outcome may fail, because the learner may take a quick look at the problem, work out the answer in his/her heads and present the answer, without showing how the answer was arrived at. In other cases the advanced learner may not show the full extent of what he/she can do, being content to just answer the question as it stands and move on.

According to Sutton (1991), there have been and still are many arguments among assessment experts about the difficulties and benefits of differentiation by outcome. What is agreed on, however, is that making differentiation by outcome effective is difficult, requiring that the task is carefully structured to avoid possible disadvantages to learners at either end of the attainment range.

**Differentiation by task**

The other major approach identified by Sutton (1991) is differentiation by task. This involves providing learners with learning or assessment experiences that are
specifically designed to cater for their particular levels of attainment. If the level of the task is matched and the level of the learner is matched, many of the difficulties of differentiation by outcome can be avoided. Tasks should ensure that the less capable or less confident learner is guided into the task, while the more capable learner can be stimulated to show the full extent of his/her capabilities. A big danger with differentiation by task is that the task or assessment assigned to a learner is at the incorrect level. In this case the learner may be obviously overwhelmed or unchallenged and the task should be changed, or the learner will rise or fall to the expectations of the educator. This leads to uncertainty as to what a learner may have been capable of if offered a task at the correct level. Sutton (1991) states that the extreme form of differentiation by task can be potentially as unhelpful as the extreme form of differentiation by outcome. Educators can avoid prejudging the situation too much by widening the opportunities and by widening the boundaries of the task to allow the learners to move beyond the range of expectations that the educator had for them.

Differentiation issues affect the way learning and assessment is organised. Creating multiple streams of learners is a form of differentiation by task, while mixed-ability teaching reflects differentiation by outcome. All the considerations discussed above are consistent with and reinforce what is already known about good mixed teaching, where it is required that learning tasks are differentiated into different levels of difficulty to allow all learners equal access (Sutton, 1991).

3.3.5 Self assessment and peer assessment

Professionals need to develop sound judgement about their own behaviour and that of their peers. This means that it is appropriate that assessment involves elements of self-assessment as well as peer assessment (Harris & Bell, 1990; Beaty, 1998). Self-assessment is largely concerned with formative assessment (Siebörger, 1998). It involves learners in their own learning processes and improves their understanding of what is expected of them.

Parkinson (1994) identifies three areas where the learners can be involved in the assessment process:

- Self-assessment and target setting;
• keeping records of progress; and
• the selection of evidence to support levels of attainment.

It is part of the educator's duties to provide regular feedback to learners about their progress through the work. If the learners are required to keep their own records in addition to the feedback provided by the lecturer, it would provide an opportunity for them to reflect on their mastery of the topic. Having their own record system shows the learners where progress is being made and gives them greater confidence in their abilities. (Parkinson, 1994).

Learners might be involved in building up a portfolio of their best work, the process of selecting which items to include may be a valuable learning experience for the learner. The learners may periodically be asked to review the evidence in their portfolio and to update it with evidence of higher achievement. Parkinson (1994) states that involving students in the assessment process strongly supports learning, but it is a time-consuming process.

Biggs and Moore (1993) as well as Mabry (1999) state that learners should take increasing control of their own evaluations (of which assessment forms a part). This is due to the fact that self-evaluation is a core process in metacognition and should therefore be cultivated in the classroom.

According to Siebörger (1998) some learners use informal self-assessment frequently, working out in advance what they think their work is worth and they have a good idea of whether they performed well or not. Others are more reluctant to undertake any form of self-assessment.

There is also an important role for formal self-assessment to assist the learners in developing a greater understanding of their own thought processes and performance (Mabry, 1999). According to Siebörger (1998) it will probably take at least a year of practice with self-assessment, before the learners can do it properly.

Siebörger (1998) presents the following main requirements for formal self-
assessment:
- Learners should be given opportunity to explain their understanding of the assessment activity;
- learner assessments should be planned;
- feedback should be given to the learners after their self-assessment; and
- they should be encouraged to talk about what they should do next to improve.

As professionals often do not work alone, but in teams, they need to learn the skills of giving and receiving feedback in a constructive manner. Peer assessment therefore plays an important role in courses for professional development (Beaty, 1998).

If the learners are to be involved in the assessment process, this needs to be managed carefully. Criteria-based assessment is well suited to this situation, because the assessment conducted by the learners are more meaningful if they have clear criteria to base their assessment on. Rubrics (see Section 3.3.6) may be used to assist in this regard.

3.3.6 Checklists ( grids) and rubrics

An assessment grid is a set of assessment criteria that specifies the required characteristics of quality for a set learning outcome where the attainment of each criterion is indicated at a level of competency on a scale. The choice of level can be highly subjective as each assessor could have a different view as to what constitutes a particular level of performance. This limitation is addressed by using a rubric in conjunction with the grid.

A rubric is a system for assessing a complex response by a learner (Trice, 2000). This may take the form of checklists or descriptions of behaviour. It is a scoring guide that differentiates, on an articulated scale, among a group of sample behaviours, or evidences of thought that are responding to the same prompt. The rubric may correlate with quantitative or qualitative scores or no scores at all (Shupe, 1998; Trice, 2000).

A common type of rubric is the combining of criteria and standards (Mabry, 1999). Along one side of the rubric could be a checklist of characteristics, which aims to
make the assessment of the quality of a learning product easier. It identifies traits and components that must be present to indicate the extent to which a learning outcome is achieved. These represent the criteria that have been chosen to be most important.

Along the top of the rubric is then placed a list of rankings that will be used to assess how well the learners have mastered each of the criteria. The criteria and performance levels together form a two dimensional grid that can be used for assessment. As mentioned above, there are shortcomings in the use of a grid on its own.

In addition to the criteria and performance levels, the rubric also defines what would constitute a particular level of achievement for each criteria, thereby reducing the subjective aspects of assessment. This defines the standard that would constitute that level of performance.

3.4 PLANNING ASSESSMENT

Rowntree (1990) states that assessment is so fundamental that the form of assessment should be decided at the beginning when planning the learning content. Sutton (1991) quotes the Task Group on Assessment and Testing (TGAT – Great Britain) as saying that the assessment process itself should not determine what should be taught and learned. She does acknowledge that this is easier said than done, but holds that the greater the educators professional confidence, the more likely that the learning needs will be placed first and assessment will adopt its appropriate role as “the servant of the curriculum” (Sutton, 1991, p.9). She also agrees that assessment should be planned into the teaching and not simply added as an afterthought.

The purpose of assessment is to determine if the objectives are being met. Every course of instruction has certain objectives, even if these objectives are not explicitly stated. OBE as an approach to education stresses the need to be clear about what the learners are expected to achieve. These expectations are expressed as
outcomes and the teaching and learning is guided by these outcomes. Assessment is essential to OBE because it is necessary to be able to measure to what degree a learner has achieved each outcome (Siebörger, 1998).

Cunningham (1998) suggests that educators should think of the objectives before assessing, regardless of whether the objectives are formally stated or not. OBE makes it clearer on what basis these assessments should be undertaken (Siebörger, 1998). In OBE the aims of the curriculum are contained in the outcomes that state the results expected at the end of the learning process. These outcomes refer to the knowledge, skills and/or attitudes, which the learners should be able to demonstrate that they can understand and apply within particular contexts. Changes in the structure of Curriculum 2005 makes it necessary to look at the planning issues involved in the old and new structures separately.

3.6.1 Curriculum 2005 assessment

Outcomes link the aims, content and the assessment of the curriculum. Because outcomes (either cross-curriculum or specific) describe the expected performance, they make it possible to specify particular performance indicators in order to specify the kind of assessment that is needed to measure it by. Performance indicators are statements that provide details of the content and processes, which a learner should master, as well as the learning context. It should assist the educator in judging what evidence is required. Such performance indicators are not provided in the curriculum itself; it is usually left to the educator to decide what the best form of assessment will be.

The way in which an outcome is written has an important effect on the assessment of the outcome (Siebörger, 1998). The verb indicates the performance, competency or achievement expected and the words which follow it describe the object intended. Consider the following example of how the wording of an outcome can influence assessment.

Learners will be able to demonstrate a critical understanding of abstract data types.

The verb, demonstrate, indicates that the intended understanding is not simply
superficial or rote learning. Something has to be done with the knowledge of abstract data types and the assessment will have to allow the learners to show their understanding of abstract data types by means of activities. If the verb had been *identify*, they would simply have had to know some of the aspects of abstract data types, without actually being required to be able to do anything with the knowledge.

The wording of the rest of the outcome also affects the assessment, so it is necessary to provide more detailed guidelines of what is expected (Siebörger, 1998). These guidelines are contained in the assessment criteria, range statements and performance indicators. An assessment criterion is a statement derived from an outcome, which describes in broad terms what a learner is expected to achieve for the purpose of assessment. They contain verbs to indicate the kind of performance intended, but will also provide further guidance about assessment. Some examples of assessment criteria for the above outcome could be:

- Key features of abstract data types are identified.
- The role of the interface of an abstract data type is explained.
- Abstract data types are used in computer programs in an effective and efficient manner.

The range statements do not affect the kind of assessment used, but provide information about the intended scope and context of the learning. These outcomes could be used at different levels of education. It would therefore be necessary that a description be provided of how assessment would take place at the different levels.

### 3.6.2 New Draft National Curriculum Statement

The new Draft National Curriculum Statement uses a new, simplified, structure for assessment (DOE, 2001d). The curriculum still defines key Critical and Developmental Outcomes, but instead of the old Specific Outcomes, it now provides a small number of Learning Outcomes for each of eight Learning Areas defined in the curriculum. These Learning Outcomes can be seen as fulfilling a similar role to the old Specific Outcomes, but having a simpler structure and being reduced in number.

The new structure, however, now adds a number of Assessment Standards for each Learning Outcome. These Assessment Standards define the knowledge, skills and
values that the learners need to show in order to achieve the Learning Outcomes in each grade (DOE, 2001d). These provide more information about the required performances at each grade than was the case in the old Curriculum 2005 structure. Some of the aspects of the old structure (like range statements) could perhaps still be useful at the lower levels of assessment, but their removal has simplified the overall structure of the assessment.

3.6.3 The Assessment cycle

Formative assessment forms an integral part of teaching and learning (Sutton, 1991; Parkinson, 1994; Beaty, 1998). This leads to an upward spiral of attainment as the formative assessment provides feedback on learning that has taken place, leading to further learning. According to Siebörger (1998) the results of assessment, as an aid to learning, are much more effective when an educator has an idea of how learners are going to make progress. At the beginning of a course the educator needs to plan the assessment in such a way that learners can benefit as much as possible from the feedback that they receive and can be motivated to improve through their assessment. The learners also need to know what results they can expect to achieve and this should be explained to them.

When teaching and training programmes are developed to help learners achieve the standards set, careful consideration needs to be given to whether or not learners with different abilities will be able to progress at their own preferred rates (Melton, 1997). It must be decided whether it will be possible to provide assessment opportunities on a flexible basis, as and when needed, or whether assessment will be at fixed points in time. These and related decisions have implications for the design of related teaching and testing.

In a behaviourist approach emphasis is typically placed on ensuring that learners achieve the standards set, regardless of the amount of time this takes (Melton, 1997). Since the learners are progressing at different rates, assessment is normally provided on a flexible basis. This does require special consideration as to how the educators will be able to provide the type of individualised guidance and support that will be needed.
If the assessment at fixed points in time is preferred, it needs to be recognised that learners of different abilities will achieve different levels of attainment within the prescribed time. This needs to be taken into account when setting the standards and in the design of the teaching process and related system of assessment. Melton (1997) states that, in such a system it makes sense when setting standards to identify core competencies and learning outcomes that might be achieved by the vast majority of learners and optional competencies and learning outcomes that might be achieved to varying degrees by more able learners. The related instructional materials should then be designed with this in mind. It is important that learners should gain credit for what they achieve and not just for the achievement of the common core competencies and learning outcomes.

The assessment has to be integrated with the teaching so that learning can be enhanced and this has to be planned for. The teaching aims to provide the learners with the opportunity to learn, while the assessment determines what has been learnt. This once again drives future teaching. This relationship between teaching, planning and assessment is presented in Figure 3.1.
This diagram shows three stages of assessment:
   i. Gathering information (evidence);
   ii. recording the results; and
   iii. giving feedback to the learners.

This shows that assessment is not the final point of teaching and learning, but rather a guide to future teaching and learning (Siebörger, 1998). This is accomplished through an analysis of what is taking place, leading into a new iteration of the teaching and learning cycle, where the teaching and learning is planned, leading into the organising of the learning. The results of the learning is assessed and recorded. This then provides feedback on the results of learning and the analysis lead right back to the revised plan for teaching and learning.

Another schematic of the assessment cycle is provided in Figure 3.2.
The first stages are to identify the aims and objectives of the organisation (1) and department (2). During this early stage the main Learning Areas would be identified. In a typical tertiary institution, these may correspond to the different subjects offered.

Following the determination of departmental goals, the objectives of the subjects (3) are determined and plans are made accordingly, comparing existing plans and topics with the learning objectives. The plans for the subject (3) must be compatible with the departmental plans (2) (Parkinson, 1994). Once the overall curriculum plan has been determined, the plan can be broken down into modules or topics. It is decided how the learning objectives may be met given the constraints of time, space and resources. It should be determined whether the activities planned will provide proper access to the learning opportunities for all the learners. The main essential is to

**Figure 3.2**: The assessment cycle
(adapted from Sutton, 1991, p. 25).
provide a range of teaching styles, to correspond to the different learning styles. These objectives would be specified in terms of the Learning Outcomes for each of the Learning Areas as well as the Assessment Standards for each Learning Outcome that would indicate its mastery at each level (for example Semester 1 or Semester 5).

The current progress of the Learners (obtained from Learner profiles (4)), together with the Assessment Standards, allow the specification of certain Assessment Criteria (5). These criteria should flow directly from those Assessment Standards specified as required when compared with those that the learners still need to demonstrate. The actual assessments chosen should take into account the characteristics of the learners involved.

Once the criteria for the next assessment has been determined, appropriate assessment techniques (6) need to be chosen. It may be necessary to cater for multiple assessment techniques and even multiple activities to allow learners with different learning styles to demonstrate their true ability.

The next step is to conduct the actual assessment and to record the results (7). The results are reported (8) and also analysed (9). The analysis determined whether the curriculum objectives are being met. The analysis is also used for evaluation and could lead to adjustments in the organisational, departmental or subject objectives.

It is necessary to plan carefully which assessment opportunities to use, as it is not desirable to conduct assessment to the detriment of other learning opportunities. Reducing the assessment load by using less assessment opportunities means that the quality of the assessment becomes more important. Each assessment should be properly planned for. One aspect that needs to be considered is the choice of an appropriate assessment strategy for each assessment objective.

Rowntree (1990) lists 10 questions that need to be answered when planning an assessment strategy:

i. Is there a need for occasional tests or assignments, or will self-assessment and activities be sufficient?
ii. If tests or assignments are needed, how frequent and time consuming should they be?

iii. Which of these assessments can be self or peer-assessed and which will require a tutor for marking and comments?

iv. Which course objectives will each test and assignment be aimed at?

v. Which assessment methods are appropriate?

vi. How can assessment be conducted in such a way that accurate details are obtained regarding the learner’s competence?

vii. If it is required to assess a task while it is being performed, how can this be arranged?

viii. Is a formal examination needed?

ix. How can appropriate feedback be provided to the learners in order to aid their learning?

x. How can the marking and commenting be made as effective as possible?

This section has looked at the process of planning assessment. It was stated that appropriate assessment opportunities should be chosen and that appropriate techniques should be used in order to ensure effective assessment. It is now necessary to look at what some of the criteria for effective assessment are.

**3.5 CRITERIA FOR EFFECTIVE ASSESSMENT**

The general purpose of assessment is to describe a person’s level of achievement or potential. Any tests or techniques used in order to accomplish this must determine this accurately. The best assessment of a person would be a complete life history analysis, free from bias or distortion that could result from examination results, achievement records, personal reports or standard test data, as these merely gives limited glimpses of the whole picture (Cotton, 1995). In this perfect assessment the assessor would achieve a flawless appraisal of the quality under examination without disturbing the candidate. This is unrealistic, but certain guidelines can be followed to ensure good assessment.
3.5.1 Validity, reliability and manageability

Figure 3.3 shows the different aspects of validity, reliability and manageability, which have to be balanced in order to find a suitable assessment.

