A CASE-BASED SYSTEM FOR LESSON PLAN CONSTRUCTION

FACULTY OF SCIENCE
DEPARTMENT OF COMPUTER SCIENCE

A CASE-BASED SYSTEM FOR LESSON PLAN CONSTRUCTION

By

ASLINA SAAD
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CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgements or in footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a degree.

.... (Signed)

28 April 2011

Dedicated to my father, my mother, my husband and son for their love,
sacrifices and inspiration

ACKNOWLEDGEMENT

ABSTRACT

Planning for teaching imposes a significant burden on teachers, as teachers need to prepare different lesson plans for different classes according to various constraints. Statistical evidence shows that lesson planning in the Malaysian context is done in isolation and lesson plan sharing is limited. The purpose of this thesis is to investigate whether a case-based system can reduce the time teachers spend on constructing lesson plans. A case-based system was designed – SmartLP. In this system, a case consists of a problem description and solution pair and an attribute-value representation for the case is used. SmartLP is a synthesis type of CBR system which attempts to create a new solution by combining parts of previous solutions in the adaptation.

Five activities in the CBR cycle – retrieve, reuse, revise, review and retain – are created via three types of design: application, architectural and user interface. The inputs are the requirements and constraints of the curriculum and the student facilities available, and the output is the solution, i.e. appropriate elements of a lesson plan. The retrieval module consists of five types of search – advanced search, hierarchical, Boolean, basic and browsing. Solving a problem in this system involves obtaining a problem description, measuring the similarity of the current problem to previous problems stored in a database, retrieving one or more similar cases and attempting to reuse the solution of the retrieved cases, possibly after adaptation. Case adaptation for multiple lesson plans helps teachers to customise the retrieved plan to suit their constraints. This is followed by case revision, which allows users to access and revise their constructed lesson plans in the system. Validation mechanisms, through case verification, ensure that the retained cases are of quality.

A formative study was conducted to investigate the effects of SmartLP on performance. The study revealed that all the lesson plans constructed with SmartLP assistance took significantly less time than the control lesson plans constructed without SmartLP assistance, although they might have access to computers and other tools. No significant difference in writing quality, measured by a scoring system, was noticed for the control group, who constructed lesson plans on the same tasks without receiving any assistance. The limitations of SmartLP are indicated and the focus of further research is proposed.

Keywords: Case-based system, CBR approach, knowledge acquisition, knowledge representation, case representation, evaluation, lesson planning.

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CHAPTER 1

INTRODUCTION

1.1   Overview

In this research, SmartLP, a case-based lesson planning system has been implemented as a means of assisting teachers in constructing quality lesson plans in a shorter time, in comparison with lesson plan construction without the tool, by addressing the issues surrounding lesson plan preparation in a Malaysian context. SmartLP enables teachers to retrieve previous lesson plans and customise them according to their constraints rather than start everything from scratch, as lesson plans should be tailored to accommodate differences according to the profiles of students and teachers as well as the facilities available. For the main part of this research, an evaluation was designed to examine the effectiveness of Case Based Reasoning (CBR) approach via its cycle; retrieve, reuse, revise and retain in assisting teachers to construct their lesson plans and to inspect the effects the system had on the lesson plans prepared by teachers.

The design of the system requires a proper understanding of the nature of the problem in preparing lesson plans, differences between good and poor lesson plans, important elements of a lesson plan, and constraints faced by teachers in constructing lesson plans. To develop the tool, a comprehensive knowledge acquisition exercise was carried out. Knowledge in the lesson plans domain was identified, analysed and represented. In order to develop a comprehensive system, the representation and modelling of a lesson plan domain within a system development methodology is crucial.

This chapter presents an overview and background of the research: the nature of devising a lesson plan for teaching, the problems of preparing lesson plans among teachers worldwide and CBR potential to overcome this problem. A summary of the evaluation results is presented to answer the main research

questions. This chapter ends by outlining the structure of the remainder of the Thesis.

1.2   Introduction

Teaching is an art, yet teachers need lesson plans as they add significant value to their teaching activity. Lesson plans help teachers, especially new or inexperienced teachers, to organise their teaching. Teaching plans encompass a number of elements such as content, materials, and assessment – and these items need to be tailored to accommodate particular classroom situations, such as diverse abilities, learning styles and student motivation.

Although teachers might teach the same subject for different classes, each class should be prepared according to the student's profile. Other factors like classroom layout, number of students, and available technologies and materials are also important in constructing suitable lesson plans for a particular class.

The issue of teachers' workload was raised by the Malaysian National Union of Teaching Profession (NUTP) in March 2010 (Dom, 2010). Excessive workloads can contribute to stress among teachers. Past research shows that teachers spend a lot of time on lesson planning (Bubb and Early, 2004). Koszalka et al. (1999) identify that teachers are busy and have little time to plan and prepare lessons. Research by PriceWaterHouseCoopers in 2001 found that teachers' working weeks were more intensive than other professionals and that holiday working was widespread (Bubb and Early, 2004). Bubb and Early (2004) listed five main causes of excessive workload – one of which was lesson planning. As a consequence of the excessive workload, teachers suffer greater levels of stress than comparable occupational groups. They also affirm that many research projects have found that planning and preparation are significant burdens for teachers. Evidence of stress amongst the teaching profession is also found in the Northern Ireland Teachers' Health & Wellbeing survey conducted in 2001. The report notes that the main causes of job-related stress revealed were 'having too much work to do' and 'too much administration/paperwork'. Sixty two percent of respondents also reported that a 'lack of time to prepare lessons' was a cause of

unwanted stress (Bubb and Early, 2004). Planning is an essential aspect of teachers' work but it is time consuming.

Since it is common for teachers to refer to the same curriculum for lesson planning, a mechanism to enable collaboration between them would be useful. The sharing of experiences might be useful for teachers to create new plans or to make modifications and improvements to existing plans according to their students' profile and classroom situation. According to Watson (1997) 'real world' problems are often fairly complex with many contributing features. The current problem may not present itself in exactly the same manner as problem stored in the database. Therefore, to simply use other teachers' lesson plans is not practicable. Thus, teachers have to customise existing lesson plans to meet their own requirements.

Case Based Reasoning (CBR) is concerned with finding relevant cases that solved similar problems to the current problem. It offers an approach to lesson preparation. With appropriate computer support, effective lesson plans could be constructed for the benefit of teachers, students, as well as school administrators.

1.3   Background

In spite of remarkable advances in computing technology and the benefits they bring, school teachers in Malaysia are still preparing their lesson plans in isolation and manually. At the moment, experience is transferred between individuals manually with many limitations and constraints. A critical issue that needs to be addressed is how the emergence of technology might facilitate teachers in lesson planning without duplication and benefit from the experience of colleagues.

A lesson plan is a written document produced by teachers in a lesson plan book using a standard format endorsed by the Ministry of Education. Currently there is little support for teachers to determine suitable lesson plans based on their particular classroom situation. John (1993) quoted that Clark and Yinger (1988) label lesson planning as 'the hidden world of teaching' because most of this planning is done in isolation. Furthermore, Shen et al. (2007) point out that

teachers who teaching in public school may enjoy the individualistic nature of work. Since lesson plans usually have a standard format, support can be provided through the implementation of a web-based lesson planning system whereby best practices in preparing lesson plans can be shared among teachers.

Open Lesson which covers the whole teaching process has been suggested by Shen et al. (2007). It can be used as a mechanism to overcome the isolated culture of teaching. The practice of Open Lesson is defined by Shen et al. (2007) as a professional-development activity which consists of a sequence of collaboration from preparing, rehearsing, and revising, to delivering among teachers, all of which are beneficial. Open lesson is a lesson planning approach consists of several processes, making it times consuming. Therefore, it is impractical to be implemented in a Malaysian context as time constraints are a major issue for all teachers.

Numerous suggestions have been made to help teachers in dealing with lesson plan preparation. One of the suggestions is to use or modify the lesson plans of others to suit one's own teaching. Teachers are also advised to recycle previously used lesson plans rather than start everything from scratch and to put their lesson plans on shared networks to allow other teachers to use them. This can be a mechanism for the knowledge of experienced teachers to be profitably shared with novices and teachers in training. Online systems have the potential to establish knowledge sharing easily among teachers.

In addition to sharing, a tool should also be flexible enough to support teachers in changing elements of a lesson plan to suit their constraints. Teachers cannot simply use the same lesson plans although they teach the same subjects for different classes. They should consider the various constraints in a student's profile as well as facilities available. After a lesson, a teacher has to record a reflection of their teaching into the lesson plan. Reflection is an analysis of specific success or failure in their teaching and identifies what could be improved upon in the next lesson. However, all these activities are done individually and they become an individual agenda to improve teaching quality. The lesson learnt from teaching reflection could be shared and benefit other teachers.

The CBR concept might offer solutions to this problem through its main activities: retrieve, reuse, revise and retain past cases. Since cases are important in CBR for their initial solution, all elements involved in lesson planning should be identified, captured, understood and represented in a case.

Preparing lesson plans for teaching can be categorised as a planning problem. This type of problem is a synthesis task because one is able to create new plans by combining parts of previous solutions. This is achieved by case adaptation to customise old plans into a new lesson plan followed by revision and retention of the new case.

1.4 Research statement

The overall hypothesis is:
 "Teachers manage to construct quality lesson plans in a shorter period of time by using SmartLP, a case-based lesson planning system, as compared to manual method."

The research questions that need to be answered to guide system development are:
- What makes a good lesson plan?
- What are the features of a good lesson planning system required by teachers?
- What are the important elements that need to be considered in preparing lesson plans?
- How can knowledge be represented in the lesson plan domain?
- How can a case in lesson plan domain be represented?
- What are the contents of a case in the lesson plans?

The question that will be answered by an experiment is:
- How effective is a Case Based System for lesson plan construction in the Malaysian context?

1.5   Contributions of the Thesis

This thesis presents details concerning:

- Results from a formative study investigating the effects of the case-based lesson planning system upon the time taken to construct a quality lesson plan. A series of statistical tests within an experiment were handled with different aims and hypotheses. Statistical significance was tested in relation to predefined hypotheses. These experiments are supported by interviews to acquire information about first-hand experience of using SmartLP

- The implementation of a web-based lesson planning tool to assist teachers in generating and constructing lesson plans in a time efficient manner. This was achieved by the design of a lesson planning system based on the CBR concept which consists of case retrieval, reuse, revise, review and retain. The design of the tool facilitates adaptation and subsequently reuses the cases. Case revision by the author is also supported by the system. In addition, the design of the system supports validation to review cases in order to avoid two similar cases being retained in the case base.

In order to support the contribution made by this research, the following works were done

- Criteria of a good lesson plan drawn from the survey, interview, research literature, and document.

- A review of current computer tools to assist teachers with lesson plans construction.

- Ontology for lesson plans domain.

- The importance of elements in lesson plans contributing to the default weight applied in advanced search.

- Proposal for a research methodology which provides guidelines to develop a case-based system.

- Access to previously constructed lesson plans via any five types of search

- The similarity measure for the indexed attributes.

- Menu-based hierarchical interface for search and to generate lesson plans

1.6   Structure of the Thesis

The importance of lesson plans and problems regarding lessons preparation by teachers together with an analysis of current available online resources for lesson preparation which underpins this research are discussed in Chapter 2. As a case-based lesson planning system needs to follow the format of Malaysian National Curriculum, this chapter also outlines important elements in the Malaysian context. An analysis and comparison of the elements in Malaysian, British and American lesson plans is made. Good and poor lesson plans are examined by taking into account the constraints teachers may have in preparing lesson plans in order to prepare a quality plan. As SmartLP applies the CBR approach it is necessary to review the CBR problem solving methodology and make decisions in an educational context. Chapter 2 also reports on CBR components, CBR cycle, knowledge acquisition and case acquisition. A number of knowledge modelling and knowledge representation techniques are also discussed. It is concluded that CBR, through its capability of retrieving, reusing, revising and retaining past cases, has great potential to assist teachers in customising their own lesson plans based on available cases in a knowledge base after relevant case adaptation.

Chapter 3 proposes a research methodology which provides guidelines in conducting this research. It integrates system development methodology to develop a case-based lesson planning system and knowledge acquisition methodology to gain understanding of various aspects in lesson planning. There are five phases; identification, knowledge analysis, system design, system implementation and testing, and evaluation.

The findings from knowledge acquisition which is rooted in knowledge analysis, modelling and representation are discussed in Chapter 4. The outcome of the analysis phase which is lesson plan ontology in hierarchical form together with case representation is presented in the chapter. The findings of knowledge in lesson plan domain including the main concepts and important elements for lesson plans retrieval are described. These help in specifying complete and detailed requirements of the proposed system. Background analysis was undertaken to understand teachers' problems with regards to lesson preparation

including teachers' current practice in lesson plans construction, teachers' perspectives regarding lesson planning and problems in preparing lesson plans.

Chapter 5 outlines the design of SmartLP system. Three types of design are included: application, architectural and user interface design. All functionalities that support the main activities in the system, namely case retrieval, case adaptation and case validation for retention new cases are designed. This is followed by a discussion of the implementation in Chapter 6.

Chapter 7 presents an evaluation design to investigate the effects of SmartLP has on the times taken to construct lesson plans. A formative study, involving a small sample of teachers was performed to assess the effects of SmartLP to assist teachers in constructing lesson plans. The lesson plans constructed with the assistance from SmartLP under different criteria of match were compared to see whether there is a significant difference in the time taken to construct those lesson plans. The quality of the lesson plans were measured to establish whether the time taken and dependence on the system influences their quality. The results show that there are significant differences in the time taken to construct lesson plan between the experimental group and the control group.

Chapter 8 discusses how the problem of constructing and customising lesson plans is solved by implementing SmartLP and subsequently assisting teachers in preparing lessons in a shorter timeframe. This final chapter summarises the achievements and limitations of the research, and suggests refinements and future scope of the research including the developments of the system to support this research. Research questions are revisited to highlight the contributions made by this work.

The skeletal outline of the relationship between these chapters is shown in Figure 1.1.

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                                          │ Chapter 1:              │
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│ Chapter 2 :             │               │ Chapter 3:              │
│ Literature Reviews      │               │ Research Methodology    │
└─────────────────────────┘               └─────────────────────────┘
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                                          │ Chapter 4:              │
                                          │ Findings - Knowledge    │
                                          │ Representation          │
                                          │ and Modeling            │
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                                          │ Chapter 5:              │
                                          │ System Design           │
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                                          │ Evaluation Design & Analysis of    │
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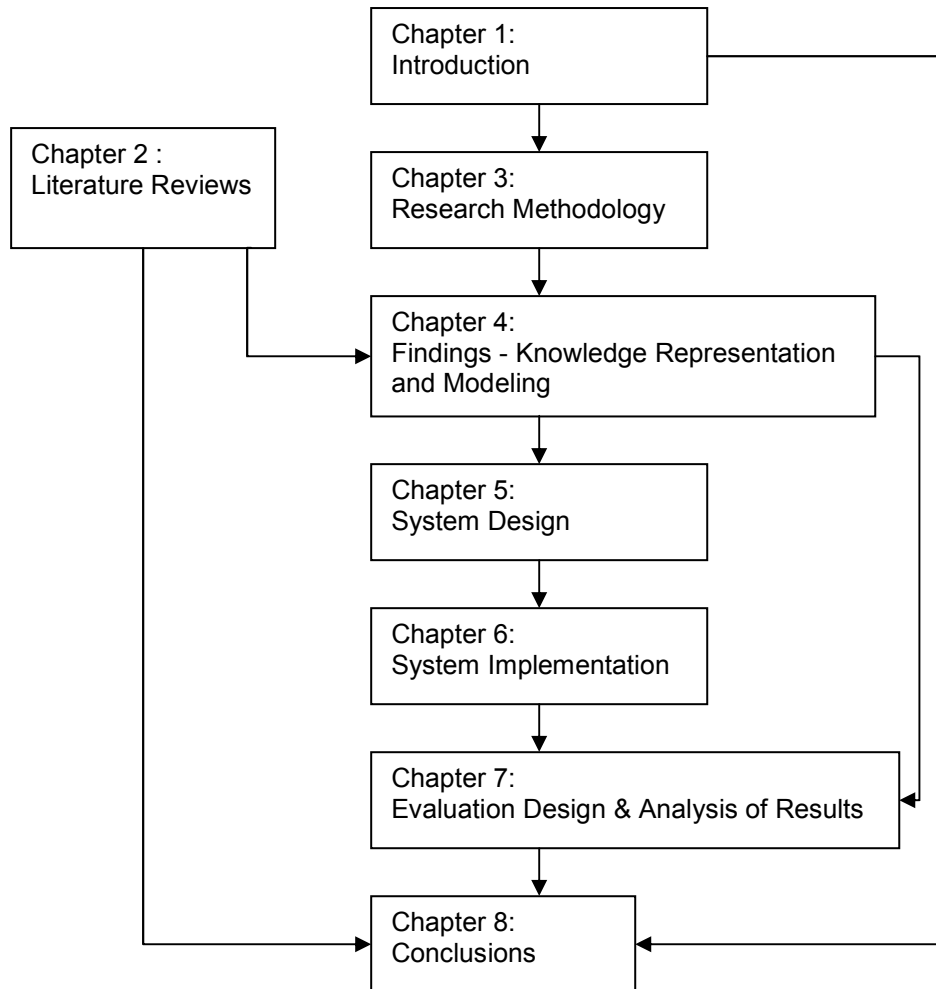
Figure 1.1: The relationship between chapters in the thesis

CHAPTER 2

LITERATURE REVIEW

"When you first start teaching, preparing lessons takes a great deal more time than it does later … if you are well prepared you can really concentrate on your teaching."

(Dean, 1996:9)

"Does planning a lesson – any lesson – seem a daunting assignment? So little time to plan! So many things to think of! So much classroom time to fill!"

(Lang et al., 1994:53)

2.1 Overview

This chapter presents the context surrounding the Thesis; the lesson plans and issues regarding lesson plan construction. CBR, the approach to implementing SmartLP is also discussed. Section 2.3 emphasises the importance of lesson planning. As lesson plans should be prepared according to the Malaysia National Curriculum, Section 2.4 outlines the relationship of teachers' lesson plans to the National Curriculum, lesson plan formats, as well as the flow of activities in preparing them. A comparison of Malaysian, British and American formats is also discussed. The need for preparing lesson plans, their components and constraints, are examined in Sections 2.5 and 2.6. Section 2.7 highlights problems regarding lesson preparation. Developing a system to facilitate teachers in creating and customising their own lesson plans requires an understanding of how teachers carry out different task manually. Three current available online resources for lesson preparation are analysed in Section 2.8. This is important to ensure that the new system offers a greater benefit for teachers than existing systems. Section 2.9 presents CBR as a potential problem solving approach in lesson plan construction by exploring the steps in CBR: case retrieval, reuse (adaptation), revise and retain (validation). The chapter ends by summarising the implications of the research for the development of the new CBR system.

2.2   Introduction

Lesson plans are written notes specifying the method of delivery, the specific goals and timelines associated with the delivery of lesson content.   Another purpose of a lesson plan is to assist teachers in structuring the teaching and learning for teachers and students respectively. Planning is essential to make sure the objectives of lessons achieved.   The details of a lesson plan might be different from one teacher to another. However, it normally follows the same format. Lesson planning can be undertaken for different timeframes – daily, weekly, termly and yearly.

Lesson plans help teachers, especially new or inexperienced teachers, to organise content, materials, and teaching methods. Although teachers might teach the same subjects for different classes, the plans should be tailored for the different classes according to students' differences in ability, previous knowledge, motivation and learning styles. Teachers' profiles such as experience, technology preference and teaching approach are other important factors to be taken into account in the lesson preparation process. Other than those elements, physical and tangible factors like classroom layout, number of students, technologies and materials available, are important in considering suitable lesson plans for particular groups of students.

A daily lesson plan is developed by teachers to give instruction, and planning the instruction can sometimes be more difficult than delivering the instruction. According to O' Bannon, (2002) teachers have to refer to the curriculum standards and develop lesson content that matches those standards. For Malaysian teachers, preparing lesson plans is compulsory and at the end of every week the plans for all the lessons taught have to submitted to the school principal for checking.

Details should be written down in a plan to assist the smooth delivery of the content. The school curriculum that students should learn is usually structured in units. The units may or may not have themes, but they include many topics that have a common thread. These units, which may involve work for days or weeks, are subdivided into daily lesson plans. Sometimes the curriculum reflects

intended learning outcomes that are processes, such as learning to research a topic, or learning long division (John, 1993).

All teachers in Malaysia refer to a standard national curriculum for preparing lesson plans. Therefore, a mechanism to enable them to collaborate would be useful. It is seen as time efficient to customise one's existing lesson plans rather than starting everything from scratch. Case Based Reasoning (CBR), which has the capability to find relevant cases that solve similar problems to the current problem, offers solutions to lesson preparation problems among teachers. The adaptation process of the previous solutions in CBR will fit the current problem's context which subsequently brings new solutions to the problem. Effective lesson plans could be constructed for the benefit of everyone: teachers, students, and the school administrator.

2.3   The importance of lesson planning

Lesson plans help new or inexperienced teachers to organise their teaching. The elements include an introduction, content and the learning steps, materials, skills to be developed and assessment.

One source of professional growth which is important is the development of lesson plans, which are used in China as tools both for personal reflection and development as well as for collegial reflection. Lesson planning allows teachers to explore multiple aspects of pedagogical content knowledge. In developing lesson plans, teachers have opportunities to think deeply about the subject matter, including the way the subject matter is represented in particular textbooks or in such aspects of the curriculum as standards and benchmarks. They also have time to develop pedagogical activities or methods that enable students to grasp the subject matter. Finally, lesson planners can ponder what students know and how they may best understand the content (Shen at al., 2007a). Lang et al. (1994:52) state, in the teaching and learning cycle, successful lessons rarely 'just happen'. Such lessons are generally the result of careful planning for the three major phases of effective lessons: set (motivation); development/delivery; and closure. These should flow naturally from one to the other. They point out three

domains of learning that should be taken into account; cognitive (intellectual), psychomotor (intellectually directed physical skills) and affective (value and attitude).

Planning is a vital activity for all teachers and they are engaged in this activity for nearly 6 hours per week compared to almost 17 hours spent teaching in the classroom (John, 1993:1). He mentioned that the routine or daily lesson plan is the key document in the process of teaching. Moreover, Koszalka et al. (1999) point out that many researchers have examined how teachers go about planning and this indicates that instructional planning plays a central role in teaching and creating an effective learning environment.

Good lesson planning is essential for any systematic approach to instruction. Although many teachers become discouraged by the time required to plan, a well written and properly used lesson plan can be a highly worthwhile teaching aid. Experienced teachers use written lesson plans for a variety of purposes. They can be checkpoints to ensure well-planned learning experiences. They can serve as teaching guides during lessons and as references for other instructors who may have to teach a lesson with very short notice. They also serve as convenient records of an instructor's planning techniques and methods of teaching. One of the most practical functions of lesson plans is that they serve as step-by-step guides for instructors in developing teaching and learning activities. Kizlik (2007) indicates that when teachers are learning the craft of teaching, organising their subject-matter content via lesson plans is fundamentally important. Besides, the first teaching work specified by the US government is to plan and prepare lessons and courses for pupils followed by delivering lessons to pupils (John, 1993).

In China, organisational structures for both individual teachers and a school's professional community embed lesson preparation in two activities: preparing a lesson plan and refining the plan through open lessons (Shen et al., 2007a). Shen et al. (2007a) analyse the differences between Chinese and American organisation of teaching according to Su et al. (2005) research. They defined a set of activities each group undertakes during the day and found a big gap

between American teachers and Chinese teachers in the organisation of teaching. The following table compares the two.

Table 2.1: The organisation of teaching among Chinese and American teachers.
(Information taken from Shen et al. (2007a))

No.	Item	Chinese	American
1	Approach	Collectivism	Individualism
2	Formal collaboration with colleagues	2 hours a week on one core subject	-
3	Informal	2 hours per day	-
4	Teaching duration	1 or 2 hours per day	6/7 hours
5	Subject	One core subject	Various subjects
6	Lesson plan preparation	Considerable	30 minutes
7	Correcting students' work	1 or 2 hours per day	Almost no time
8	Homework feedback	30 minutes per day	-
9	Lunch	40 minutes	Short, isolated
10	Rest time	40-60 minutes	-
11	Recreational time with other teachers	30 minutes	A few minutes
12	Professional development activities	Every Friday afternoon	-
13	Study with colleagues	90 minutes	-

The significant difference between times allocated in preparing lesson plans for Chinese teachers and American teachers confirmed that Chinese teachers are more concerned with lesson preparation. Chinese elementary teachers allocate at least two periods a day to prepare and secondary teachers usually have even more time available. Shen et al. (2007a) states it is widely held that planning is a primary factor in the quality of the lessons.

Shen et al. (2007a) conclude that teachers in China successfully carry out lesson planning as a professional activity, besides the fact that lesson planning in China also presents its own difficulties. Individualizing instruction may be more difficult in large classes because the number of students range from 40 to 80 students in

the developed areas of the country. Second, lesson planning occupies so much of the professional day that some teachers feel they could spend that time productively on other responsibilities. Third, planning too extensively might neglect student learning issues that arise spontaneously in class. A fourth issue is that each geographic area in China uses the same set of textbooks, so teachers are usually within a few days of teaching the same lesson. To a certain extent, this rigidity constrains teachers' creativity in designing lesson plans.

2.4   Planning and the curriculum

Lesson planning and curriculum are closely related. Planning is when you look at the curriculum standards and develop lesson contents that match those standards (O'Bannon, 2002). As lesson plans are crucial for lesson preparation, a standard format based on the same curriculum has been issued by Malaysian Ministry of Education and referred by Malaysian teachers in preparing their lesson plans. Dean (1996) emphasises that each piece of work needs to fit into an overall pattern that is more detailed than the National Curriculum.

2.4.1 *Introduction*
In the Malaysian context, lesson plans are prepared based on the same curriculum standardised by the Ministry of Education. It is a detail standard containing these elements; learning area, topic, learning outcome, content, skills, and time period. It is important that the planning sequence is considered before preparing a lesson plan because it impacts the following activities and these will affect overall planning.

Dean (1996:9) implies that at all stages in teaching, particularly in a first post, success depends to a large extent on the preparation the teacher has made. He listed several areas of information teachers should gather. The working list is shown below and it is closely related to a lesson's preparation:
- Lesson notes for each day
- Lists of each class and a note of those with special needs
- Information about age and ability range of each class

- Seating plans if appropriate
- Timetable
- The overall scheme of work and section of the National Curriculum
- Long term or overall plans for each class they teach;

John (1993:12) conceptualises the relationship between long range planning and the micro planning characterised by the daily lesson planning through the diagram in Figure 2.1. The diagram shows that that multiple lesson plans for class teaching are produced from the same curriculum. After classroom teaching, evaluation has to be made.

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                    │   National Curriculum    │
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        │   School Policy and curriculum planning   │
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                    │      Schemes of Work      │
                    │        a. Topics          │
                    │        b. Subjects        │
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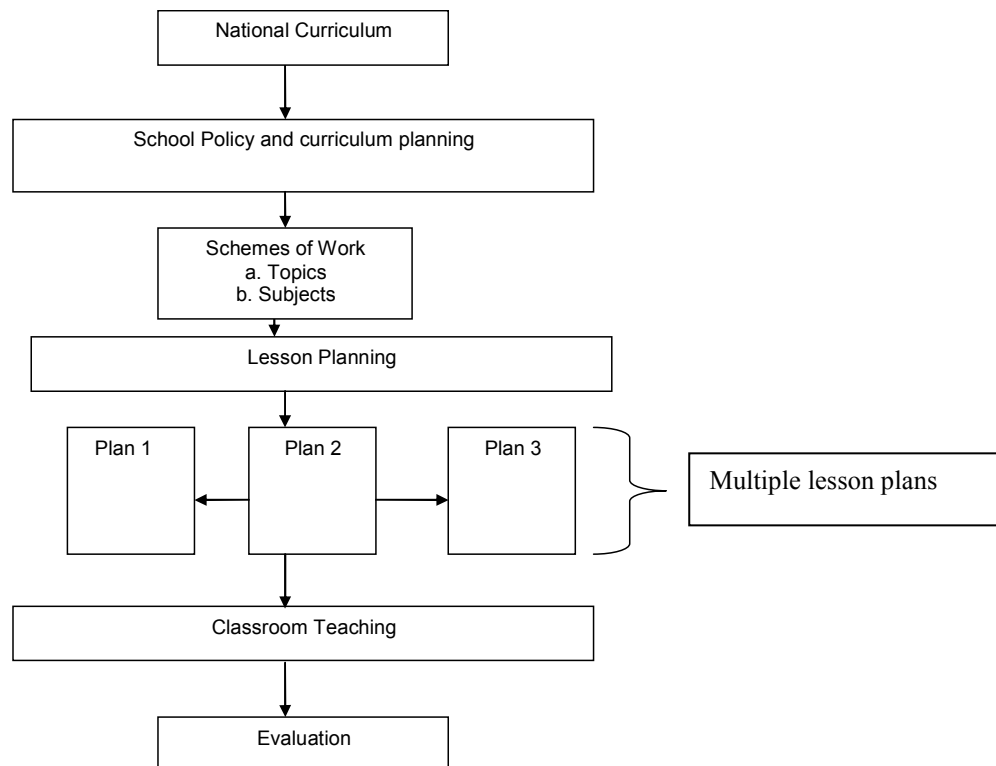
Figure 2.1: Planning and the curriculum (adopted from John, 1993)

The above diagram shows that a variety of lesson plans can be prepared by teachers based on the same curriculum. Some lesson plans might be useful for other teachers and they can be improved continuously if they are shared nationwide.

Common planning sequence of preparing lesson plans was illustrated by John (1993:8) as shown in Figure 2.2. It refers to the National Curriculum and should

have evaluation and reflection, followed by assessment. Before this, lesson plans have to be designed and executed by taking into account the teaching and learning style. A similar flow of lesson preparation is followed by teachers in Malaysia for their teaching session.
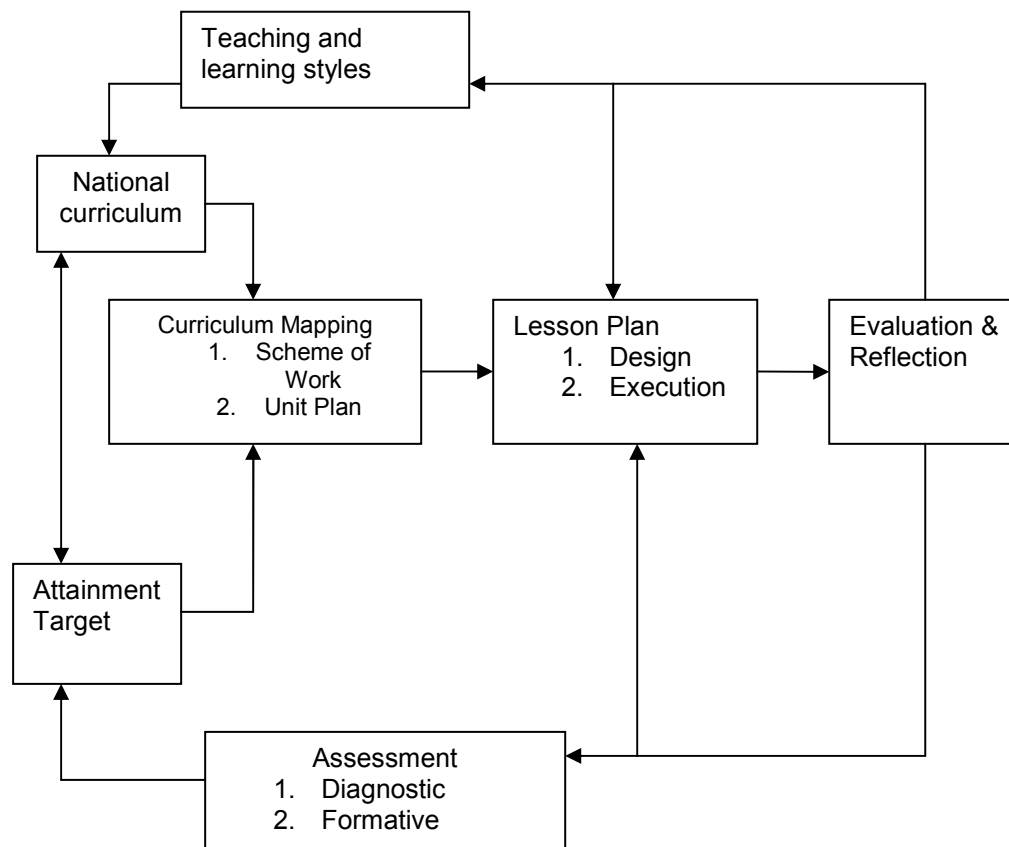
Figure 2.2: The planning sequence (John, 1993: 8)

The Malaysian education system implements almost the same planning sequence for lesson plans. The Malaysian Education Department issues a standard curriculum that has to be implemented by all teachers throughout Malaysia. Evaluation and reflection need to be done after implementing the lesson plans and a more holistic assessment is required afterwards. However, teaching and learning style is never been considered in Malaysian context.

2.4.2 *Lesson Plan Format*

Koszalka et al. (1999) indicates that teachers use a variety of formats and components to create plans that will help them manage their classrooms and create effective learning environments. Lesson plans assist teachers by documenting specific objectives, motivational introductions, outlines or descriptions of the procedures, instructional methods, material and media requirements, assessment and evaluation strategies, summary and closure points, and provisions for student interactions such as assignments or homework (Ornstein (1997) in Koszalka et al. (1999)).

The Malaysian Ministry of Education suggests a lesson plan template that should be followed by all teachers as shown in Figure 2.3.

Class:

Subject:

Learning Area:

Topic:

Learning Outcomes:

Previous Knowledge: Attitudes/ moral values:

Time: Teaching aids:

Skills:

Phase	Content	Teaching and Learning Activities	Remarks
Set			
Step 1			
Step n			
Closure			
Reflection			

Figure 2.3: Suggested Lesson Plan Outline.

Although there are some variations in standardised lesson plan formats by education departments from different countries, they principally have the same elements. Table 2.2 shows some of the similarities and differences in lesson plan elements from Malaysian, British and American lesson plans.

Table 2.2: Comparison of the elements in Malaysian, British and American lesson plans.

(Information taken from http://www.tutor.com.my,
http://www.pgce.soton.ac.uk/IT/Teaching/LessonPlanning/html_lp.htm**,**
http://www.amnestyusa.org/resources/educators/lesson-plans**)**

No.	Items	American	British	Malaysian
1.	Subject	√	√	√
2.	Topic	√	√	√
3.	Lesson author	√		
4.	Year /class	√	√	√
5.	No of pupils		√	√
6.	Skills			√
7.	Scientific attitude & moral value			√
8.	Ability range		√	√
9.	Gender		√	
10.	Time allotted		√	√
11.	Room		√	
12.	Resources	√ (+ materials & technology, web address)	√	√
13.	Short description of lesson	√		
14.	Pre requisite skill	√		√
15.	Curriculum standards met in the lesson	√		
16.	Classroom layout and Grouping of students	√		
17.	Objectives	√ Instructional objectives	√ Literacy & Behavior objectives	√
18.	Outcomes		√ Literacy & Behavior outcome	
19.	Timing of each activity		√	√
20.	Induction set			√
21.	Planned Content/lesson outline	√ (Techniques & activities)	√ (Plus visual, auditory, kinaesthetic column)	√
22.	Adaptation for special learners	√		
23.	Differentiation		√ (Including names of SN pupils)	
24.	Student products	√		
25.	Assessment		√	√
26.	Extension/ Homework	√	√	
27.	Closure			√

The three nations all have subjects, topics, objectives and planned contents in their standard plan format. Resources used for a specific class and year are also

taken into account by all three. This indicates that they are the main elements in a lesson plan. For the British lesson plan, lesson outline is detailed to additional column (visual, auditory and kinaesthetic column) while American and Malaysian lesson plans require teachers to specify activities and techniques.

Time allotted, timing of each activity, room and assessment on the topic being taught are both considered in the British and Malaysian lesson plans. However, the Malaysian and American lesson plan formats require teachers to identify pre-requisite skills.

Short lesson description, curriculum standards met in the lesson, classroom layout and grouping of students are identified attention in lesson plans prepared by American teachers. Requirements for special learners are also taken into account by American teachers. Closure, the last activity in a teaching session, is specified by Malaysian teachers whilst both American and British consider extending the lesson in terms of homework.
Although there are some differences in the elements that have to be prepared by teachers in different countries, elements that are given priority by the American and British might be useful in Malaysian lesson plans.

2.4.3   *Stages of lesson plans preparation*

A lesson plan should be prepared in a sequence of stages because one stage might affect the others. Lang et al. (1994:73) summarise that lesson plans must take into consideration both teaching and learning components. Effective lesson planning begins with identifying instructional objectives in terms of students' performance.

According to Lang et al. (1994), the first step is to choose a topic that relates to a particular instructional unit. Then, lesson objectives are constructed by determining what knowledge, skills, attitudes and value students should acquire as the outcome of the lesson. This is followed by identifying more particulars relating to topic-specific content, student learning and skills objectives and the choice of appropriate presentation strategies. Then, teaching methods, students activities and evaluation techniques should be carried out. Finally, lesson content

has to be planned, taking into account of pre-requisite, the level of difficulties and expected of students' performance. They insist that practical factors that make for successful lesson delivery include pre selecting teaching aids, providing positive set, choosing appropriate teaching methods, arranging for feedback and planning lesson evaluation and closure. However, they state that lesson plans may and should be adjusted 'on the spot' for a good reason.

Lang et al. (1994:56) suggested an approach to lesson planning that stresses the key steps and factors in lesson planning as itemised below:

1. Set: advance organisers or outline or general principles or question

2. Brief description of learning objectives and key concepts

3. Presentation of material in small, organised, sequence steps

4. Frequent checks for student understanding to ensure mastery

5. Closure: review of main points and how they fit together

6. Follow up with questions or provide assignment for understanding and application of learning.

John (1996:10) denotes seven steps of unit planning, starting with selecting the topic based on the US National Curriculum. Step two discusses the long-term objectives, blended with knowledge, skills, understanding, attitudes, abilities, ideals and appreciation. An outline of content coverage is then prepared. This is followed by planning the types of learning activities to be used. Teachers might select the teacher-pupil activities and subject matter from which pupils will learn appropriate knowledge, skills and abilities or select optional activities based on differentiation. Then, teachers should break the scheme down into manageable individual chunks which will form the basis of the lesson plans during teaching of the unit. Afterwards, the necessary materials and resources for the activities should be planned, prepared and secured. Finally, teachers should plan and prepare the necessary assessment, evaluation, materials and exercises.

Dean (1996:17) reports that many lessons start with working on the new material, a revision of what was learnt in the previous occasion, or some investigation of what students already know about the topic. This is followed by work that is planned to help students make the learning their own. At the end of the lesson, teachers monitor how much has been learned. Teachers may wish to end the

lesson with some activities that consolidates the learning. Each of these tasks can be undertaken in a variety of ways. Dean (1996) suggested a checklist of a plan and it is in this sequence; introduction, activity, monitoring and evaluation, summing up and homework.

Dean (1996) suggests the checklist of lesson preparation. The first item is clarity of the objectives for the lessons, followed by students' existing knowledge and experience on the topic, the introduction, the questions, clarity of students' activities and how to set them in action. The teachers should consider whether the lesson plans cater for all student abilities and plan materials for those who finish early. Teachers should ensure that materials and resources are ready to be used. Also, monitoring activities, the closure, and the possibility of homework, needs to be prepared by teachers.

From the above discussion, it can be concluded that generally lesson plan preparation follows specific steps. It starts with objectives formulated by referring to the topics, subjects, skills, abilities, knowledge and attitudes. Appropriate introduction and activities should be planned by teachers depending on the materials and resources available in order to achieve the specified objectives. Finally, it is important to consider assessments and evaluations before reflecting on the lesson plan.

2.4.4 Good versus poor lesson plans

Kizlik (2007) notes that effective lesson plans communicate, whereas ineffective ones do not. He concludes that a key principle in creating a lesson plan is specificity. He implies that teachers create lesson plans to communicate their instructional activities regarding specific subject-matter. Almost all lesson plans developed by teachers contain learning objectives, instructional procedures, the required materials, and some written description of how the students will be evaluated.

Kizlik (2007) also states that in his experience as a teacher and teacher educator, the six main mistakes made by teachers while preparing lesson plans are:

1. Lesson objectives do not specify what the students will do that can be observed.

2. The lesson assessments are disconnected from the behaviour indicated in the objective.

3. The prerequisites are not specified or are inconsistent with what is actually required to succeed with the lessons. Prerequisites mean a statement of what a student needs to know or be able to do to succeed and accomplish the lesson objective.

4. The materials specified in the lessons are extraneous to the actual described learning activities.

5. The instruction in which the teachers will engage is not sufficient for the level of intended student learning.

6. The student activities described in the lesson plan do not contribute in a direct and effective way to the lesson objective.

Lang et al. (1996:99) highlight that in planning lesson delivery, teachers should frame interesting introductions, provide advance organisers, state learning goals clearly and direct students' attention to elements that require special concentration. Besides, new information has to be linked to familiar material. Suspense could be introduced or curiosity might be aroused by building up to a 'punch line' or including an element of surprise.

When preparing lessons, teachers can enhance the quality of the lesson by following certain guidelines (John, 1993:66):

- Communicate clear instructions and expectations.
- Keep pupils adhere to their task as much as possible.
- Ensure that work is appropriate to pupils' needs and abilities.
- Give regular and prompt feedback.
- Relate past learning activities to the present.
- Develop a system of positive and frequent rewards.
- Plan your praise.
- Develop an incentive scheme that rewards without arbitrarily discriminating.

Lang et al. (1994:97) suggest that students' success can be promoted in several ways. Some of them are related to lesson planning and listed below:

- Make sure they are well prepared for tasks of appropriate difficulty.
- Divide learning task into manageable parts.

- Teach students to analyse each task they are set.
- Provide discouraged students with additional help.
- Teach students to backtrack and find the cause of any mistakes they may have made.

2.4.5 *Theories in lesson planning*

Holtrop (2008) indicates that there are several models for lesson plans, such as Bloom's Taxonomy, Multiple Intelligences (Howard Gardner), and Instructional Scaffolding (Jerome Bruner; Langer & Applebee). For Malaysian teachers, Bloom's Taxonomy is the most popular model and is used by teachers in preparing not only their lesson plan but also examination questions.

i.   Bloom Taxonomy

Lang et al. (1994:52) propose that in planning lesson development, three domains that should be taken in account are cognitive, psychomotor and affective (value and attitude). Cognitive is about mental skills or kn o w l e d g e , affective is growth in feelings or emotional areas or a t t i t u d e while psychomotor is manual or physical skills. This is aligning with Bloom's domain of learning described by Atherton (2011) and (Clark, 2006). Soto (1998) mentioned that Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, to increasingly more complex and abstract mental levels and the highest order which is classified as evaluation.

Clark (2006) quotes that Benjamin Bloom lists six major categories of cognitive educational activities, starting with the simplest behaviour to the most complex as shown in Table 2.3. The categories can also be considered as the order of degree of difficulties.

Table 2.3: Cognitive educational activities in Bloom taxonomy (Clark, 2006)

Category	Key Words
Knowledge: Recall data or information.	Defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	Comprehends, converts, defends distinguishes, estimates, explains, extends, generalizes, gives examples, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.
Application: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.	Applies changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves and uses.
Analysis: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	Analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers outlines, relates, selects and separates.
Synthesis: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	Categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
Evaluation: Make judgments about the value of ideas or materials.	Appraises compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes and supports.

According to Holtrop (2007), the key principle in creating a lesson plan is specificity. Holtrop (2007) supports the six levels of Bloom's Taxonomy and Critical Thinking. Figure 2.4 shows an example of a lesson plan based on the model.

- Knowledge - recall
- Comprehension - understand
- Application - use, practice
- Analysis - dissect, generalise
- Synthesis - create, combine

- Evaluation - appraise, value
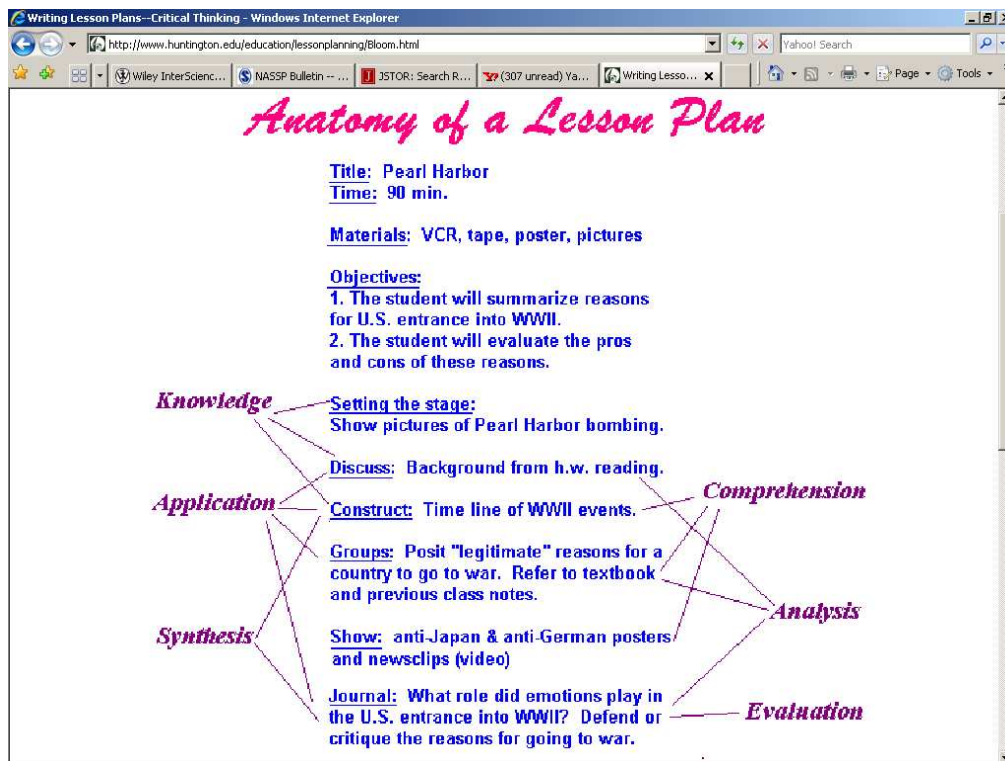
Figure 2.4: Lesson plan based on Bloom taxonomy

ii. Multiple Intelligence

Multiple Intelligences was suggested to be used in planning learning activities. Amstrong (2011) affirms that Dr. Gardner proposes eight different intelligences to account for a broader range of human potential in children and adults. These intelligences are as follows:

- Linguistic intelligence ("word smart")
- Logical-mathematical intelligence ("number/reasoning smart")
- Spatial intelligence ("picture smart")
- Bodily-Kinesthetic intelligence ("body smart")
- Musical intelligence ("music smart")
- Interpersonal intelligence ("people smart")
- Intrapersonal intelligence ("self smart")
- Naturalist intelligence ("nature smart")

Amstrong (2011) insists that the theory of multiple intelligences proposes a major transformation in the way our schools are run. It suggests that teachers be trained to present their lessons in a wide variety of ways using music, cooperative learning, art activities, role play, multimedia, field trips, inner reflection, and much

more. He pronounces that the good news is that the theory of multiple intelligences has grabbed the attention of many educators around the country, and hundreds of schools are currently using its philosophy to redesign the way it educates children. The bad news is that there are thousands of schools still out there that teach in the same old dull way, through dry lectures, and boring worksheets and textbooks. The challenge is to get this information out to many more teachers, school administrators, and others who work with children, so that each child has the opportunity to learn in ways harmonious with their unique minds.

iii.   Gagne 9 commandment.

According to Robert Gagne (1985), there are nine events that activate processes for effective learning. Gagne believes all lessons should include this sequence of events (Clark, 2004). Clark (2004) discusses example of activities for each step in details and simplified as below:

1. Gain attention.

Present a problem or a new situation. Use an "interest device" that grabs the learner's attention. The ideal is to grab the learners' attention so that they will watch and listen, while presenting the learning point.

2. Inform learner of Objective.

This allows the learner's to organize their thoughts and around what they are about to see, hear, and/or do. There is a saying in the training filed to 1) tell them what you're going to tell them, 2) tell them, and 3) tell them what you told them. This cues them and then provides a review which has proven to be effective. e.g. describe the goal of a lesson, state what the learners will be able to accomplish and how they will be able to use the knowledge.

3. Stimulate recall of prior knowledge.

This allows the learners to build on their previous knowledge or skills. Although we are capable of having our "creative" minutes, it is much easier to build on what we already know. e.g. remind the learners of prior knowledge relevant to the current lesson, provide the learners with a framework that helps learning and remembering.

4. Present the material.

Chunk the information to avoid memory overload. Blend the information to aid in information recall. Bloom's Taxonomy and Learning Strategies can be used to help sequence the lesson by helping chunk them into levels of difficulty.

5. Provide guidance for learning.

This is not the presentation of content, but is instructions on how to learn. This is normally simpler and easier than the subject matter or content. It uses a different channel or media to avoid mixing it with the subject matter.

6. Elicit performance.

Practice by letting the learner do something with the newly acquired behavior, skills, or knowledge.

7. Provide feedback.

Show correctness of the learner's response, analyze learner's behavior. This can be a test, quiz, or verbal comments. The feedback needs to be specific, not, "you are doing a good job" Tell them "why" they are doing a good job or provide specific guidance.

8. Assess performance.

Test to determine if the lesson has been learned and also give general progress information.

9. Enhance retention and transfer.

Inform the learner about similar problem situations, provide additional practice, put the learner in a transfer situation, and review the lesson.

In this section, lesson planning and its relation to the curriculum have been examined. All important elements in lesson plans should be identified. Teachers' priority in determining which elements should be considered first and the sequence of determining items should be understood. Other than the listed elements, the constraints faced by teachers in constructing lesson plans should be considered. The proposed lesson plans can follow either Bloom's Taxonomy which covers six levels of knowledge or Gagne's 9 commandments to help teachers to organise their content of lesson. In addition, multiple intelligences

theory which considers various intelligences among students should be considered by teachers in planning learning activities. Furthermore, common mistakes by teachers when constructing lesson plans should be avoided in the proposed lesson plan.

2.5 Constraints to lesson planning

Dean (1996) points out that the better teachers know their students, the more they are able to match work to individual student needs. In addition, he indicates that the good teachers takes every opportunity to get to know students by talking to them outside the classroom and getting to know their background and interests as well as working with them in the classroom.

This is supported by John (1996) who suggests that teachers need specific information about the class to be taught. The age range of the students, timing, motivation and behaviour should be incorporated into consideration. Number of students in a group, class laid out and its justification and how the groups are constructed should also be considered. The groups might be based on ability, friendship, gender or their previous work. It is important for teachers to know student ability where based on banded, group set, streamed or mixed ability as well as composition and friendship. Equipment also needs to be taken into account, regarding their availability, booking requirement and safety precautions.

2.5.1 Lesson planning and learning style

One issue in lesson planning is student learning style. Planning too extensively might neglect student learning issues that arise spontaneously in the class (Shen et al., 2007). Fleming (2001) in Hawk & Shah (2007) defines learning style as "an individual's characteristics and preferred ways of gathering, organizing, and thinking about information". Students learn in diverse ways and that one approach to teaching does not work for every student or even most students.

About 41% of the population who have taken the instrument online to identify their learning style have single style preferences, 27% two preferences, 9% three

and 21% have a preference for all four styles(Fleming (2001) in Hawk & Shah (2007)).

There are a vast number of websites pertaining to learning styles. Support4Learning.org.uk includes learning style in its education section and has links to selected websites that suggest ways of recognising a variety of learning styles and making best use of them. This is because individuals learn best in many different ways, but teachers and trainers may not always present information and learning experiences in a way that best suits individuals.

Generally, everyone perceives the world through the five senses. However, different people rely on each of the senses to varying degrees. We usually have a preference for one or more of the modalities, (mainly auditory, visual, and tactual / kinaesthetic) but can function using others when necessary. Our preferred modes of perception influence our learning styles (Golubtchik, 2007).

McKeachie (1995) believes that thinking about learning styles can lead a teacher to think about different ways of teaching, which is good. He indicates that in the last 30 or 40 years, a number of educators have proposed that teaching would be more effective if teachers took account of differences in students' learning styles. Nonetheless, there are potentially undesirable side effects from the use of learning style concepts. Probably the most serious is that styles are often taken to be fixed, inherited characteristics that limit students' ability to learn in ways that do not fit their learning styles.

In a class where such a mismatch occurs, the students tend to be bored and inattentive, do poorly on tests, get discouraged about the course, and may conclude that they are not good at the subjects in the course and give up (Oxford et al., 1991; Zhenhui 2001).

However, Reid (2005) rejects the claim that in an inclusive classroom it may not be realistic to match every student's learning style so teachers have to consider the importance of ensuring that classroom activities and materials are sufficient to meet a range of styles and assistance should be given to students to ensure that they have an awareness of their own learning style. Brown (2003) discusses

whether an individual's approach to learning can be modified and explains that students have to adjust their cognitive style to do so. Students need to become better all-around learners by investing extra effort in underdeveloped or underutilised styles.

2.5.2 *Teaching style*

Zhenhui (2001) presented two cases of mismatches between teaching and learning styles that caused students to fail their course. In the first case, the student had claimed that she was introverted, analytic and reflective while the teacher has an extroverted, global and impulsive teaching style. The second case revealed a student's negative response to the teacher's style of teaching because they opposed the prevalent teaching style in that particular country.

Brown (2003) quotes that (Miller 2001; Stitt-Gohdes 2003) state that a significant amount of research supports the view that when students' learning preferences match their instructors' teaching styles, student motivation and achievement usually improves. Furthermore, Reid (2005) indicates that teacher perceptions, teaching style and willingness to engage in learning styles as well as help students take charge of their learning are instrumental to the success of learning style teaching. To reduce teacher-student style conflicts, some researchers advocate teaching and learning styles be matched (e.g. Griggs & Dunn, 1984; Smith & Renzulli, 1984; Charkins et al., 1985).

Kumaravadivelu (1991:98) states that: "… the narrower the gaps between teacher intention and learner interpretation, the greater are the chances of achieving desired learning outcomes". There are many indications (e.g. Van Lier, 1996; Breen, 1998) that bridging the gap between teachers' and learners' perceptions play an important role in enabling students to maximise their classroom experience (Zhenhui, 2001). To motivate all learning styles, Reid (2005:92) suggests teachers should incorporate a range of styles that can accommodate visual, auditory, kinaesthetic and tactile learners. He also suggests that teachers should use learning styles at the planning stage.

For a variety of reasons, including previous experience and cultural background, everybody has a preferred learning style and it varies in every group of students. Therefore teachers who vary the presentation of subject matter reach and interest more students. If teachers find some students do not understand, they would try to explain to explain in another way rather than repeating the same explanation again.

2.5.3 Classroom grouping method

Grouping within the classroom is becoming more popular and this has the advantage of allowing the teachers to plan work according to age or ability. Tasks can be planned and set accordingly. However, this approach can be divisive and make a mockery of the mixed ability approach which emphasizes collaborative learning (John, 1993).

Zhenhui (2001) points out that it is always helpful for the teachers to divide the students into groups by learning styles and give them activities based on this for a class made up of students with various learning styles and strategies. According to Zhenhui, this should appeal to the students because they will enjoy the lessons and be successful.

Zhenhui (2001) concludes that no matter how students are grouped, teachers should make a conscious effort to include various learning styles in daily lesson plans. One simple way to do this is to code the lesson plans so that a quick look at the completed plan shows if different learning styles have been included. On the other hand, Dean (1996) focused on grouping based on student ability and for cooperative work. Collaborative work is more effective if groups contain some really able students who are able to give a lead to the thinking of a group.

Dean (1996) believes that ability grouping allows teachers to teach a group at a level that matches the students' ability at any one time. However, he argues that it is easy for ability grouping to become a self-fulfilling prophecy, because students recognise that less is expected of them if they are in a low ability group and perform accordingly. He also quotes Dunne and Bunnet (1990), who suggest that collaborative work is more effective if each group contains some really able

students who can lead the thinking of a group. Mixed gender group is also possible in mixed schools.

2.5.4 *Classroom formation (layout)*

John (1993:62) reports that when planning lessons, the arrangement of furniture should be a major consideration and could influence the overall effectiveness of the lesson. He also suggests that preferred teaching style should be linked to the arrangement. He pointed out three common seating arrangements: clusters, rows & columns and circle. Dean (1996) maintains that grouping affects the arrangement in a classroom. He proposed that a group of five might seem an ideal size but is not easy to arrange when students are normally sitting in pairs.

A classic study by Rosenfield et al. (1985) showed that particular seating arrangements are more conducive to particular teaching and learning strategies. For instance, they recommend that brainstorming and discussion should take place with desks arranged in circles or arches (John, 1993).

2.5.5   *Student ability*

A study (Swing and Peterson, 1982) examined student aptitude and behaviour during small group interactions as mediators of the effectiveness of small group learning. The groups consist of four students with mixed abilities and the study showed they could help themselves by teaching others. High quality interaction must occur if the small group method is as effective as possible.

Teaching mixed ability classes are different from teaching classes which are grouped by ability. Even when there is ability grouping there will be a range of abilities within the class. One form of grouping makes it possible to match work to students of different ability. It is by forming small groups of similar ability or achievement, providing them with work suitable to their ability (Dean, 1996).

John (1993) suggests that teachers accurately diagnose the ability levels of the students and set tasks that are appropriate to their needs amongst other suggestions to help maximise the academic and learning potential of the

students. He maintains that specific information needed about the specific classes to be taught includes ability. Teachers need to identify the range of abilities in the class.

Dean (1996) reports that sometimes teachers are working in a school which works on the basis of mixed ability teaching which requires different approaches to teaching. Kelly (1974:3) comments about mixed ability teaching: "there is no denying that teaching in this kind of situation, although more rewarding, is a much more difficult, demanding and complex job than teaching classes that are relatively homogeneous in term of ability". He argues that another problem for the new teacher is that good mixed ability teaching requires the teacher to know the students well, and this takes time. It may be wise to obtain from other teachers some information about those with serious difficulties.

Sand and Kerry (1982:106) suggest that teachers with mixed ability classes need to be flexible, employing a range of teaching strategies, varying the style and pace of lessons and using a variety of resources (Dean, 1996).

2.5.6 *Previous knowledge*

One of the factors affecting students' learning in science is their existing knowledge prior to instruction. The students' prior knowledge provides an indication of the alternative conceptions as well as the scientific conceptions possessed by them (Hewson, 2006).

Students learn more effectively and remember new information best when they already know something about a content area and when concepts in that area mean something to them. When teachers link new information to the students' prior knowledge, they activate the student's interest and curiosity, and infuse instruction with a sense of purpose. This enables them to connect the curriculum content to their own culture and experience (Kujawa and Huske, 1995).

2.6   Components of lesson plans

Lesson plans are rarely a linear or a fixed process. The important point is that the finished lesson plans should contain all the elements that apply, and all these elements be congruent (fit logically) with one another. However, it is not always possible to rigidly follow the lesson plans that have been prepared. Teachers should be prepared to deviate from a lesson plan for a good reason (Lang et al., 1996:62). They state that there are many types of lessons and many types to organise, but teachers of effective lessons usually cover; induce set, present new information and link it logically to familiar content and end with a statement or event that consolidates the information, summarises learning and points out what students have achieved.

2.6.1 *Choosing topic*

Lang et al. (1994:56) indicates that the first step in preparing a lesson is to choose a topic related to a particular unit. He implies topics can be found in curriculum outlines, students' text, demonstration lessons, films and many more areas.

2.6.2 *Aims and objectives*

Aims are broad statements and are prepared before objectives, while objectives are more specific and can be behavioural or non- behavioural. Behavioural objectives are very specific and describe what students will be able to do and under what conditions and normally involve verb like use, write, list, draw or demonstrate. Non-behavioural objectives are usually expressed in terms of what the teachers do.   The more clearly it is stated, the easier to judge the successfulness of the teaching. However, clear objectives should not prevent teachers from being flexible (Dean, 1996:10).