![Diagram showing the balance between validity, reliability, and manageability]

**Figure 3.3:** A “best fit” model for high-quality assessment  
(Adapted from Sutton, 1991)

**Validity**

Biggs and Moore (1993) state that validity is the most important property of a test. Sutton (1991) refers to this as the “fitness for purpose” and “validity” principles, meaning that the method of assessment should be appropriate for the assessment goals and should not measure something else. Cunningham (1998) also refers to the validity of assessment and adds that this is difficult to quantify and is therefore often ignored.

An assessment is only valid if it achieves what it intended (Parkinson, 1994; Siebörger, 1998; Cotton, 1995; Trice, 2000). Sutton (1991) defines an invalid assessment as one where the context, structure or requirements of the task gets in the way, preventing the learner from demonstrating the reality of what he or she knows and can do. Examples of these would be questions containing words that the learner does not understand, or time constraints, which may have no direct relevance to what is being assessed. A specific assessment may be valid for one learner and be less valid, or even completely invalid, for another learner due to the different ways
of presenting and receiving information. Sutton (1991) concedes that absolute validity is impossible in reality, mainly due to manageability constraints.

Reliability

A reliable assessment is one, which would give the same result each time it is applied to work of equal standing (Parkinson, 1994; Cunningham, 1998; Cotton, 1995). Reliability is "the extent to which error is eliminated from the assessment process" (Trice, 2000, p. 29). A test that measures something consistently is therefore reliable (Siebörger, 1998). It is however possible that a test may be reliably, invalid.

Ensuring the reliability of assessment involves recognising the variables that could affect the outcome of the assessment and reducing their effect. The four major variables considered by Sutton (1991) are:

i. Interpretation of the assessment criteria;
ii. level of the evaluator’s involvement and intervention during the assessment task;
iii. perception of the evaluator; and
iv. the circumstances under which the evaluation takes place.

Absolute accuracy with words is difficult to attain and this leads to problems of interpretation of the exact meaning of criteria used during criterion-referenced assessment (Sutton, 1991; Parkinson, 1994). This means that the more evaluators are involved, the more difficult it is to have a consistent interpretation of the criteria. In addition, if the goal is formative assessment, the learners’ interpretation of the meaning of the criteria is also a factor, which affects its usefulness.

When the assessment involves the evaluation of tasks performed in the day-to-day activities where the learner and educator are both involved, the effect any intervention by the educator may have, should be kept in mind when assessing (Sutton, 1991). This is particularly important when assessing programming ability using ongoing assignments, because students may, and in fact should, learn during these assignments by receiving help in doing them. The nature of this help does, however, affect the formative assessment, because it is also important to know what
the learner is capable of without help.

The preconceptions of the evaluator can have an impact on how the decisions taken by the learners are perceived. Sutton (1991) warns of the danger of selective assessment, which leads to the gathering of evidence that reinforces the subconscious assumptions and may adversely affect the reliability of the assessment.

Sutton (1991) lists various ways that the circumstances of assessment may affect the reliability of the assessment. These include the effect of formal exams in exam halls, or assessing on a Friday afternoon when both the evaluator and learners may be tired.

Another factor that test scores are influenced by is characteristics of the learner that are independent of the content measured. This is positive for reliability, but has a negative impact on validity and applies to all forms of testing (Biggs & Moore, 1993). These effects are due to the fact that particular forms of testing would favour different types of personalities. An example could be an assessment where a learner’s knowledge of systems analysis is judged based on a verbal presentation. One learner may only have a little knowledge, but be a good speaker, while another with a lot of knowledge may be very poor at presentations. In the end both these learners may each produce a presentation of equal standing and would get the same assessed result. This means the assessment is reliable, but the validity suffers as the work produced was influenced by a characteristic that is independent of the content being measured.

According to Biggs and Moore (1993) this distortion is not completely negative, because the form of testing could be made appropriate for the kind of skills required anyway. This means that this effect can be usefully considered by evaluating programmers in terms of their ability to actually implement a solution on the computer, rather than by essay writing, as this is the context in which they would be required to apply the skill. This means that a person with high theoretical knowledge of programming, but who is unable to actually operate a computer, would be biased
against, but that this bias would not be inappropriate, considering the context.

**Manageability**

The manageability of the assessment is often a constraining factor when attempting to provide valid and reliable assessment (Sutton, 1991; Parkinson, 1994; Rushby, 1996). Even though a multiple-choice test may be the most manageable form of assessment, it is not appropriate for all kinds of assessment. “The questions that are easiest to ask may not be the ones you most need to have answered” (Rowntree, 1990, p. 305).

Of course there are some situations where this form of assessment would be appropriate and individual conversations with each learner would provide no greater validity or reliability. This search for a balance between validity, reliability and manageability is illustrated in Figure 3.3. Some of the experiences in the implementation of Curriculum 2005 illustrate the dangers of forgetting manageability. Many interpreted continuous assessment to mean frequent testing and this led to an explosion of accounting and record keeping in the classroom, with a resulting interference with teaching and learning (C2005 Review Committee, 2000; DOE, 2001a).

According to Siebörger (1998) assessment can never be completely valid and completely reliable. This is due to the interaction between the context of the assessment, the individual learner and the human judgement of the educator, as well as the constraints of manageability.

Siebörger (1998) suggests the following ways to create more time for assessment:

- Use group work, which reduces the number of items to assess. By changing the groups regularly, it should still be possible to distinguish those who are coping from those who are not.
- Group outcomes and assessment criteria together for assessment purposes. Projects and exercises can be done with more than one assessment criterion in mind. This does require careful planning.
- Make careful use of tests and examinations. A single question can be broken into parts that assess aspects of a few different assessment criteria. Some educators
may need to use tests and examinations more under OBE than before, because they can create more time for assessment. This is particularly the case if the learners are not able to do much work at home.

“Best fit”

As illustrated in Figure 3.3, managing assessment involves finding the best balance between validity, reliability and manageability. In its simplest form this involves choosing between different techniques of assessment. For example, if there is a tangible product like the source code for a computer program, this can be assessed away from the learners, but if there is no tangible product, for example in an oral presentation, the assessment has to be done at the time. The strategy of assessment has an effect on the validity, for example a learner who may be able to explain something orally, may be unable to do so in writing. The language level used is an issue, especially, but not exclusively, where second-language learners are concerned. Sutton (1991) suggests that if it is our belief that learners learn in different ways and we therefore offer them different ways of learning, we should also be prepared to offer as wide a range of assessment styles as possible.

3.5.2 The importance of feedback

Assessment should not just focus on what is wrong, but consideration must also be given to providing praise to the student (Rowntree, 1990; Parkinson, 1994). This may be achieved by focussing on the progression of the individual learner rather than comparing with other learners. This allows the learners to know that they have achieved something, even if they have not completely mastered the subject.

According to Rowntree (1990) it may be best to ignore some minor weaknesses in order to help the learner correct major weaknesses. This is due to the limit to the range of criticism and advice that a learner can absorb at one time. This would also be a motivation for a larger number of smaller assessments in order to provide more feedback. According to Beaty (1998), courses should include regular and thorough feedback throughout the training period. Siebörger (1998) also says that learning is promoted by more frequent rather than less frequent assessment.

The purpose of comments is to help the learners think again about what they have
done and what they might do differently in future. It is not sufficient to simply fill the learner’s work with tick marks, question marks, etc. The learner needs to be told precisely where and how he or she has gone wrong and how the faults may have been avoided (Harris & Bell, 1990; Rowntree, 1990). “Do all you can to make each assessment a learning experience – and not just a formal check-up on what has been learned already” (Rowntree, 1990, p. 332)

Rowntree (1990) also notes that feedback must also contain positive points in order to improve learning by providing indications that there is some realistic prospect of improving. Additionally, he also proposes a dialogue format for feedback in order to stretch the learner’s thinking by asking stimulating questions rather than providing ready-made answers.

Rowntree (1990) lists some ways in which tutors may use their written comments to teach. These comments may:

- Draw the learner’s attention to facts that may have been overlooked;
- suggest alternative approaches or interpretations;
- suggest other sources of information or feedback;
- identify gaps in the learner’s reasoning;
- suggest ways of presenting ideas more effectively;
- provide comments on ways that the learner can improve practical skills;
- ask for further explanations of unclear answers;
- demonstrate shortcuts in procedure that are useful;
- assist learner in reflecting on how the work could be improved;
- point out relationship between present work and earlier work; and
- commend the learner for any unexpected insights, special efforts or improvement in competence.

It should be clear that some of these uses of comments can only be provided if the educator has good knowledge of the learner’s performance over time. Assessment results provide insight into the strengths and weaknesses of the learner and can therefore suggest ways that the educator may help the learner. The comments that the educator provides should take the strengths and weaknesses of the learner into
3.6 THE NATURE OF ASSESSMENT FOR OUTCOMES-BASED EDUCATION

This section highlights the main principles of an outcomes-based approach to assessing learners.

Following the OBE model, the Draft National Curriculum Statement does the following (DOE, 2001d):

- It outlines Learning Outcomes and their associated Assessment Standards in each Learning Area and for each grade in General Education and Training (Grades R to 9). The Learning Outcomes set out the knowledge, skills, values and attitudes the learner must be able to demonstrate in every grade.
- It contextualises the Critical Outcomes and Developmental Outcomes within the Learning Outcomes and Assessment Standards of each Learning Area.
- It places Assessment Standards at the heart of the assessment process in every grade. They describe the expected level of performance and range of performance for each of the Learning Outcomes for each grade. Assessment Standards are the means for achieving Learning Outcomes. The performance of learners in the Learning Outcomes must be assessed against the Assessment Standards.

According to the Draft National Curriculum Statement (DOE, 2001d), the following are key elements of assessment to help learners reach their full potential:

- The assessment should be transparent, democratic, clearly focused and participatory.
- Assessment should be integrated with teaching and learning.
- It should be based on pre-determined criteria or standards.
- The assessment should be integrated, by making use of integrated tasks and activities, and a variety of methods, tools, techniques and contexts in assessing learners' performance.
• Assessment should be valid, reliable, fair, learner-paced, and flexible enough to allow for expanded opportunities.

Siebörger (1998) presents the following attributes of assessment in OBE:

• Outcomes should improve planned progress, since learners can be informed in advance of the outcome that they need to achieve. They cannot simply be told what the outcome is, without also being informed by what process they will be helped to achieve the assessment criteria at the appropriate level. If they are not informed of this, there may be no planned progress at all.

• OBE requires more detailed records of progress or achievement than was previously required.

• The use of outcomes will lead to greater authenticity in assessment, as the assessment will be directly dependent on the outcome and the assessment criteria.

• The assessments of outcomes favour self-referencing and criterion referencing, particularly since each learner has to achieve each outcome. Norm referencing and reference to perfection will still take place, however, as this will be a guide as to what performance can reasonably be expected when a learner achieves an outcome.

• Informal assessment will remain important to help the educator guide learners towards the competence, which they require, but OBE encourages formal assessment. This is because the learners must understand clearly what is expected of them and how they will be assessed.

• Assessment needs to be used in a formative way to show the learners what progress has been made and what still needs to be achieved. Assessment needs to be used in a summative way to demonstrate that an outcome or assessment criterion has been attained.

• Continuous assessment benefits the achievement of outcomes, as it helps the learners to progress towards them. The continuous assessment model is the model recommended for the assessment of learners in the Draft National Curriculum statement (DOE, 2001d).

According to the Draft National Curriculum Statement (DOE, 2001d) the main
purpose of assessing learners is for their individual growth and development, not only for the promotion decisions. In other words: “Assessment *is to help the learner, not to provide a set of marks for the teacher*” (Siebörger, 1998, p. 58).

The Draft National Curriculum Statement (DOE, 2001d) defines assessment as a continuous planned process of gathering information about the performance of learners as measured against the Assessment Standards. As part of this process, it is necessary to:

i. Provide constructive feedback to learners;
ii. record the results; and
iii. reflect and report to outside entities with an interest in the learner's progress.

The Draft National Curriculum Statement suggests the following guidelines to help make assessment responsive to the needs of learners (DOE, 2001d):

- The learners should be invited to be active participants in learning and assessment.
- It should be ensured that the assessment criteria are understood by both the learners and the educators.
- Learners should be encouraged to reflect on their learning.
- Strategies that cater for a wide variety of learners needs should be used.
- Educators should be sensitive to barriers to learning.
- There should be flexibility in the assessment style to cater for the different rates and styles of learning within the group of learners. It is not necessary to assess all the learners at the same time, or in the same way.

Assessment must provide useful information about the learner’s progress against the Assessment Standards in a grade. When you report on achievement, you should include information about strengths and the areas where support is needed (DOE, 2001d).

### 3.7 EVIDENCE OF LEARNING IN OBE
As previously discussed, assessment involves the making of decisions regarding the learning that has taken place. These decisions have to be based on some form of evidence.

In OBE both the educator and the learner need to know the outcome that needs to be achieved and when it has been achieved (Siebörger, 1998). This means that the evidence required to show that the outcome has been achieved is now much more important than it was when only a mark was needed. Good record keeping is essential in an outcomes-based system.

Learners need to receive continuous constructive feedback outlining their strengths and areas where more development is needed. It is therefore important that appropriate methods of feedback be developed (DOE, 2001d).

Every outcome that may be set for learners has a range of possible evidences for assessment. It is also possible that more than one outcome (or assessment standard) may be assessed from the same evidence (Siebörger, 1998; DOE, 2001d). This is important, as it reduces the amount of assessment and marking. It also helps with the integration of the outcomes within the curriculum.

3.7.1 Stages in assessment

The Draft National Curriculum Statement (DOE, 2001d) lists four progressive stages of learner achievement:

i. Performance in assessment activities based on the Assessment Standards for each grade within a Learning Area or a learning programme, in order to provide a measure of

ii. the performance against the Learning Outcomes of the grade in a Learning Area or programme. This provides a measure of

iii. the performance in the Learning Area or programme, which finally provides a measure of

iv. the performance in the grade.

Each of these stages has certain record keeping requirements. It is suggested (DOE, 2001d) that integration be ensured by assessing a grouping of Assessment
Standards and choosing an appropriate assessment activity. During the assessment process it is essential to provide detail of the knowledge, skills, values and attitudes that the learners are expected to display during the assessment.

The Assessment Standards indicate both the depth and breadth of what should be taught and learnt at each grade. This means that they should be used for purposes of learner assessment, both for continuous formative assessment, as well as for a summative and systematic assessment (DOE, 2001b). When being used for formative assessment, the learners' work is assessed in terms of the assessment standards and whether they are making progress towards achieving the learning outcomes. When used summatively, the assessment standards indicate what has to be tested to discover whether the learners have achieved the standards or not. This provides an indication as to the extent to which the learning outcomes have been achieved.

The Draft National Curriculum Statement (DOE, 2001d) states that a variety of methods of assessment should be used to make certain that all the Assessment Standards are catered for. There may be a problem for record keeping and reporting when many different kinds of evidence are used for the assessment of learners. Siebörger (1998) suggests the use of records of achievement or profiles in such a situation.

3.7.2 Records of achievement

A record of achievement is a record of all a learner's achievements, qualifications and informal experience. It makes possible a cycle of review, reflection and future planning by the learner. This record may contain the results of marks attained, comments by both the teacher and the learner, as well as examples of work done. The record of achievement is more useful to the learner than a report, as it gives more helpful information. A record of achievement may contain a number of profiles for the particular learner.

3.7.3 Profiles

A separate record for each student with more detailed comments of progress is advisable. Even though the keeping of records may be tedious, it leads to more
accurate reporting (Parkinson, 1994).

A profile is a more detailed way of using different kinds of evidence to give a better all-round assessment of learners. It is a systematic and comprehensive description as well as assessment of a learner’s academic and non-academic achievements, attributes and interests. It is a continuous record and includes the holistic development of values, attitudes and social development (DOE, 2001d). A profile firstly presents information about the learner and secondly about the assessment of the learner's achievements. According to the Draft National Curriculum Statement (DOE, 2001d) the learner profile must be safeguarded for each learner. These profiles should accompany the learners throughout their school careers.

Profiles can be made in different ways, but must all contain (Siebörger, 1998):

- A list of items such as personal qualities, outcomes, assessment criteria and/or performance indicators and the learning programme or course;
- an indication of the levels achieved or performance in each item; and
- an indication of the kind of evidence on which the assessment has been based.