John (1993:31) quoted the comparison of advantages and disadvantages of objectives in planning by MacDonald-Ross (1973) as shown in Table 2.4.

Table 2.4: Advantages and disadvantages of objectives

Advantages	Disadvantages
Form the basis for a well prepared method of rational planning	Defining objectives too closely at the outset of planning makes the process of planning rigid
Encourage teachers to think and plan detailed specific terms	Laying down objectives too closely can inhibit opportunist learning
Help teacher construct appropriate teaching strategies	Objectives do not help teachers deal with unpredicted classroom events
Provide a rational basis for evaluation and assessment of action and learning	There are an infinite number of pathways through a particular topic and strict adherence to objectives reduces the effectiveness of the design.
	Learning opportunities often emerge during lessons and prescription too early on may blind the teacher
	Objectives are inherently ambiguous and the level of specificity is often problematic
	Trivial and over simplified objectives, which are often the easiest to operationalise may be used too frequently

John (1993) concludes that objectives for both novice and veteran teachers should therefore be approached flexibly as they can vary from the very complex to the simple and straightforward.

2.6.3 *Prerequisites*

Learning only becomes meaningful when the learner has integrated it into what he already knows (Sutton 1981:4 in Dean 1996:28). Lang et al. (1993) comments that objectives are related to pre-requisites and teachers have to identify all prior knowledge or skills in order to learn the content teachers are planning to teach. He proposes that if teachers do not know whether their students already have these skills or knowledge, they should use some form of enquiry or pre-test to determine how basic the lesson introduction should be.

2.6.4 *Introduction*

Dean (1994:10) notes that there are various ways that could be applied by teachers for the introduction, by presenting new material, revising what was learned previously or finding out what students already know about a new topic. In addition, teachers may present new material themselves, ask students to read about it, use work cards, undertake field work, use video, films or radio programmes, invite a visitor with special knowledge, or many other things. Furthermore, sharing aims and objectives is good as they know where teachers intend them to go and what they are going to learn.

(John, 1993:45) points out that the impact of an introduction seeks to open the lesson and teachers should arouse maximum interest in the lesson. It can take a variety of forms ranging from a simple instruction giving phase, linking the previous lesson to the present one or by laying out the aims of the lesson with the key points.

2.6.5 *Selecting content*

John (1993:36) states that an important area of planning is the decisions made about the content of the lessons and selecting appropriate content is a complex and sophisticated skill. The desired outcomes in relation to that knowledge may vary but the content still forms the vehicle for many tasks and activities that teachers set. John (1993:44) lists several criteria that can guide the selection and organisation of the content; validity, significance, balance, interest, utility, accessibility and feasibility.

2.6.6 *Activities*

Research into experienced teachers' planning has shown that the search for activities in relation to resources is high on the list of teachers' planning priorities. Usually teaching activities are related to learning style (John, 1993). Golubtchik (2007) suggests different activities should be carried out based on different

learning styles. The acronym VARK stands for Visual (V), Aural (A), Read/Write (R), and Kinaesthetic (K). VARK is in the category of instructional preference because it deals with perceptual modes. The VARK inventory provides metrics in each of the four perceptual modes, with individuals having preferences for anything from one to all four. Individual students have relative preferences along each of the four perceptual modes but can learn to function in the other modes (Hawk and Shah, 2007).

Hawk & Shah (2007) state that there are differences in learning approaches for the four VARK Learning Styles. Fleming (2001) offers extensive suggestions on classroom approaches for matching teaching styles and learning styles (Hawk & Shah, 2007). Golubtchik (2007) explains how the three types of learning style are more effective and the classroom implications for them. The following table simplifies the differences.

Table 2.5: The Difference of Three Learning Styles. (Adapted from Golubtchik, 2007)

Learning Styles	Kinaesthetic	Auditory	Visual
How students learn	Through their senses. They want to touch, taste, smell, hear and see. They learn by experiencing They build and take part. Muscle memory is important Their muscles can remember as well as their brains. These learners also respond well to interpersonal relationships and remember stories and metaphors. They learn to read using whole words and context clues.	By listening and recall information by hearing it. Like a cassette recorder, they must often go through a tape from the beginning until they locate the information they need. They learn to read phonetically. However, comprehension skills may not be as strong as decoding skills. They pick up languages and accents.	By graphic representation and symbolic abstractions. They learn by taking notes and reading them back. They can picture where information appeared in their texts and go back to it. Successful learners can visualise concepts in their heads.

2.6.7 *Material*

A key aspect of task construction in lesson plans is the production of appropriate resources and a variety of materials and media often mark the success or failure of lessons. John (1993:52) indicates that many lessons are less than successful because inadequate and inappropriate resources have been prepared. He

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stresses that materials and media should be accurate, well laid out, readable, interesting, varies, linked to the objectives and content of the lesson, and used constructively. He suggests teachers list the teaching aids such as overhead projectors, charts, models, maps and texts and student learning material that the plan calls for.

2.6.7 *Resources*

Dean (1996:16) implies that when preparing for a lesson, teachers need to think carefully about the resources they need. The materials used will require specific resources. For example, transparencies need overhead projectors, video needs a video recorder and television set. Computers need the right software and how to get the program started.

2.6.9 *Assessment and evaluation*

When planning the lesson, have your evaluation procedure at the forefront of your mind and the role of evaluation is central to the process of planning (John, 1993:54). Dean (1996: 14, 15) suggests that evaluation and monitoring needs to be both formative, taking place as the lesson proceeds, and summative, assessing the outcomes of the lesson in the form of students' work. In addition, in using students' work to assess their learning, teachers also need to talk to students about their work and ask questions to check whether the real learning has taken place. Talking to a small group of students and gradually moving around the class is another method that could be applied. He points out that a very important part of evaluation is giving feedback to students, individually and collectively. To test what students have learnt, assessments need to be prepared in advance. Worksheets could be given from time to time as teaching reaches completion. This gives teachers a lot of information and is very helpful in planning new work. He also indicates that various suggestions for study and presentation will require different forms of evaluation.

Several types of assessment were outlined by Dean (1996: 145) are; observation, tests and examination, students self and peer assessment and students' assessment of teaching.

2.6.10   *Closure*

Closure is the summation of the lesson and how it relates to future lessons. Dean (1996) implies that closure or summing up the lesson is not essential but sometimes helpful. At the end of the lesson, teachers may want to consolidate what has been learned so that students go away with a clear idea of the work they have covered. Teachers can sum up themselves but it may be better to ask questions to the students (Dean, 1996:16). This gives a starting point for the next lesson.

Lang et al. (1994: 62) suggest that sufficient time for closure (bringing the lesson to a productive end) could leave the students with a sense of satisfaction in what they have accomplished. Homework should ideally grow out of the work in the classroom, and it is important that students are given very clear instructions about it because students cannot ask the teachers when they are working at home (Dean, 1996:16).

2.6.11   Reward

Dean (1996:32) suggests that teachers should be concerned with what motivates students to learn. He claims that students are more likely to be motivated if they feel they have some control over events. Therefore, he implies teachers should involve students from time to time in planning how a piece of work might be carried out, giving them responsibility occasionally and involving them assessing their own work and peers. According to him, it is important that young people feel that they are known and valued as individuals. He notes that praise is very important to us all and teachers need to look for ways of giving genuine praise to all students from time to time for behaviour as well as work.

Many teachers believe that student motivation can be "jump started" by providing tangible rewards such as stickers, candy or prizes. One teacher reported: "I used to use tangible rewards because they had immediate results. Now, instead, I use praise and positive feedback that is sincere, timely, and specific. Many teachers report that they prefer intangible rewards over tangible ones. These teachers provide opportunities for their students to earn points or tokens that can be

exchanged for special privileges. Some examples are free activity time, reading time, computer time, choosing a book to be read to the class, assisting the librarian, extra recess, leading a class game, eating lunch with the teacher, or having their picture taken with the principal. Also timely, sincere verbal comments like, "I notice Ally is sitting down and ready to listen. I appreciate that." Also, written positive comments, such as, "100! Super work! On to division!" also serve to motivate most children. Another example is when a teacher calls a parent to comment on a child's progress. Or, when a class has worked particularly hard on a project, having a surprise popcorn party can serve as a reward that promotes a feeling of classroom community (Davies, 2000).

2.6.12   *Time*

The key to effective planning is to ensure that all your segments, whether they include activities or particular tasks, are carefully timed. When considering the timing it is important for all teachers to keep the pace of the lesson moving according to the ability and sorts of activities that have been set. Some exercises require slow, careful attention, whereas others need speed and accuracy (John, 1996).

2.6.13   *Reflection*

Teachers need to reflect on what has happened in the class as it will help teachers with planning for the next day lesson (Dean 1996:15). It maybe helpful to list the things that went well and those that didn't, and to build on those that went well in order to improve upon those which did not.

2.6.14   *Conclusion of components in lesson planning*

Positive impact of considering learning style in preparing lesson plan for teaching has been shown by previous researches. Therefore, it is important to accommodate students to learn using their learning preference. Such technologies might helps teachers in determining appropriate lesson plan

elements for diverse learning styles as some research stated that teachers are not skilled in learning theory.

Previous research also revealed that grouping students by their learning style shows positive impacts, while the ability is not. Therefore, students might be grouped based on their learning style to accommodate teachers in selecting suitable activities for them. All the important elements in preparing lesson plan should be considered as it contributes to the successful teaching in a classroom.

2.7   Problems regarding lesson preparation

2.7.1 *Lack of time which also lead to stress*

Kelly (1997) reports that one of the most challenging, time consuming and just plain problematic areas facing new teachers is that of instructional planning or the writing of lesson plans. He states that there is perhaps no other single function that a teacher must perform that threatens to take as much time, effort and energy outside the classroom. Koszalka et al. (1999) insist that teachers are busy and have little time to plan and prepare lesson, thus World Wide Web (WWW) is worth resources to teachers.

In Malaysia, teachers' overload workload is not a new issue. Teachers' workload issue was raised by Malaysian National Union of teaching Profession (NUTP) in March 2010 (Dom, 2010). Prior to this, Ministry of Education in 2005 admitted that teachers' workload has increased as they have to handle files and records and write reports besides teaching (Bernama, 2005). It was reported that teachers in four states in Malaysia, Selangor, Melaka, Johor and Kuala Lumpur have excessive workload; 74 hours per week compared to maximum 48 hours, specified by   International Labour Organisation (ILO)(*Sharuddin and Rahim*, 2005). They listed five main works done by teachers other than teaching and the first   task   is   to   manage   data,   files   and   teaching   record   book. In 2008, The Education Ministry was said to give emphasis in resolving the teachers workload issue, which is the main agenda in the second term of the

Education Development Master Plan (PIPP) (Bernama, 2008). The latest, the Education Ministry has set up a committee to look into complaints that teachers are being burdened with too much work. The panel includes representatives from the NUTP (Vasudevan et al., 2010). In 2010, June, the ministry plans to ease teachers' workload with several suggestions (Bernama, 2010).

The PriceWaterHouseCoopers research in 2001 found that teachers' working weeks were more intensive than other professionals and that holiday working was widespread (Bubb, Early, 2004). The School Teachers' Review Body examined the work of teaching and identified several activities undertaken by teachers. The following table shows how much time teachers in the UK spend on each of these aspects every week (Bubb and Early, 2004).

Table 2.6: Average hours worked by full time classroom teachers (STRB, 2003)
(Adopted from Bubb and Early, (2004)).

Activities	Average hours		Percentage of total	
	Primary	Secondary	Primary	Secondary
Total	51.8	50.8	100	100
Teaching	18.6	19.6	36	39
Lesson preparation, marking	12.9	14.8	25	29
Non teaching contact	5.8	6.7	11	13
School/staff management	3.9	2.9	8	6
General administration task	6.1	3.6	12	7
Individual/professional	3.2	2.2	6	4
Other activities	1.2	1.1	2	2

Table 2.6 shows that a quarter of teachers' time is allocated to lesson preparation and marking in primary schools. The percentage in secondary schools is higher with nearly one third of time dedicated to those activities. Bubb and Early (2004) listed five main causes of excessive workload and one of the reasons was planning; including lesson planning. They added that as a consequence of the excessive workload, teachers suffered greater levels of stress than comparable occupational groups.

Evidence about stress amongst the teaching profession is also found in the Northern Ireland Teachers' Health & Wellbeing Survey conducted in 2001. The report notes that the main causes of job related stress were 'having too much work to do' and 'too much administration/paperwork'. Sixty two percent of the respondents also reported that a 'lack of time to prepare lessons' was a cause of unwanted stress (Bubb and Early, 2004).

Many research projects have found that planning and preparation are significant burdens for teachers (Bubb and Early, 2004). Planning is an essential aspect of teachers' work but it is time consuming. All teachers need to plan what they will teach and how they will teach it, but spending excessive amounts of time on long, detailed plans does not necessarily lead to better teaching and learning.

2.7.2 Lack of support tool for sharing

In Malaysian context, it is hard to retain teachers' expertise. Hammond and Ducommun (2007) point out that recognition to expert teachers is perhaps the most fundamental resource to improve student learning. Therefore, they believed that there is growing interest in figuring out how to recruit and retain strong teachers, especially in high-need schools. They claimed that the United States lacks a systematic approach to recruit, prepare, and retain teachers.

However there is no suggestion on how technology might overcome this problem. When teachers leave schools, their knowledge included in lesson planning, will not be kept somewhere to be used by other teachers. In Malaysia, the retirement age for teachers is 56 but some teachers prefer to retire earlier. Generally, at this age, teachers can be considered as an expert with more than 30 years teaching experience including preparing a lesson plan. If their expertise is not retained and stored anywhere, nobody will benefit from it. This shows the importance of teachers' experience and expertise to be retained and managed systematically for the sake of education.

Besides, Dean (1996) implies that teaching is a problem solving activity because teachers are constantly looking at the best way to put over the material they want to teach, dealing with students who pose specific problems, managing with the

resources available and so on. In addition, teachers are continually making decisions; as they become more experienced, they are able to draw on experience as well as their value system to decide how to deal with particular situations, but new teachers have to make decisions about situations by drawing only on their value system and what they have learned. The knowledge of experienced teachers could be profitably shared with novices and for training teachers.

2.7.3 Isolation culture in lesson plan construction

Most of this lesson planning is done in private, a process which led Clark and Yinger (1988) to label it as 'the hidden world of teaching' (John, 1993). The practice of open lesson has implications for helping to overcome the culture of teachers' isolation that prevails in American education (Grossman, Weinberg, and Woolorth 2001; Lortie 1975 in Shen et al. (2007b). An open lesson is a collective effort among teachers from designing to reflecting on the lesson taught. This professional-development activity encompasses a number of activities: (a) someone, usually a teacher gives a lesson to his or her regular class; (b) colleagues – and sometimes researchers and parents – observe the lesson; and (c) the teacher and the observers discuss and reflect upon the lesson. The characteristics of the open lesson include the following: the students are usually the teacher's regular students; the content of the lesson is part of the standardised curriculum; the lesson is usually a demonstration or an exploration; and after the open lesson, there is always a session for collective reflection (Shen et al., 2007b). This approach seems very beneficial to teachers, nevertheless it is impractical in the Malaysian context as time constraint is a major issue for all teachers.

Furthermore, Shen et al. (2007) point out that teachers who remain teaching in public schools may enjoy the individualistic nature of their work. Open Lesson has been suggested as a mechanism to challenge and to overcome the isolated culture of teaching. From designing the lesson to reflecting on the lesson taught, teacher community is a common theme running through the whole process. The example of an open lesson that took place in Jiading District Shanghai has been

elaborated by Shet et al. (2007) by referring to Zhen (2003). The first step in offering the open lesson was that the group of thirteen teachers developed the lesson plan together. This collective approach reduced the pressure on the teacher who gave the lesson. The second step was an instructional rehearsal followed by revising the lesson plan whether it has achieved the instructional objectives. After exploring the strengths and weaknesses of the lesson, the group revised the lesson plan for an in-class open lesson (Shen et al, 2007). This suggests that a medium that supports collaboration among teachers in lesson planning would be beneficial.

2.8 Computer supported lesson planning

The popularity of World-Wide Web has resulted in more and more teachers having access to the Internet from their schools and houses. Since teachers are referring to the same curriculum, a mechanism to enable a greater collaboration among them is seen as crucial. Online lesson plans have great potential to encourage teachers to construct and share knowledge in lesson plan preparation. Shen et al. (2007a) remarks that it is common in China to publish compilations of lesson plans as a resource for teachers. This allows other teachers to examine student responses to a particular lesson's content and methodology.

2.8.1 *Comparison of existing online lesson planning systems*

Koszalka et. al (1999) concluded that the World Wide Web (WWW) is a useful resource for teachers in preparing lesson plans because thousands of lesson plans can be found online. This suggestion arises from the fact that teachers are busy, not only with academic work, but also administrative activities. The power of the WWW is that it offers a vehicle that teachers can use to find and share successful lesson plans.

Various lesson plans can be accessed freely and some must be paid for. They are published by government organisations, educational institution, individual

teachers, as well as profitable companies such as Microsoft Teachers. The purpose, usage and how these websites help teachers all vary. Figure 2.5 is a website that has links to various online lesson plans.
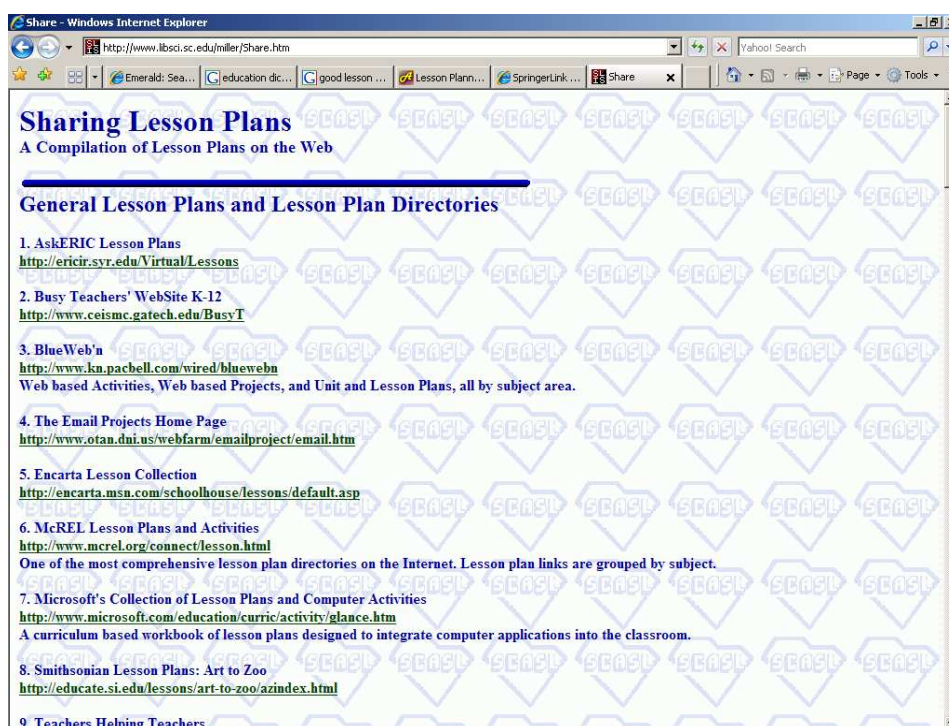

Figure 2.5: A website that has a list of online lesson plan
(http://www.libsci.sc.edu/miller/Share.htm)

Some example sites include teachers.net (http://teachers.net/), HotChalk's *LessonPlansPage.com* (http://www.lessonplanspage.com/) and teachernet community(http://www.teachernet.gov.uk/teachingandlearning/resourcematerials/ Resources/). Three quite comprehensive online resources that focus on helping teachers in preparing lesson plans were analysed and with respect to how they support teachers in developing lesson plans. The sites are INTIME, KITE and lesson planner. These sites were scrutinised in terms of their main purpose, their target users, sharing mechanisms and repository. In addition, other aspects evaluated were their search methods and how they support lesson preparation. Some resources have models which show how the processes of learning take places.

2.8.2 INTIME

INTIME is a well maintained online resource which is based in the US. It is video based and contains a collection of video clips that enable users to find videos by subject. It was sponsored by Preparing Tomorrow's Teachers to Use Technology (PT3) committee, the U.S. Department of Education and can be access by the URL (http://www.intime.uni.edu/casestudies/).

The main purpose of this resource is to help prepare pre-service teachers to effectively integrate technology in their lessons and to aid learning of effective pedagogical techniques. Additionally, these online tools can help in-service teachers upgrade their knowledge of technology integration and revise their lessons and units to improve student learning. INTIME enables educators to watch online video vignettes of PreK-12 teachers from various grades and subjects and shows how to integrate technology into classrooms using numerous teaching strategies. Figure 2.6 shows a webpage of INTIME.

Figure 2.6: A webpage showing a video clip and an associated lesson plan

http://www.intime.uni.edu/video/036iahs/5/

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The team use contemporary technology, high quality conceptual models, online streaming videos, case studies and probing questions analysis to help educators learn the skills necessary for improving student learning. This resource helps teachers through its case study builder which aims at helping teachers to determine which theoretical components and videos are most appropriate for educational purposes. Each video vignette kept in the repository is accompanied by a detailed lesson plan, provided by the teacher featured in the video, a set of probing questions, and a scrolling text. In addition, it allows educators to create a case study by designing an activity using video descriptions available on the InTime site and creates a printable customised handout for their students. Users can find the video according to several keywords such as content area, grade level, learning element, information processing element, pre-service teacher technology, competency, teacher knowledge element, multicultural education element, teacher behaviour element, democracy element, teacher name, state, video title, video code, special area, software and hardware

INTIME takes into account students' characteristics and acknowledges individual differences among students. It mentions that teachers should adjust their practice according to these individual differences based on observation and knowledge of their students' interests, abilities, skills, knowledge, family circumstances, and peer relationships.

2.8.3 *The Knowledge Innovation for Technology in Education (KITE)*

KITE aims at developing a CBR case library in the educational technology integration community. This project was supported by the U.S. Department of Education and aims to assist teachers by providing access to a case library with over 1200 stories of teachers' experiences with technology. The cases are intended to be used by teacher educators, in-service and pre-service teachers. It is a web-based system with teachers as target users. It is free and accessible from; http://kite.missouri.edu/. The homepage is shown in Figure 2.8.

The repository of this system is made up of cases in the form of stories containing what technologies were included in the teaching activity. It gives

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details of how the teachers decided which particular technology to use and what was the overall purpose of the activity. Any difficulties that arose during the activity and how the teacher solved the problem are also being revealed. The teachers discussed their role and the role of students in the activity as to whether they had help from anyone else in conducting a particular activity.

The KITE project worked with a group of seven partner universities to visit schools. The project's members interviewed experienced teachers and organise their experiences as cases in story form. Therefore, teachers might learn from the recorded experiences on how to integrate technology in their teaching based on several elements and adapt their teaching to support them as they learn more about how to use technology in learning situations.

Users can access the cases by using keyword, super search or by browsing them. Queries are possible through teachers' teaching experience, teacher technology experience, skill level, grade level of students subject/unit, kind of school, school location, connectivity, location of technology resource, social economical situation of student, planned level of learning, outcome, sought activities in lesson standards, technologies used in lesson, reason for using technology, nature of activities, help/assistance used and finally role of teacher. The output is a list of matched lesson plans ranked according to other teachers' experience as a percentage; the higher the percentage, the closer the match.

Many other technology integration cases are displayed as a story, rewritten by an outside observer who tells a story of the experience. KITE technology integration cases are transcribed interviews that describe, in the storyteller's own words, the experiences. While this may not seem to be a significant difference, it is the difference between reading about someone's experiences in a book and talking to a colleague who has actually participated in the experience.
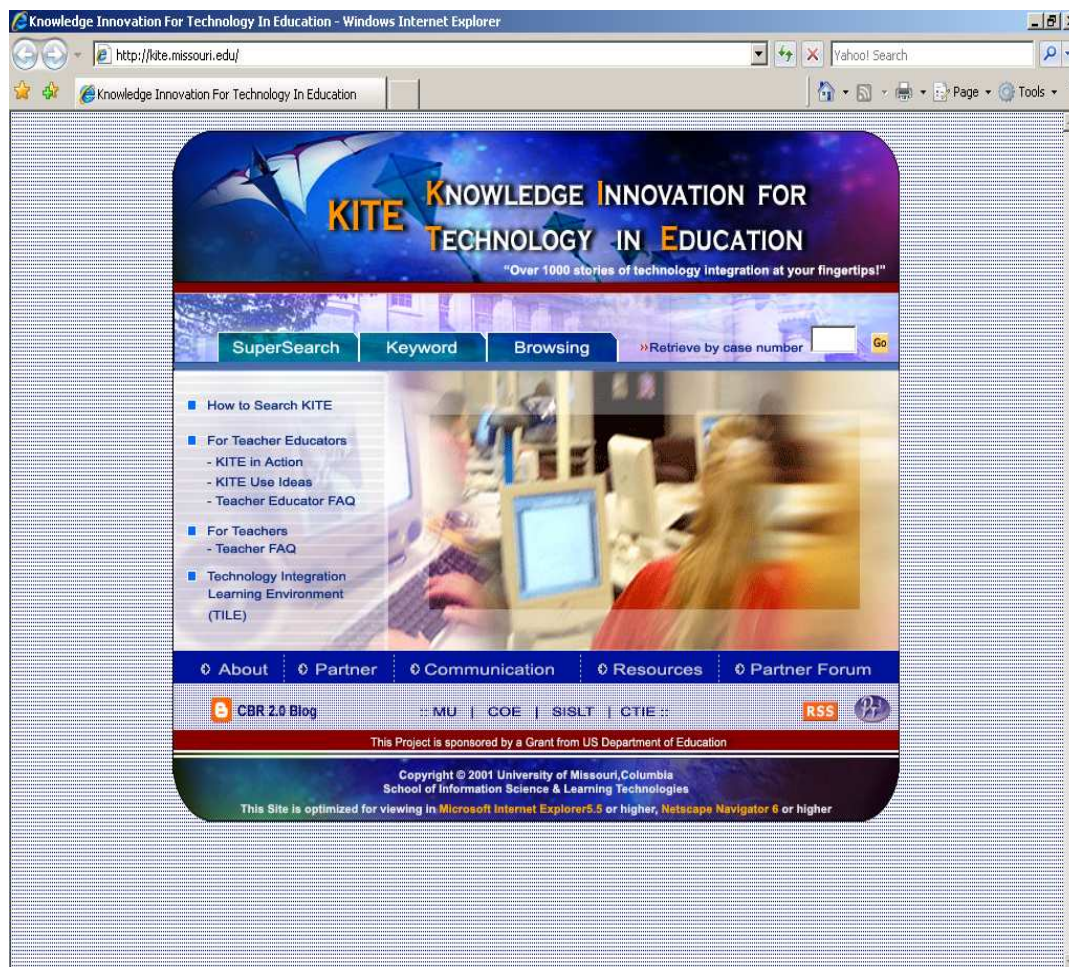
Figure 2.7: The homepage of KITE project

2.8.4 The Lesson Planner

The Lesson Planner, which can be accessed via http://intranet.yorkcollege.ac.uk/yc/lessonplan/, aims at helping pre-service teachers as well as in-service teachers. It is capable of speeding up and creating one's own online lesson plan as well as personalising the templates available to suit a teacher's area requirement. Figure 2.8 shows the homepage of Lesson Planner.

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Figure 2.8: The homepage of Lesson Planner

(http://intranet.yorkcollege.ac.uk/yc/lessonplan/index.html)

This site considers students' profiles as it suggests teachers to present material based on learning style and can also use a mix of styles. Specifically, it considers the main three learning styles; visual (seeing), auditory (hearing) and kinaesthetic (doing), but other intelligences, such as interpersonal, linguistic, intra-personal and logical, are worth bearing in mind too.

Three software tools for lesson preparation which were suggested are Promethean Boards/ActivStudio, Mindgenius and Blackboard. The lesson plan template encompassing Power point, web page (have to install mind map), and promethean board flipchart (need mind genius enterprise education installation). Several activities templates are also available besides a template of activities such as keywords and definitions, visual cues and key points. All teachers need to do is to select materials manually and customise them manually without special query. Table 2.7 summarises the difference of the three discussed resources.

Table 2.7: Comparison of three online resources for lesson plan

Features	Lesson Planner (York)	KITE	INTIME
Source	http://intranet.yorkcollege.ac.uk/yc/lessonplan/	http://kite.missouri.edu/.	http://www.intime.uni.edu/casestudies/
Purpose	To speed up and create own online lesson plan To personalise the templates available here to suit teachers' area's requirements	To develop a CBR case library in the educational technology integration community.	To apply technology in teachers' lessons and units effectively
Target User	Teacher, pre-service teacher	Teachers	Pre-service teachers
Assistance mechanism	Lesson plan template - Power point - web page (have to install) - mind map - promethean board flipchart (Need mind genius enterprise education installation) Template of activities.	Assist teachers by providing access to a case library with over 1200 stories of teachers' experiences with technology. Teachers might learn from the recorded experience on how to integrate technology in their teaching based on several elements and adapt in their teaching	Help to determine which theoretical components and videos are most appropriate for educational purposes. Allows educators to create a case study by designing an activity using video vignettes available on the InTime site and creates a printable customised handout for their students
Sponsor	York college, UK	The U.S. Department of Education	The U.S. Department of Education
Search Method	Select materials manually & customise them manually without special query	Query by: Teaching experience, Teacher technology experience/skill level, Grade Level of Students Subject/Unit, Kind of school, School location, Connectivity, Location of technology resources, Social Economical Situation of Student, Planned Level of learning outcome ,sought, Activities in Lesson, Standards Technologies used in Lesson, Reason for using technology, Nature of activities, Help/Assistance used, Role of Teacher	Search by (1) Content Area, (2) Grade Level, (3) Teacher Name, (4) Particular Element of the Technology as a Facilitator of Quality Education Model. (5) Software or hardware used, and several other categories
Features	Lesson Planner (York)	KITE	INTIME

Weakness	Cannot access previous lesson plans.	No example of lesson plans	Not accurate/ match between the keyword inserted & video presented
Sharing	No sharing from a teacher to another	Teachers experience in term of story collection.	Teachers can make manual suggestion
Repository	-	A collection of stories on how to apply technology in classroom	Video (Each video vignette is accompanied by a detailed lesson plan, provided by the teacher featured in the video, a set of probing questions and a scrolling text.