Regardless of the methods of assessment chosen, it is important that accurate records are kept of the learners' work, in order to be able to report with confidence. Parkinson (1994) suggests the following information as useful to have a record of:

- Learning opportunity attendance: Allows the identification of patterns on non-attendance, as well as highlighting which areas of work the learner has missed.
- Whether assignments were submitted: This prevents arguments over whether work was submitted or not.
- Lateness in submitting assignments: Help identify learners who regularly submit late.
- Completeness of work: It is necessary to know what work the learner must still complete.
- Grades or marks for assignments: Their importance should be determined in the light of their relevance to the objectives.
- Marks for tests: Should be cross-referenced with master copy of the test with full mark scheme.

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A simple profile containing the results achieved by a learner in all the different parts of a learning programme or module would make it easy to see which areas the learner has done well or poorly in. According to Siebörger (1998) one might also wish to profile skills, such as those found in languages, to show the strengths and weaknesses in the different areas. Any of these profiles can be included in a record of achievement.

Some profiles may be more personalised with learners and educators writing more comments, while others might be depersonalised, with comments only in the form of ticks in boxes. “Don’t attempt to keep as many records as possible, but try to be systematic in record keeping and to give each learner the same attention and the same detail as the others in your records” (Siebörger, 1998, p. 64).

The Draft National Curriculum Statement (DOE, 2001d) considers the central purpose of a learner profile to be to assist a learner by having access to the variety of information it includes. This information includes:

- personal information, including the learner’s photograph in the current phase;
- physical condition and medical history;
- schools attended and record of attendance;
- participation and achievements in extra-curricular activities;
- emotional and social behavior;
- parental involvement;
- areas needing support by special support services;
- samples of the learner’s work as evidence of areas for support;
- summative end of year overall report;
- samples of the learner’s work in each learning program;
- promotion summary records of the schooling years; and
- the transfer form.

Some of this detail is simply administrative requirements of the school system, while some other details recorded regarding each learner can be used to construct a learner model, which shows the learner’s current understanding of the subject matter.
This model can then be used to provide more meaningful feedback. According to Barker, van Schaik and Hudson (1998) mental models form the basis for all teaching and learning activities. It is therefore desirable to obtain a mental model of the learner, which is as clear as possible.

One way to reduce the amount of evidence used and involve the learners is to make use of portfolios.

3.7.4 Portfolios

The problem with having many different kinds of evidence is what to do with them. The records kept for each piece of evidence is important, but they cannot show what the learners have achieved. Siebörger (1998) says the answer is to use portfolios in addition to record or mark books. He identifies three features of a portfolio:

- It can show only the best work done, which means the learner selects what is best and leaves out the rest.
- It can show all the different types of work that has been produced, to give an impression of everything that the person can do.
- It gives the learner the opportunity to manage his/her own work.

This means that the learners are given the responsibility of keeping a portfolio of everything that they have done in a learning programme. It becomes their responsibility to ensure that the portfolio contains enough evidence of what they have achieved and that the best evidence is selected. They can see by looking at the portfolio what they still need to achieve or what they can improve. This could be through either increasing the range of different types of evidence or by improving the quality of the evidence in the portfolio. This also helps the consolidation of learning by making assessment an integral part of the learning process (Cotton, 1995; Lazear, 1999).

According to Siebörger (1998) portfolios are an authentic way of assembling evidence for the assessment of learners. They give the learners some control over their assessment and reduce the amount of direct control the educator needs to have. The portfolio need not be assessed frequently and may even be assessed only once a year, provided that the pieces of evidence within it have already been
assessed in some way.

Despite these advantages of allowing the learners to control what is placed in their portfolios, Trice (2000) has certain problems with this approach. When the learners select materials for their portfolios they take responsibility for their own learning, but not all learners necessarily do so successfully. In portfolio evaluation the selection of the material for the portfolio is a critical component of the process. Making the learners responsible for this can affect the reliability of the assessment, as they might not make the correct choices. The effect of this might be reduced if the educator assesses the items before the learners make the selection for their portfolios (as suggested by Siebörger (1998)). This would give the learners a clear indication of their performance in the particular item. Knowing precisely what needs to be demonstrated may also help (as should be the case in OBE (DOE, 2001b)), but the dangers should not be forgotten. If the learner does the selecting, then it will need to be in consultation with the educator (Redman, 1994; Trice, 2000).

Trice (2000) emphasises the fact that a portfolio can contain anything, whereas a gradebook contains only marks. More importantly, a gradebook would have no indication as to why the grades have been obtained while a portfolio would contain the evidences from which the grades were determined. This allows corrective action to be more effectively taken. Therefore, according to Trice (2000), the real value of portfolios is that they contain rich data, which can be used to find patterns or trends. These multiple examples are also seen as the greatest weakness of portfolios. If too much is collected in the portfolio, then there may never be enough time to review it all. It is necessary to continually review the content of the portfolio and to remove items that are no longer needed.

Redman (1994) describes the principles used in the building of portfolios using the following sequence:

i. The story of what has been done;
ii. learning from the discovery that some of what has been done is significant;
iii. proof or demonstration that what has been learnt can be used in other relevant ways;
iv. ownership that comes from taking responsibility for the development of the portfolio; and
v. growth that comes with looking for new learning opportunities.

Figure 3.4 shows how managing portfolios promote interaction between teachers and learners. This diagram also illustrates the opportunity for learners to take responsibility for aspects of their own growth.

![Diagram of the interaction between dialogue, implementing targets, recording achievements, and identifying new aims]

**Figure 3.4: Managing portfolios (Siebörger, 1998, p. 51).**

3.7.5 Reporting

It is not sufficient simply to gather and assess evidence; it is also necessary to report on the progress of the learners.

According to the Draft National Curriculum Statement (DOE, 2001d) each report on a learner’s overall progress should include information on:
- The learning achieved;
- the learner’s strengths;
- support needed; and
- constructive feedback.
In addition to the above, portfolios on each Learning Area or program should be available as additional evidence.

3.7.6 Marking

This section has taken a closer look at the handling of evidence and its assessment in an OBE environment. An aspect that needs to be briefly looked at is the process by which a performance is evaluated. In the case of a product assessment, some form of marking is probable.

In big classes, this marking can be one of the most effective ways of personal motivation as it represents a form of personal contact. Siebörger (1998) suggests the following ways of improving the efficiency of marking:

• Do more ‘annotating’ and less ‘marking’. In outcomes-based education it is often not as important to give a mark as it is to give an indication or comment as feedback to the learner. It is not necessary that all assessments should have a mark, but it is necessary to have a record of what was done and to provide the learners with feedback.

• Assess in broad levels, without spending time on detailed marking, this gives learners an indication of progress, without taking as much time.

• Give learners the assessment levels/criteria and allow them to assess themselves. This not only gives them a better sense of what to expect in their next assessment, but also speeds up the educator’s assessment as this can be done by comparison to their assessment. If these criteria and levels are provided to the learners before the start of the activity, it will in addition give them a clear idea of what standards are expected of them.

• Use time in class to assess. Whether for formal or informal assessment, all activities, which can produce evidence of achievement should be assessed and the assessment recorded. This assessment could be done by the educator or through peer assessment.

• Tell the learners when they can expect to receive their assessments. This can make up for not being able to return them quickly.
3.8 SUMMARY OF MAIN POINTS FROM THIS CHAPTER

3.8.1 Decision-making

- Educators are required to make a large number of decisions, often in a short amount of time, based on what is known at the time.

3.8.2 Forms of assessment

- Assessment does not only mean tests, examinations and written exercises, but also many other ways of gaining information and giving feedback about the progress of learners.
- Any act of assessment can be both summative and formative.
- Assessment needs to be used in a formative way to show the learners what progress has been made and what still needs to be achieved. Assessment needs to be used in a summative way to demonstrate that an outcome or assessment criterion has been attained.
- Formative assessment may have an individual or group focus.
- The form of assessment used should be appropriate for the type of decision to be taken. The educator should be able to make day-to-day decisions based on information gathered, no matter how informal this gathering of information may have been.
- Informal assessment will remain important to help the educator guide learners towards the competence, which they require, but OBE encourages formal assessment. This is because the learners must understand clearly what is expected of them and how they will be assessed.
- The mass of detail generated in formative assessment is of use to both educators and learners, but is less useful for those not directly involved in the learning process.
- Continuous assessment benefits the achievement of outcomes, as it helps the learners to progress towards them. The continuous assessment model is the model recommended for the assessment of learners in the Draft National Curriculum statement.

3.8.3 Teaching and learning

- Assessment of learning and progress is central to teaching and learning and
should form an integral part of teaching and learning.

- Learning tasks should be differentiated into different levels of difficulty to allow all learners equal access.

### 3.8.4 Feedback

- Feedback, specifically in the form of knowledge regarding the outcomes of learners’ actions, is required. This feedback should be continuous and constructive. It should indicate where the learner’s strengths and weaknesses lie and what developmental needs there are. This feedback should also include the outlining of an action plan on how learners will be supported.
- The accounting and record keeping should not be allowed to interfere with teaching and learning.
- Assessment should be planned into the teaching and not simply added as an afterthought.
- Outcomes-based education as an approach to education stresses the need to be clear about what learners are expected to achieve. These expectations are expressed as learning outcomes.

### 3.8.5 Managing assessment

- When learning programmes are developed to help learners achieve the standards set, careful consideration needs to be given to whether or not learners with different abilities will be able to progress at their own preferred rates.
- It must be decided whether it will be possible to provide assessment opportunities on a flexible basis, as and when needed, or whether assessment will be at fixed points in time. In practice, most university courses use predominately fixed time assessments. In such a case it needs to be recognised that learners of different abilities will achieve at different levels of attainment within the prescribed time. This needs to be taken into account when setting standards. In such a system it makes sense to identify core competencies and learning outcomes that might be achieved by the vast majority of learners and optional competencies that might be achieved to varying degrees by more able learners. The related instructional materials should then be designed with this in mind.
- Reducing the assessment load by using less assessment opportunities means the quality of the assessment becomes more important. Each assessment should be
properly planned for.

- Plan assessments in such a manner that they can be used to assess multiple assessment standards at the same time.
- For each assessment objective, an appropriate assessment strategy should be chosen.
- Use group work, thereby reducing the number of items assessed. By changing the groups regularly, it should be possible to distinguish those that are coping from those who are not.
- In order to generate specific information about learning strengths and needs, the learning goals and criteria for success must be stated as precisely as possible. The assessment process must be stated as precisely as possible. The assessment process should be designed to provide evidence, for each individual learner, that those particular criteria for success have been met.

3.8.6 Purpose of assessment

- The purpose of assessment is to determine whether the learners have achieved the instructional objectives. Assessment is not simply to measure what learners have achieved, but to help learners to achieve more.
- The main purpose of assessing learners is for their individual growth and development, not only for the promotion decisions.
- Learners should be given equal access to learning opportunities offered and special recognition should be given for their particular strengths and difficulties. No learner should be excluded from any of the learning experiences.
- The information provided by formative assessment should be available at a time and in a form, which will enable the learners to develop.
- The emphasis for individuals is usually on determining any shortcomings in the learner's understanding. It provides feedback on how they are performing and gives them guidance on what they need to do to remedy apparent weaknesses.
- When focussing on class groups, the intent is to determine whether the rate at which content is presented should be changed and if a certain topic needs to be repeated.
- The result of assessment as an aid to learning is more effective when an educator has an idea of how learners are going to make progress. At the beginning of a
course the educator needs to plan the assessment in such a way that learners can benefit as much as possible from the feedback that they receive and can be motivated to improve through their assessment.

- Feedback should not only focus on what is wrong, but also provide praise to the learner. This may be achieved by focussing on the progression of the individual learner rather than comparing with other learners.
- The learner's thinking should be stimulated through the feedback provided. To do this effectively, the educator needs to have a good knowledge of the learner's performance over time.

3.8.7 Reporting

- Assessment must provide useful information about the learner’s progress against the Assessment Standards in a grade. When reporting on achievement, the educator should include information about strengths and the areas where support is needed.
- The assessment should be transparent, democratic, clearly focused and participatory.

3.8.8 Learner involvement

- Assessment involves elements of self-assessment and peer assessment. Learners can be involved in the assessment process by: Self-assessment and target setting; keeping records of progress; and the selection of evidence to support levels of attainment.
- The learners should be invited to be active participants in learning and assessment.
- The learners need to know what results they can expect to achieve and this should be explained to them.
- Learners should be encouraged to reflect on their learning.
- Having their own record system shows the learners where progress is being made and gives them greater confidence in their abilities.
- The continuous work done by learners can be collected in a portfolio of the learner’s work.
- Learners might be involved in building up a portfolio of their best work.
- Formal self-assessment will assist learners in developing a greater understanding
of their own thought processes and performance. The following are requirements for formal self-assessment: Learners should be given an opportunity to explain their understanding of the activity; learner assessments should be planned; feedback should be given to the learners after their self-assessment; and they should be encouraged to talk about what they should do next to improve.

- The involvement of learners in the assessment process needs to be carefully managed.

### 3.8.9 Structure

- The curriculum should define key Critical and Developmental outcomes. The curriculum should be broken up into Learning Areas, with a small number of Learning Outcomes for each Learning Area. For each Learning Outcome, a number of Assessment Standards need to be defined. These standards should indicate the knowledge, skills and values that the learner needs to show in order to achieve the Learning Outcome at a particular level.

- The new Draft National Curriculum Statement places Assessment Standards at the heart of the assessment process. The performance of learners in the Learning Outcomes must be assessed against the Assessment Standards.

- Rubrics can be used to provide clear criteria on which to base the assessment.

### 3.8.10 Analysis and diagnosis

- Assessment is not the final point of teaching and learning, but serves as a guide to future teaching and learning. It is necessary to provide for analysis of what is taking place.

- Test and exam questions can be broken into parts that assess aspects of a few different assessment criteria.

- The assessment should be diagnostic (assisting in identifying strengths and weaknesses).

### 3.9 DESIGN REQUIREMENTS FOR OBE ASSESSMENT

The following requirements for an OBE support system have been identified in this chapter:
3.9.1 General design principles

- Outcomes-based education as an approach to education stresses the need to be clear about what learners are expected to achieve. These expectations are expressed as outcomes and the teaching and learning is guided by these outcomes.

- The main purpose of assessing learners is for their individual growth and development, not only for the promotion decisions. Assessment is not the final point of teaching and learning, but serves as a guide to future teaching and learning. It is necessary to provide for analysis of what is taking place.

3.9.2 Features needed by an educator support system

- In order to generate specific information about learning strengths and needs, the learning goals and criteria for success must be stated as precisely as possible. The assessment process must be stated as precisely as possible. The assessment process should be designed to provide evidence, for each individual learner, that those particular criteria for success have been met. This approach requires that a detailed list of what the learner is to achieve be developed prior to instruction. This list is constructed in the form of instructional objectives (learning outcomes and assessment standards).

- It should be possible to collect the continuous work done by the learner in a portfolio of the learner's work.

- It should be possible to break test and exam questions down into parts that assess aspects of different assessment criteria.

- Assessment involves elements of self-assessment and peer assessment. Learners can be involved in the assessment process by: Self-assessment and target setting; keeping records of progress; and the selection of evidence to support levels of attainment. An educator support system should ideally support this.

- It should be possible to assess multiple assessment criteria at the same time.

- Feedback, specifically in the form of knowledge regarding the outcomes of learners’ actions, is required. This feedback should be continuous and constructive. It should indicate where the learner’s strengths and weaknesses lie and what developmental needs there are. This feedback should also include the
outlining of an action plan on how learners will be supported.

- The educator should have access to a record of the learner’s performance over time in order to provide more effective feedback.
- The support system must make it easier to inform the learners of the outcomes and assessment standards, as well as informing them of the process by which they will be helped to achieve the assessment standards to the appropriate level.
- The educator should be able to make day-to-day decisions based on information gathered, no matter how informal this gathering of information may be.
- The support system needs to provide for the creation and storage of rubrics to provide clear criteria on which to base the assessment.
- The support system needs to cater for integrated assessment. It should be flexible enough to handle integrated tasks and activities, and a variety of methods, tools, techniques and contexts in assessing learners’ performance.
- The system must provide for the planning of assessment in such a way that the learners may benefit as much as possible from the feedback.
- The system should be able to cater for group work.