Lesson Planning System (LPS)

The importance of such tools to support teachers in lesson planning is apparently shown by this payable system which can be accessed from this URL: http://lessonplanningsystem.com/. A subscription to the LPS costs £300 + VAT per year plus £50 + VAT per year for each class set up on the account. The context of the system was set for schools in England, Wales and Northern Ireland based on the National Curriculum in Foundation Stage, Key Stage 1 and Key Stage 2.

LPS is an online system that allows teachers to plan their lessons at any time and place where they have access to an internet connection. According to the owner, LPS is a powerful tool for improving standards in teaching and for providing evidence of lesson planning and assessment. To access LPS the teacher logs on to the system by entering the name of their school, the name of their class and their password. There is no need to install any software on the teacher's computer; LPS resides on the web server. It also means that changes to the system only need to be installed on the server and they become available immediately to all LPS user.

2.9 CBR: Problem solving approach in lesson plan construction

Lesson construction system is a planning system that follows a sequence of activities, starting with a review of the curriculum and ended with writing teaching reflection. Could CBR solve planning system problems, and in what sense it has potential to helps teachers. What are various problems that must be handled in planning should be revealed to avoid. Besides, there is diversity of planning system in other area that can be learnt from.

Planning is the task of producing a series of steps or a schedule for achieving some state of the world. Planning is a problem-solving task that consists of a given domain theory (a set of states and operators) and a problem (an initial state and a set of goals) to obtain a plan (a set of operators and a partial order of execution among them) such that when executed this plan transforms the initial state into a state where all the goals are achieved (Fernandez et al., 2007). Kolodner (1993:34) investigated how the earliest case based planner CHEF created new recipes based on current knowledge about it. It found a single plan from the old recipe that fulfilled as many of its active goals as possible. To satisfy the new goals that it did not cover, it altered and adapted the plans. Some adaptations were done and a set of special purpose modification rules were applied. Afterward, a repairing process was carried out using general planning knowledge.

Several CBR planning systems have been developed for physicians, financial consultants and engineers (Aamodt, E. Plaza (1994). A CBR planning system was also developed to determine dose plans for prostate cancer patients in the City Hospital at the Nottingham University Hospitals NHS. It aided the oncologist in the complex analysis and the calculation of dose plan and provided a good decision aid for less experienced oncologists (Song, 2007).

Case-based planning has grown from a mere application of case-based reasoning to a promising approach to solve planning problems (Spallazi, 2001).

He remarks that the design of a case-based planner usually involves the solution of problems which can be grouped in the following areas:

• *Plan Memory Representation*. This is the issue of deciding what to store and how the memory should be organised in order to retrieve and reuse old plans effectively and efficiently.
• *Plan Retrieval*. This is the issue of retrieving one or more plans which solve problems similar to the current one.
• *Plan Reuse*. This is the issue of reusing (adapting) a retrieved plan in order to satisfy the new problem.
• *Plan Revision*. This is the issue of testing the new plan and repairing it if a failure occurs.
• *Plan Retention*. This is the issue of storing the new plan in order to be useful for future planning. Usually, when the new plan fails, it is stored with the justification of its failure.

According to Watson (1997), CBR application can be broadly classified into two main problems types, classification and synthesis where each task comes in a wide variety of forms. Planning could be considered in either classification or synthesis types depending on the problems they solve. The reuse of travel plans is a classification task while the creation of new plans from elements of old ones is considered a synthesis task.

Schrieber (2008) classifies planning as a synthetic task whose inputs are goals and requirements, and whose output is an action plan. Meanwhile, knowledge related to planning are actions, constraints and preference while the features are actions partially ordered in time. Synthesis tasks attempt to create a new solution by combining parts of previous solutions. They are inherently complex because of the constraints between elements used during synthesis. Schrieber (2008) explains that CBR systems that perform synthesis tasks must make use of adaptation and are usually hybrid systems combining CBR with other techniques.

2.9.1 *The steps in CBR system.*

Many authors emphasise CBR in terms of its cyclical activities rather than its components. Watson (1997:16) explains that CBR starts by retrieving the most similar case(s), reusing the case(s) to attempt to solve the problem, revising the proposed solution if necessary, and retaining the new solution as a part of new case.

While the implementation techniques may vary, most CBR systems include the following five steps in some form or other (Raman, 1995; Watson and Marir, 1994):

- representation where problem storage is handled
- retrieval where the closest-matching precedent is identified
- adaptation where a solution is generated from the retrieved problem
- validation where the accuracy of the solution is verified, and finally
- update, where the database is modified or updated with the information gained from this problem solving process;

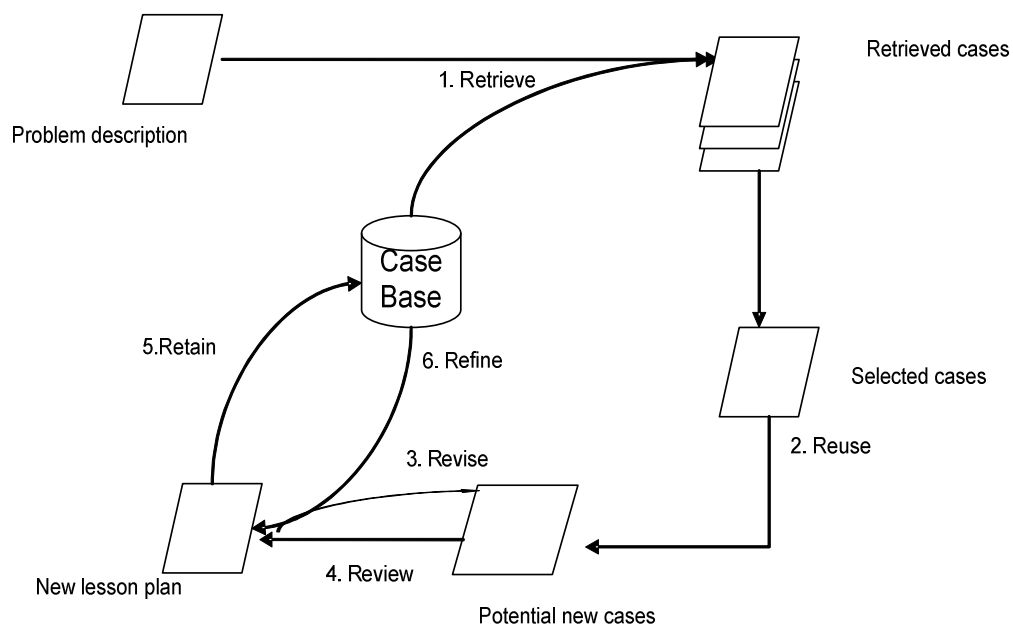Watson (2003) illustrated the CBR cycle as shown in Figure 2.9:

Figure 2.9: The CBR cycle (Watson, 2003)

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Berghofer and Iglezakis (2003) revisit the traditional four step process model and discuss some shortcomings regarding maintenance. Consequently, they extend the four step cycle by the two steps; adding review and restore. Watson (2003) compares CBR techniques for six applications from seven different organisation as shown in Table 2.8.

Table 2.8: The comparison of CBR techniques in seven organizations

Organization	No. of cases	Representation	Retrieval	Revision	Review process
National Semiconductor	200+	Structural	Nearest neighbour	Manually	Yes
General electric	20,000	Flat	Nearest neighbour	Automatically	No (automatic review)
QPAC (aluminium foundry)	200x4	Flat	Nearest neighbour	Manually	No
Deloitte &Touche	200	Flat	Nearest neighbour and induction	n/a	Yes
Analog Devices	n/a	Structural	Nearest neighbour	n/a	n/a
Western Air	19,000	Flat	Nearest neighbour	Manually	Yes semiautomatic

2.9.2 Case Retrieval

The ability to retrieve past experiences is one of the most fundamental aspects of human cognition and is associated with the capacity of learning. The retrieval of relevant cases is crucial for recognition and classification and it plays an important role in scientific reasoning and creativity (Azuaje et al., 2000). They point out three fundamental approaches for the retrieval of relevant cases in CBR namely:

- computational approaches, (based upon measures of similarity)
- representational approaches, (based upon indexing structures)
- hybrid approaches, which combines computational and representational;

Matching and ranking is a procedure in case retrieval that selects which cases are appropriate among the cases in the case library. As the process of searching

the library is done, the search process asks the matching function to compute for the degree of match among indexes. Based on the result of the matches, the search function collects a set of cases that partially match the new situation. The matching cases are then ranked to identify which best address the requirements of the new situation (Reyes and Sison, 2002).

In CBR, the basic processes of solving a new problem or interpreting a new situation entail the retrieval of relevant cases from a memory of cases (case base) followed by the adaptation of the past solution. Given the description of a new problem called the query case, the first, and arguably most crucial step, in a CBR system is to retrieve those cases from the case base that are most relevant to solving the query case.

The key factors affecting the performance of the retrieval mechanism are representation, indexing and similarity metric of parts. A good representation, indexing and similarity metric will enable the system to retrieve the most similar case rapidly and correctly (Chang et al., 2000).

Techniques used in other retrieval systems might be useful in being considered for case retrieval. According to Chang et al. (2003), proper query terms significantly affect the performance of document retrieval systems and can be improved by using query expansion techniques. They present a new method for query expansion based on user relevance feedback techniques for mining additional query terms. According to the user's relevance feedback, the proposed query expansion method calculates the degrees of importance of relevant terms of documents in the document database.

Guha et al. (2003) distinguish two major forms of search: Navigational and Research. In navigational search, the user is using the search engine as a navigation tool to navigate to a particular intended document. On the other hand, in research search, the user provides the search engine with a phrase which is intended to denote an object about which the user is trying to gather/research information.

Rather than using ranking algorithms such as Google's PageRank to predict relevancy, semantic search uses semantics or the science of meaning in language, to produce highly relevant search results. In most cases, the goal is to deliver the information queried by a user rather than have a user sort through a list of loosely related keyword results. Other authors primarily regard semantic search as a set of techniques for retrieving knowledge from richly structured data sources like ontology as found on the Semantic Web.

Boolean searching allows users to narrow down their search by using special terms before the keywords. It's useful because it can help users make sure they do not get thousands of results when they search (BBCi, 2010). Bosswell (2010) explained that Boolean searches allow users to combine words and phrases using the words AND, OR, NOT and NEAR or use their math equivalents to limit, widen, or define search. Clapperton (2010) explains that with Boolean searching users use AND to make sure a keyword is included, AND NOT (ANDNOT, NOT) to make sure a keyword is not included and OR to give alternative keywords.

2.9.3 *Case Adaptation and Reuse*

Case adaptation is crucial in a CBR system as the retrieved cases might not have 100% similarity to users' constraints. In CBR, when an old solution is retrieved, it is reused to solve the new problem. Since each new problem is usually different from previous ones, even slightly, the old plan must be adapted to the new problem, in order to solve it. Adaptation is one of the most difficult tasks in case-based planning and reasoning. As a consequence, reuse is treated very differently in many case-based planning systems (Aamodt and Plaza 1994; Hanney et al. 1996; Jurisica 1993; Kolodner 1993; Kolodner and Leake 1996; Watson 1997 (Spalazzi, 2001). However, Chung (2007) indicates that automatic adaptation is not essential in many applications. In addition, solutions to synthesis tasks like design are difficult to adapt.

Mantaras et al. (2006) indicate that the reuse process in the CBR cycle is responsible for proposing a solution for a new problem from the solutions in the retrieved cases. In the '4 res' of Aamodt & Plaza's (1994) classic CBR cycle, reuse appears second after retrieve and is followed by revise and retain. For adaptation, the task is to recognise when an adaptation should be applied

because the new and retrieved problems are sufficiently different in some relevant way, and to perform some change(s) to the retrieved solution (Craw et al., 2006).

Kolodner (1993) cited by Craw et al. (2006) identify three types of adaptation:

- Substitution - replaces values in the retrieved solution with new values appropriate for the new problem (e.g. changing a house price);
- Transformation - alters the retrieved solution by adding, deleting or replacing parts of the retrieved solution to suit the new problem (e.g. altering steps in a plan);
- Special methods apply specialised heuristic knowledge to repair the retrieved solution, or replay the method used to derive the retrieved solution for the new problem.

Hanney et al. (1995) review a large number of CBR systems to determine when and what sort of adaptation is currently used. Their initial taxonomies show that CBR systems using adaptation are predominantly used when prediction and design is required. It is clear that strong dependencies exist between the adaptation knowledge used, the task to be achieved and the nature of the case solution. Although there are others activities and processes in CBR, the three processes; retrieval, reuse and adaptation were most extensively discussed by many researchers.

Lesson plan construction is a synthesis planning task since it attempts to create a new solution by combining parts of previous solutions. There are very limited CBR planning applications in the education area especially in planning the plan domain.

2.9.4 *Case Revision, Validation and Case Retention*

The revision process is usually performed by people using the retrieved cases as a guide or basis upon which to work. Case revision or adaptation need not be automated (Watson, 2003). Case bases are dynamic. They acquire new knowledge as cases and equally may need to forget old or redundant cases.

Typically this process is done periodically. If refinement process is ignored, the case base's value will degrade with time (Berghofer and Iglezakis, 2001).

Once a new solution has been generated, the outcome of the case should be reviewed. The outcome of the review process is a decision to retain the case as a new case in the case base, or not. This activity provides an explicit way for decisions and their outcome to be reviewed and for the knowledge they contain to be managed (Watson, 2003:42). The review step consists of two tasks: measure and monitor. The review step considers the current state of the knowledge containers and assesses their quality.

The retention process involves adding the case to the case base. Watson (2003) presents approaches to case retention; adding a new record to the database or some pre-processing of the case or acquisition of other supporting information and knowledge required to make the case complete. Cases are retained because they contain valuable knowledge or lesson. Goker and Berghofer (1999) suggest marking those cases as unconfirmed. This approach is applied in validation process of new lesson plans. This is discussed in chapter 6; validation of new lesson plan.

2.10 Conclusions and implications for this research

Preparing lesson plans is a critical part of teachers' daily work as they spend extensive amount of time on lesson planning. Previous research shows the significant burden to teachers that causes of excessive workload and contributes to stress among teachers. Teachers have to consider so many elements in preparing lessons in order to accommodate diversity in the profiles of students , teachers and facilities. Preparing lesson plans is, therefore, a main part of teaching work. Hence, some efforts should be made to help teachers in this significant task so that teachers can be effective in constructing quality lesson plans.

Many researchers have made various suggestions to overcome the problem of lesson planning. Although there are an extensive number of computer supported lesson plan systems (online or standalone), there are a number of limitations of such systems that could be overcome and solved by implementing a system that facilitate teachers in lesson plan preparation work. A computer supported system is aimed to help teachers facing these problems.

Recently, the popularity of the World-Wide Web has resulted in more and more teachers having access to the Internet from their schools and houses. In addition, most schools are equipped with a computer laboratory with Internet access. Since teachers are referring to the same curriculum, a mechanism to enable a greater collaboration among them is seen as crucial. Online lesson plans have great potential to encourage teachers to construct and share knowledge in lesson plans preparation.

Sharing lesson plans, using online resources and modifying existing lesson plans according to needs are some of the suggestions for improvements in this area. However, there are limited mechanisms to support decision making as well as determining suitable lesson plans based on constraints. These limitations could be improved through the implementation of an information system whereby best practice in preparing lesson plans can be shared.

Therefore, a web based system, SmartLP that has CBR features has been implemented to assist teachers in customising lesson plan based on existing cases in the case base. The SmartLP system can be classified as a synthesis type of CBR system, whereby synthesis tasks attempt to create a new solution by combining parts of previous solutions in the adaptation process. The inputs are constraints in the curriculum, students' and facilities, while the outputs are appropriate elements that match constraints in the constructed lesson plan. A research methodology that combines both system development and knowledge acquisition method provides a guideline in this research. The methodology is presented in the next chapter, Chapter 3.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Chapter 3 proposes a research methodology which provides guidance in conducting this research. It integrates knowledge acquisition methodology to gain understanding of various aspects of lesson planning and system development methodology to develop a case-based lesson planning system. The proposed methodology covers methods and tools regarding the objective of the research which is to investigate the effectiveness of a case-based system for lesson plan construction in a Malaysian context. The effects of SmartLP, a case-based lesson planning system focusing on the efficiency of constructing quality lesson plans, were studied and compared to the conventional way in constructing them, in terms of the time taken to construct those lesson plans. This research is a design-demonstration type of research where a prototype system is constructed, tested and evaluated to answer the research questions. Research methodology is discussed in this chapter together with the phases and activities within each phase.

Section 3.2 discusses the research methodology in general. This is followed by Section 3.3 which presents each activity in the identification phase in sequence subsections. The second phase, knowledge analysis, is explained in Section 3.4 together with activities within this phase. System design, implementation and evaluation are presented in Sections 3.5, 3.6 and 3.7 respectively.

3.2 Research Methodology

A hybrid methodology was proposed by the researcher to carry out this research. System development research process introduced by Hasan (2004) was used in conjunction with the one proposed by Nanumaker and Chen (1990) as a base

line for the phases involved this research. It is supported by a modification of CommonKADS, a complete methodological framework for the development of a knowledge-based system (KBS). The new methodology used this research consists of five phases together with several activities within each phase as shown in Table 3.1. Activities within identification phase were mainly referred to 'stages of knowledge acquisition' by Gruber (1989) and CommonKADS. Activities in the following phases; knowledge analysis, system design and system implementation were classified based on CommonKADS and 'sub processes in the CBR software development process' by Bergmann (1998), with major changes to the structure and sequence of activities. The last phase, evaluation was taken from experimental design methodology by Six Sigma (2010).

Table 3.1: The research methodology for a case-based lesson planning system

Phase	Activities
Identification	1. Background analysis 2. State a meaningful research questions 3. Investigate user requirements and systems functionalities 4. Understand and gather knowledge in lesson plans domain via knowledge acquisition
Knowledge Analysis	1. Knowledge representation & modelling 2. Case representation 3. Case acquisition
System Design	Design the system to implement system's functionalities 1. Application (modules) design 2. Architectural design 3. GUI design

System Implementation and Testing	1. Case base development
	2. Retrieval Engine Development
	   • Similarity definition
	   • Similarity characterisation (weighting/ ranking)
	   • Similarity development
	3. GUI development
	4. Case entry into case base
	5. Case adaptation for reuse (Customisation)
	6. Case Revision
	7. Case Validation (for retention)
	8. Test whether the system works

Evaluation	1. Evaluate the impact of using the system in lesson plans construction and users' acceptance of the implemented system
	   • Define the problem and the questions to be addressed/ the population of interest/ the need for sampling.
	   • Define the experimental design.

The idea of information systems development process as a research methodology was popularised by two groups of researchers; Hasan (2004) based on the work by Nunamaker and Chen (1990). Hasan (2004) proposes that due to their distinctive nature, information systems development can be a knowledge creating activity in which those systems relate to emergent knowledge processes (EKP) (Markus et al., 2002) and that in such cases, information systems development is a legitimate research method.

There are four stages of systems development research proposed by Hasan (2004). They are concept design, followed by constructing the architecture of the system, prototyping and finally product development. Hasan proposed that these stages are interactive and dynamic. The research activity is continually influencing these four stages, which means that the boundaries between the stages are blurred. A stage may be continually revisited or, sometimes, one or more may be left out of the process. Nunamaker and Chen (1990) proposed a framework to explain the dual nature of systems development as a research methodology and a research domain in IS research. They suggested five phases in a system development research methodology. It starts with a construction of conceptual framework, followed by developing system architecture. The system then needs to be analysed and designed before being implemented. The final phase is observing and evaluating the system.

The two methodologies above consider all the important activities in system development but give little attention to knowledge acquisition. In developing a case-based system such as SmartLP, knowledge acquisition is crucial, and thus was given priority. Two existing knowledge acquisition methodologies, CommonKADS and knowledge acquisition process by Gruber (1988) were used as guidelines to gain knowledge in lesson plan domain. In addition, the effectiveness of a case based system need to be evaluated and experimental design methodology provide guideline for this purpose. CommonKADS is well documented and derived from Knowledge Acquisition and Documentation Structuring (KADS), a de-facto standard for Expert System specification. Knowledge acquisition tools exist to support the specification of CommonKADS models, and these could be used for capturing knowledge to store in a database.

(Allsopp et al., 2002). Schreiber et al., (1999) affirm that the CommonKADS methods are now in use for purposes other than system development, such as knowledge management, requirements capture, and business process analysis.

According to Milton (2003), there are six phases in CommonKADS. It starts with organisational analysis including problem and opportunity identification. Then, knowledge acquisition (including initial project scoping) needs to be done. This is followed by knowledge analysis and modelling. Analysis of system integration issues have to be handled after capturing user requirements and ending with knowledge system design. Gruber (1989:127) introduced a number of stages of knowledge acquisition with main tasks and the results. The main tasks in sequence are to identify problem characteristics, find concepts to represent knowledge, design structure to organise knowledge, formulate rules to embody knowledge and validate rules that organise knowledge.

3.3   Identification

There are four main activities in the first phase of this research. Gap and limitation of the current situation was identified through the first activity in the first phase, background analysis. A background analysis was undertaken to understand current problems faced by teachers in constructing lesson plans. This stage involves a substantial literature review of previous research published in journals, conference papers and books. In addition, first-hand experience of teachers who teach secondary schools in Malaysia was gathered via a series of interview sessions. From the background analysis, research territory map (RTM) was constructed. The map is shown in Figure 3.1.
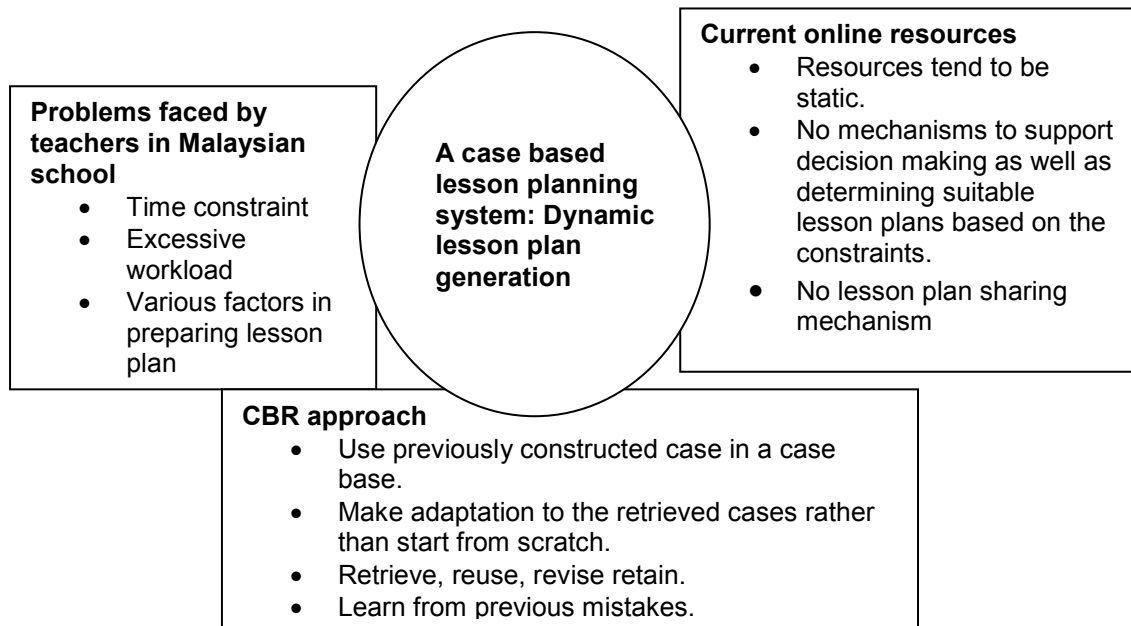
Figure 3.1: The RTM of a Case-Based Lesson Planning research

The RTM provide a basis on which to construct research statement as already given in Chapter 1. The users' system requirements were gathered so that the constructed system will meet the users' needs. In order to acquire knowledge in the domain of lesson plans, knowledge acquisition was performed. This is crucial as the knowledge was modelled to solve problems accordingly. The details of each activity in the first phase are presented in the following subsections.

3.3.1 *Background analysis*

Schools teachers generally face numerous problems and issues in preparing lesson plans. Past research finds that teachers spend a lot of time on lesson planning. Bubb and Early (2004) indicate that a quarter of a teacher's time is allocated toward lesson preparation and marking in primary school. For secondary schools the percentage is even higher, with nearly one third of the time dedicated to those activities.

A survey was conducted in this research to understand teachers' problems and their perspectives on lesson planning. An online questionnaire as attached in Appendix B and can be accessed from this URL,
https://spreadsheets.google.com/ccc?key=0Ajn6VjysEOhldE5aMXIxYS1tVzJ5U WN6Y1huY29neIE&hl=en#

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was distributed to 25 teachers who taught various subjects in a Malaysian secondary school. Most of them were new teachers with less than 5 years teaching experience. The questionnaire consists of different types of questions. Some questions use the Likert scale, which ranks from 1 to 5. The teachers' were asked to express their preferences in carrying out certain processes in lesson planning. Other were true or false questions with a few open-ended question. The questionnaires were analysed using SPSS and the results are reported in Chapter 4.

3.3.2 *State meaningful research questions*

Research questions should be set in the first phase of the proposed methodology by Nunamaker and Chen (1990) and Hasan (2004). Table 3.2 shows the first phase in Nunamaker and Chen (1990); a conceptual framework, in comparison to concept design, the first phase by Hasan (2004). Both stated that research questions needs to be defined in the first phase.

Table 3.2: The first phase Nunamaker and Chen (1990) and Hasan (2004)

	Nunamaker and Chen (1990)	Hasan (2004)
1st Phase	Construct a Conceptual Framework	Concept design
Activities	• State a meaningful research question • Investigate the systems functionalities and requirements. • Understand the systems building processes/procedures. • Study the relevant disciplines for new approaches and ideas.	• An adaptation and amalgamation of current technical and theoretical advances in the area of interest. • The researcher must find, synthesise, use, apply existing knowledge to identify gaps or limitations of existing systems and develop a meaningful research objective. • may involve a substantial literature review. • locating and synthesising existing knowledge

The research questions stated in Chapter 1 were derived from the following overall research statement.

 "Teachers manage to construct quality lesson plans in a shorter time period by using SmartLP, a case-based lesson planning system as compared to manual method."

3.3.3 *Investigate user requirements and system functionalities*

Section C of the questionnaire was used to gain input from teachers regarding the functionalities required and other requirements in a lesson planning system. Their expectations of the system were elicited. User requirement is crucial in order to develop a system that will meet users' expectations and fulfil the objectives specified. The questions regarding this matter were asked in one section: online resources. The results are reported in Chapter 4.

3.3.4 *Understand and gather knowledge in lesson plan domain via knowledge acquisition*

Knowledge acquisition is crucial in building knowledge-based systems (Neches et al., 1999). A major part of knowledge acquisition is capturing knowledge from experts (Milton, 2003).

In this research, knowledge acquisition processes, covering both qualitative and quantitative methods, were carried out. Knowledge acquisition began with data collection strategy which was carried out from July to September 2008 in fifteen Malaysian secondary schools.

The main objectives of data collection are to identify all important elements in lesson plans and rank them, to gather teachers' requirements in the lesson planning system, in order to extract knowledge from teachers on how they decide instances of the elements in preparing lesson plans and to identify the flow of activities teachers apply in preparing lesson plans. The expected deliverable from data acquisition and elicitation are knowledge in lesson plan domain; in terms of elements in lesson plan, how these elements relate to each other and lesson planning sequence. The inputs gathered from this fact finding were used to construct a knowledge model of the lesson plan domain, constructing a knowledge base of teachers' experience in lesson plans preparation as it is a valuable component of a CBR system, particularly in building cases after defining its component, organising and representing the knowledge.

For quantitative methods, surveys were distributed; for qualitative methods, interview sessions, which include teach back technique, were performed with teachers who teach Science and Mathematics subjects from five secondary schools. In addition, a document review was carried out. To involve school teachers in this research official permission was acquired from the State Education Department of Malaysian. Prior to this, the Malaysian Economic Planning Unit (EPU) and the Malaysian Research Department were informed about the research by providing details of the researcher and research project. The schools' management were then contacted to obtain information about the teachers who teach the two subjects, Science and Mathematics. The teachers were contacted and meetings with teachers from the same schools were arranged. In the meeting, the whole research processes that involve them were discussed and explained.

3.3.4.1   Techniques designed to capture knowledge

Milton (2003) listed several knowledge acquisition techniques and the most suitable ones for this research were selected. Protocol Generation techniques (interview, teach back), Protocol Analysis (categories of fundamental knowledge such as concepts, attributes, values, tasks and relationships) and Matrix-based techniques were the most suitable techniques. The results are reported in Chapter 4.

Case Study

The case study involved experienced teachers who taught Science and Mathematics for form two students (age 14) in Malaysian Secondary Schools. The topics which have had not been taught yet were identified and a lesson plan for the selected topic was asked to be prepared by the teachers. The specific aims for the case study are to identify the flow of activities teachers apply in preparing lesson plans and identify all the important elements in lesson plans. Furthermore, it was to extract knowledge from teachers on how they decide instances of the elements in preparing lesson plans in addition to ranking the importance of each element in lesson plans.

Teach Back and Interview

The interview and teach back techniques aim to elicit important knowledge regarding lesson preparation from 15 experienced teachers. Documents related to lesson plans construction were also studied. The teach back technique was used during the interview. In this technique, the researcher elicits knowledge from the teachers by mutual reference to a diagram on paper. The classes and attributes in lesson plans domain that were gathered from preliminary investigation were shown to the teachers to obtain their input and opinion. In addition, part of the knowledge that has been acquired during previous sessions with teachers was described to other teachers.

In laddering techniques, a rough flow of lesson plans preparation that was reviewed in background analysis was presented to the teachers to get their feedback. A comparison of lesson plans elements based on Malaysian, British and American elements guidelines were shown to teachers to elicit their views.

In Matrix-based technique, attributes and value for elements in lesson plan domain were presented to teachers. It is then established as to whether the pairs of attributes and values are correct. Problems in lesson planning together with their possible reasons were also listed using matrix-based technique while sorting techniques were applied in ranking the elements in lesson plan according to their importance for case searching. Prior to this, a graph showing how elements in a lesson plan relate to each other was presented to teachers to get feedback and comments.