3.9.3 Supporting processes needed in the model

- The entire assessment cycle needs to be catered for, including the setting of assessment criteria, the choosing of appropriate assessment techniques, conducting of the actual assessment, the recording of the results, as well as the reporting and analysis of the results.
- It is necessary to cater for multiple assessment techniques and multiple activities to allow learners with different learning styles to demonstrate their true ability.
- OBE requires more detailed records of progress or achievement than was previously required. These records need to be managed. This includes automating some of the processes whereby progress in the individual assessment standards indicate attainment of the learning outcomes and overall progress.
- Assessment must provide useful information about the learner’s progress against the Assessment Standards in a grade. When you report on achievement, you should include information about strengths and the areas where support is needed.
- Tools for analysing the assessment results are required.
• The entire portfolio management cycle of Section 3.7.4 should be supported.

3.9.4 Storage requirements

• The curriculum should define key Critical and Developmental outcomes.
• The curriculum should be broken up into Learning Areas, with a small number of Learning Outcomes for each Learning Area.
• For each Learning Outcome, a number of Assessment Standards need to be defined. These standards should indicate the knowledge, skills and values that the learner needs to show in order to achieve the Learning Outcome at a particular level.
• Every outcome that may be set for learners has a range of possible evidences for assessment. It is also possible that more than one outcome (or assessment standard) may be assessed from the same evidence.
• Use individual learner profiles. These profiles should contain all of the required information, as listed in Section 3.7.3. The details regarding each learner can be used to construct a learner model, which shows the learner's current understanding of the subject matter.
• Each report on a learner's overall progress should include information on: The learning achieved, the learner's strengths, support needed and constructive feedback. Portfolios on each Learning Area should be available as additional evidence.
• There should be a record of what was done, without burdening the educator with too much management.

3.10 CONCLUSION

This chapter discussed the principles of assessment in general and for outcomes-based education in particular. In OBE the assessment should be in terms of the learning outcomes and the feedback given to the learners must indicate to them the progress made towards the attainment of these outcomes. It is also necessary to provide an indication of the future learning that should take place in order to rectify any shortcomings identified.
The record keeping requirements of OBE assessment were also considered. A specific assessment can be used to show evidence towards more than one learning outcome and different assessments could give evidence for the same learning outcome. It is not required that all assessments are kept, but there is a requirement to keep a portfolio of evidence for each learning area. This makes it possible to refer back to this and serves as proof that the learning has indeed taken place.

Various design requirements of an OBE support system were identified and listed in this chapter. These requirements will be used in the conceptual storage model in Chapter 5.

At this point the requirements of a typical OBE environment have been identified. The next chapter covers the topic of computer integrated learning environments, by discussing learner-centred environments and learner models used in intelligent tutoring systems.
CHAPTER 4:

COMPUTER INTEGRATED LEARNING ENVIRONMENTS

4.1 INTRODUCTION

South Africa has opted for an outcomes-based system of education to try to address the educational challenges facing the country. If successfully implemented, this could provide for the needs of the learners. The previous chapters looked at what requirements a support system would have in this environment.

The computer has been suggested as a tool to help solve many of the problems in education. It has, however, had mixed success in this regard.

In this chapter the learning environment and the various role-players are discussed. This includes the role of computers in education in general and ITSs in particular. Finally the chapter concludes with some lessons learnt from ITSs and other computer learning environments which could be fruitfully applied in assisting in an OBE environment.

4.2 THE LEARNING ENVIRONMENT (LE)

With the situation of diminishing financial support that educational institutions are facing, the issue of efficient and effective knowledge transfer is particularly important, as institutions are facing demands of greater results with less financial resources. Traditionally paper-based technologies have been the technologies most extensively used for knowledge sharing applications. New developments in information technology have made it important to consider whether paper is still the most efficient way to record and disseminate information and knowledge (Richards, Barker, Tan, Hudson & Beacham, 1997).

The actual learning material itself is, however, only part of the total learning
environment within which learning takes place. There are many other entities and actors that comprise the learning environment.

Wasson (1997) presents a conceptualisation of the learning environment with the learner at its centre. This conceptualisation is an extension of earlier work by Schneider and Peraya (1995), which was itself an extension of an earlier schematic which resulted from interviews with researchers in education and technology (Sandberg & Barnard, 1993). This overall representation of a technologically rich learning environment with the actors and entities is depicted in Figure 4.1. In this figure LE refers to the learning environment, while LM is the learning material.

Figure 4.1: The learning environment (LE) (Wasson, 1997, p. 573).

The actors are the teacher, monitor, learner, fellow learners and learning environment designers. Teachers are responsible for instruction and guidance. Monitors are responsible for the assessment of the learners to ensure that the intended learning is taking place. Fellow learners enrich the learning environment
and learning is enhanced through learner interaction. Learning environment (LE) designers are responsible for the design of the learning material as well as the learning environment. These may be human or computer agents.

The entities include the school/university/workplace/self-study environment, tools, information sources, learning material and the particular sociocultural niche within which the learning environment is situated. These respectively provide the curriculum, the content that needs to be learnt and additional knowledge, as well as supporting tools and utilities.

4.2.1 The learner

Historically the behaviourist theory of learning with its emphasis on observable and measurable behaviour formed the foundation for the design of the earliest computer-based instructional technology. In the late 1970s and through the 1980s cognitive theories of learning replaced the behaviourist views. These cognitive theories focused on the “hidden” mental processes that need to take place for learning to occur (Wasson, 1997). Shuell (1992) summarises cognitive theories as stressing that learning is an active, constructive, cumulative, self-regulated and goal-oriented process where the role of the learner is central. Simons (1993) added that learning is diagnostic and reflective. Figure 4.1 represents this shift of focus onto the learner by having the learner at the centre, surrounded by the supporting actors and entities.

In addition to the above-mentioned move to cognitivism, constructivism and sociocultural approaches to learning are having an influence on the design of computer-based instructional technology (Wasson, 1997). In the constructivist view, the major goal of education is the creation of a set of cognitive tools to help learners explore their environment. The sociocultural approaches to education focus on the joint activity of teachers and learners sharing knowledge. Although the relative merits of these psychological theories are continually debated, all of these theories recognise the centrality of the learner.

4.2.2 The school, university, workplace or self-study environment

This represents the societal entity, which defines the learning environment characteristics. These characteristics include the learning setting, the curriculum,
technological constraints and administrative issues. The characteristics for a school, university, workplace or self-study environment is different. This entity defines and controls the characteristics within which the actors must operate and with which the other entities must coexist.

An example of a technological constraint is if learners do not all have their own computers, but rather have to share special computer laboratories with other learners.

4.2.3 The teacher
Current research calls for teachers to no longer be an information transmitter who transfer their own knowledge into the heads of the learners, but rather to act as information organisers and managers of the learning experience. This contemporary teacher acts as a guide and partner. This teacher organises information in a pedagogical manner and can even develop computer-based learning material (Wasson, 1997).

In the learning environment the teacher can be a human, a computer agent or a combination of human and computer agents.

4.2.4 The monitor
The monitor is responsible for ensuring that the intended learning takes place by modelling aspects of the learner relevant to the learning process and using this learner model to provide individualised and adaptive instruction. This could be aspects like knowledge, errors and misconceptions, cognitive or learning style.

This modelling and monitoring process is called student modelling and can be done by (Wasson, 1987):
• A human agent (e.g. teacher or tutor);
• a computer agent (e.g. a student modelling component of adaptive learning material);
• in collaboration with the learner (e.g. a negotiated student model); or
• any combination of these three.
As an example, a lecturer might observe that a particular student is having problems with the concept of recursion. This observation may be from a test or practical assignment. The lecturer has effectively performed a student-modelling task to identify this problem of the student. This may have been a conscious formal process, or may simply have been an informal intuitive decision. Based on this information the lecturer may assign the student to work with an intelligent tutoring system (ITS), which covers the concept of recursion. This ITS’s student modelling module would then use its own model tracing abilities to assist the student in learning the concept.

4.2.5 Learning material

Electronic course delivery (ECD) is “concerned with the use of electronic materials and delivery platforms to support and enhance teaching and learning experiences – either on an individual or a group basis.” (Richards et al., 1997, p. 5).

There are many types of learning materials, for example books, microworlds, educational television programs, hypermedia systems and simulations. Many of these materials can form the basis of adaptive learning materials. These will be discussed later in this chapter.

The World Wide Web (WWW) is increasingly being used as the medium for ECD. The goal of these Web-based education systems is “to reach a wide distance audience in a cost effective and educationally sound manner, and in particular accommodating the requirements of students from underrepresented groups” (Brusilovsky, Eklund & Schwarz, 1998, p. 291). This objective is in line with the general goal of ECD. According to Brusilovsky et al. (1998) an analysis of the situation regarding Web-based education showed that these systems are still far from achieving this goal.

4.2.6 Tools

The tools entity includes everything, besides the actual learning material, that the learner can use to facilitate the learning process (Wasson, 1987). These include calculators, wordprocessors and, if used to enhance understanding of the behaviour of programming constructs, the debugger in a programming environment.
Richards et al. (1997) state that the software and courseware products that are used must fully implement three important pedagogic activities:

i. They must provide methods and strategies to ensure adequate assessment of learning.

ii. They must embed appropriate facilities for remediation.

iii. Suitable performance support tools must be available to facilitate effective and efficient skill development.

Assessment and remediation

The need for assessment of learning and appropriate remediation was addressed in Chapters 2 and 3. The products used for ECD should provide for mechanisms that assist in the conversion of the information viewed into full knowledge transferral. The learners also need to be able to assess their own progress. Any discrepancies between intended knowledge and the learner’s interpretation must be remedied. The use of assessment can also have a motivating effect and moves learners into a more active mode rather than leaving them in a relatively passive process of information access (Richards et al., 1997).

In addition to making the learning process more active, assessment also serves to determine what the learners know and do not know. This allows appropriate remedial action to be taken.

Computer-based assessment tools can be used to accelerate skill acquisition by providing real-time monitoring and feedback. In addition to this deeper knowledge and remediation can be provided by knowledge based tools such as expert systems or intelligent tutoring systems (ITSs). These ITSs will be discussed further later in the chapter.

Performance support

In contrast to the assessment of ability and the provision of remedial action, performance support techniques are intended to extend human ability beyond the levels normally accessible to them (Richards et al., 1997).

A performance support system (PSS) is a tool or technique that enables individuals
to perform at a level beyond what they are capable of without additional support (Barker, van Schaik & Hudson, 1998). The tasks being supported can be either physical or intellectual (Richards et al., 1997). An example of a physical PSS would be the pole used in pole-vaulting, which enables an athlete to jump over a higher bar than would be possible without the aid of the pole.

A PSS attempts to address three aspects of performance:
- Assistance in task execution;
- training; and
- information provision.

Computer technology is increasingly being used as the basis for performance support systems. A system that is based on an embedded computer facility can be referred to as an electronic performance support system (EPSS). Such an EPSS can be defined as “a human-activity system that is able to manipulate large amounts of task related information in order to provide both a problem solving capability as well as learning opportunities to augment human performance in a job task by providing information and concepts in either a linear or a non-linear way, as and when required by a user.” (Richards et al., 1997, p. 6). The use of an EPSS according to this definition implies the use of a just-in-time instructional paradigm and on-the-job training. This would require either a learner-driven system where the learner requests the appropriate assistance or a monitoring system, which monitors the learners actions and provides help as identified. An example of requested assistance would be the capability to ask the office assistant for help on a particular topic in the Microsoft Office applications. There is also a capability for the office assistant in these applications to try to determine what the user is trying to do and to offer help based on these actions. This would be an example of a simple monitoring EPSS system.

Another example of an EPSS would be the Visual Basic integrated development environment, which provides assistance through such means as dialogue-based creation of methods and properties, as well as the debugger. These assistance tools can often compensate for a lack of knowledge of the syntax on the part of the programmer. Extensive use of the same assistance tool can result in the
development of a better understanding on the part of the programmer. Tutorials supplied cater for a simple form of training, while the online help covers information provision. In this case these are all examples of assistance driven by user requests. It is also possible to extend the Visual Basic agent with custom agents, which could be given more active monitoring capabilities to provide dynamic assistance, without the need for user requests. The more accurate the user modelling process is, the more appropriate the agent help will be.

According to Richards et al. (1997) EPSSs are being increasingly used within the educational setting. They contend that in this setting they can help to support educators and learners in one of two ways. Firstly, these systems can accelerate skill and knowledge acquisition. Secondly, they can enhance the abilities of both educators and learners.

4.2.7 Fellow learners
This entity represents those learners with whom the learner can communicate during the learning process. These fellow learners can be either human or computer agents. Once again both human and computer agents can be present at the same time.

Wasson (1997) lists three variations of small-group learning where a learner and fellow learners communicate, namely collaborative, co-operative and competitive learning.

Collaborative learning involves the learners working together, negotiating and sharing meaning relevant to the problem-solving task at hand in a co-ordinated and synchronous manner.

Co-operative learning, in contrast, involves the division of an activity into smaller subactivities, each of which is the responsibility of a different learner. On completion of the individual activities, the results are pooled.

Competitive learning involves situations where individuals or groups compete against each other to produce superior performance. This competitive learning sometimes involve a group of learners collaborating to challenge a simulated computer
opponent.

The majority of artificial intelligence in education (AIEd) research in the area of fellow learner interaction has focussed on computer-supported collaborative learning (CSCL). This includes human-human and human-computer collaboration. The role of human-computer collaboration in ITSs will be discussed in more detail later.

4.2.8 Information sources

Information sources refer to accessible information which is not directly stored in the learning material. This includes encyclopedias, dictionaries and the World Wide Web (WWW). The learners need to learn how to select appropriate resources, as well as how to extract information from these resources to aid their learning. According to Richards et al. (1997), ECD includes the use of electronic lectures and mechanisms for lectures on demand. Further they also note the importance of support facilities such as electronic libraries to provide for the learner information needs.

4.2.9 Learning environment designers

The instructional use of computers has taken many forms, from simple drill-and-practice sessions and simulations, to complex ITSs. All of these systems are influenced by the designer’s theoretical position regarding learning and cognition. Different designers could also have different views on how these ideas are best implemented using technology. Even when the learning material does not make any instructional decisions itself, its very design will have an implicit instructional design that will influence the learning that takes place.

4.2.10 Sociocultural niche

The sociocultural niche represents the broader environment, in which the learner lives and learns. This entity is included in order to take into account the social, historical and political aspects when looking at education (Wasson, 1997).

The following section takes a brief look at the case for the use of web-based adaptive learning materials as illustrative of the most commonly used adaptive learning materials. Web-based technologies have to be understood as allowing both Internet and intranet applications.
4.3 THE CASE FOR ADAPTIVE LEARNING MATERIALS

Currently Web-based education is a common and popular form of ECD. Kapur and Stillman (1997) note that it is surprising how much of classroom practice can be incorporated on the Web.

Most of the positive experiences show that Web-based education works well for well-prepared and well-motivated students in reasonably homogeneous virtual classrooms (Brusilovsky et al., 1998). Teaching less prepared students who require more attention from the educator has proven to be more difficult. Currently Computer Mediated Communication (CMC) tools for instructional delivery work best for on-campus students who can visit lecturers in office hours. The distance experiences show that they only work where lecturers and assistants can afford a large amount of time for Web-based, e-mail or telephone communication with their students. Brusilovsky et al. (1998) finds this discouraging.

Kapur and Stillman (1997) are of the opinion that the problem with many current Web-based courses is that the course material is still implicitly oriented towards a traditional on-campus audience. They view this type of audience as reasonably homogeneous, reasonably well-prepared and well-motivated students who have access to teachers and assistants to help resolve misunderstandings. This is not true for the typical student body at a South African University, where there may be a large variance in student preparedness and motivation. This means even in on-campus courses the groups are not homogenous, therefore even on-campus courses should incorporate some of the flexibility and adaptability.

Web-based courses are intended for a wider variety of users. If these courses are not flexible, some students will waste their time learning irrelevant or already known material, while others will fail to understand or misunderstand the material. This will lead to the educator being overloaded with multiple questions and requests for additional material (Kapur & Stillman, 1997). The reality is that this problem is present in many on-campus courses as well, so it is a problem that needs to be addressed
regardless of whether the course is a distance course, or a Web-component to a face-to-face course. A potential solution to this is to develop courses that can adapt to learners with different backgrounds, goals and prior knowledge.

Kapur and Stillman (1997) distinguished three levels of increasing complexity towards flexible and adaptive courseware.

- The first level is the provision of a well-designed hypermedia course containing all the required educational material. The Web interface makes it theoretically possible for the learner to find his/her unique path through the learning material. This first level is not enough for the less-prepared student, for example many first-year students in technology courses. These users may never have worked with sophisticated information systems and would not be able to find the most relevant path through the learning material for their needs (Kapur & Stillman, 1997).