Survey

Questionnaires were distributed to 25 teachers after the other fact finding techniques. The results from the interview sessions, observations, and case studies were used as a basis to compile the questionnaire. The survey aims to identify teachers' constraints and factors that influence them in selecting particular elements in lesson planning. It also aims to obtain teachers' input towards preparing lesson plans and whether it could be improved by implementing an *online* case-based lesson planning system. Teachers' requirements for the system and their expectations of online lesson planning

system is crucial in order to develop a computer-assisted system which helps them in preparing lesson plans.

The questionnaire consists of three sections. Part A is about teaching profile, part B is about lesson plans and part C is about perception towards online resources. The questions were structured in various styles. The questionnaire consists of different types of questions. Some questions use the Likert scale, which ranks from 1 to 5. Other were true or false questions with a few open-ended question The questionnaires were analysed using SPSS. The expected knowledge is delivered in the lesson plan domain; elements in a lesson plan, lesson-planning sequence and the importance of each element in lesson. Also, user requirements of the new system were elicited from the results.

Document Review

Documents relating to lesson plans were gathered from teachers and online resources. The curriculum syllabus was gained from teachers. It contains almost all of the important information in constructing lesson plans such as skills, and time period of a particular learning area. Lesson plan books were also shown by teachers to elaborate important elements in a lesson plan.

3.4   Knowledge Analysis

After knowledge elicitation from users, knowledge analysis has to be performed. Milton (2007:14) mentions that knowledge analysis is concerned with identifying elements of knowledge that will be entered into the knowledge base to form its structure and main components.

The main goal of the analysis is to specify complete and detailed requirements of the proposed system. The deliverable from knowledge analysis process is all the main concepts in the lesson plans domain with their details. This is crucial to assure that all related knowledge in lesson planning is modelled appropriately and implemented accordingly in the system.

3.4.1 *Knowledge Representation (KR)*

Various aspects of lesson plan domain should be considered in knowledge representation. Knowledge of lesson plan domain has to be modelled and transformed into some format that works for representing cases. Therefore, elements in a lesson plan were analysed, and how they relate to each other was modelled. There is a wide range of representational formalisms such as frames, semantic nets, rules and relational database techniques or a combination of different knowledge representations.

A semantic net, a labelled, directed graph was used in knowledge representation of lesson plan domain. The structure of a semantic net is shown graphically in terms of nodes and the arcs connecting them. Nodes are often referred to as objects and the arcs as links or edges. Giarratano and Riley (2000) imply that the semantic net is an example of a shallow knowledge structure because all the knowledge is contained in the links and nodes. A deep knowledge structure has causal knowledge that explains why something occurs.

The semantic net was modelled using MS Visio in order to have a good understanding of the problems and constraints faced by teachers. From the semantic model, ontology of lesson plans domain was built in the form of hierarchical taxonomy. It is elaborated in Section 4.6 of Chapter 4, lesson plans ontology construction. Mizoguchi (2007) express that the origin of ontology development is to model the world, while Abdullahi (2007) state that ontology can be represented using many formalism. Schreiber (2008) mentions that ontology provides guidelines for building domain conceptualisation.

The model is crucial for the development of a knowledge base; a valuable component of any CBR system. Subsequently, a case in the proposed system was defined appropriately based on the taxonomy created. The knowledge provides a basis for the system, particularly in building cases in SmartLP System. Urosevic et al. (2006) point out that one problem in knowledge representation consists of how to store and manipulate knowledge in an information system in a formal way, so that it may be used by a mechanism to accomplish a given task.

3.4.2 *Case representation*

Watson (1997) insists that case representation process is one of the most important phases in designing CBR systems. It should contain information that has a direct impact on the outcome or the solution of a problem situation. According to Abdollahi (2007), the first step in building a CBR model is the "Representation of Cases" as well as knowledge. He highlighted four main challenges for case representation:

- Case searching and matching.

- Integrating new cases into the existing memory (model).

- Qualitatively and quantitatively data types to store in cases.

- Organising and indexing cases for effective retrieval and reuse.

SmartLP system which is a kind of knowledge-based system is dependent on the cases stored in a case base. The cases which were acquired from teachers' are stored in a case base; they provide initial solutions to the problems faced by teachers. A case in the lesson plan domain has to be represented as database tables, as it is the most important part of CBR systems especially for the very first activity in CBR after knowledge acquisition.

Case representation which consists of problem description and solution is discussed in Chapter 4. Kolodner (1993:80) discussed some case-based planners such as CASEY and PROTO that use attribute-value representations, besides other variety of notations. There are various representations and the one that is appropriate to serve the objectives of SmartLP is the attribute-value representation. The implemented representation influences case retrieval and adaptation, the two important processes in a case-based system.

CBR components

A case in CBR is composed of three major parts; problem or situation description, solution and outcome. The goals to be achieved in solving the problem can be diagnose, create and plan accompanied by the sub goals of the reasoning process such as remember, adapt and decompose. Constraints on those goals are conditions put on goals. Each time it has different constraints, it has to be modified so that the result will be attained. Features of the problem situation are the catchall that holds any other descriptive information about the situation relevant to achieving the situations' goal (Kolodner, 1993). Watson (2003) points

out the similar components of a case by combining both solution and outcome as another component beside problem description. The components of a case in SmartLP system, the goals and constraints are discussed in Chapter 4, Knowledge Representation and Modelling.

3.5 System Design

The design model aims to support choosing case representations and programming techniques in the implementation phase. In this research, SmartLP was designed in the third phase. Knowledge in lesson plan domain that was analysed in the second phase is essential in this phase.

Hasan (2004), proposed the stages of systems development research and s/he considered system design in the second phase, constructing the architecture of the system. Here, the researcher engages in the creative and innovative design activity of architecture development, defining components, models, algorithms and data structures. On the other hand, Nanumaker and Chen (1990), established design activity in the second and third phase of their proposed research methodology. The second phase is to develop system architecture. Here, unique architecture designs for extendibility and modularity need to be developed. Furthermore, functionalities of systems components and interrelationships among them should be defined. This is followed by the third phase, which is to analyse and design the system. The database/knowledge base schema and processes to carry out systems functions should be designed. Alternative solutions are considered and one solution is chosen.

Many researchers suggest several designs processes in this phase. In SmartLP application design, architectural design and user interface design were chosen. They are discussed extensively in Chapter 5, System Design.

3.6 System Implementation

Hasan (2004) defined system development in the fourth and fifth phase; prototyping phase and product development. Prototyping is the stage where proof of concept is often used to demonstrate that a system can be built based on the results of the previous stage. According to Hasan (2004), this may be done with a single working prototype or involve the iterative analysis, design and implementation of an evolving prototype. Learning occurs through the evolutionary system building process where insight is gained about the problem and the complexity of the system. Nanumaker and Chen (1990) proposed prototyping as a method of learning about the concepts, framework, and design through the systems building process. They claim that this is an opportunity to gain insights about the problems and complexity of the system.

An evolutionary prototyping approach was used to develop the different components of the SmartLP system. This is followed by system integration and this system evolves into the final product. According to Dawson (2009), the evolutionary approach is much more defined than the build-and-fix approach whereby an initial specification for the system must be investigated and produced, and the process must follow a planned series of releases (evolutions). Hasan (2004) affirms that the evolutionary prototyping development process includes regular expert/user evaluation feeding back into the systems development process. The phase is followed by prototyping where here it is possible to freeze and formalise the systems specifications to build, test and evaluate a robust system. At this stage it may be possible to evaluate the use of the system with case and field studies or laboratory experiments, consolidating experiences learnt.

Implementation of a system is important to demonstrate the feasibility of the design and the usability of the functionalities defined. Knowledge in lesson plans domain that was modelled and system that was designed were implemented in the system development phase. The tasks in the development phase follow the one proposed by Bergmann and Althoff (1998) with some modifications. The tasks are GUI development, and CBR engine development which consists of similarity definition and case-base development.

System functionalities and user interfaces that were designed in the previous phase were implemented. Case base that contains cases that were collected are

entered into the case base and used as initial solutions to the problem specified by users.

Retrieval engine for five types of search in SmartLP, Advanced search, Hierarchical, Basic, Boolean and Browsing were programmed. The different types of search were implemented to support the users. The next processes in the CBR cycle after retrieval: reuse was implemented via case customisation, followed by case revision and case validation for retention in the case base. The implementation of SmartLP plan which was devised according to the different steps of CBR system – retrieve, reuse, review, refine, revise and retain – was explained in Chapter 6, System Implementation. Solving problems in this system involves obtaining a problem description and making suggestions to assist teachers in constructing lesson plans through CBR cycle.

3.7   Evaluation

The final phase which is the evaluation stage aims to evaluate the implemented system in several aspects. Nunamaker and Chen (1990) listed system evaluation as the fifth (final) stage in Research Process of Systems Development Research Methodology. Hasan (2004) recommended the evaluation to be carried out as the last activities in product development phase. At this stage it may be possible to evaluate the use of the system with case and field studies or laboratory experiments, consolidating experiences learnt and even developing new theories of use. This may feed back into a new research cycle.

According to Gu and Aamodt (2006), the ideal evaluation method among various evaluation methods for intelligent systems is statistical evaluation. It involves executing the constructed system in different task environments in order to investigate its performance in different application.

The evaluation of the SmartLP system applies both quantitative and qualitative approach and consists of two main techniques which are experiment and interview. Multiple methods were used because it permits a wider and more complete understanding of the phenomenon studied. This is particularly important

because each data collection method is limited as to what it can measure effectively. The quality of data is also enhanced because triangulation is possible.

A formative study, involving a small sample of in-service teachers, was performed to assess the acceptance and effects of SmartLP in assisting teachers in lesson plans construction. The overall objectives of system evaluation are to assess whether the user's needs are met, the system is suitable for the tasks and users perform better with the implemented system. The process of evaluation and the results are discussed in Chapter 7.

The experiment aims to compare the lesson plans produced under two different groups, experimental and control group. In addition, lesson plans constructed under three different situations with different match was set up for the experimental group. Prior to this, the time taken to construct those three lesson plans independently (control group) is measured. This is essential to ensure they are within the same level of difficulties. This is important in measuring the time taken to construct lesson plans with different match. The details are given in Chapter 7. These tasks were followed by interview sessions. By conducting interviews, first-hand experience in using SmartLP can be acquired. The interview sessions were handled by telephone call after the experiment took place and the participants' responses were recorded, and transcribed. Results from the interview support the finding in the experiment.

3.7.1 *Types of evaluation*

Evaluation of SmartLP applied the experimental design methodology. Experimental design methodology is one of the most powerful methods for evaluating the implementation of software systems (Dix et al., 2004). It involves an experiment which provides empirical evidence to support a claim or hypothesis. The evaluator chooses a hypothesis to test which can be determined by measuring some attribute of subject behaviour. A number of experimental conditions are considered which differ only in the values of certain controlled variables. Any changes in the behavioural measures are attributed to the different conditions. For a reliable experiment, Dix et al., (2004) recommends careful

consideration of a number of factors namely: choice of subjects, variables to test and manipulated and the hypothesis to test.

Subjects

Dix et al. (2004) imply that the choice of subjects needs to match the expected user population as closely as possible. It is better to that the test experiment be done on actual users with a similar age group, level of education, experience with computers and the system being tested as well as their experience or knowledge of the task domain. Moreover, the sample size chosen should be large enough to be considered representative of the population taking into account the design of the experiment and the statistical methods chosen. As a rough guide, Dix et al. (2004) recommends a sample size of at least 10 subjects. Other usability studies have recommended 4 to 5 users such as Nielsen (2006).

Variables

Experiments manipulate and measure variables under controlled conditions. There are two types of variables; those that are manipulated called independent variables and those that are measured called dependent variables. Independent variables are characteristics of the experiment which are manipulated to produce different conditions for comparison such as criteria of a lesson plan. On the other hand, dependent variables are the variables which can be measured in an experiment (Dix et al, 2004).

Hypothesis

Hypothesis is framed in terms of the independent and dependent variables forecasting that a variation in the independent variable will cause a difference in the dependent variable. Prediction of the outcome of an experiment is that the hypothesis is correct. After ascertaining the subjects, variables and the hypothesis, the next stage is to decide on the experimental method to use (Baguma, 2010).

Two main methods, between groups and within groups are applied in the evaluation. In the between groups method, each subject is assigned a different

condition – that is either the experimental condition in which the variable has been manipulated or the control condition which is identical to the experimental condition except for the manipulation. This is aimed at ensuring that it is the manipulation which is responsible for any differences which are measured.

The primary aim of evaluating the implementation of the framework was to find out if the system was adequate to assist teachers in constructing a lesson plan as compared to that of manual method. The variables used to measure efficiency were the rating of time taken to construct lesson plans and if the constructed lesson plans were within satisfactory level.

The test subjects included 10 new ICT teachers as the prototype was implemented for this subject. This exceeded the minimum 5 recommended by research studies on sample size for usability evaluation studies discussed above. Moreover for usability studies involving multiple groups of disparate users like this one, Nielsen (2000) recommends 3-4 users from each category.

The nulls hypotheses are, there is no significant difference across the group in times taken to construct the lesson plans. The independent variables are the tasks with different match criteria. The dependent variables were: the rating of time taken to construct lesson plans and the quality of the constructed lesson plans. The details of subjects, variable and hypothesis are described in Chapter 7, evaluation.

3.7.2 *Analysis of the experiment*

Analyses of the results from the evaluation of SmartLP implementation were done using SPSS, a statistical computer package. It is a powerful computer program which is capable of a wide variety of statistical analysis and is the standard statistical package used by governments, business and academia (Cook, 1993). *SPSS* was used to calculate if there was a significant difference between the time taken to complete tasks across the groups as well as the quality of the constructed lesson plans.

The Wilcoxon Mann-Whitney Test, a nonparametric test for comparing two populations was used to test the null hypothesis that two populations have identical distribution functions against the alternative hypothesis that the two distribution functions differ only with respect to location (median), if at all. The Wilcoxon Mann-Whitney test does not require the assumption that the differences between the two samples are normally distributed. This test can also be applied when the observations in a sample of data are ranks, that is, ordinal data rather than direct measurements. In this test the results of the two samples are combined and arranged in order of increasing size and given a rank number. In cases where equal results occur the mean of the available rank numbers is assigned. The rank sum R of the smaller sample is now found. Let N denote the size of the combined samples and n denote the size of the smaller sample. A second quantity, R_1= n (N+1) – R is calculated. The values of R_1 and R are compared with a critical value. If either R or R_1 are less than the critical value the null hypothesis of the same mean would be rejected (Kanji, 1993). The results of analyses were discussed in Chapter 7, evaluation.

3.8 Conclusion

The research methodology discussed in this chapter provides a guide to conduct this research. Knowledge in lesson plan domain was acquired, followed by a development of a case-based lesson planning system, SmartLP system, before the evaluation takes place. Information systems development process as a research methodology that was popularised by two groups of researchers, Hasan (2004) and Nunamaker and Chen (1990), together with the combination and modification of CommonKADS and Gruber's knowledge acquisition stage provide a systematic guideline in this research. Each phase has to be carried out in sequence but iterative because the output and deliverables from one phase will be used as input to the following phase. The knowledge of the lesson plan domain that was acquired in knowledge acquisition process were modelled in the following chapter, knowledge representation and modelling.

CHAPTER 4

FINDINGS: KNOWLEDGE REPRESENTATION & MODELLING

4.1 Introduction

This chapter discusses the second phase of this research; knowledge analysis, which presents findings from knowledge acquisition about concepts and approach surrounding lesson planning in a Malaysian context. The main goal of knowledge analysis is to specify complete and detailed requirements of the proposed system. This is accomplished by working closely with current and future system users and by careful study of existing documents (lesson plans format, curriculum syllabus). Prior to this, background analysis was undertaken to understand teachers' problems with regards to lesson planning. In addition, user requirements and system functionalities of SmartLP system need to be investigated. Therefore knowledge in lesson plans also has to be understood.

The deliverability of knowledge analysis is the finding of knowledge in lesson plans domain and includes important concepts, important elements and knowledge required for system development. The modelled knowledge is presented as cases, followed by case acquisition that is stored afterwards in a case base for retrieval. Section 4.2 discusses the background analysis including teachers' current practice in lesson plans construction, teachers' perspectives regarding lesson planning and problems in preparing lesson plans. Users' requirement and system functionalities are discussed in Section 4.3. This is followed by knowledge requirement in lesson planning in Section 4.4. This section encompasses a discussion about elements in lesson plans, criteria of a quality lesson plan, lesson plan model and flow in preparing lesson plans. A semantic network of elements in lesson is discussed in Section 4.5 while plans lesson plan ontology is presented in Section 4.6. In Section 4.7 case representation, which discusses case definition, attribute-value representation and indexing, is presented.

4.2   Background Analysis

As discussed in Chapter 2, teachers in school generally face numerous problems and issues in preparing lesson plans. Teachers are busy, not only with teaching and learning activities, but also administration work, co-curricular activities and invigilating exams. Thus a mechanism to assist teachers in this task is essential.

A study of several online lesson plans was undertaken and evaluated. From the background analysis, it was found that currently there are limited mechanisms to support teachers in constructing lesson plans based on various constraints. Therefore, a suggestion has been made to assist teachers in constructing quality lesson plans effectively through an implementation of a dynamic web-based information system. From the findings, several suggestions were made to maximise the potential of online resources by making them flexible with considering students' and teachers' profiles. It was discovered that most online lesson plans appear to be aimed at pre-service teachers and are primarily concerned with integrating technology into teaching. Findings from the analysis of online resources show that users' contributions to current lesson planning systems are limited and resources tend to be somewhat static. There are no mechanisms to support decision-making as well as determining suitable lesson plans based on various constraints in students, curriculum and facilities.

A survey was conducted to understand teachers' problems and their perspectives towards lesson planning. This is supported by interview sessions with 10 experienced teachers. A questionnaire was distributed to 25 teachers who taught various subjects in a Malaysian secondary school. A total of 80% of them were between 20 and 30 years old with less than 5 years experience. There were 12 % between 31 and 40, and 8% between 41 and 50. The overall objectives of the survey are discussed in Chapter 3.

4.2.1 *Teachers Practice in Lesson Plan Construction*

Some questions were outlined to establish teachers' current practice in constructing lesson plans. From the results analysed, it was found that of the 25 respondents, 76% indicated that lesson planning is time consuming. In addition, the study revealed that 84% of the respondents prepare their lesson plans individually as opposed to collectively. At the same time, 72% of teachers prepare different lesson plans (including the elements within them) for different classes. Say for example teachers spend around 50% of their time on teaching, 67% of the respondents allocated more than 25% of their time preparing lesson plans. Unsurprisingly, all the respondents refer to the reflections of their previous lesson plans to plan for future lessons. This indicates that previous implemented lesson plans are key to lesson plan construction. Thus, such a system based on CBR concept to assist teachers in constructing lesson plans seems essential.

In order to implement this kind of system, several aspects in preparing lesson plans need to be acquired. Thus, several interview sessions were handled. Based on interview sessions with the teachers, it was found that lesson plans are constructed based on students' ability. Learning style, teaching style and students' motivation had never been a consideration by teachers in constructing lesson plans. Teachers imply that in general, students with a good ability are highly motivated compared to those with lower ability. However there are isolated cases where poor ability students have high motivation.

Currently, school administration is required to keep records of the students' background. However, teachers imply that in lesson planning it is difficult to consider the socio-economic background of each student because the number of students ranges from 25 to 40 in each class. Furthermore, a teacher normally teaches various subjects to more than one class. Although there is a lot of discussion about learning activities matching the teaching style and learning style, it has never been highlighted in the Malaysian context. Teachers do not even know their own teaching style, so are unlikely to be able to identify the learning styles of the 25-40 students in their class. Therefore, in a Malaysian context, these factors – socio economic background, teaching style and learning style – are not of major concern when compared to other countries like the UK

and the US. However, teachers are looking forward to learning of other approaches that might improve lesson plan construction and ultimately improve the teaching and learning process. Teachers in Malaysia are more familiar with these three educational theories: Bloom's taxonomy in lesson plan content, Gagne's nine steps in instructional design, and multiple intelligence in teaching and learning activities. These theories are said to correspond to cognitive processes that can be used to support learning.

Although the grouping method for learning activities is implemented in teaching and learning sessions, it is not written in the lesson plan book. Most teachers state that the idea of good students helping weak students is not really practical. That is why the majority of schools have class streaming based on the students' ability. Teachers indicate that students tend to work with their friends at the same level. Rewards are normally planned for the learning session but are infrequently written into the lesson plans.

4.2.2 *Teachers' perspectives regarding lesson planning*

Part C of the same survey collected information about teachers' perspectives regarding lesson planning. A total of 96% teachers, 24 out of 25 respondents agreed that daily lesson planning is the key aspect in the process of teaching. A total of 92% of respondents agreed that the success of teaching depends on the preparation made. Not less than 68% of them admitted that lesson plans are crucial at the beginning of a teaching career. None of the respondents thought that lesson planning is unimportant in assuring the success of teaching. The results show that lesson planning allows teachers to explore multiple aspects of pedagogical content knowledge, as acknowledged by 80% of the respondents.

More than half of the respondents (72%) confirmed that lesson planning is important throughout their teaching career, not only during pre-service and early teaching. A total of 88% of the respondents agreed that if teachers plan appropriately in terms of teaching activities, the class could be controlled. Thus, teaching and students can be managed effectively.

From the interview sessions, the teachers insist that lesson plans are not sufficiently detailed during their training but it remains important. It was stated that lessons plans give confidence to teachers to deliver their teaching and manage to avoid chaos in class management. Although the lesson plans are simple, they have to be prepared and submitted to the school principle to be checked.

4.2.3 *Problems in Lesson Planning*

From the literature review and background analysis, problems faced by teachers in preparing lesson plans were identified. The possible reasons were analysed from interviews, a document review and analysis from the literature review as listed in Table 4.1.

Table 4.1: Problems faced by teachers and possible reasons

	Problem	Possible reason
1	Objectives are not achieved	1. Objectives were not planned based on students' ability and students' previous knowledge. 2. The objectives were not explicit (do not specify what the student will do, that can be observed). 3. Content/learning activities were not planned to achieve the objectives stated. 4. Enrichment did not match the content to support the objectives of the lesson. 5. Time period of the lesson was not taken into account in determining the objectives to be implemented. 6. Assessment was not suitable to test the objectives.
2	Time constraint	1. Time for each step in the lesson plans was not flexible and reasonable. 2. Time for each activity is not diverse according to students' ability.
3	Introduction	1. Students' ability, previous knowledge and motivation were not taken into account in outlining the introduction. 2. Introduction was not interesting enough to attract students' attention to the lesson.
4	Learning Activity	1. Student activities described in the lesson plan did not contribute in a direct and effective way to the lesson objective.

		2. The learning activities were not planned base on students' ability and motivation.
		3. The planned activities did not involve all the students.
		4. Clear instructions were not given according to the students' ability.
		5. The materials (teaching aids) were not sufficient and appropriate.
		6. The resources were not enough and suitable.
		7. Time to carry out the activity was not enough and appropriate.
		8. Group size was not appropriate.
		9. Reward was not reasonable.
		10. The skills/ attitude value to be achieved did not match.
		11. The instruction in which the teachers engaged was not sufficient for the level of intended student learning.
5	**Enrichment**	1. The enrichment did not reinforce the concept and main points of the lesson.
6	**Assessment**	1. The assessment mechanisms did not test all the objectives listed and did not match students' ability.
7	**Closure**	1. The closure did not summarise and conclude lesson content.
		2. The closure does not relate the current topic to the next topic
8	**Material**	1. The materials specified in the lessons are extraneous to the actual described learning activities.
9	**Pre-requisite**	The prerequisites are not specified or are inconsistent with what is actually required to succeed with the lessons.

4.3   User requirements and system functionalities

The survey was also investigated user requirements towards the system and expected functionalities of the system. From the results analysed, it was found that 80% of the respondents have used online resources to construct their lesson plans and this shows that almost all teachers have experience in using online resources for lesson planning. On the other hand, 68% respondents did not know of any mechanism to share lesson plans among Malaysian teachers or worldwide. In spite of this, 96% of respondents had a positive attitude towards web-based systems in lesson plans construction.

In addition, teachers were given some choices of the final output from the lesson planning system that would assist them in constructing lesson plans such as videos for successfully implemented lesson plans, stories on how teachers implement the lesson plans and text-based (current style in manual process). Text-based format of successfully implemented lesson plans leads the rest which was preferred by 64% of the respondents.

A lesson planning system that manages to retrieve previously implemented lesson plans and teaching materials is more valuable to teachers than just a system which explains how to integrate technology in teaching, as offered by some online lesson planning systems. Furthermore, the system should be dynamic, whereby the users can interact with and change the elements of the retrieved lesson plans, not only able to be viewed and printed. The system should be made available on a 24/7 basis. Therefore, SmartLP allows users, not only to retrieve previous implemented lesson plans by other teachers on the Internet, but also to generate their own lesson plans based on multiple lesson plans with access to all related materials and teaching aids.

4.4 Knowledge Requirement in Lesson Planning

Knowledge acquisition strengthening the facts gathered in background analysis. Crucial knowledge in lesson planning that was gathered from the acquisition phase is analysed. They are then modelled using several tools such as Ms Visio in order to have a good understanding of the problems and constraints among teachers. Moreover, teachers' requirement of the systems and the kind of explanation that would be useful to the end users are used to design the system.

4.4.1 Elements in a Lesson Plan

All important elements in the lesson planning domain were identified. In general, elements in a lesson plan can be divided into five main categories as classified in Table 4.2. They are curriculum, students' constraints, teachers' details, facilities available and its contents. The contents of a lesson plan are based on Gagne 9 commandments of learning activities, as discussed in Chapter 2.

Table 4.2: Important elements in lesson plan domain

Curriculum	Subject	Pre-requisite
	Year	Time period
	Learning area	Skill
	Topic	Value
	Learning outcome	
Students	Ability	Number/class
	Previous knowledge	Background (socio-economy)
	Motivation	Age
	Learning style	
Teachers	Teaching style	
	Technology preference	
	Experience	
	(year of teaching)	
Facilities	Resources	Class Layout
	Materials	Time period
	Class size	
Contents (deliverable)	Objectives	Homework
	Introduction	Closure
	Short explanation	Rewards
	Learning Activities	Reflections
	Enrichments	

Previous knowledge and pre-requisite are the two same elements and were used interchangeably. Ability is sometimes refers to the level of student, which describes students' performance in academic. Enrichment is not normally stand alone in the lesson plan. It is carried out in accordance with learning activities. At the end of activities that are related to any specified objectives, teachers should reinforce the concept and main points. Although theoretically students should

consider the various elements in planning their lesson, some elements are not taken into account due to several conditions. For example, one class might consist of 40 students and a teacher might teach more than one class. Therefore, it is not easy for the teacher to identify each one learning style, motivation, as well as socio-economy background.

Figure 4.1 shows an example of a lesson plan for ICT. The full version is attached in Appendix C.

Subject	: Information and Communication Technology
Date	: 20 October 2008 Form : 5 Technology
Time	: 9.00 am – 9.40 am [40 minutes]
Number of students	: 25 Attendances : 25
Topic	: 5.1 Basic programming concepts
Synopsis	: In this topic, students will learn about programs and programming language.
Learning outcomes	: 5.1.1 Define 'program' and 'programming language'
	5.1.1.1 State the definition of 'program'.
	5.1.1.2 State the definition of 'programming language'.
Learning objectives	: At the end of this lesson, the student should be able to:
	a) Write correctly the definition of 'program' using their own words.
	b) Write correctly the definition of 'programming language' using their own words.
	c) Verbally list at least three examples of programming language correctly.
Teaching materials	: 1. Dancing robot.flv (video)
	2. Topic 5.1.ppt
	3. Exercise.ppt
	4. Recipe.jpg
Teacher references	: 1. ICT Module Score A SPM
	2. Timothy J. O'Leary & Linda I. O'Leary, 2006. *Computing Essentials 2006* (Complete Edition). McGraw Hill International Edition, United States.
Student references	: ICT Module Score A SPM
Pre-requisite knowledge	: The topic does not require any pre-requisite knowledge because it is the first topic for form five Information and Communication Technology students. However, a basic knowledge of the topic may be based on their experience in real life.
Student references	: ICT Module Score A SPM

STEPS	CONTENT	LEARNING ACTIVITIES	MATERIALS/NOTES
Induction Set 5 minutes (9:00 – 9:05 am)	Introduction of programs and programming language	1. Teacher gives an overall explanation of the topic. 2. Teacher presents the video. 3. Students see the video and try to understand it.	**CCTS:** Generate idea **Value:** Understanding **Teaching aids:** 1. Topic 5.1.ppt 2. Dancing robot.flv

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		Definition of <u>programming language</u> Programming language is a set of words, symbols and codes that enables humans to communicate with the computer. It is a language used for writing computer programs that directs the computer to perform computation and to organize the flow of control between mechanical devices.	1. Students read objective two provided by the teacher in the slideshow. 2. Students read the definition of 'programming' from the slideshow provided. They then discuss it with the teacher in order to achieve the meaning of 'programming language'. 3. Students demonstrate their understanding of programming language. 4. Students read about career opportunities in programming field (shown in slideshow).	**CCTS:** Generate idea **Value:** Inquiry **Note:** ICT Module Score A SPM **Teaching aids:** 1. Topic 5.1.ppt 2. Exercise.ppt
Step 1 10 minutes (9:05 – 9:15 am)				

Figure 4.1: Sample Lesson Plan

Table 4.3 extends the analysed components of a lesson plan in Malaysian, UK and US which was done in Chapter 2. The table lists the example and meaning of the components, the currently available components, and components that are available in other lesson plans which can possibly be added in the Malaysian context.