- The second level is for the educator to tune a generic course to the needs of particular learners by specifying a particular subset of topics and order of learning.

- The third level is to provide adaptive guidance mechanisms, which are specifically designed to support learners based on their needs. This starts moving into the range of adaptive instructional programs, which are often qualified as intelligent tutoring systems (ITSs) (Vos, 1999).

Web-based hypermedia course material is only one form of learning material. The need for adaptability to the needs of the learner is not only limited to these resources, but are rather needed for all materials where the student body is not homogenous.

AIEd researchers have developed adaptive learning material for complex domains such as programming languages, mathematics and medicine. These adaptive materials include intelligent tutoring systems, intelligent simulation-based learning environments and learning companion systems. One of the goals of adaptive learning material is to provide a given student with an optimal learning environment. How this may be accomplished is discussed later in this chapter.
4.4 INTELLIGENT TUTORING SYSTEMS (ITSS)

Intelligent computer aided education (ICAE) systems are software systems that are aimed at assisting in the teaching and learning of students (van Biljon, Janse Tolmie & du Plessis, 1999). The term ICAE is used in preference to the similar term intelligent computer aided instruction (ICAI) to emphasise that these systems are meant to support all aspects of student learning and not just instruction. Even though this chapter focuses on adaptive course material and ITSs, there are other types of ICAE systems as well. Such types of systems include the various types of simulations (Gutierrez, Elopriaga, Fernandez-Castro, Vadillo & Diaz-Ilarraza, 1998), and case- or problem-based learning (Burke, 1996; Woolf, 1996; van Biljon et al., 1999) environments. Many of these learning environments are also being extended to include ITS components to improve their educational capabilities (Woolf, 1996; Gutierrez et al., 1998).

The need for more efficient and adaptive training gave rise to the incorporation of artificial intelligence (AI) techniques into training systems. This led to the production of intelligent tutoring systems (ITSs). Such an ITS is considered an expert in two areas: the subject domain and the instructional knowledge (Gutierrez et al., 1998). One of the main differences between an ITS and the conventional Computer Based Training (CBT) systems is that the ITS explicitly separates the material to be taught (domain knowledge) from the way it is used (instructional strategy). This characteristic and the explicit representation of both kinds of knowledge overcome the rigidity of previous CBT systems.

The aim of intelligent tutoring systems (ITSs) is usually to take a student from his current knowledge level to a higher order of accomplishment. They diagnose and interpret learner behaviour in order to gain insight into the current state of the learner’s knowledge and to adapt the instruction according to the individual learner’s needs (Blumenthal, Meiskey, Dooley & Sparks, 1996; Siemer, 1997). ITSs incorporate flexibility and interactivity into computerised instruction, because they possess knowledge of teaching strategies in addition to domain knowledge (Gutierrez
et al., 1998). The interaction between the ITS and learner should simulate the process that occurs between a teacher and a learner when they interact in a one-to-one learning situation (Seidel, 1994; Blumenthal et al. 1996; Siemer, 1997; Gold & Steven, 1998). The ITS requires artificial teaching intelligence in order to fulfil this role. An ITS is thus a complex knowledge based system that can make use of a wide range of AI techniques (Gutierrez et al., 1998).

An ITS needs to pass three tests of intelligence (Angelides & Paul, 1999):

i. The system needs sufficient knowledge of the subject matter to draw inferences or solve problems in the domain of the application.

ii. It needs to be able to deduce the learner’s current understanding of the subject matter and use this knowledge to adapt the instruction to the needs of the learner.

iii. The tutor needs to be able to apply tutoring strategies that will lead to the learner’s performance, becoming closer to that of the expert.

In order to accomplish this, an ITS combines a set of techniques, such as knowledge representation of the subject domain, rule-based processing, intelligent communication with the student and tracking of learner behaviour and progress using a student model. In addition to this the ITS is equipped with teaching expertise.

The system must be able to adapt its presentation, based on its knowledge of the curriculum and the student’s knowledge and skills. The goal is to provide prompt feedback in order to allow the learner’s knowledge to grow incrementally. Most ITSs also have the ability to help their users to clear up any misconceptions.

An ITS should be capable of adapting to the needs of individual students. This adaptation should include the ability to adjust to the student during the learning period, thereby providing the student with the most appropriate instruction at the right moment in the most appropriate form. This is, arguably, the biggest value of an ITS if this ideal can be realised. An ITS may also provide the learner with more control over the learning process.
4.4.1 Overview of historical development of adaptive material using AI

Wasson (1997) traces the evolution of adaptive learning material by looking at the main research foci during the 1970s, 1980s and 1990s. The main architectures for the 1970s and 1980s seen from this point of view are represented in Figures 4.2 and 4.3 respectively. This section traces the development, as listed by Wasson (1997), and then follows that with other authors’ views on this development.

**Figure 4.2:** The 1970s architecture and important issues of learning material (Wasson, 1997, p. 584).

The typical 1970’s architecture for intelligent computer-based learning material is represented in Figure 4.2. This shows that the domain knowledge, learner and teaching strategies were considered the cornerstones. Such a system typically consisted of a tutor, student model, domain knowledge and a surrounding environment. These systems were often Socratic tutors (leading the students thinking through questions) or reactive learning environments. The focus was on problem generation, representation of the subject knowledge and problem-solving strategies. Databases of errors and misconceptions and overlay student models were used to provide simple student modelling. These will be discussed later in this chapter.

These traditional ITSs are based on three models that dynamically interact (Woolf, 1996; Yum & Crawford, 1996; Rosas, Nussbaum, Strasser and Csaszar, 1997; Siemer, 1997; Angelides & Paul, 1999):
i. **Domain model**: This is the knowledge base that stores objects and rules that represent the learning domain. This includes an explicit representation of the domain specific knowledge and problem solving knowledge of the topic to be taught to the student. This is sometimes also referred to as the Expert module.

ii. **Student model**: This stores the relevant characteristics of the student. This could include the level of understanding or frequency of errors. Many different techniques exist for the representation of information regarding the learner.

iii. **Pedagogical/Tutoring model**: This model represents the conceptualisation of the expert teacher in the domain. The teaching expertise is often contained in the form of teaching strategies, which determine the form and timing of intervention (Siemer, 1997).

The 1980s saw a greater standardisation of approaches. Simulations, discovery worlds and intelligent tutors were the main design foci of learning material. The domain knowledge component was affected by a progression of mental models, the use of simulations and case-based reasoning. Model tracing and more buggy-based systems became the standard for diagnosing the student knowledge and misconceptions. An interest in natural language processing and graphical interfaces led to the introduction of a communications component in the system architecture.

In addition to the above three models a fourth model was also identified. This is the communications component that manages the interaction with the learner and would typically include natural language processing abilities. This extended architecture is presented in Figure 4.3.

**Figure 4.3**: The 1980s architecture and important issues (in italics) of learning material (Wasson, 1997, p. 585).
Angelides and Paul (1999) present a model for an ITS which is compatible with the one in Figure 4.3, but which includes more detail. Their model (presented here in Figure 4.4) is a process model, which reflects the four components, as well as the actions or responsibilities of those components, represented by five process models. These processes and their relation to the above models will now be discussed.

The model in Figure 4.4 divides the process models into those in the lower half (Expertise and Interface) which do not directly take part in any major pedagogical decisions and those in the upper half (Diagnosis, Didactics and Pedagogical control) that result in decisions that shape the course of instruction.

i. The Expertise process

The Expertise process model does not directly take part in the pedagogical decisions, but instead supports the tutoring process by making the representation of the domain knowledge available. The domain process model (Expertise) can directly answer student questions, or can provide other models with information about the domain as needed. This is where the ITS’s knowledge and reasoning concerning the subject domain is situated. The domain process model applies reasoning to extract useful information from the domain knowledge representation. ITSs use different techniques for storing this knowledge, for example as sets of rules, semantic nets or frameworks.
ii. The Interface process

The interface process model is also not directly involved in the making of pedagogical decisions, but is an important support system. This process is responsible for the translation of information during interaction with the student. This process manages the interaction with the learner and is responsible for the presentation of information.

iii. Diagnostics

The Diagnostic process determines the current state of a learner’s knowledge and learning needs by making use of planners, plan recognisers or user models (Woolf, 1996). The information collected about the learner is stored in the student model. Many different techniques exist for the representation of information regarding the learner:

- With an **overlay representation**, the learner follows the format of the expert knowledge. Essentially, the learner is modelled as having mastered certain parts of the expert module’s knowledge, while not having mastered other parts. This method allows for easily determining what should be taught next, but does not identify what misconceptions the learner has, because it only knows that the
learner is wrong, not why the learner is wrong.

- Another approach that can be used is that of error diagnosis, where the learner’s answer is analysed in order to determine why the learner is wrong. There are different ways of doing this, ranging from the simple comparison against a database of errors and misconceptions to analysis through neural networks or distributed agents. This can be used in conjunction with an overlay model. In that case the error diagnosis section identifies errors, while the overlay provides information regarding what should be taught next. In essence the overlay model says what the learner does not know or can not do, while the error diagnosis says why the learner does not know or cannot do it.

The student model may also store extra information regarding the learner, for example preferred learning styles or motivational level.

The ITS must be able to perform detailed diagnosis in order to create and maintain student models. The artificial intelligence techniques for doing this are far from perfect (Siemer, 1997).

The results of diagnosis is used for corrective feedback on student errors and selection of instructional topics (Siemer, 1997). This is the role of Didactics.

iv. Didactics

Didactics refers to the pedagogical activities, which are intended to have a direct effect on the student (Angelides & Paul, 1999). This is in contrast to diagnosis, which makes discoveries about the learner, but does not, in itself, affect the learner directly.

v. Pedagogical control

The task of the pedagogical activities (Diagnostics and Didactics) is to create a pedagogical bridge between the tutoring model, domain model and student model. The strategies involved with this take the form of pedagogical plans that incorporate fixed sets of diagnostic expectations, as well as mechanisms for dealing with common student problems, like misconceptions. The pedagogical control process manages and controls the processes of diagnostics and didactics.
Most authors refer to a tutoring module. This tutoring module contains teaching expertise in the form of teaching strategies which determine the form and timing of interventions (Siemer, 1997). The strategy chosen is dependent on the topic being taught and the student's preference. This concept of a tutoring module includes the Pedagogical Control, Didactics and Tutoring Model as presented in Figure 4.4.

The responsibility of the pedagogical control module is the optimisation of the combination of diagnosis and didactic operation in order to provide a coherent pedagogical strategy. This is central to an ITS, because it includes decision making about the degree of control exercised by the system, the choice of teaching strategies to apply, the selection of strategic contexts (opportunistic vs. plan-based), the interleaving of pedagogical episodes and the target level of operations (Angelides & Paul, 1999). Essentially the pedagogical control process uses the diagnosis of the student to determine which didactic operations to initiate in order to achieve the pedagogical goals.

Angelides and Paul (1999) identify two strategic contexts, each with different implications for student diagnosis and didactic operation:

- **In opportunistic strategies**, the activities that are monitored provide the focus for both diagnostic and didactic activities, but diagnosis is the driving force, because it reveals opportunities for tutorial intervention. The pedagogical goals are associated with diagnostic units and differential modelling is used to monitor their attainment.

- **In plan-based strategies**, the main task of diagnosis is the monitoring of the implementation of the teaching plans that embody the pedagogic goals. These plans provide the focus for the diagnostic activities. This leads to the differential modelling being performed in terms of plan failures, in order to make revisions.

This section has discussed the processes involved in the provision of instruction to the learners. An ITS can also provide support to the human educators. Rosas et al. (1997) states that the present model of ITS contains two complementary elements related to the support of learning:

i. **Dynamic projection of learning**: Mediation can be provided automatically by
the decisions being taken by the pedagogical model. Alternatively the decisions can be taken manually by a human instructor using expert system inferences as a guide. In the first option the human mediator is completely removed from the teaching process, while in the second approach the human acts as manager of the process. In this case the expert system is limited to acting as a consultant only. In other words this would represent a move away from viewing an ITS as a self-contained teaching system, but rather a tool that supports a human instructor in the teaching process. This places the Pedagogical control process in the hands of the Human educator, while the ITS performs the Diagnosis and provides suggestions via its Didactics process model.

ii. **Static projection of learning:** The use of computerised mediation allows the data from the teaching process to be used to analyse student behaviour over time and to choose individualised teaching activities. This allows the expert pedagogic knowledge stored in the system to be validated, modified and enhanced. This provides a report on the learning that has taken place over the course of the ITS's use. Its value in enhancing learning directly is limited, but rather serves as an evaluation of the overall effectiveness of the teaching and learning that has taken place. This would then form the basis for improvement of the ITS system.

Issues of the 1990s, included:

- **Learner control.** There has been a move toward more open learning materials, where the student has more control over the learning (Wasson, 1997).
- **Collaborative learning material.** The merits of individual versus collaborative learning material and environments have received increasing attention (Koppi, Lublin & Chaloupka, 1997; Kapur & Stillman, 1997; Wasson, 1997).
- **Situated learning versus the information processing of learning.** The debates regarding these different views affect the design of learning materials (Wasson, 1997).
- **Virtual reality.** Developments in this field lead to a question regarding the utility of these technologies. This is particularly relevant for simulations. (Wasson, 1997)
- **Instructional planning.** This continues to be a focus of AIEd research.
Researchers are particularly showing interest in the utility of instructional planning (Paquette, Aubin & Crevier, 1994; Brusilovsky et al., 1998) and the use of contemporary theories of learning in collaborative learning environments (Wasson, 1997).

- **Telelearning.** There has been a lot of interest in distance education, online teaching and the use of the WWW (Barker & Tan, 1997; Kapur & Stillman, 1997; Richards et al., 1997; Brusilovsky et al., 1998).

- **Intelligent multimedia learning material.** An area of research is dynamically choosing between various presentation media as the learning needs change (Burke, 1996; Wasson, 1997). Some work has been done to expand the usefulness of simulation systems (Woolf, 1996).

- **Reusability, shareability and interoperability of ITS components.** The use of object-orientation and metadata has received particular attention (Klingenstein, 1998). A potentially important development in this regard is the Instructional Management System (IMS) project (Collier & Veres, 1999; Collier Veres & Anderson, 1999; Smythe, Tansey & Robson). This project is attempting to develop a broad range of standards in support of virtual learning and can be implemented using Extensible Markup Language (XML), thereby facilitating sharing of information (Bryan, 1997; Walsh, 1997; Britt & Duynstee, 2000; Babcock, 2001; Bourret, 2001). XML is particularly useful for sharing information over the Internet or an Intranet (ETHOS, 2001).

Unfortunately everything has not gone as well as hoped with ITSs.

### 4.4.2 Problems with ITSs

Patel and Kinshuk (1997) state that ITS designers have traditionally attempted to provide facilities that satisfy all of the student, teacher, curriculum and institutional needs. They also state that the student modelling aspects of research into intelligent tutoring systems, expert systems and hypertext has failed to address the diversity and richness of the educational environment. They say this is due to the large number of possible modes of instruction in various subject disciplines. The problems faced are immense, even without considering the complexity of identifying and catering for individual differences.
Siemer (1997) also mentions the following problems with traditional ITSs:

i. Firstly, most ITSs are based on the assumption that learners’ thinking processes can be modelled, traced and corrected using computers. Research into complete and precise student models have made very little progress and that, those where diagnostic processes have been developed, are domain specific. Most of the systems developed are in procedural domains, for example Geography and Programming.

ii. Secondly, emphasis is mainly placed on cognitive analysis, without considering the effect of other factors such as student motivation, attention and preference for a particular teaching strategy. These factors have, however, already been mentioned as factors that should ideally be included into an ITS system. Siemer (1997) seems to indicate that many ITS systems do not implement these in practice but does not state the reason for ITS systems not using this information. Not catering for this may either be an oversight on the part of many of the ITS developers, or may be indicative of difficulties for a computer system to make adequate use of this information.

Siemer (1997) states that the doubt concerning the feasibility of constructing perfect student models has led to an approach by some researchers whereby a guided discovery mode of learning is used which does not rely on determining student knowledge or determining a teaching strategy. In this approach the tutor reduces the intervention as the teaching process progresses. The sequencing of material to be learnt and choice of teaching strategy is typically placed under student control in this approach. This approach can allow effective learning to take place through the learner consciously reflecting and this control keeps the student involved and motivated.

However, this approach may lead to the student acquiring and applying incorrect knowledge, or not mastering some knowledge or skills that should be learnt. The student’s choice of teaching strategy may not be the best strategy either. These problems can be addressed by the ITS monitoring progress and intervening with corrective feedback or suggested learning strategies should a problem be identified. Essentially, Siemer (1997) proposes that student modelling should be used in
conjunction with guided discovery to monitor the learner and provide constructive intervention without taking over complete control. This would be one of the opportunistic strategies as mentioned in the previous section.

Of course, this still means that there may be problems with the timing of the system’s intervention and the selection of a teaching strategy. The selection of a particular teaching strategy is a particular sensitive issue and further research is needed in this regard. Siemer (1997) concludes that in the future “less intelligent tutoring systems” may be more prominent. If it was possible for some of these choices to be made by the human educator on behalf of the ITS, some of these problems could be alleviated.

4.4.3 Learner modelling tasks

Cheeks (1996) made the following recommendations to ITS designers:

- ITSs should be built out of modular software units that communicate by means of messages encoded in a language that is platform independent. This would improve the scalability of the system.
- ITSs and external applications must be able to communicate with each other to ensure that ITSs have as much information as possible at their disposal.
- Designers must specify the input and output relationships of ITS components in an implementation-independent manner. This would ensure that no matter how the ITS was implemented, it would still be able to exchange data with other systems.

The establishment of techniques for developing learner modelling components and the increase in architectures for systems that rely more strongly on the communication between applications suggest the need to consider learner modelling to be performed in an independent and general manner (Paiva, 1996). This would allow it to be used and re-used in different settings and by several types of applications. If this learner model is centralised, it could allow a large amount of information sharing about the learners.

A first type of generalisation was achieved with the development of user modelling shell systems (Blumenthal et al., 1996; Paiva, 1996). However, some of these
systems still suffer from an independence problem. The user and learner modelling systems constructed through the shells are often tied to the application or domain knowledge.

Paiva (1996) believes that the fundamental shift to achieve more general and reusable user and learner models can only be obtained by de-coupling the user and learner modelling systems from the other software systems, and to consider them as a kind of software agent. For that to be achieved, user and learner modelling tasks have to be clearly defined, and the communication between user and learner modelling systems with other software applications must be established.

If the learner modelling systems are seen as agents, they would be autonomous, independent entities that have knowledge about the modelled learners. These entities are also capable of changing the respective models according to new situations and messages received from the applications (ITSs).

Giroux, Leman and Marcenac (1996) described a multi-agent approach to student modelling. In their approach, different types of agents are generated to monitor the learner's attempt at solving the problem. The relationships between the agents form a reasoning graph and by using multiple graphs at the same time it allows the reasoning of the learner to be determined. This is in effect a distributed overlay model, with a built in error diagnosis capability.

Paiva (1996) compiled the following list of general learner modelling tasks:

- informative tasks - the learner modelling systems should be able to inform the applications of the content of the models kept by its own initiative;
- acquisition tasks - the learner modelling systems should be able to infer new information about the modelled learners, possibly by using uncertain reasoning techniques, and according to the information given by the applications;
- diagnosis tasks - the learner modelling systems should be able to detect inconsistent situations or unexpected events in the models;
- maintenance tasks - the learner modelling systems should be able to maintain
and handle the data/knowledge representing the learner models;

- query tasks - the learner modelling systems should be able to query both the applications or the other agents whenever there is information that is needed to execute its tasks; and
- answering tasks - the learner modelling systems should be prepared to answer questions, even if they require extra inference effort, posed by the other agents.

Paiva (1996) looks at three problems that need to be addressed in order to specify the communication between the learner modelling agents and the ITS applications (which can also be viewed as agents in this context):

- the problem of establishing the communication, and what protocols are necessary for two agents to establish such a communication;
- the problem of constructing the messages for the communication, and what types of speech acts are possible to use in the communication; and
- determining what language can be used to communicate and what ontologies can be shared between the agents.

The first and second problem requires the establishment of the protocols of communication and agreeing on a common set of communicative acts to be used by the learner modelling systems and the applications. The third problem is more problematic, as it involves defining conceptualisations and language which both the applications and the user modelling systems should be able to share.

Paiva (1996) started by looking at the work carried out in the area of interoperability between agents. The Knowledge Query and Manipulation Language (KQML) is a language and an associated protocol to support high level communication among intelligent agents. Adopting such a standard would allow the sharing of learner modelling mechanisms, since a learner-modelling agent can interact with several applications (which will be using the same mechanisms and techniques for the construction and update of the models). It would also allow the sharing of the learner models between applications.
Paiva (1996) found that using a general approach such as KQML has some problems. On the one hand it includes a lot of unnecessary complication, while it does not cover all of the specific issues involved. To address this, Paiva (1996) selected a subset of KQML that seemed to be enough to satisfy the above tasks execution. Some additions were also made to cover missing aspects.

4.5 DESIGN REQUIREMENTS FOR AN OBE SUPPORT SYSTEM

This chapter has looked at attempts to assist learners by using artificial intelligence systems to guide the learner. Although these systems have many problems, a few useful lessons can be learnt in regard to the information storage requirements.

4.5.1 General design principles

- Make use of a modular design.
- Learner models must be de-coupled from the other parts of the system to improve reusability.
- Should make use of standards to ensure maximum reusability.

4.5.2 Features needed by support system

- The model should be accessible by both the human educator and computer systems.
- The system should support in the monitoring and controlling of the learning, even when automated systems such as ITSs are used.

4.5.3 Supporting processes needed in model

- The learner modelling system should be able to inform the applications or human educator of the content of the models kept by its own initiative.
- The learner modelling system should be able to infer new information about the modelled learners using set guidelines and taking uncertainty into account.
- The learner modelling system should be capable of detecting inconsistent situations or unexpected events in the models.
- The learner modelling system should provide the necessary tools to maintain the data representing the learner models.
• The learner modelling system should be able to obtain the information it needs through queries to other entities, for example, if the learner modelling system determines a potential gap in a learners understanding, it should be able to request the educator or an ITS to provide it with more information. This may require special action to be taken by the entity queried to obtain this information.
• The learner modelling system should be able to respond to queries from other entities, for example, the educator might request information regarding a learner’s mastery of a particular learning outcome. The modelling system should be able to respond to such queries.

4.5.4 Storage requirements
• An overlay model can be used to record what the learner has attained and what still needs to be mastered.
• A database of typical misconceptions or errors can be used.

4.6 CONCLUSION

A conceptualisation of a learner centred learning environment was presented in this chapter. The different role-players were identified and the role that each plays in the learning environment was discussed. This led into a brief discussion of adaptive learning materials, before the topic of Intelligent Tutoring Systems (ITSs) was covered.

A brief overview of the historical development of adaptive material using artificial intelligence (AI) led into a discussion of the components of an ITS. The curriculum and student modelling tasks received particular attention. The discussion on ITSs concluded with a discussion of some of the problems of ITSs.

The chapter concluded with a listing of the design requirements for an OBE support system. While Chapters 2 and 3 provided insight into the requirements of an OBE system, this chapter provided guidance as to how to approach the problem by looking at the way similar situations have been handled in ITSs.
These different design requirements that have been identified, were divided into general design principles, features needed, support processes needed and storage requirement to make it all work. It is now necessary to follow the general design principles in defining a storage model that will allow the supporting processes to be implemented. This storage model needs to be able to serve as a foundational model on which further development aimed at the provision of either supporting processes or support features can be built. Such a model is presented in the following chapter.
CHAPTER 5:
AN OBE SUPPORT SYSTEM

5.1 INTRODUCTION

South Africa has moved to an outcomes-based system of education and training. This has led to certain record-keeping requirements as discussed in Chapters 2 and 3. These requirements need to be met in order to fulfil the educational requirement of allowing the learners to progress towards the defined goals.

ITSs have also attempted to assist learners and some lessons were taken from these and were identified in Chapter 4.

This chapter presents a framework for the development of integrated learning environments, which allow the use of automated tools in conjunction with direct educator involvement, while allowing all the role players (computer systems, educators and learners) to take an active role and allow all parties concerned to share information effectively. This framework is built around a central set of informational models.

A model of the storage requirements of an OBE support system is presented in the form of conceptual level class diagrams to show the type of information that needs to be stored in these models.

5.2 A FRAMEWORK FOR AN INTEGRATED LEARNING ENVIRONMENT

Learners have various resources and learning experiences available to them. They do however require some guidance to use these to best effect. For most of human history, this guidance and other support has been provided by human educators. In
recent times there have been attempts to provide computer systems that can assist in this role. Together with these computer assisted education systems, there has also been a move to using communication and computer technologies to provide this support over a distance. Chapter 4 discussed these systems in more detail. Figure 5.1 represents this situation.

![Diagram of supported learning](image)

**Figure 5.1:** Supported learning.

The problem with the situation in Figure 5.1 is that co-ordination between the different support systems is difficult, as there is limited capacity for information sharing. The learners can interact directly with various educational resources, or can interact with human educators or use some form of electronic educational material, which can include adaptive material or ITSs. Computer mediated communication (CMC) may account for some of this interaction, for example in courses that make use of the WWW as communications medium. In this model each supporting entity is aware of only its own actions and information it has gathered regarding the learning that has taken place. Some interaction is possible, for example the educator can get a report from an ITS, but the information sharing is limited.

Figure 5.2 presents a model, whereby a central Learner model and Curriculum model can be kept separate from the entities providing the support to the learner. All the entities involved (learners, automated systems and human educators) can share information in the central store through an information exchange interface. This interface provides a level of abstraction to allow the information to be used by the different users. This allows the educator to update the Learner model with any
observations that may be made in class. Any ITS that the learner uses will then have the benefit of being able to use this information. The educator is also able to make use of the information generated by any ITS as suggested in Section 4.4.3.

![Diagram of an integrated educational system](image)

**Figure 5.2:** Model for an integrated educational system.

The updating of the Learner model is based on an assessment of the learner’s progress.

The learner could also have access to the information in the learner and curriculum models. The learner can access educational resources through the information exchange interface, based on the information within the learner model.

The following section presents conceptual models for the storage component of the integrated educational system model.

### 5.3 STORAGE CONCEPTUAL MODEL

In this section the parts of an information system to assist in managing student progress in an OBE course is presented. The diagrams in this section use the UML (Unified Modeling Language) notation. This is a standard notation for object and class diagrams. The meanings of all diagrams will be explained, thus a knowledge of UML is not required to follow this section.
Various design requirements were identified in Chapters 2, 3 and 4. The general design principles are bulleted below, together with a short description of how the conceptual model implements these principles.

- Outcomes-based education as an approach to education stresses the need to be clear about what learners are expected to achieve. These expectations are expressed as outcomes and the teaching and learning is guided by these outcomes. (Chapter 3).

The curriculum model is used to clearly define what has to be achieved.

- The main purpose of assessing learners is for their individual growth and development, not only for the promotion decisions. Assessment is not the final point of teaching and learning, but serves as a guide to future teaching and learning. It is necessary to provide for analysis of what is taking place. (Chapter 3).

The learner will be able to access the model in order to determine the perceived gaps or misconceptions in their knowledge. As will be seen, adjustment of the teaching and learning plan is possible based on the assessment results.

- Learner models must be de-coupled from the other parts of the system to improve reusability. (Chapter 4).
- In order to manage the complexity, there should be a focus on the interfaces and boundaries of components, together with their connections and arrangements. By focussing on the interrelationships between these parts, co-ordination can be ensured. (Chapter 2).
- Make use of a modular design. (Chapter 4).
- Should make use of standards to ensure maximum reusability. (Chapter 4).

Throughout the presented models, the emphasis is on packaging related objects together into components. The focus is on the relationships between the components and objects. The precise interfaces are not modelled, as these are more implementation specific.
Figure 5.3 uses the UML package diagram notation to illustrate the main components of the system and the dependencies between the packages.

Figure 5.3: Conceptual level package diagram.

Figure 5.3 presents the five components, namely:

i. The Curriculum package containing the Curriculum model, which defines what it is the learners should be trying to achieve.

ii. The Teaching and Learning Plan package (T+L Plan) contains the plan of the learning process and keeps track of the interventions that have taken place. This package is also responsible for the planning of assessment activities.

iii. The Learner package with the definition of the Learner model that traces the learners' progress towards the goals.

iv. The Evidence package defines the items of evidence that are assessed to provide an indication if the learner's are meeting the goals set. This focuses on the structure of individual evidence items, such as a specific learner's practical
assignment returned or exam script.

v. The Assessment package defines the actual assessments that have taken to monitor learner progress and is used to determine the achievement of goals.

The arrows between the packages illustrate the dependencies between these packages. These indicate which of the class definitions are dependent on which other class definitions. They do not indicate any specific process or order of instantiation. For example the arrow from the Learner package to the Curriculum package indicates that the Learner package is dependent on the Curriculum package. This means that if there are any changes to the class interfaces in the Curriculum package, then the Learner package needs to be checked as there may potentially be changes needed in this package as well. These dependencies are an aid to managing relationships between packages during system development.

From these it can be seen that the Curriculum package is not dependent on any other packages, but that both the T+L Plan and Learner packages are dependent on it. It would therefore be prudent to define the interface of the Curriculum package first, before defining these other packages. The same is true for the Evidence package. Next should be the Learner package, followed by the T+L Plan package and finally the Assessment package.

A brief overview of the process that would be involved will now be provided.

5.3.1 Process overview

At the heart of an OBE curriculum are the outcomes that need to be attained. Therefore, the defining of the outcomes and assessment standards will precede the other aspects. The structure of these is contained in the Curriculum package.

Next the teaching and learning plan has to be determined. This is where the overall plan for the provision of learning experiences is defined. This plan is defined in terms of the class definitions provided in the Teaching and Learning (T+L) package. At this time the scheduling of assessments is also determined. These assessment plans, including the rubrics by which the resulting evidence will be assessed are also defined in accordance with the T+L package definitions. At this stage the teaching
and learning plan will have a group focus.

At entry into the learning covered by the OBE support system, a record of each learner needs to be created. From this point onwards, the progress of the learner will then be recorded in various profiles defined in the Learner package. This includes keeping track of the learner’s progress towards the attainment of the various assessment standards. In addition to these profiles, a record also has to be kept of the items of evidence produced by the learner. Some of these items are kept in portfolios, at least one of which needs to be kept for each learning area as supporting evidence of the claims of accomplishment contained in the profiles. The definition of individual items of evidence and portfolios are done according to the structure defined in the Evidence package.

As the learners progress through the planned educational experiences and they are given the information about the assessments required, they produce items of evidence (presentations, projects, test answers, etc.) to allow an assessment to be made of their progress. These items of evidence form part of the learners’ respective learner profiles. The assessments are conducted on the evidences produced by the learners using the assessment plans defined using the T+L package. The result of the assessment is then recorded in the respective learning profiles of the learners and feedback is provided to the learners. This relationship is defined in the Assessment package. The Evidence and Assessment packages are closely tied to the Learner package and should be seen as supporting models defining auxiliary aspects of the learner model. The main reason for separating these is to keep the Learner package simpler and less cluttered.

As a result of the assessments and the progress of the learners, certain changes will be needed in the teaching and learning plan. These additional learning experiences could be focussed at entire learner groups, or could be aimed at addressing a specific learner problem. These follow-up events are provided for in the T+L package.

The conceptual level class diagrams (using UML notation) for each package will now
be considered. It is important to note that these are conceptual level diagrams and are not indicative of any particular implementation. Besides the obvious lack of specific interface details, the most important difference to note is that a conceptual level diagram might leave some necessary implementation classes unlisted for clarity. For example, some implementations of a package might make it necessary to add extra classes to support the physical implementation and are not directly related to the conceptual function of the package. The additional classes needed to distribute the data stored over multiple systems would be an example of this.

In addition to this, some classes that appear on the conceptual level diagram might simply be there for clarity and these classes might not be present in an actual implementation. This will be most notable in the cases where there is a 1-to-1 relationship between classes. In actual implementation these would usually be combined into a single class, but the conceptual diagram might be clearer with these listed separately. Fowler and Scott (2000) state that UML diagrams drawn from the conceptual perspective represent the concepts in the domain. These concepts naturally relate to the classes that implement them, but there is often no direct mapping. These diagrams are therefore drawn with little or no regard for the software that might be used to implement them. The attributes and methods of the individual classes have also been left out for simplicity and clarity.

5.3.2 Curriculum package

This package contains the definition of the educational goals that need to be attained by each learner. As the intention is to create a support system that is specifically aimed at an OBE environment, these goals are expressed in terms of the intended learning outcomes and assessment standards.