Table 4.3: Components of a lesson plan in Malaysian context

No.	Elements	Meaning/ example	Currently Available in Malaysian lesson plans	Available in lesson plans by other nations (US and/or UK) but not Malaysian
1	Subject	ICT, Science, History	√	
2	Topic	Computer System	√	
3	Lesson author	The name of the teacher		√
4	Year/ Form	Form 1, Form 4	√	
5	No of pupils	23, 25,30, 35, 40	√	
6	Skills	Communications, Information management	√	
7	Attitude & moral value	Confidence, responsibility, integrity, respect, cooperation, appreciation, courtesy	√	
8	Ability range	(Level of students)		

No.	Elements	Meaning/ example	Malaysian lesson plans	nations (US and/or UK) but not Malaysian
		Excellent, average		
9	Time allotted	60 minutes, 80 minutes	√	
10	Room	Computer lab, classroom	√	
11	Teaching aids	Hardware.ppt, Exercise1.doc		
12	Resources	Computer, printer, scanner	√	
13	Short description of lesson	Brief explanation of overall lesson.		√
14	Pre requisite skill	A statement of what a student needs to know or be able to do to succeed and accomplish the lesson objective	√	
15	Grouping of students	Based on ability, learning style etc		√
16	Objectives	A more specific and can be behavioural or non-behavioural	√	
No.	Elements	Meaning/ example	Malaysian lesson plans	nations (US and/or UK) but not Malaysian
17	Classroom layout	The arrangement of furniture		√
18	Outcomes	What should be achieved by the end of lesson		
19	Timing of each activity	5 minutes (9.00-9.05am) 10-15 minutes (8.10-8.25am)	√	
20	Induction set	Introduction	√	
21	Planned Content/lesson outline	Outline for each step in lesson plans	√	(should consider students' learning style)
22	Adaptation for special learners	Extended time for certain students in carrying out activity. Different approach in carry out learning activities.		√
23	Student products	Scrap book	√ (not for all subject & each lesson)	
24	Enrichment	Activity to reinforce students' understanding of what each objective stated	√	
25	Assessment	Exercises, quizzes etc, by the end of lesson to measure students' understanding	√	
26	Extension/ Homework	To reinforce what has been learnt in the class	√	
27	Closure	summation of the lesson and how it relates to future lessons	√	
28	Reflection	reflect on what has happened in the class as it will help teachers to plan for the next lesson	√	

Table 4.4 shows the ranked lesson plan elements according to users' requirements for case retrieval. The data were gathered from a survey distributed to 25 teachers. The teachers were asked which keywords they prefer to use to obtain the desired elements in their lesson plans. These facts are important to determine the weighting of each element applied to get the most relevant cases in the retrieval process. The top ranking elements in Table 4.4 are used in the user interface of advanced search for inserting keywords while searching for similar lesson plans. This is discussed in chapter 5. Teachers prefer to gather some elements over others when preparing lesson plans. The respondents were asked which components of lesson plans they prefer to obtain while searching. The results are listed and ranked in the second column, the desired content.

Table 4.4: Ranked lesson plans elements and the content

No	Elements for retrieval	The desired content
1	Learning Outcome	Resources/ material
2	Topic	Short Description
3	Learning Area	Learning activity
4	Students ability	Learning objective
5	Students' previous knowledge	Introduction
6	No of students in class	Enrichment
7	Time period	Assessment
8	Year	Closure
9	Subject	Reward
10	Skills	
11	Attitude/ value	
12	Students' motivation	

From Table 4.5 it can be seen that learning outcome is ranked higher than other elements for retrieval. Teachers are more interested in the learning outcome than the learning areas and topics, because it is more specific to the searched content. Out of 25 respondents, 68% preferred to search the learning outcome as opposed to topic (64%) and learning area (60%). On the other hand, learning objective are defined by teachers based on the learning outcome, students' ability, and students' previous knowledge.

More than half of the respondents (76%) stated that reflection is a vital element in lesson plans as it feeds into the next class. This also indicates the importance of

a case-based reasoning system in which previously implemented lesson plans are referred, to construct a new lesson plan. Teachers can also learn from reflection written by other teachers.

4.4.2 *Quality lesson plans*

The criteria for a quality lesson plan were identified, as SmartLP not only aimed to assist teachers in constructing a lesson plan quickly but also ensured that they are at a satisfactory level. Those criteria were deduced from background analysis in Chapter 2 and interviews.

Table 4.5: Criteria of a quality lesson plan

	Aspects	Details
1	Objectives	Objectives should be planned base on students' ability and students' previous knowledge.
		Content/learning activities should be planned to achieve the objectives stated.
		Have to be explicit, specific, according to students' ability & follow the syllabus.
		Time period of the lesson should be taken into account in choosing the objectives to be implemented.
		Should specify what the student will do, that can be observed. Direct students' attention to elements that require special concentration.
2	Time constraint	Flexible and reasonable time for each activity and diversified according to students' ability.
		Take into account the class period.
		Keep the pace of the lesson moving according to the ability and sorts of activities that have been set
3	Introduction	Based on students' ability, students' previous knowledge and motivation.
		Frame interesting introductions to attract students' attention to the lesson.
4	Learning Activity	The student activities described in the lesson plan contribute in a direct and effective way to the lesson objective.
		Ensure that work is appropriate to students' need, abilities and motivation.

		Involve all students.
		Communicate clear instructions according to students' ability.
		Enough and suitable material (teaching aid) and resources.
		The materials specified are pertinent to the actual described learning activities.
		Reasonable time to carry out the activities.
		Reasonable group size for grouping activities.
		Reasonable reward.
		Match the skills/ attitude value to be achieved.
		Keep students on task as much as possible.
		New information has to be linked to familiar material.
		Suspense could be introduced or curiosity might be rouse by building up to a 'punch line' or including an element of surprise.
		Give regular and prompt feedback.
		Relate past learning activities to the present.
5	Enrichment	Reinforce the concept/ main points of the lesson.
		Enrichment should match the content.
6	Assessment	Test all the objectives listed.
		Should match students' ability.
7	Closure	Should summarise lesson content.
		Relate the topic or coming topic.
8	Prerequisite	The prerequisites are specified or are consistent with what is actually required to succeed with the lessons.
9	Reward	Develop a system of positive and frequent rewards.
		Plan the praise.
		Develop an incentive scheme that rewards without arbitrarily discriminating.
10	Content	Appropriate with the objectives to be achieved and follow the syllabus.
		Content is clear, follow sequence to achieve the objectives.
		Suitable to be implemented via content delivered.
11	Material (Teaching aids)	Interesting, suitable and are expected to assist in teaching and learning activities.
		Quantity is appropriate and involves all students.
12	Resources	Enough and appropriate resources.

4.4.3 *The Flow of Constructing Lesson Plans*

The flow of events in constructing lesson plans is shown in Figure 4.2. It is based on the categories of lesson plan elements in Table 4.1. It starts by referring to the syllabus for a particular subject and year. All details, namely learning area, topic, learning outcome, pre-requisite, skills and value, need to be identified.

Later, students' profile which represent students' ability, previous knowledge and motivation need to be recognised. Although some nations emphasise students learning styles and their socio-economic background, they are not major concerns in a Malaysian context due to several factors that were explained before.

Later, facilities such as material, technology resources and classroom features also need to be investigated and considered. Eventually, a lesson plan is designed based on the above considerations. After the lesson has taken place, teaching reflection should be written down as it provides a guideline to plan for the following lesson.
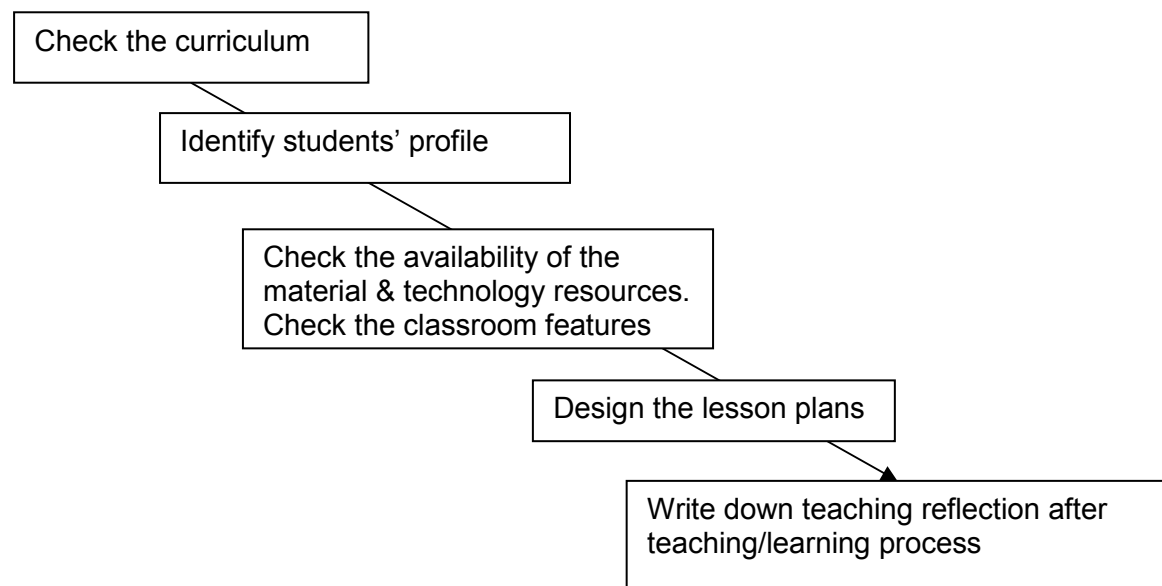
Figure 4.2: The flow of events in preparing lesson plans

Based on this general basic flow, the details of preparing lesson plans as in Figure 4.3 was established.
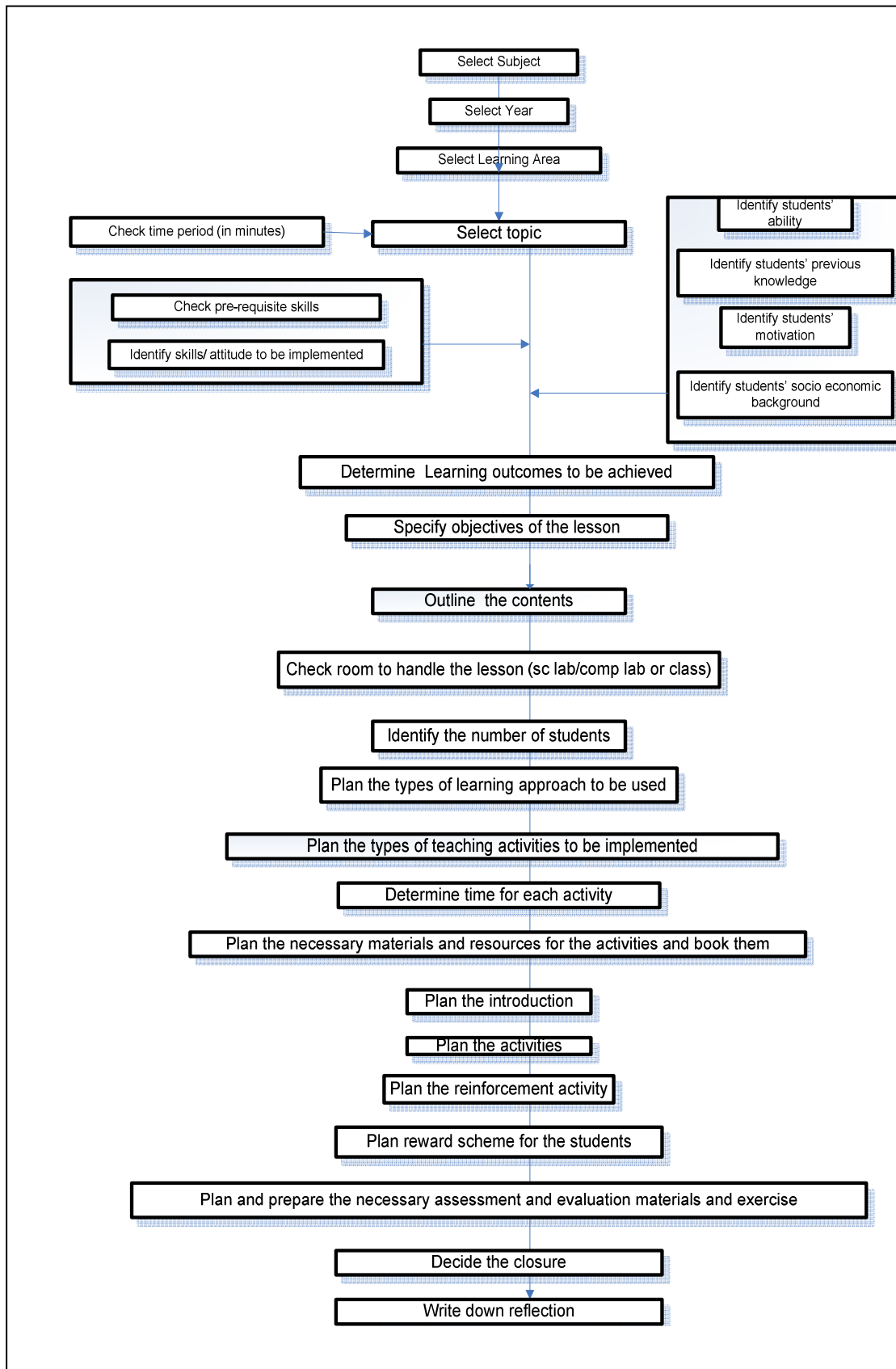
Figure 4.3: The detail of events in constructing a lesson plan

A standard curriculum is specified for each subject and year of study. There are several learning areas to be covered in one subject which is specified to some topics. After selecting a topic, a reasonable learning outcome should be planned within the set class period. In addition, students' previous knowledge and pre-requisites of a particular learning outcome need to be present before deciding on the learning outcomes. This is followed by specifying objectives of the lessons after considering students' ability

4.4.4 *Lesson planning theories*

Malaysian teachers apply Bloom's taxonomy when constructing their daily lessons, as discussed in Chapter 2. In this model the three important domains are cognitive, psychomotor and affective (value and attitude). Haltrop (2007) listed words associated with the six levels, as follows: knowledge (recall), comprehension (understand), application (use, practise), analysis (dissect, generalize), synthesis (create, combine) and evaluation (appraise, value).

The following figure shows the content (the 'solution' in a case is the appropriate elements that match the constraints faced by teachers) of a lesson plan that consists of the six levels of Bloom's taxonomy. For effective learning, it is suggested that the content of a lesson plan follows Gagne's nine events. By using the SmartLP system, a lesson plan that fulfils these two theories can easily be constructed. Figures 4.4 and 4.5 show the same lesson plans generated by using the SmartLP system that has the features of bloom's taxonomy and Gagne's nine commandments.

INTRODUCTION	1) The teacher shows a cartoon animation. 2) The students will give an opinion that relates to education. 3) The teacher introduces the topic and states the objective.	KNOWLEDGE
STEP 1	1) The students form groups of 4 or 5 members. 2) The teacher provides four fields in multimedia application: business, arts, medicine and engineering. 3) Each group will get one field based on the 4) The students need to find relevant examples with their contribution in society based on the field they get within 15 minutes and transfer the information into Microsoft Office PowerPoint.	COMPREHENSION APPLICATION ANALYSIS
STEP 2	1) The students need to present the results clearly in front of the class. 2) The other students will add some opinions and ask questions.	SYNTHESIS
ASSESSMENT	1) The teacher distributes the simple quiz 2) The teacher discusses the answer with the students	EVALUATION
CLOSURE	1) The teacher asks the students to summarize the lesson 2) The teacher makes the overall conclusion 3) The teacher will tell them about the next topic.	
EXTENSION	Multimedia for those with low vision http://www.w3.org/WAI/EO/Drafts/PWD-Use-Web/ http://emedicine.medscape.com/article/1832033-media	

Figure 4.4: The six levels of Bloom's taxonomy in a lesson plan

	Introduction	1) The teacher shows a cartoon animation. 2) The students will give an opinion that relates to education. 3) The teacher introduces the topic and states the objective	

Present the material →

Gain attention ←

Inform the objectives ←

	Introduction	1) The teacher shows a cartoon animation.	Gain attention
Present the material	Introduction	1) The teacher shows a cartoon animation. 2) The students will give an opinion that relates to education. 3) The teacher introduces the topic and states the objective	Gain attention Inform the objectives
Provide guidance for learning the material Elicit performance	Step 1	1) The students form groups of 4 or 5 members 2) The teacher provides four fields in multimedia application: business, arts, medicine and engineering. 3) Each group will get one field based on the teacher's decision. 4) The students need to find relevant examples with their contribution in society based on the field they get within 15 minutes and transfer the information into Microsoft Office PowerPoint.	Stimulate recall of previous knowledge
	Step 2	1) The students need to present the result clearly in front of the class. 2) The other students will add some opinions and ask questions.	Provide feedback
	Assessment	1) The teacher distributes the simple quiz. 2) The teacher discusses the answer with the students.	Assess performance
	Closure	1) The teacher asks the students to summarize the lesson 2) The teacher makes the overall conclusion 3) The teacher will tell them about the next topic.	Enhance retention and transfer
	Extension	Multimedia for those with low vision http://www.w3.org/WAI/EO/Drafts/PWD-Use-Web/ http://emedicine.medscape.com/article/1832033-media	

Figure 4.5: The Gagne's nine commandments in lesson plan content

4.5 Knowledge Representation: Semantic Network of the Elements in Lesson Plans

A semantic network is a form of knowledge representation that was used to represent relations between elements in lesson plans. The structure of a semantic net is shown graphically in terms of nodes and the arcs connecting them in a directed graph which represents semantic relations between the concepts. Nodes are often referred to as objects and the arcs as links or edges. Four important elements or knowledge objects that were identified during knowledge analysis are concept, attributes, value and relation.

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Figure 4.6 is a directed graph illustrating how elements in lesson plans relate to each other. In lesson plan construction, a causal network shows how one element determines the other elements. The arrow → indicates the 'determine' relationship. For example, learning outcome, ability and pre-requisite determine learning objectives to be implemented. Learning objectives, on the other hand, determine introduction, learning activities, enrichment, assessment, extension/ homework and closure. They also can be read the other way around; those elements are determined by the learning objectives.

Learning outcomes to be achieved in a class vary depending on several factors; namely, students' ability, class period and students' previous knowledge. This directed graph is useful for case retrieval by using a query. For example, in order to get a suitable introduction to one topic, users need to know learning objectives, students' ability and students' motivation.
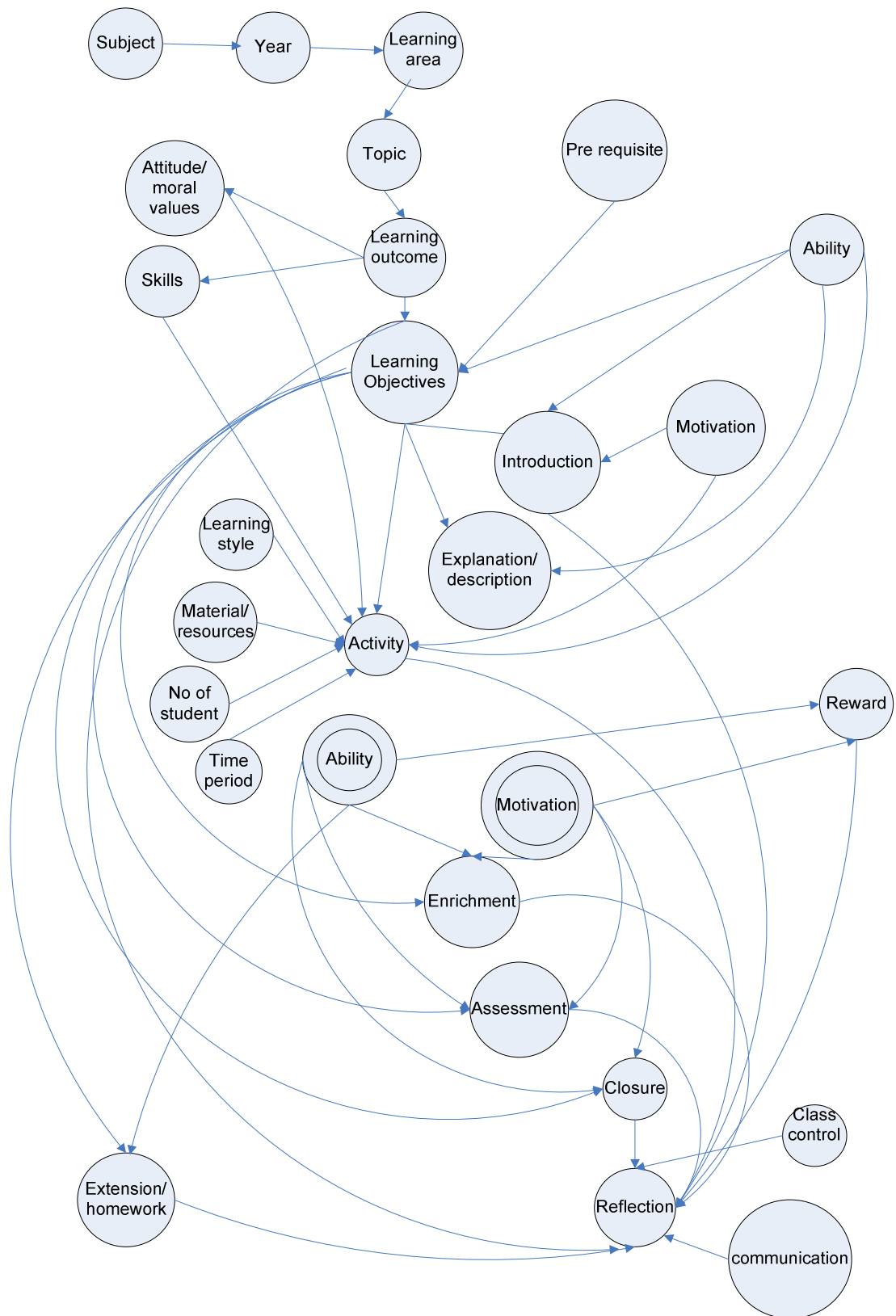
Figure 4.6: Directed graph of elements in lesson plan domain.

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The values of the elements in preparing lesson plans were revealed from a knowledge acquisition process. As discussed earlier, students' ability plays an important role in designing lesson plans in the Malaysian context. Therefore, the values of each element in lesson plans are mainly influenced by students' ability which is due to class streaming, which in turn is subject to students' performance in their yearly examination.

From the survey conducted, 23 out of 25 respondents (92%) consider students' ability in planning teaching activities on top of the time period for the lesson (80%). This is followed by 'resources available' which are preferred by 40% of respondents, number of students per class (28% respondents), and students' motivation (24% respondents).

Group of good-excellent students manage to handle activities themselves with minimum supervision, whereas the lower ability group of students need demonstrations or detailed explanation from teachers before carrying out the learning activity. For instance, the values of the introduction to a lesson are diversifying. To a group of students with lower ability, suitable types of introduction are daily life examples and revising of previously related topics. On the other hand, better students manage to cope with various kinds of introduction such as analogy, multimedia presentation, real life examples and practical activities such as acting as directed. Activities to be implemented are also numerous; subjects to number of students, teaching resources, time period, students' motivation and definitely students' ability.

4.6   Lesson Plans Ontology Construction

In order to identify the core concepts to be organised in lesson plan taxonomy, knowledge in lesson plans domain that was analysed in the previous stage was inspected. Each concept was then linked to the other concepts by exploring the relationships, and the whole set of concepts was expressed according to a taxonomic representation. The taxonomy of lesson plan domain that was built based on a semantic net was constructed as shown in Figure 4.7. Lesson plans

taxonomy consists of four main nodes which are curriculum, students, facilities and content. Each node is then divided into detail nodes.
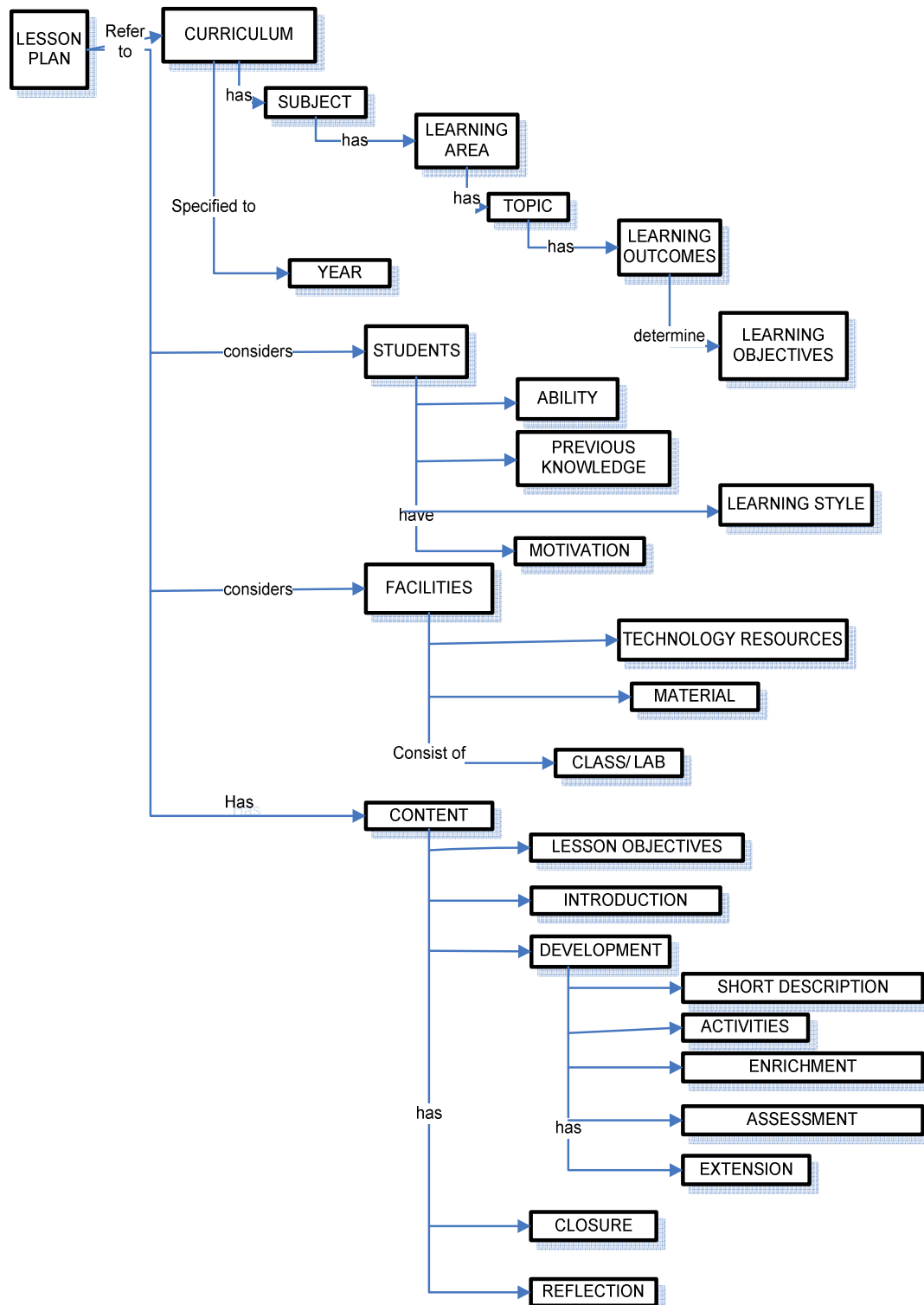
Figure 4.7: Taxonomy of Lesson Plan Domain

The lesson plan ontology that was constructed is mapped to a case of the SmartLP system as explained in the next section. From the hierarchical ontology illustrated in Figure 4.7, it can be seen that the first consideration in lesson plans construction is curriculum.

The detail of the curriculum hierarchy that is shown in Figure 4.8 is explained in four levels. ICT was chosen to be implemented in the prototype system, as schools that offer this subject have Internet access and complete computer laboratory facilities. There are six learning areas in this subject. Each learning area has several topics and each topic has one or more learning outcomes. Based on these learning outcomes, teachers should construct learning objectives based on constraints they have in hand; their students profile and facilities available. In this diagram only multimedia learning area is illustrated. The first level is the subject, ICT, followed by the second level, learning area; this is then detailed in the third level, topic. The topics are specifically elaborated in the fourth level, learning outcome. Teachers are then referring to the learning outcome to specify learning objectives to be achieved in their teaching.
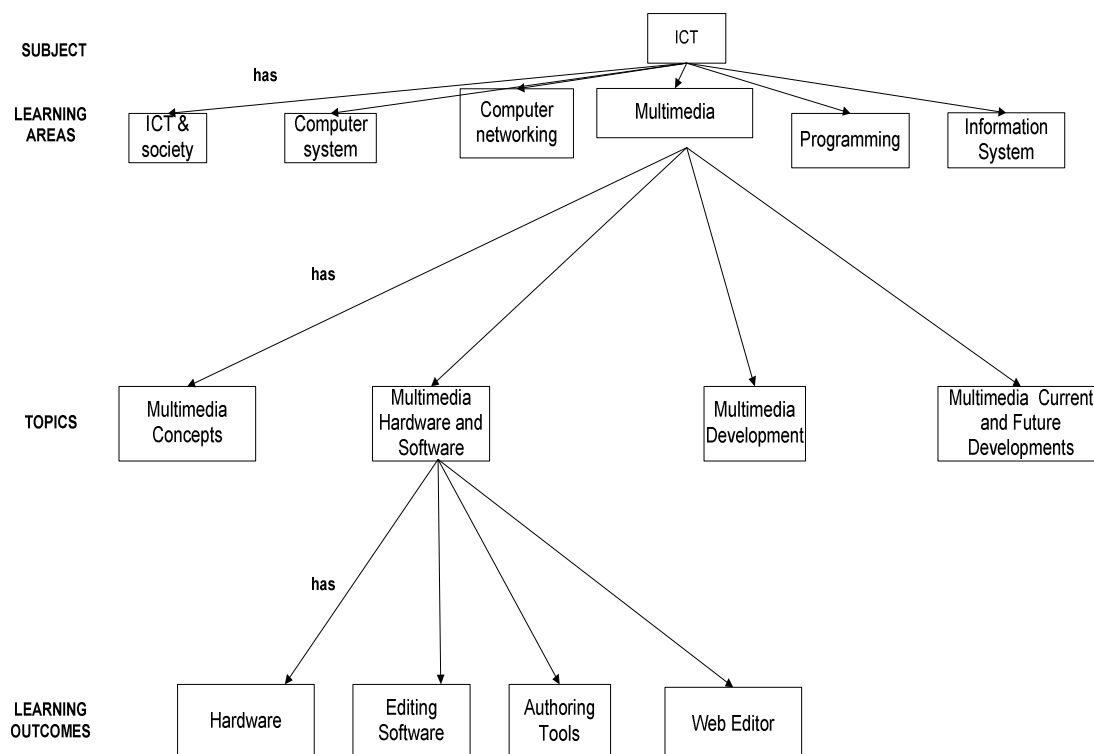
Figure 4.8: Hierarchical structure of ICT syllabus

This curriculum hierarchy is used in similarity calculation for advanced search that applies a nearest neighbour algorithm. As there are several levels in the curriculum and the search keywords are organised in a hierarchical menu, only attributes that relates to a particular parent will be compared. This is discussed in Chapter 6, System Implementation. In addition, the same hierarchy was used for hierarchical search to display hierarchical concepts – upper level (ancestors), the same level (sibling) and lower level (children) in the database. This too is explained in the implementation chapter.