Figure 5.4 presents a conceptual level class diagram (using UML notation) to describe the parts of the Curriculum package.

As was seen in Chapters 2 and 3 the OBE outcomes can be divided into Critical (and Developmental) and Learning Outcomes. These are types of Outcomes and are therefore represented as sub-classes of the Outcome class. As discussed in those chapters, the Critical outcomes are cross curricular and not tied to a particular
learning area, while the Learning outcomes are the broadly defined goals within the learning area. These Learning outcomes are grouped together into various Learning Areas.

![Diagram](image.png)

**Figure 5.4:** Curriculum package.

In order to be able to assess if the goals are attained, more specific details are needed and these are contained in the Assessment standards. These standards drive the assessment of learning, as was shown in Chapter 3. It is the successful completion of these assessments, which will indicate learner progress towards attaining the Learning outcomes.

With the capability to define the different learning outcomes and assessment standards, it is possible to define the educational objectives of the course. The learner progress can then be measured against these. This provides for the representation of the course in OBE terms as discussed in Chapters 2 and 3. An ITS system would require a lower level of detail than is desirable for an OBE support system, so the ITSs cannot use this model directly to define their subject domain in the detail they would require for their functioning.

This higher level definition of the curriculum could still be useful for defining the overall progress of the learner in ITSs. As long it is ensured that each ITS system is
capable of handling at least one complete Assessment standard, the progress of the learner can be adequately modelled to allow different ITSs to more effectively cater to the learner’s needs.

Even if the level of the model used here is at a higher level that that used by ITS systems, the sharing of higher level details that are applicable beyond the narrow sessions is still useful. One aspect mentioned in Chapter 4 is that many ITS systems do not simply trace learner progress in terms of the knowledge and skills to be attained, but that they identify the reasons for failure to demonstrate mastery of a particular aspect. This is accomplished by identifying and recording the errors and misconceptions of the learner. This information would also be useful to the human educator as it gives some insight into the problems the learner is having and would suggest ways of addressing the problem.

As stated earlier in this section, the function of the Curriculum package is the definition of the educational goals to be achieved. The educational aims are not simply to add knowledge and skills, but also to eliminate any misconceptions the learner may have. It is therefore appropriate that typical errors and misconceptions be defined in this package as well. This is defined as a Misconception/Error class. An error or misconception should be associated with some Learning Area, as they are likely to re-occur within a learning area, so are not associated with individual outcomes or assessment standards.

This package fulfils the following of the Storage requirements:

- There should be a planned combination of learning outcomes. These outcomes must have a defined purpose and should be intended to provide qualifying learners with applied competence and a basis for further learning. (Chapter 2).
- Assessment standards that describe the level at which learners should demonstrate achievement of the learning outcomes at various points during the course should be stored to guide the learning and assessment. This, together with their relationship to learning outcomes and learning areas define the curriculum. (Chapter 2).
- The curriculum should define key Critical and Developmental outcomes. (Chapter
3).

- The curriculum should be broken up into Learning Areas, with a small number of Learning Outcomes for each Learning Area. (Chapter 3).

- For each Learning Outcome, a number of Assessment Standards need to be defined. These standards should indicate the knowledge, skills and values that the learner needs to show in order to achieve the Learning Outcome at a particular level. (Chapter 3).

- A database of typical misconceptions or errors can be used. (Chapter 4).

This package defines what needs to be attained, but the real goal is for the learner to make progress towards these goals. It is therefore not sufficient to only define these outcomes and misconceptions; it is also necessary to know the progress that each individual learner has made towards the attainment of these goals. This is the role of the Learner package that will be discussed later. It is, however, necessary to plan the learning that is to take place, so the teaching and learning package is discussed next.

### 5.3.3 Teaching and Learning package

The Teaching and Learning package is presented in Figure 5.5 and defines the plan by which the learning opportunities and assessment events are managed. The T+L Plan (Teaching and Learning Plan) ensures that the different outcomes of the Learning Areas are achieved. A Teaching and Learning Plan contains various Events and these can be either Learning or Assessment events.

Each instance of an Event class contains an indication of whether it has been implemented already, or if it is still just planned. In this way the Teaching and Learning Plan is not only a representation of what is intended to happen, but also serves as a record of what has actually taken place. Some events may cause follow-up events. A learning event may be followed by assessment, or an assessment may suggest a need for a future learning event.

Each event could be planned for individual learners, or for groups. In the case of events planned for groups, attendance lists should be kept. This is the responsibility of the Group class. This makes it possible to determine what each individual learner
was exposed to.

An Assessment Event consists of many Assessment Units. The Assessment Units allow the assessment to be broken down in order to be more focussed on the Assessment Standards. These could be sub-parts of a test or exam.

![Diagram showing the relationship between Assessment Standard, Learning Event, Resource, Rubric, Assessment Unit, Assessment Event, Learning Area, T+L Plan, Event, Group, Learner, and follow-up event.]

**Figure 5.5: Teaching and Learning package**

For each Assessment unit there can be a number of Rubrics defined that define the meaning of different levels of achievement of the Assessment Standard. Some Rubrics are more general and some may be reusable with different Assessment Standards.
Learning events aim to promote the eventual attainment of certain Assessment Standards and make use of certain Resources in order to do this.

This package fulfils the following of the Storage requirements:

- There should be a record of past and planned learning interventions for each learner. (Chapter 2).
- A record needs to be kept of available learning resources. (Chapter 2).
- There should be a record of what was done, without burdening the educator with too much management. (Chapter 3).

### 5.3.4 Learner package

This package is concerned with keeping track of the progress of the individual learners towards the attainment of the Assessment Standards and is presented in Figure 5.6. This is achieved by keeping track of the attainment of Assessment standards in Achievement profiles and any misconceptions identified in Misconception profiles. In addition to this any other relevant information, such as learning preferences are also stored in this package.

In this model, most of the information concerning a learner is stored in a number of profiles. As was seen in Chapter 3, profiles are a way of using different kinds of evidence to give a better all-round assessment of a learner’s achievements, attributes and interests. There can be many different types of profiles, differing in both the purpose for which they are created and their exact contents. Profiles are used to provide maximum flexibility, albeit at the expense of specificity in the model.

The different sub-classes of a Profile presented in Figure 5.5 are only a subset of the different types of profiles that could be defined. The use of object-oriented technology will allow for easy extension of these profiles.

The Learning Preference profile is defined to allow a record to be kept of the learning styles preferred by the learner. This allows the learning environment to be tailored for the needs of the individual learner.
The Achievement profile represents the learner’s attainment of the Assessment Standards. This is in line with one of the uses of profiles identified in Chapter 3, as well as being one of the major aspects of an overlay model in an ITS as discussed in Chapter 4. There can be different types of achievements and therefore different types of Achievement profiles, but as all of the higher level achievements can be deduced from the Assessment Standards achieved, this is the only one of great interest during the learning process and is the one presented here.

The Misconception profile keeps track of any misconceptions that may be identified during the course of interactions with the learner. The usefulness of this type of
profile was identified while discussing ITSs in Chapter 4.

In addition to the above profiles, a Report profile has been modelled. This allows two or more of the other types of profiles to be grouped together into a single Profile as part of the reporting process. This provides for the aggregate reporting requirements.

A requirement of OBE is that evidence of learning should be kept. The Learner package includes linkages to the various items of evidence that the learners have created. A particular item could be linked to multiple learners if it was a group project. For reporting purposes, portfolios are kept of a learner's work. These portfolios are for the different learning areas.

It is not enough to simply be able to keep track of the learner progress. It is also necessary to base the updating of the learner model on an assessment of the learners’ progress. Keeping track of the assessment and the evidence it is based on is the responsibility of the Assessment package, but first this has to be planned for. This is the responsibility of the Teaching and Learning package.

This package fulfils the following Storage requirements:

- Each individual learner’s learning style and preferences should be recorded. (Chapter 2).
- The progress of each learner should be recorded in terms of the learning outcomes and assessment standards. (Chapter 2).
- There should be a record of the evidence used to assess the learner’s progress. (Chapter 2).
- There should be a distinction between the learning experiences, assessment evidence and the actual learning that has taken place. (Chapter 2).
- A learner centred view should be catered for. (Chapter 2).
- Use individual learner profiles. These profiles should contain all of the required information, as listed in Section 3.7.3. The details regarding each learner can be used to construct a learner model, which shows the learner's current understanding of the subject matter. (Chapter 3).
- Each report on a learner’s overall progress should include information on: The
learning achieved, the learner’s strengths, support needed and constructive feedback. Portfolios on each Learning Area should be available as additional evidence. (Chapter 3).

- An overlay model can be used to record what the learner has attained and what still needs to be mastered. (Chapter 4).
- A buggy model will indicate the identified problems and misconceptions the learner has. (Chapter 4).

5.3.5 Evidence package

Figure 5.7 provides the definition of the Evidence package. This package provides for the fact that there can be different types of evidence. This includes the concept of a portfolio, which is an item of evidence which is itself an aggregation of other items of evidence. This figure provides examples of types of evidence and is not meant to be exhaustive. Other types of evidence can always be added.

![Diagram: Evidence package](image)

Figure 5.7: Evidence package.

Whenever possible, these items of evidence should be stored where they could be easily accessible later (online would be ideal), but this is not always possible, as some items of evidence might not exist in electronic format, or might be transient, such as a presentation. In these cases, the Item of Evidence can only provide information about the item, but not the actual content.
This package enables the following storage requirement to be fulfilled:

- Different types of assessment should be catered for. (Chapter 2).

### 5.3.6 Assessment package

The Assessment Plan provides the plan and framework according to which the Assessments take place. It is however possible for an Assessment to take place without any Assessment Plan. This is to cater for the possibility of updating the Profile based on some observed event, which might have been unplanned. This updating should be formally recorded for accountability purposes.

![Assessment Package Diagram](image)

**Figure 5.8:** Assessment package.

This Assessment is based on some form of evidence and, as a result of this, Feedback is provided to the Learner. This is done in accordance with the criteria defined in the Assessment Plan and based on the evidence provided. In the case of Items of Evidence submitted by groups, the feedback would be to multiple Learners.
This package fulfils the following of the Storage requirements:

- There should be a record of the evidence used to assess the learner’s progress. (Chapter 2).
- Each assessment done should be recorded. This assessment should not be in terms of a single score, but should be recorded in terms of the assessment standards. (Chapter 2).
- There should be a distinction between the learning experiences, assessment evidence and the actual learning that has taken place. (Chapter 2).
- Every outcome that may be set for learners has a range of possible evidences for assessment. It is also possible that more than one outcome (or assessment standard) may be assessed from the same evidence. (Chapter 3).

5.4 CONCLUSION

Different role-players are involved in a modern educational environment. There are the learners, as well as various educational agents. These could be human educators or some form of computer tutors. This chapter presented a framework, whereby these different entities could share information regarding learner progress to allow their actions to be better co-ordinated. This framework is built around a central information store containing two major components, namely the Curriculum model and the Learner model.

The Curriculum model defines what is to be achieved while the Learner models contain a record of each learner’s progress towards the attainment of the curriculum goals.

This chapter presented conceptual models defining the different items in these components and their relationships. These models provide a guideline of which items to include in the storage of an OBE support system and how these items should relate to each other. The conceptual model was presented in the form of five packages: The Curriculum, Teaching and Learning Plan, Learner, as well as the Evidence and Assessment packages. It was shown that these models address the
storage requirements identified in Chapters 2, 3 and 4.

The development of a functional OBE support system would involve the implementation of the storage model with the appropriate supporting processes. These would then form the basis for the provision of the different functions required of an OBE support system as identified in Chapters 2, 3 and 4. The following chapter provides a summary of the dissertation shows how the model presented in this chapter provides the foundation upon which the OBE support services can be built.
CHAPTER 6:

CONCLUSION

6.1 INTRODUCTION

The need for systemic changes in South African education has led to the introduction of the NQF and an outcomes-based approach to education. The learner-centredness of this approach, with its greater emphasis on record keeping has increased the requirements to know what each learner knows. With the large number of learners at many education institutions it can be difficult for the educator to keep track of each learner’s progress.

ITSs attempt to aid the progress of learners from their current level of accomplishment to a higher level by keeping track of a learner’s behaviour and thereby gaining insight into the current state of the learner’s knowledge and abilities. The ITS then uses this information to adapt its instruction to the needs of the learners.

Despite its promise, the field of Intelligent Tutoring is widely acknowledged as having many shortcomings, the most notable of which is the limits of current artificial intelligence systems and the lack of flexibility of these systems.

Computer systems are good at storing and processing information, but are deficient in the areas of innovation and adaptability. Humans are consistently more flexible and adaptable than computers, but have problems storing and processing large amounts of information accurately.

Considering the fact that all of these abilities are needed, but that neither computer or human educators are good at all of these, it would be desirable to somehow combine these different capabilities in such a manner that their strengths support each other.
A common way of doing this is to provide the human with an information system that is responsible for the storage and processing of information, while the human can then use this information and support tools to function more efficiently. It was therefore decided that a possible solution to the record-keeping and management problems in an OBE environment would be to provide for supporting computer systems that provide the information storage and processing capabilities, while the human educator provides the necessary innovative and adaptive capabilities.

It was felt that it is desirable that all the educators, computer systems and learners should be able to share the information regarding individual learner progress in order to allow the learners to progress as effectively as possible.

6.2 OBJECTIVES REVISITED

This dissertation aimed to satisfy three objectives, namely:

i. the determination of the informational needs resulting from the adoption of an outcomes-based education system in South Africa;

ii. determining the requirements of a system for the provision of the informational and managerial support of educators in an OBE environment; and

iii. providing a conceptual model of the storage requirements of a support system for OBE. The development of a system using this storage model should be able to provide for the implementation of the support functions needed for an effective OBE support system.

This section shows how these objectives have been met.

6.2.1 Informational needs

Chapters 2 and 3 discussed the nature and structure of OBE in South Africa. The structure proposed in the draft curriculum statement was used as a basis when specific details were required. These led to the determination of the requirements of a support system for OBE.
6.2.2 OBE support system requirements

The information gathered through a literature study of OBE in South Africa, led to the identification of the following general system features required by an OBE support system:

Chapter 2

- The educator is directly responsible for the design of the curriculum and especially assessment. An OBE support system should therefore assist the educator in fulfilling this responsibility.
- The educator has to arrange and relate the learning objectives in such a way that the learning objectives can be attained in the most effective and efficient way possible. These objectives are stated in terms of learning outcomes in an OBE environment. The support system should allow these learning outcomes to be effectively communicated to all the learners.
- What the learners need to achieve must be clearly stated and the performance expected of the learners must be specified in advance. Emphasis is on what the learners should know and be able to do.
- The goal is not instruction, but producing learning in each individual learner. This means the effect of learning interventions on each individual learner should be the focus. The education should be learner centred. It is the responsibility of the educator to identify the needs of the learners and to plan future learning experiences based on these needs. The support system should provide facilities to enable the educator to identify these needs and to plan accordingly.
- There should not be a particular time constraint on achieving a particular standard or outcome, therefore the support system should assist in the tracking of learner attainment of outcomes.

The Curriculum package presented in Section 5.3.2 provides for the storage of the learning outcomes, while the Teaching and Learning plan of Section 5.3.3 provides the outcomes and assessment standards that the learners must know in advance. The Learner package (Section 5.3.4) then allows the recording of the progress towards the attainment of these outcomes. The Teaching and Learning plan made provision for planning future learning experiences in response to the needs of the
learners.

- The educator should use various sources as evidence for the inferences made to satisfy the requirements for public accountability. It would be beneficial if a support system could assist in managing these sources of evidence in order to satisfy the accountability requirements.

The storage makes provision for the keeping of items of evidence of different types and for the keeping track of these items. This is accomplished by the Learner (Section 5.3.4), Evidence (Section 5.3.5) and Assessment (Section 5.3.6) packages.

- A distinction is made between the experiences from which learners learn and the outcomes, which are the results of learning. Different inputs can lead to the attainment of the same outcome and a single input may lead to the attainment of more than one outcome. Input to learning from other sources needs to be acknowledged. Prior learning can be recognised on the basis of outcomes already achieved. This means that the support system should keep track of the outcomes attained by the individual learners, as well as the assessments that have taken place.

The storage model does provide for this being kept, by keeping track of the accomplishments of each individual learner and by separating the outcomes to be achieved and the learning experiences.