4.7   Case Representation

Representation is the issue of deciding what to store and how the memory should be organized in order to retrieve and reuse old plans effectively and efficiently. Cases can be represented using a variety of notations. Prior to this, a case in the lesson plan domain that consists of problem description and the solution needs to be defined.

4.7.1 Case definition

Cases are records of experience that contain knowledge (Watson, 2003). A case in CBR comprised three major parts which are problem or situation description, solution and outcome.

In a SmartLP system, about 60 cases are stored in the case base as initial solutions to solve lesson planning problems. The 60 cases were acquired from the case acquisition processes in which the lesson plans were prepared by ICT teachers in Malaysian secondary schools and by ICT students who prepared the lesson plans for their pedagogical class. Watson (2003) points out that large case bases are not necessarily better than small case bases or vice versa. However, she states that the greater the number of cases, the greater the coverage of the problem space and the less adaptation will be required. A homogeneous case base means all cases share the same record structure, have the same attributes but varying values. This type of case base was used in SmartLP.

Problem/ situation description

Features of the problem situation are the catchall that holds any other descriptive information about the situation relevant to achieving the situation's goals (Kolodner, 1993). Other features of the situation include anything else that might be taken into account in achieving the situation's goals. In short, problem/situation descriptions are elements in lesson plans that do not suit the constraints in students' profiles, teachers' profiles, curriculum and facilities, thus affecting the successful or unsuccessful learning objectives. Constraints are conditions put on goals. Each time teachers have different constraints, they have to modify the retrieved lesson plan so that the specified learning objectives can be achieved.

Solution

The main goal to be achieved in producing lesson plans is to plan suitable and appropriate lesson plans, which contain appropriate learning objectives to be achieved, materials, introduction, learning activities in steps, enrichment, evaluation and closure that meet the constraints; the curriculum syllabus, students' profile and facilities available. Generally, proper lesson plans result in good teaching and learning and subsequently make the objectives of the lesson achievable. The sub goal is to adapt current lesson plans to match new problems.

As the goal of SmartLP is to prepare an appropriate lesson plan for a particular group of students, the constraints are various students' profiles such as ability, previous knowledge, socio economic background and motivation. Teachers' profiles consist of their experience and technology preference and should be considered separate from the facilities profile such as classroom layout, material and technology available. Another crucial factor is curriculum standards which encompass numerous elements like skills, knowledge, content, learning outcome and value that should be developed in students through their learning process. However, teachers' profile, students' motivation and socio economic background are not given priority in Malaysian context, thus do not considered in this research. Four crucial activities; retrieve, reuse, revise and retain should run in cycles so that the benefit can be fully realised.

Components of a case in SmartLP, which is shown in Table 4.6 consist of problem descriptions; the various constraints that teachers face in constructing lesson plans and their pair solution.

Table 4.6: A case of lesson planning system, SmartLP

Problem	Concept	Elements
	Students	Ability, previous knowledge, motivation, number of student per class
	Facilities	Resources, material (teaching aids), venue
	Curriculum	Year, subjects, learning areas, topics, learning outcomes, objectives, time period
Solution	Lesson Plans/ content	Appropriate teaching material, skills, learning objectives, short description, introduction, activities, timing of each activity, enrichment, extension, conclusion

4.7.2 *Attribute – Value Representation*

In SmartLP, attribute – value representation was used due to its support for case searching and matching using the chosen software; MySQL. It was supported by other scripting- namely Php, javascript, CSS and Ajax. In addition, by using this representation, new cases can easily be integrated into the existing memory. It allows structured data in web applications, thus giving support to query a relational database. Furthermore, organising and indexing cases can efficiently be done using MySQL, resulting in effective retrieval and reuse of the cases. Table 4.7 shows the details of attribute-value representations in SmartLP

Table 4.7: Attributes of lesson table and the data types.

Attributes	Types
ParentID	Varchar
LessonID	Varchar
Date	Datetime
Form	Int
Subject	Varchar
Learning area	Varchar

Topic	Text
Learning outcome	Text
Objectives	Text
Ability	Varchar
No of Students	Int
Minutes	Int
Skills	Mediumtext
Resources	Varchar
Value	Varchar
Prerequisite	Mediumtext
Introduction	Text
Step1	Longtext
Step2	Longtext
Step3	Longtext
Step4	Longtext
Step5	Longtext
Assessment	Longtext
Extension	Longtext
Closure	Text
Reflection	Longtext
Verified	Varchar

4.7.3 *Indexing*

Indexing is applied in the case base to allow the database server to look up rows more quickly, thus speeding up the retrieval. Several attributes which are used for indexing the cases are year, subject, learning area, topic, learning outcomes, skills, values, time period, number of students and ability. Each of these attributes has a similarity value in comparison to the searched keywords chosen by users. Some of them adopted a hierarchical similarity measure while the rest applied a linear similarity measure. These two types of similarity measure are explained in Chapter 6, System Implementation. The structure of the similarity table is shown in Table 4.8.

Table 4.8: Attributes of similarity table and the data types.

Field	Type
Id	Int
Query	Varchar
Case	Varchar
Similarity	Float

4.8   Case Acquisition

Cases in SmartLP which are the ICT lesson plans in attribute value representation were gathered before being keyed-in to the database. As not all schools in Malaysia offer ICT, schools which have this subject options were identified. After getting information about the potential respondents who are teachers that teach ICT for Form 4 from school administrator, they were contacted by telephone and emails. Meetings with the teachers were held separately in each school. In the meeting, the research purpose was explained to them. The topics to prepare lesson plans were discussed. After that, the dates to collect lesson plans were decided.

4.9   Conclusion

The complete and detailed requirements of the proposed system are specified in knowledge analysis. Knowledge in the lesson plan domain was analysed and modelled in this chapter considering the concepts and approaches surrounding lesson planning in a Malaysian context. The important theories in lesson planning need to be visible in the lesson plans as a mechanism to ensure that the lesson objectives are achieved. The ontology of the lesson plan domain was constructed in a taxonomic form, and the elements within the taxonomy were represented as problem descriptions and solutions in a case. The taxonomy was produced based on a semantic net to see how all the elements and concepts in a lesson plan relate to each other. The structure of a semantic net is shown graphically in terms

of nodes and the arcs connecting them. Cases were acquired from teachers in scattered locations. The acquired cases were stored in a case base using attributes-value representation to facilitate the case retrieval, reuse, revision and retaining processes in the CBR cycle. The next chapter will discuss the design of these processes in the SmartLP system.

CHAPTER 5

SYSTEM DESIGN

5.1   Introduction

This chapter discusses the third phase of the research methodology, which involves system design. Prior to this, problems and issues faced by teachers in preparing lesson plans were revealed. In consequence, a dynamic case-based lesson planning system to assist teachers in constructing quality lesson plans was proposed. Subsequently, the system needs to be designed properly with the intention that the system fulfils its objectives and eventually meets users' needs after being implemented. The design of SmartLP, a case-based lesson planning system, comprises three main types of design, which are application, architectural, and user interface design. SmartLP is a synthesis type of CBR system whereby synthesis tasks attempt to create a new solution by combining parts of previous solutions in the adaptation process. The inputs are requirements and constraints in the curriculum, students' profile, facilities available, and the output is an appropriate lesson plan.

Section 5.2 discusses application design which encompasses modules for CBR activities in Subsection 5.2.1; retrieval, reuse, revise, review, retain and refine. Section 5.2.2 is about the sharing mechanism. Another important module, Registration, Support for Users and Admin Centre is explained in Subsection 5.2.3, 5.2.4 and 5.2.5. Architectural design, which considers architectural style, the structure and properties of the components that comprise the system, and the interrelationships that occur among all architectural components of a system, is presented in Section 5.3. User Interface for case retrieval, adaptation, revision and verification are explained in Subsections 5.4.1, 5.4.2, 5.4.3 and 5.4.4 respectively, under Section 5; user interface design.

5.2   Application Design

Application design involves designing all modules in the system – especially the main activities of the CBR cycle; namely, retrieval, reuse, revise and retain, which aims to solve the lesson planning problem. The module to facilitate knowledge sharing among teachers, namely uploading and inserting lesson plans, are designed here.

In application design, processing techniques that were applied in the implementation phase are determined. Combinations of various processing techniques were used in different modules within the system. For example, real-time processing was used for adding and sharing new lesson plans while batch processing was implemented in case verification by the system administrator.

5.2.1 *Modules for CBR activities: retrieval, reuse, revise, review, retain.*

Solving problems by CBR involves obtaining a problem description and making suggestions through the cycle. Figure 5.1 illustrates this process in general. The design plan was devised according to the different steps of case-based reasoning.
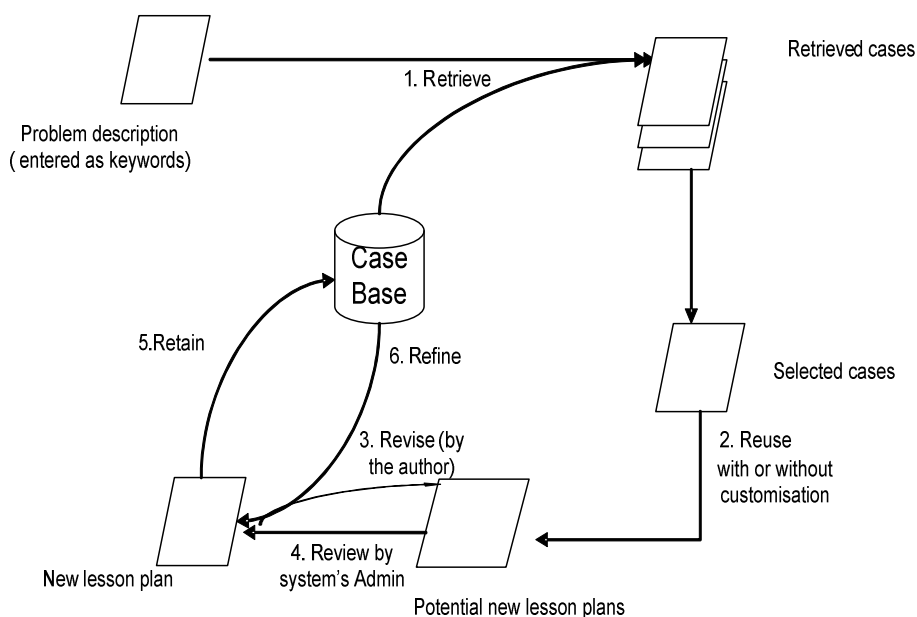
Figure 5.1: The CBR cycle (adapted from Watson (2003))

In this research the steps shown in Figure 5.1 are applied to assist teachers in constructing lesson plans. The steps start with queries entered by teachers using any keywords they prefer, via any of five types of search; advanced search: hierarchical; Boolean; basic; or browsing. The similarity of the current problem (keywords) to previous problems stored in a case base will be measured. The cases that match the queries will be retrieved from the case base. Then, one or multiple lesson plans can be chosen to generate a new lesson plan with or without modification and reused by teachers.

This modification or adaptation will be done in the system by teachers to suit the constraints they have in problem descriptions. The new cases prepared by teachers become potential new lesson plans and stored as new cases in the case base. The new lesson plan is saved as unverified and will not be considered for retrieval until it is verified by the system administrator. This is known as the review process in the CBR cycle. The list of unverified lesson plans is only visible to the system administrator and they have responsibility to verify these lesson plans.

The new problem description and its solution prepared by teachers can be accessed by other teachers with other modifications to suit their needs. This is congruent to Aamodt and Plaza's (1998) suggestion that a new case should be retained each time a problem has been solved, making it immediately available for future problems.

Lesson plans which have been generated, customised or shared can be revised by the authors in their next visit to the system. The author of the lesson plans can access their previously created lesson plans and make modification to the content. Therefore, the login module is crucial as the user name is important to identify lesson plans.

In the future, the system administrator can refine the case base by editing or deleting obsolete lesson plans or change users' level, view users' status or delete users as a maintenance process. This continuous process will expand the

system. The details of these main activities in the SmartLP system; retrieval, reuse, revise and retain are described in Chapter 6, Implementation Phase.

5.2.2 *Sharing Mechanism Module*

A sharing mechanism of lesson plans in SmartLP system is offered to users via uploading and inserting functionalities in the system. In order to encourage users to share their lesson plans, they can simply upload their lesson plans without filling in the detail such as introduction, steps of activities, enrichment, evaluation and closure as required by insert function. Only indexed attributes in the curriculum and student domain need to be keyed-in in sharing by uploading lesson plans. Attachment of any materials can be uploaded (similar to attachment in customisation).

5.2.3 *Registration*

In order to support users in retrieving their previously constructed lesson plans and identify the author of each lesson plan, the registration module is essential. It was designed to be simple with just three important pieces of information namely; username, password and email. Password assistance is also provided to users to generate a new password whenever it is forgotten. A new password will be sent to the correspondence email upon registration. Usernames and passwords need to be keyed in by users to fully utilise the system. A list of members who are online will be displayed to all users, in case they want to contact other users regarding any questions relating to lesson planning. By clicking on the username, other users can view members' contact details via email address.

5.2.4 *Support to users*

Several modules were made visible to users to support them in using this system effectively. Default values are offered to users whenever possible. Web search allows users to search the content of the web, not the database of the system. Users can enter any keywords and it searches for result from all pages in SmartLP system. This help users to find specific terms to know their context within the system.

Frequently Asked Questions (FAQ) provides guidelines in using the system. It explains how to carry out different tasks in the system, search, customise, revise and retain the lesson plans in a short and concise form. The user manual explains the tasks within the system step-by-step and the detailed approach.

The school calendar supports users in lesson planning via school sessions periods and break periods throughout the year. By referring to the calendar, teachers can plan to finish the syllabus within the appropriate period.

ICT syllabus covers the syllabus for ICT subjects for Form 4 and Form 5 students, age 16 and 17. It contains the details of skills, learning areas, topics, learning outcomes and time length to finish each learning area. Contact administrator function gives opportunities for users to contact system administrator for any reasons.

5.2.5 *Admin centre*

The Admin centre is only visible to users with Admin status. The two main modules are unverified lesson plans and user control. The administrators can change users' level and verify the lesson plans to make them available for the public. The details of this application are explained in Chapter 6, System Implementation.

5.3   Architectural Design

Architectural design represents the structure of data and program components that are required to build a computer-based system. It considers the architectural style that the system will take, the structure and properties of the components that comprise the system, and the interrelationships that occur among all architectural components of a system.

This system is implemented using MySQL, a multi-user and multithreaded relational database management system. MySQL database has been used to store all cases and data to be manipulated and retrieved. PHP, a widely used general-purpose scripting language that is especially suited for web development, was used as a development tool interfacing with MySQL. Unlike Java or ASP.Net, PHP does not have tools to make it work on the client side. For that

reason, it is essential to combine Ajax, CSS, JavaScript and PHP scripts to develop powerful web-applications. JavaScript scripting is mainly used as a client side scripting language with support from Ajax, while PHP is a server side technology. During its development an Apache web server was used to run and compile the system while Dreamweaver MX 2004 is used for user interface development.

The details of how elements in SmartLP work together are illustrated in Figure 5.2. The detail of techniques and technologies implemented in each type of search will be elaborated in Chapter 6 which discusses the implementation phase.
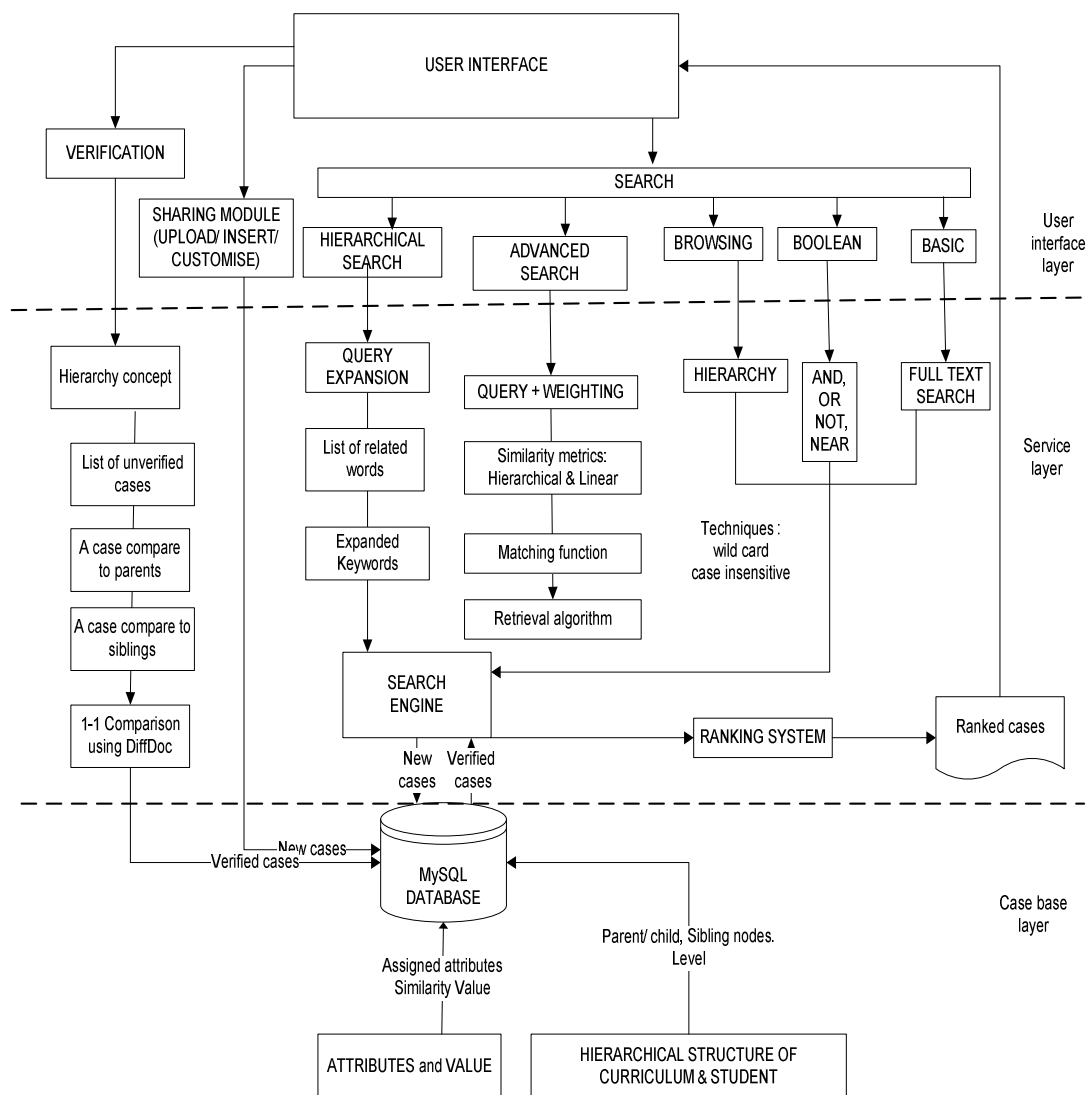
Figure 5.2: The architecture of SmartLP System

SmartLP was developed based on a 3-Tier Architecture; thin client technology. In thin client technology, most of the application processes are done on the server side. The three tiers are the user interface, service layer and case base layer. The user-interface (client) tier is the layer of user interaction and it focuses on an efficient user interface design and accessibility.

Service layer refers to server-based code with which the client code interacts. It performs tasks such as uploading, searching, saving and customising lesson plans, as well as user account management (user session, active users).

The case-based tier is made up of objects that store all tables. Lesson plans are stored in a lesson table and similarity tables contain similarity values that are used to compare values of a query and cases. Users' information is also kept here in order to keep track of the owner of the lesson plans for revision purpose. Figure 5.3 illustrates the three layers of the SmartLP system followed by an explanation of how they interact with each other.
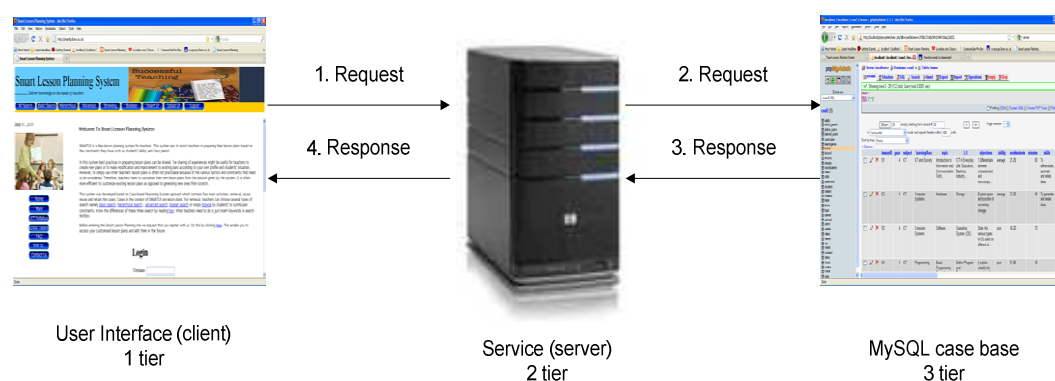
Figure 5.3: 3-tier architecture in SmartLP System

1. The client application receives input from users and sends the request to the server layer;

2. The server application receives and processes the request, passing it to the database layer;

3. The database retrieves data and sends the data to the server application;

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4. The server application receives the data and passes it to the client application.

5.4   User Interface Design

User interface design principles were considered in designing the interface for the SmartLP system. All interfaces were kept simple and straightforward. Three level of users exists in the system; members, guests and administrators. There are some differences in the user interface for these groups to support their activities in the system. For example, members can access their previously saved lesson plans in the system while guests are not able to do so. System admin manages to access all inserted and uploaded lesson plans to verify them, besides controlling users of the system. A Graphical User Interface (GUI) is used in SmartLP. Dix et al. (2004:110) states that if the interface is well designed, it will allow the system's functionality to support the user's task. However, if the interface is poor, the functionality is obscured and users will have trouble accomplishing their task.

Simple designs provide both aesthetic and functional benefits (Mullet & Sano 1995):
1. **Approachability:** Simple designs can be rapidly understood and thus support immediate use, or encourage further exploration.
2. **Recognisability:** Simple designs present less visual information and are therefore more easily assimilated, understood, and remembered, than more elaborate designs.
3. **Immediacy:** Simple designs can be immediately recognised and understood with minimal conscious effort, and therefore have greater impact than complex designs for precisely this reason.
4. **Usability:** Simple designs that remove unnecessary variation or detail ensure the element remains more important and informative. It is nearly impossible to operate a simple design incorrectly;

The navigational flow within a user interface is shown in Figure 5.4.
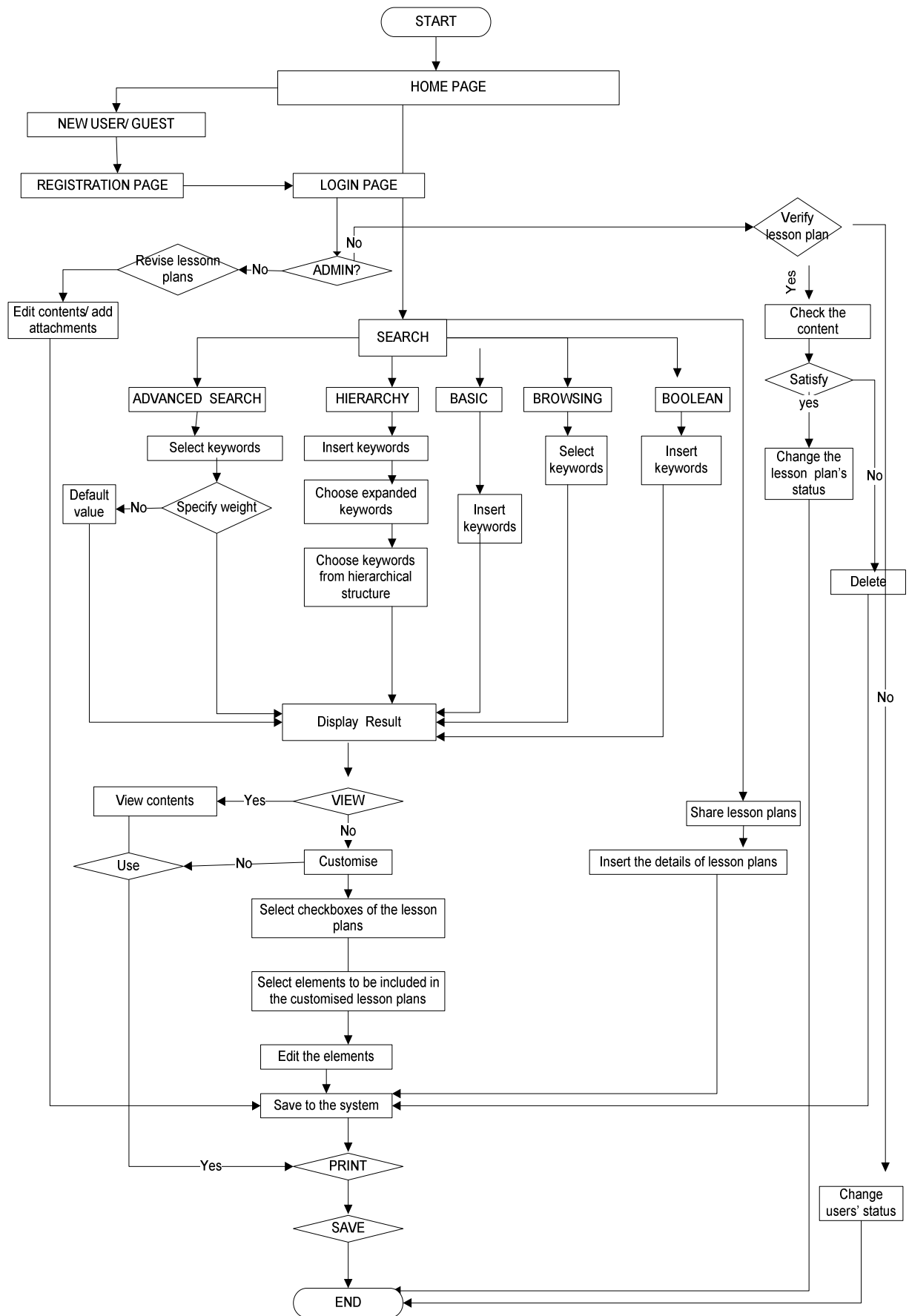
Figure 5.4: Navigational flows in SmartLP interfaces

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To facilitate users in using the system effectively, instructions are given clearly at the top of every page as guidance for users in using the system. Furthermore, notification to users of the progress in the system is a feedback mechanism; to inform users of what is happening in the system, such as uploading, inserting and saving lesson plans together with the teaching aids attachment.

The pages to upload and insert lesson plans were built based on users' prior knowledge, a text-based format that is similar to their current experience in constructing lesson plans. It is compulsory for the 'problem description' elements in the case to be keyed in to the system. Other elements in lesson plans such as introduction, learning activity, enrichment, assessment, conclusion and reflection can be typed in or they can simply upload the whole lesson plan.

A hierarchical drop down menu assists in easily choosing elements to insert lesson plans. For example, if users select certain learning areas, only topics that are related to that learning area will be displayed in the next list box. After they choose any topic, only learning outcomes that are relevant to that topic will be presented. The hierarchical drop down menu is also used in the Advanced Search. Here, the default values are shown next to the attribute's name and the values can be changed by selecting a value range from 1 to 5 in the menu list.

5.4.1 *User Interface for case retrieval*

A standard search result is used although users apply different types of search for case retrieval. Each record is presented in a row starting with a 'select checkbox', followed by result number, lessonID and the rest of the attribute's value. The searched terms, keyed in by users will be displayed at the top of the results page, together with the number of results. The default number of results per page is 10. However, the pagination allows users to specify the number of results per page, starting with 5, followed by 10, 25 and 50. In addition, 'search again' and 'back' link allow users to easily search and go back to the previous page. Figure 5.5 shows this interface.

THESE LESSON PLANS MATCH YOUR QUERY.						
Date						

CLICK ON THE LESSON ID TO VIEW DETAILS OF THE LESSON PLAN. TO CREATE YOUR OWN LESSON PLANS BASED ON THESE LESSON PLANS, SELECT THE CHECKBOXES OF THOSE LESSON PLANS AND CLICK 'SELECT LESSON PLAN' BUTTON.

Searched terms: 1 2 Next>Last>>

Number of results: 10 ▼

Search again   Back

Select Lesson Plans

		Attributes(A)				
Select	**Result no.**	**A1- Lesson ID**	**A2**	**A3**	**A…..**	**A..n**
	1.	ID(i)	value	value	value	value
	2.	ID(ii)	value	value	value	value
	3.	ID(..)	Value	value	value	value
	n	ID(n)	Value	value	value	value

Figure 5.5: The design of search result page

For the Advanced Search, there is an additional column which shows the similarity percentage of the query and case in descending order. The higher percentage shows a closer match, means the case is more similar to the constraints specified by users. Users just need to select checkboxes of particular lesson plans to customise those lesson plans. By clicking the lessonID link, details of the selected lesson plan will be presented to the users. The interface is shown in Figure 5.6.