**Chapter 3**

- In order to generate specific information about learning strengths and needs, the learning goals and criteria for success must be stated as precisely as possible. The assessment process must be stated as precisely as possible. The assessment process should be designed to provide evidence, for each individual learner, that those particular criteria for success have been met. This approach requires that a detailed list of what the learner is to achieve be developed prior to instruction. This list is constructed in the form of instructional objectives (learning outcomes and assessment standards).
The storage of these is provided for in the model in the Curriculum and Teaching and Learning plan packages (Sections 5.3.2 and 5.3.3).

- It should be possible to collect the continuous work done by the learner in a portfolio of the learner’s work.

The Learner package (Section 5.3.4) provides for the keeping of portfolios of the learner’s work.

- It should be possible to break test and exam questions down into parts that assess aspects of different assessment criteria.

Provided for in the structure of the Assessment event of the Teaching and Learning package.

- Assessment involves elements of self-assessment and peer assessment. Learners can be involved in the assessment process by: Self-assessment and target setting; keeping records of progress; and the selection of evidence to support levels of attainment. An educator support system should ideally support this.

Although the model does not prevent this being implemented, careful consideration needs to be given to the access controls if this is implemented.

- It should be possible to assess multiple assessment criteria at the same time.

The rubrics defined using the Teaching and learning package (Section 5.3.3) can be used to link a particular assessment event to multiple assessment standards for assessment.

- Feedback, specifically in the form of knowledge regarding the outcomes of learners’ actions, is required. This feedback should be continuous and constructive. It should indicate where the learner’s strengths and weaknesses lie
and what developmental needs there are. This feedback should also include the outlining of an action plan on how learners will be supported.

This is provided for by the Feedback class of the Assessment package (Section 5.3.6) and the follow-up plans defined in the Teaching and Learning package.

- The educator should have access to a record of the learner’s performance over time in order to provide more effective feedback.

The different objects in the model are responsible for keeping a record of changes to themselves over time. This allows performance over time to be monitored.

- The support system must make it easier to inform the learners of the outcomes and assessment standards, as well as informing them of the process by which they will be helped to achieve the assessment standards to the appropriate level.

The model makes provision for the storage of these outcomes and assessment standards, as well as a plan of learning experiences by which the learners will attain these outcomes. This would provide the necessary information required for this function.

- The educator should be able to make day-to-day decisions based on information gathered, no matter how informal this gathering of information may have been.

By separating the goals achieved from the assessments determining their achievement, it is possible to record information about learner progress for which there might be no formal assessment.

- The support system needs to provide for the creation and storage of rubrics to provide clear criteria on which to base the assessment.
- The support system needs to cater for integrated assessment. It should be flexible enough to handle integrated tasks and activities, and a variety of methods, tools, techniques and contexts in assessing learners’ performance.
The Teaching and Learning package of Section 5.3.3 provides for the definition of rubrics for assessment. These rubrics are flexible tools that can be used for assessment and link the item or activity being assessed to the learning standards, therefore allowing flexibility in the things that can be assessed.

- The system must provide for the planning of assessment in such a way that the learners may benefit as much as possible from the feedback.

The model provides for the storage of the assessment plan in the Teaching and Learning package (Section 5.3.3). It provides for the linking of this plan to the assessment standards to be attained. The Assessment package (Section 5.3.6) allows for feedback based on the assessments using the assessment plan.

- The system should be able to cater for group work.

The model does cater for any particular item of evidence being linked to multiple learners, so too its assessment.

In addition to the required features identified from the study of OBE and OBE assessment requirements, the following features were identified as desirable when current computer integrated learning environments were investigated.

**Chapter 4**

- The model should be accessible by both the human educator and computer systems.

This would be accomplished by providing an interfacing layer above the storage system to cater for the different needs of computer systems and humans. In the case of computer systems, the IMS project is working on standards to allow this kind of interoperability (Collier & Veres, 1999; Smythe, Tansey & Robson, 2000). These can be implemented using Extensible Markup Language (XML). XML would also be useful for communication to the humans (either educators or learners), but in this case it would not be in terms of IMS standards, but would be in the form of XHTML.
• The system should support in the monitoring and controlling of the learning, even when automated systems such as ITSs are used.

By using centralised information where the progress of learners is recorded, the system allows better monitoring and controlling. The communication between the ITSs and the storage system would have to be in some form of standard, such as the IMS standards.

6.2.3 Conceptual model of the storage requirements

Chapter 5 presented a framework for an integrated learning environment (Figure 5.2) based around a central storage that is accessible to human educators, automated learning support systems and the individual learners. This central storage would be responsible for the information regarding the curriculum and the information regarding the progress of the individual learners. This information would be stored in a Curriculum model and a Learner model. The accessing of these models would be via an Information Exchange Interface, to allow the information to be presented in a form appropriate for the entity accessing it.

The conceptual storage model presented consisted of various packages defining the various classes of objects that should be stored and their relationships to other classes. This conceptual model provided details of the type of information that would need to be contained in the central data store of an OBE support system. (See Figures 5.3.2 to 5.3.6).

Besides the immediately obvious Curriculum and Learner packages responsible for the curriculum and learner models respectively, there is also a Teaching and Learning package that provides for the planning of the learning interventions and resulting progress intended. In addition to this two more packages provide for the completeness of the central storage. These are the Evidence package, which defines the structure of the different evidences stored in the learner model as supporting evidence, and the Assessment package to provide for the assessment of the learning
taking place and the provision of formative feedback.

Section 5.3 discussed these models and showed how this model addresses the storage requirements identified in Chapters 2, 3 and 4.

6.3 USING THE MODEL

The model presented in Chapter 5 provides guidelines on which items to include in the storage of an OBE support system and how these items should relate to each other. In Chapters 2, 3 and 4 various support system requirements were identified. In addition to the general design principles, features of an OBE support system, storage requirements of such a support system, as well as supporting processes of the storage model were identified.

The manner in which this model caters for the support processes required will now be discussed.

6.3.1 Supporting processes needed

This section lists the identified processes in bulleted form together with brief discussions of their relationship to the packages in the conceptual model.

- The educator needs to be able to manage the different learning resources. (Chapter 2).

This aspect has not been looked at in detail, but the Teaching and Learning package makes provision for this by defining the relationship of learning resources with learning events. This is also being investigated in a linked project at the Port Elizabeth Technikon.

- It needs to be possible to keep track of the different learning styles and preferences of the learner. (Chapter 2).

The learner profiles defined by the Learning package makes provision for different types of profiles. The learning styles and preferences of the learners would be stored
as profiles in the learner model.

- The educator should be assisted with identifying the needs of the learners in order to plan future learning experiences. (Chapter 2).

Extra inference capabilities would be useful for this. The needed information for this is contained in the achievement profiles and misconception profiles, as well as the Teaching and Learning plan, stating what learning opportunities the learner has already had.

- The educator should be able to arrange and relate the learning objectives in such a way that the learning objectives are attained in the most effective and efficient way possible. This is done in terms of the learning outcomes and assessment standards. (Chapter 2).

The Curriculum package provides the foundation by defining the structure to be used to define the curriculum in terms of learning outcomes and assessment standards.

- Outcomes-based education argues for assessment that measures and reports on many dimensions of performance rather than reducing the achievement to a single score. A particular performance has to be analysed in relation to relevant outcomes and the learning that is demonstrated. (Chapter 2).

This is achieved by the Teaching and Learning package defining the structure of an Assessment Plan. This plan includes rubrics that relate the intended assessment to the assessment standards. When the learner’s evidence is assessed according to this plan, it is in relation to the defined assessment standards.

- Different types of both formative and summative assessments should be catered for. This should include the capability to handle things like portfolios, simulations, workplace assessments, as well as written and oral examinations. (Chapter 2).

The Evidence package provides a structure, whereby many different types of
evidence can be catered for and grouped into portfolios. From the storage perspective, no distinction is made between formative and summative assessment. In Chapter 3 it was stated that any particular act of assessment could be both summative and formative, so there is no need for distinguishing at this level.

- Tests are still important, but need to be analysed in relation to the learning outcomes and assessment standards. (Chapter 2).

The dividing of the Assessment Plan into Assessment Units allows multi-question test papers to be defined and stored. The associated rubrics allow these tests to be analysed in relation to the learning outcomes and assessment standards.

- The amount of the educator’s time taken to cater for the needs of the learners at different levels within the class should be minimised. (Chapter 2).

This aspect would be very dependent on what other supporting processes were provided and the degree of automation implemented. The only direct support for this in the storage model is the provision of a flexible grouping mechanism, whereby different groups of learners can be defined and learners can be members of multiple groups and groups consist of subgroups. This allows the amount of management time needed to be reduced. This area in particular would be a fruitful area for further investigation.

- The amount of time spent on managing and administering assessment should be kept to a manageable level. (Chapter 2).

Once again this is a similar situation to the previous point, but this time focussed on the assessment. The Teaching and Learning package treats the planning of the assessment and learning events in a similar way, so provides the foundation for their management in a similar way.

- The entire assessment cycle needs to be catered for, including the setting of assessment criteria, the choosing of appropriate assessment techniques,
conducting of the actual assessment, the recording of the results, as well as the reporting and analysis of the results. (Chapter 3).

The supporting processes for the assessment cycle would have to be developed using the storage classes defined in the model as their basis. The assessment criteria would be stored as rubrics related to appropriate assessment standards. The techniques to be used are part of the information contained in the assessment plan. The definition of these is provided for by the Teaching and Learning package, together with the Curriculum package. No direct support is provided for the actual conducting of the assessment, but the teaching and learning plan will allow for planning when it will occur and the defined rubrics will assist in the assessment once the evidence has been rendered. The actual recording of the assessment results and the providing of feedback to the learners are provided for by the Assessment package. Analysis and reporting functionality could be built upon this storage model.

- It is necessary to cater for multiple assessment techniques and multiple activities to allow learners with different learning styles to demonstrate their true ability. (Chapter 3).

This could be accomplished by defining multiple assessment plans for the same assessment standards. Some checking processes could be incorporated that would analyse the learning style profiles of the different learners and compared that against the types of assessments planned. This would then be able to show if there are some assessment standards for which some learners might not be given a fair opportunity to demonstrate their ability. This would need additional research to determine how to do this and to keep assessment fair.

- OBE requires more detailed records of progress or achievement than was previously required. These records need to be managed. This includes automating some of the processes whereby progress in the individual assessment standards indicate attainment of the learning outcomes and overall progress. (Chapter 3).
The storage model presented allows for the storage of these different individual records of progress and would form a suitable base on which to build further supporting mechanisms.

- Assessment must provide useful information about the learner’s progress against the Assessment Standards in a grade. When you report on achievement, you should include information about strengths and the areas where support is needed. (Chapter 3).

The assessments in this model are related back to the assessment standards. This allows achievement profiles to be updated for the individual learners, providing details of their progress. This information can then be used to provide information about their current progress and that would indicate where more support is needed. The misconception profiles in particular would show areas where particular attention is needed.

- Tools for analysing the assessment results are required. (Chapter 3).

The model makes provision for a detailed breakdown of the assessments in relation to the assessment standards. This information could be analysed by any supporting tools built on top of this model. As the model calls for objects in this model to keep a record of their history, it would be possible to provide tools that analyse trends over time.

- The entire portfolio management cycle of Section 3.7.4 should be supported. (Chapter 3).

The storage model simply provides for the storage and assessment of the items of evidence and portfolios. In addition to this, the Assessment package does not place any limits on who does the assessing, thereby leaving room for self-assessment on the part of the learner. The storage model also does not address access rights, so it would be possible to provide the portfolio management facilities that included interaction between the learner and educator and allowing the learners to be
responsible for managing their own portfolios.

• The learner modelling system should be able to inform the applications or human educator of the content of the models kept by its own initiative. (Chapter 4).

The object-oriented nature of the models allows a certain amount of intelligence to be built in into the various objects that make up the model. With an appropriate agent architecture, the model could support the automatic detection of certain conditions and automatically report on these events.

• The learner modelling system should be able to infer new information about the modelled learners using set guidelines and taking uncertainty into account. (Chapter 4).

• The learner modelling system should be capable of detecting inconsistent situations or unexpected events in the models. (Chapter 4).

These are more areas where a fair amount of work would be needed, but the object-oriented nature of the model and the keeping of a complete history would assist in the provision of this capability.

• The learner modelling system should provide the necessary tools to maintain the data representing the learner models. (Chapter 4).

• The learner modelling system should be able to obtain the information it needs through queries to other entities, for example, if the learner modelling system determines a potential gap in a learners understanding, it should be able to request the educator or an ITS to provide it with more information. This may require special action to be taken by the entity queried to obtain this information. (Chapter 4).

These processes flow directly from the fact that the model is for information storage and retrieval.

• The learner modelling system should be able to obtain the information it needs
through queries to other entities, for example, if the learner modelling system determines a potential gap in a learners understanding, it should be able to request the educator or an ITS to provide it with more information. This may require special action to be taken by the entity queried to obtain this information. (Chapter 4).

The necessity of this process would be dependent on the environment in which this support system is used. If all entities (human or computer) involved in the provision of learning opportunities use the single centralised information store, then this would probably not be necessary. One case where it may be necessary is if the system determines that a learner’s ability in a certain aspect is uncertain. It can then generate a query requesting this information. This could be to another system that might have this information, or it could be a query send directly to the educator. If this other entity is not in a position to provide the answer, it may still be possible for that entity to obtain the answer. For example, if the system determines that there is some doubt about a learner’s ability in a certain aspect, the educator can be alerted to this fact and the educator can then pay particular attention to that aspect at the next available opportunity.

6.4 LIMITATIONS OF THE RESEARCH

The introduction of OBE in South Africa was accompanied by a fair amount of uncertainty and confusion. This confusion was often reflected in the literature, as many people were unsure of the direction that things were taking in South Africa. Late in the research, the release of the draft Revised National Curriculum Statement presented a difficulty. It needed to be decided if the conceptual model would continue to be aimed at the old (currently in effect) structure, or if the model would be based on the new structure.

Due to the fact that the model is meant to provide the basis for further developments, combined with the fact that the new structure was developed in response to problems in the old structure, it was decided that the new structure would be embraced.
A further limitation is that the model has not been implemented, therefore its effectiveness could not be tested.

### 6.5 FUTURE RESEARCH

The model presented here provides only the barest foundational structure to ensure that all the important classes are represented and that different tools developed in future will have a common view of the storage to allow easier integration.

Some of the supporting processes needed are reliant on more than simple data storage and access and would benefit from analytical processing of the information in the model. More research would need to be conducted into this.

The issue of information exchange has not really been addressed in this dissertation. Standards in this regard are emerging. The development of these standards such as those developed as part of the IMS project should be followed and their impact assessed. Some of the issues that need to be addressed are the mapping of informational views into different forms that cater for the particular needs of the educators, learners and computerised systems.

The model provided a point to link educational resources into the structure, but any system aimed at catering for that would need to expand on that aspect. Similarly, the storage of portfolios is catered for, but more research would be needed to determine the best ways of incorporating active learner involvement in the process.

The model does not concern itself with the source of the assessments, so self-assessment and peer-assessment could be easily accounted for. It would however be desirable to consider these issues more closely, because in a case like this, not all assessments can be considered equally reliable. This is also true even of assessments done by the educator, as the circumstances of the assessment could differ. This is not addressed in the model and would need to be researched further.

The overall framework for the role of the storage model includes provision for
automated computer systems such as ITSs to be used and share the common information store. More research is required in this regard to make this a reality.

The model presented here needs to be used to implement an actual support system. This would allow further research into effective architectures for support systems.

6.6 CONCLUSION

The introduction of OBE in South Africa has led to a more learner-centred approach and increased record-keeping requirements. It would be desirable for a computer system to provide the educator with the necessary support to reduce the burden of this and to enhance the learning that takes place.

This dissertation determined the requirements of such a support system and proposed a conceptual object-oriented model that would allow OBE support systems to be more easily developed. More importantly, it is likely that different support systems will emerge that only cover some aspects of the support, rather than the entire spectrum of features identified. If these were developed using the proposed model these different systems would more easily integrate if they have a common approach to the storage. It is hoped that the conceptual model presented in this dissertation will provide a common approach that can be used in the development of the support tools that will needed when the new OBE structure is implemented.
BIBLIOGRAPHY


SAQA. (2001c). Criteria and guidelines for the registration of assessors. [Cited November 2001] Available at:


http://tecfa.unige.ch/tecfa/tecfa-research/CMC/FLISH95