Subject	
Year	124
No. of Students	
Time period (minutes)	
Learning Area	
Topic	
Learning Outcome	
Objectives	
Skills	
Pre requisite	
Resources *Click on 'Add' to attach* *lesson materials*	<u>Add</u>
Introduction	
Step1	
Step 2	
Step 3	
Assessment	
Closure	
Extension	
Reflection	

Figure 5.6 : The detail of a lesson plan

5.4.2 *User Interface for Adaptation*

In order to allow users to customise lesson plans from several retrieved cases,
users can select the lesson plans using a check box button. After selecting the
checkboxes, users need to click the 'Select Lesson Plan' button. The selected
lesson plans will be presented side-by-side in a comparison table as shown in
Figure 5.7. Subsequently, users are allowed to select unlimited values from a
particular attributes to construct their own plans after clicking the 'Select' button.
The selected values are then accumulated in the related attributes and users can

still modify the content. In case they prefer to use most of the elements in a particular selected lesson plan as opposed to the others, they can check the 'Select all' button at the bottom of the chosen and compared lesson plans. On the other hand, if users decided not to include any of the elements, they can choose the 'Remove' button from the comparison table. The selected values in the comparison table will be accumulated in their particular attributes.

	Compared lesson plans		
	Lesson 1	Lesson 2	Lesson 3
Attribute A	value ☐	value ☐	value ☐
Attribute B	value ☐	value ☐	value ☐
Attribute C	value ☐	value ☐	value ☐
Attribute ….	value ☐	value ☐	value ☐
Attribute n	value ☐	value ☐	value ☐
Select all	☐	☐	☐
Remove	☐	☐	☐

Select

Figure 5.7: Elements of the selected lesson plans are listed.

In the newly generated lesson plan, users can edit the attachment files in the resource column . In case users want to add a new file, they need to click 'Add', and a row containing file name and button to choose the file will appear. Users are required to click 'choose file', and an attachment dialog box will be popup. The files can simply be deleted by selecting 'remove'. Figure 5.8 illustrates the appearance of this interface.

	Add		
Click on 'Add' to attach lesson materials	File No. ☐	Browse	Remove

Figure 5.8: Interface to add new attachment files

All attachments from the original lesson plans will be listed in the newly
generated lesson plan. This column was colored with a light pink color so that
users are aware of the attachments which can be removed, retained or deleted,
as shown in Figure 5.9. The instruction is given to users to deselect the checkbox
of the files to be removed and to retain the checkbox if they intend to let them
remain as attachement files.

	Filename	Select
Deselect the checkbox if you want to remove the files	*(name of files)*	☐ ☐

Figure 5.9: Interface to choose attachment files to be retained or removed

5.4.3 *User interface for Refinement*

Personalisation is available in the system whereby users are allowed to access
their previously constructed lesson plans and make some changes to them.
Users need to click on the lesson ID to edit the content. This instruction is given
at the top of the page. Figure 5.10 shows this main interface for revision before
the content is presented in editable mode.

Hi, *username*

Back

Here is list of your lesson plans. You can update /edit them.

LessonID	Learning Area	Learning Outcome	Objectives	No. of students	Ability
lessonID	value	value	value	value	Value
lessonID	value	value	value	value	value
lessonID	value	value	value	value	value

Figure 5.10: Revision interface

5.4.4 *User Interface for verification*

The user interface for the verification module as shown in Figure 5.11 was designed to make the verification process effective with little effort from system administrator. A list of unverified lesson plans will be displayed to the administrator when they choose the verification module. An instruction is given on the top of the page.

Welcome Admin,

Here is the list of unverified lesson plan. Please click the ID number to see the details. To compare the lesson plan to their parents/siblings, & subsequently verify the lesson plans, please click verify.

lessonID	LearningArea	Learning Outcome	Objectives	No. of students	ParentID
LessonID Verify	value	value	value	value	Value
LessonID Verify	value	value	value	value	Value

Figure 5.11: Verifation interface

When the administrator clicks 'Verify', the newly generated lesson plans will be compared side by side to their parents and siblings so that the differences among columns can easily be identified. This is shown in Figure 5.12. To see the detailed difference of two lesson plans, the system administrator can download and compare them using DiffDoc, a free document comparison software and they can just download those lesson plans beforehand.

	New lesson	Parent lesson I	Parent lesson II	Sibling (lesson plans with the same parent ID)
ID	ID(i)	ID(ii)	ID(iii)	ID(iv)
Attribute A	value	Value	Value	value
Attribute ….	Value	Value	Value	value
Attribute n	Value	Value	Value	value
Download	Download	Download	Download	Download

Select

Figure 5.12: Elements of new lesson plans in comparison to their parents and siblings

The important documents to support users in constructing lesson plans, such as curriculum syllabus and school calendar, are made available for users and easily accessible from the left navigator. In addition, a Frequently Asked Question (FAQ) page assists teachers in using the system easily and effectively.

5.5   Conclusion

A review of lesson planning related systems presented in Chapter 2, revealed that no system has attempted to assist teachers in constructing lesson plans in a time efficient manner by customising previous lesson plans. By adapting the contents of a lesson plan based on constraints in hand, the Bloom taxonomy, Gagne 9 commandment and multiple intelligence activities can easily be planned by add, delete and modifying the contents of the retrieved cases. Thus, user interface, application and architecture of SmartLP was designed accordingly to achieve its implementation objectives. Application design involves designing all modules in the system to support CBR activities in SmartLP - retrieval, reuse, revise and retain the cases. User interface design principles were considered in designing interfaces for the SmartLP system, to support user's tasks and system functionalities. Architectural design represents the structure of data and program components that are required to build a case-based system. System design is important to ensure the success of a system implementation which is explained in the next chapter. The proposed implementation is based on a client/server web-based architecture working on top of a relational standard DBMS as has been discussed in this design phase.

CHAPTER 6

SYSTEM IMPLEMENTATION

6.1   Introduction

This chapter discusses the implementation of the main modules of the SmartLP system. The implementation of the SmartLP system was completed with an evolutionary working prototype and involves iterative analysis, design and implementation. Learning occurs through the evolutionary system building process where insight is gained about the problem and the complexity of the system.   The evolutionary prototyping development process includes regular expert and user evaluation feeding back into the system's development process.

Section 6.2 describes the retrieval module which consists of five types of search. Tolerance retrieval approach, which comprises query term expansion and query term weighting which is applied in hierarchical search and advanced search, is also described in detail. Section 6.3 describes case adaptation for multiple lesson plans. This is followed by case revision that allows users to access and revise their constructed lesson plans in the system. Section 6.4 describes validation mechanisms in SmartLP followed by a case and retention process using a verification process in Section 6.5.   Section 6.6 explains lesson-plan sharing mechanisms in SmartLP before the conclusion in Section 6.7.

6.2   Case Retrieval

The case retrieval module refers to search functions that acquire relevant lesson plans from the case base due to the constraints teachers have. SmartLP system provides five types of search; namely, Advanced Search, Hierarchical, Boolean, Basic Search and Browsing. Similarity definitions and similarity characterisation (weighting/ranking) were implemented in an advanced search. In hierarchical search, the similarity is based on the curriculum and students' hierarchy of the term in their domain structure. Search by browsing utilises the same approach as

hierarchical search. Free keywords are allowed in basic search (full text) while the Boolean Search applies Boolean concept. The next subsections describe the details of each type of search together with the enabling technologies and various approaches within the search.

Wild card queries and uppercase/lowercase flexibility are implemented in all types of search for flexible case retrieval. At the end of each subsection, a retrieval example is presented to illustrate the retrieval process. The explanation includes a retrieval algorithm and similarity measure ending with an example, which illustrates the function of each type of search. Computational approach which is based upon measures of similarity was used in conjunction with representational approaches that are based upon indexing structures in different types of search. They are elaborated in the corresponding type of search.

6.2.1 *Advanced Search*

A hybrid approach, which combines computational (also known as distance-based approach) and representational approach (indexing), was used for case retrieval in the Advanced Search. The distance-based approach in this system applied a standard function-based measure for hierarchical and linear similarity while the index-based approach enforced weight adaptation for the indexed attributes which is discussed in the following subsection.

According to Ashford and Willett (1988), best match searching implies the calculation of some quantitative measure of similarity between the query and each document in the file- the calculated similarity then forming the basis for the ranking. They emphasised that the most important component of a similarity measure is the term weighting scheme which is used to allocate numerical values to each of the index terms in a query or a document to demonstrate their relative importance. Therefore, query weighting is used in this system to give flexibility for users and to get a better search result. Ranking, which gives significant value to the search result, was also implemented in the SmartLP system as those at the top are likely to have a strong degree of relevance to the query.

6.2.1.1 Terms Weighting

Searched keywords may have different importance to different users. Therefore, in the Advanced Search, weights are assigned to each searched keyword to indicate their relative importance. It tells the system how much weight is to be assigned to each attribute as compared to the other attributes that make up the case. The weights are taken into account in calculating the similarity of the searched keywords in comparison to attributes in each case in the case base.

Users are allowed to freely rate each element which implies the importance of the searched keywords weighting in the range of 1 (least important) to 5 (most important). Alternatively, they can simply use the default values defined in the system. The default values were gathered in the knowledge acquisition process as teachers need to specify the importance of every element in lesson plans. This is essential for the similarity calculation between the problems (searched keywords) and cases in the case-base. The default weights of the indexed attributes are shown in Table 6.1:

Table 6.1: Elements in a Lesson Plan and Their Default Weight

Weight	Elements
5	Topic, Learning Outcomes, Ability
4	Learning area, No. of Students, Previous Knowledge
3	Year, Subject, Time Period
2	Skills
1	Values

6.2.1.2 Similarity measure

In the Advanced Search, the similarity of two cases is calculated rather than calculating the difference. A similarity calculation is applied in order to find the most similar cases to the given problem. A similarity value is in the range of 0 and 1, whereby 0 corresponds to totally dissimilar while 1 is a perfect match.

For similarity values, some attributes are based on hierarchical matching and some are linear matching. Learning areas, topics, year and learning outcomes are attributes that use hierarchical matching concepts while ability, knowledge, motivation, time period and number of students per class use linear matching concepts. The following equation is used to calculate the similarity between

problems searched by users and the cases in the database for hierarchical matching (Chung, 2007):

$$\text{Similarity (Problem Attribute}_i, PA_i, \text{Case Attribute}_i\, CA_i) =$$

$$\frac{(\text{Distance } PA_i \text{ to common parent} + \text{Distance } CA_i \text{ to common parent})}{(\text{Distance } PA_i \text{ to root} + \text{Distance } CA_i \text{ to root}}$$

The example of the similarity calculation for topic in curriculum hierarchy is shown in the Equation 6.2:

$$\text{Similarity (Overview of Computer System , Data Representation)} =$$

$$1 - \frac{(1 + 1)}{(3 + 3)}$$

$$= 1 - (0.33)$$

$$= 0.67$$

The hierarchical similarity based on the hierarchical structure of a curriculum syllabus which was discussed in Chapter 4 produces the similarity values in Table 6.2 (learning area) and Table 6.3 (topic). As there are several levels in the curriculum and the search keywords are organised in a hierarchical menu, only attributes in the same level will be compared to the parents.

Table 6.2: Similarity value for Learning Area (ICT and Society)

Case -Query	Introduction to ICT	Computer Ethics and Legal Issues	Computer Security	Current and Future Developments
Introduction to ICT	1	0.5	0.5	0.5
Computer Ethics and Legal Issues	0.5	1	0.5	0.5
Computer Security	0.5	0.5	1	0.5
Current and Future Developments	0.5	0.5	0.5	1

Table 6.3: Similarity value for topic (Computer Systems)

Case - Query	Overview of Computer Systems	Data Representation	Introduction to Binary Coding	Data Measurement
Overview of Computer Systems	1	0.67	0.67	0.67
Data Representation	0.67	1	0.67	0.67
Introduction to Binary Coding	0.67	0.67	1	0.67
Data Measurement	0.67	0.67	0.67	1

In linear similarity, the distances of the path between the searched keywords and the related data in the database were assessed. The similarity for class time period (in minutes) is presented in Table 6.4.

Table 6.4: Similarity value for time period (in minutes)

Query -Case	40	50	60	70	80
40	1	0.8	0.6	0.4	0.2
50	0.8	1	0.8	0.6	0.4
60	0.6	0.8	1	0.8	0.6
70	0.4	0.6	0.8	1	0.8
80	0.2	0.4	0.6	0.8	1

The above similarity is based on the distance that is illustrated in Figure 6.1. The time period for each teaching lesson ranges from 40 minutes to 80 minutes. The range of each 10 minutes interval is 0.2. When it goes further from the case value, the similarity decreases by 0.2, as each range represents 0.2. For example, if the search keyword is 40 and the cases in the case base contain the same value (40), then the similarity is 1, a perfect match. If the case is 50, then the similarity is 1-0.2, which yields 0.8.
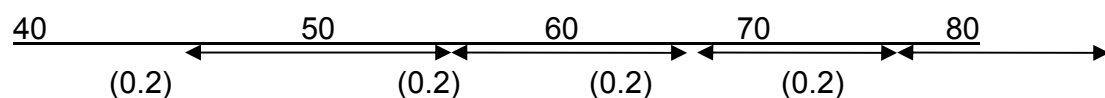
Figure 6.1: Linear similarity value based on distance

These similarity values, which are in the range of 0 and 1, are kept in the database. All records in the case base were taken into account in calculating the

similarity. The similarity of each element is then multiplied with the weight defined by users. If users do not specify any weight, the default value as shown in Table 6.1 will be used.

For weighted similarity, the calculation is shown in Equation 6.3.

$$\text{Weighted similarity} = \frac{\sum_{i=1}^{n} \text{Similarity (attribute}_i) * \text{weight}_i}{\sum_{i=1}^{n} \text{weight}_i}$$

The similarity between query Q1 and case C1 is defined as in Equation 6.4.

$S(Q1;C1) = \dfrac{wA*S(A1;\ A2) + wB*\ S(B1;\ B2) + wC*\ S(C1;\ C2)}{wA+wB+\ wC}$

Where S= Similarity

      Q1 = Query

      C1 = Case

      wA, $wB,\ wC$ = weight of attribute A, B and C.

      A1, B1, C1= attribute1, 2 and 3 from Q1 (query)

      A2, B2, C2= attribute1, 2 and 3 from C1 (case)

6.2.1.3   Retrieval algorithm

The nearest neighbour, the retrieval algorithm, is used for advanced search with weights in comparing the attributes in the new case with each old case. The similarity for all the indexed fields is calculated based on the hierarchical and linear similarity measure as explained before. In the end, all the similarities are summed to find the total similarity for all cases. The cases with the highest similarity are ranked on top. This is demonstrated in Figure 6.2.

1. *Read entered keyword 1 – attribute A ,*

2. *Read entered weight of attribute A, WA*

3. *Read entered keyword 2 – attribute B ,*

4. *Read entered weight of attribute B, WB*

5. *Read entered keyword…n – attribute n ,*

6. *Read entered weight of attribute n, Wn*

7. Search for attribute A, B, n in lesson table

8. Search for attribute A in similarity table A

9. Compare and read similarity value of attribute A in similarity table.

10. Search for attribute B in similarity table B

11. Compare and read similarity value of attribute B in similarity table.

12. Search for attribute *n* in similarity table *n*

13. Compare and read similarity value of attribute n in similarity table.

14. Calculate similarity:

= multiply similarity value of each attributes and weight of that attribute

= (SA * WA, SB * WB , Sn * Wn)

15. Total up the similarity = $\sum$ (SA * WA, SB * WB , Sn * Wn)

16. Get the percentage = (total of the similarity/total weight)*100

17. Rank cases from table lesson.

Figure 6.2: Retrieval algorithm for weighted search of SmartLP system

6.2.1.4   A Retrieval Example

In the following example for case retrieval, only two attributes are taken into account. In this system there are 10 attributes altogether and it depends on how many attributes were keyed-in by the user.

Table 6.5: Advanced Search similarity calculation.

A1: Attribute 1 (time period)

W1: Weight of A1

S1 : Similarity of A1 to other attribute values (case 1 and case 2)

A2: Attribute 2 (objectives)

W2: Weight of A2

S2 : Similarity of A2 to other attributes values (case 1 and case 2)

	A1	W1	S1	A2	W2	S2	Total similarity/ total weight	Total similarity (%)
Query	**50**	3		**Input Devices**	5			
Case 1	40		0 .80	Input Devices		1	7.4/8	92.5
Case 2	70		0.60	Output Devices		0.67	5.15/8	64.4

In Table 6.5, Case 1 has a 92.5% similarity to the query; compared to Case 2 that scores only 64.7%. Therefore, Case 1 is more similar to the query and will be displayed above Case 2 in the result list. Whenever users decide to view a particular case, they will see the details of that lesson plan in a text-based format; a similar format to what they constructed manually.

The snapshot in Figure 6.3 shows the Advanced Search page. Instructions are presented clearly at the top of the page. The elements of a lesson plan are presented in a text-based format and are structured in a similar form to the paper-based format that they should have been familiar with. Default values of the elements' weight that show their importance are shown in the list box. If users would like to assign different values for the weights, they can select the values from the list box which holds numbers 1 to 5.

Figure 6.3: Advanced search page

The hierarchical drop-down menu is implemented on this page. Whenever users select a particular learning area, only topics related to the learning area will be listed. The same steps are applied to learning outcome. The example is shown in Figure 6.4.

Figure 6.4: Hierarchical drop-down menu in Advanced Search.

After selecting keywords and specifying the value of each element together with the weight, users will be presented with a list of lesson plans that are relevant to the query as displayed in Figure 6.5. In advanced search, the search results are presented in descending order starting with the most relevant case to the least relevant. To view the detail, users should click the lessonID and the content of that lesson plan will be presented to the users.

Figure 6.5 Search result of Advanced Search in descending order

Details of the lesson plan are shown as in Figure 6.6. Besides viewing the content, users have other choices which are to print the lesson plan or save them to any devices. Attachments for each lesson plan are also downloadable and printable.

Figure 6.6: Details of the selected lesson plan.

6.2.2 Hierarchical Search

Hierarchical search in SmartLP system uses a semantics approach to produce highly relevant search results rather than using ranking algorithms as in Advanced Search to predict relevancy. The related terms are generated from richly structured data sources, the lesson plans ontology. This is based on a semantic relationship that has been transformed into hierarchical representation as discussed in knowledge representation section in Chapter 4.

In addition, it seeks to improve search accuracy by understanding searcher intent via the contextual meaning of terms as they appear in the searchable database within the system, to generate more relevant results. By allowing users to choose the context of the searched keywords, what evolves is a

means for restricting the volume content that is fed through and displayed on the results page.

This is one mechanism of a query terms expansion technique that can improve performance of the system whereby users can specify their intent in more specific ways. Query terms expansion provides flexibility for users to choose related terms to the searched keywords, based on user relevance feedback techniques for mining additional query terms. Whenever users select any keywords, a list of related keywords will be suggested to them. If they click any of these terms, other related terms are presented to them in three levels; upper level (ancestors), same level (siblings) and lower level (children). They can freely choose those terms for further searching the lesson plans. It aims to support users in looking up keywords (searched attributes) that users do not understand.

The algorithm for this hierarchical search is shown in Figure 6.7.

1. *Read entered keyword 1 – attribute A ,*
2. *Search for attribute A in syllabus table*
3. *Search for attribute A in student table*
4. *Display results from related table*
5. *Particular terms selected by users*
6. *Show results of the terms in hierarchical structure*

Figure 6.7: Retrieval algorithm for semantic search

A retrieval example

Figure 6.8 and 6.9 demonstrate how the hierarchical search works in SmartLP. For example, if users search for the keyword 'computer systems', all terms in the computer systems context will be displayed to them. Users are expected to select any of the given terms. Subsequently, they will be presented with other detailed terms in the hierarchical structure. For instance, if users select the first term, Overview of Computer Systems, Figure 6.9 will be displayed on the screen.
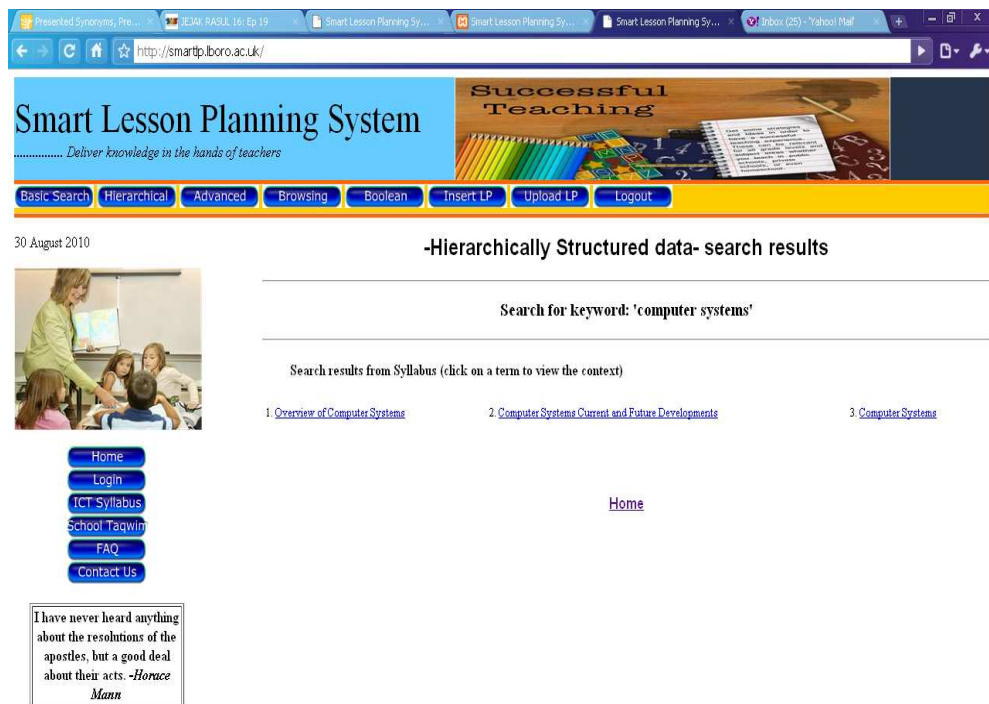
Figure 6.8: All related words to computer system

Figure 6.9: Hierarchical presentation of the chosen terms

6.2.3 Boolean search

Boolean search allows users to combine words and phrases using the words AND, OR, NOT and NEAR to limit, widen, or define their search. In this system, users are able to search lesson plans with or without specific keywords as stated next to the searched keywords. The terms 'with all of these words' represent AND, 'with at least one of these words' means OR while 'without this word' implies NOT. Figure 6.10 shows the Boolean search page of SmartLP.

Figure 6.10: Boolean search page

6.2.4 Basic Search

In basic search, lesson plans that contain the exact searched keywords will be displayed to users. The keywords are searched from all fields and tables in the case base. This search implements wild card queries for tolerant retrieval purposes.

6.2.5 Browsing

In search by browsing, users are presented with a choice of subject area by taking a broad subject area and drilling down through various subject headings and subheadings until the specific subject is reached. Furthermore, the terms are organised in a general to specific manner, and visualised by cascade menus. Therefore, users can expand and shrink the tree to find lesson plans with specific terms. Users can browse from two main areas which are 'Students' and 'Subjects'. Figure 6.11 shows the browsing page of SmartLP System.

Figure 6.11: Browsing page of SmartLP

6.3 Case Adaptation

The adaptation process is crucial in SmartLP as it is the process by which users can modify the elements of the retrieved lesson plans to match their constraints. Apart from viewing the content, users are able to customise the lesson plans according to their constraints and save them as new lesson plans. This is achieved by the customisation function in the system. For adaptation, the task is

to recognise when an adaptation should be applied because the new and retrieved problems might be sufficiently different in some relevant way, and to perform some changes to the retrieved solution. An adaptation can be considered as a situation (problem description)/action (solution) pair. When users specify a new problem description, the new solution will be presented to them.

Several techniques for case adaptation were discussed in Chapter 2. In SmartLP, manual adaptation, that used a transformation technique which alters the retrieved solution by adding, deleting or replacing parts of the retrieved solution to suit the new problem, was applied. The retrieved cases can be modified by users to suit their constraints in hand by adding new values, delete inappropriate values or update them. Although the adaptation process is done manually, the process becomes easier via the smart interfaces it offers.

In the SmartLP system, a new lesson plan can be generated from one or several customised cases. Users are able to generate new lesson plans by modifying elements of the retrieved lesson plans that do not match their problems and save them as a new lesson plan. They become the author of this lesson plan and can revise them in their next visit to the system. Figure 6.12 shows the search result page whereby the lesson plans can be chosen to generate a new lesson plan by checking the check box of a particular record in the select column. The elements of the selected lesson plans can be compared side by side in a table as shown in Figure 6.13.

Figure 6.12: The selected lesson plans to be customised

Figure 6.13: Selected elements in a comparison table

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In case the users prefer most elements in a particular lesson plan rather than the others, they can check the 'select all' button at the bottom of that lesson plan. At this stage, if users do not want to select any elements from a particular lesson, they can click the 'remove' button, as shown in Figure 6.14.

Figure 6.14: Selected elements in a comparison table

Here users can select whatever elements they would like to include in a newly generated lesson plan. Elements from these different lesson plans will be accumulated in their particular fields in the generated plan, as shown in Figure 6.15. All fields are editable and users can modify the elements in this lesson plan before save as a new lesson plan. The author of this customised lesson plan is identified by the user session.

The adapted cases will be available to everyone in this teacher community after being verified by the system administrator. When another teacher happens to construct a lesson plan with similar constraints, s/he can use any types of search to retrieve the customised case, and possibly revise and create a new case to be

used. The solutions in the adaptation process will fit the current problem context which subsequently brings in a new solution to the problem.

Figure 6.15: The selected value from several lesson plans in new generated lesson plan

Attachment files from the original lesson plans can be retained if users want to include them in the new generated lesson plans or they can be removed. In addition, new files can be attached by clicking on the 'add' link to add more attachments. If users would like to remove any attachment files, they can simply deselect the checkbox of those particular files. Figure 6.16 and 6.17 show files attachment procedure in the new generated lesson plans.
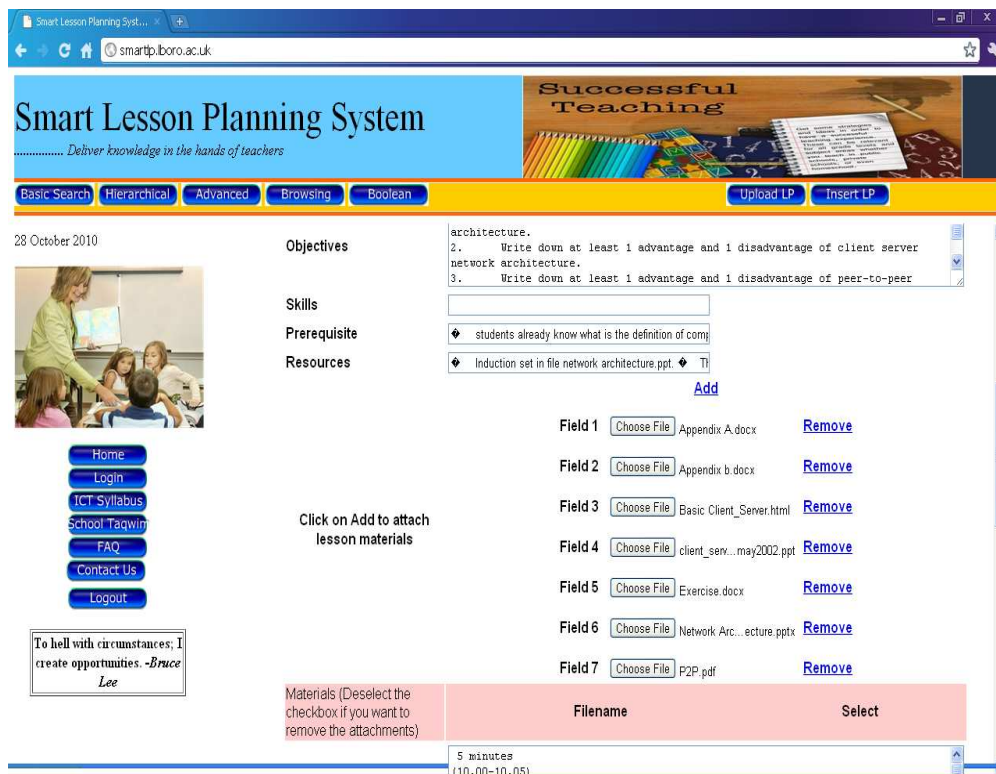
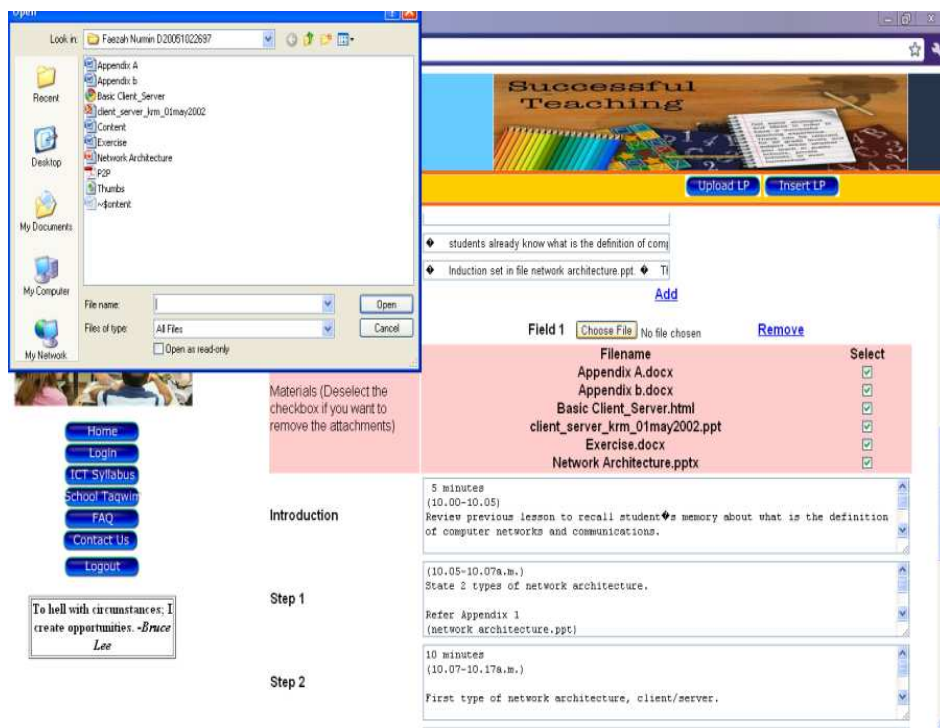**Figure 6.16: Add and remove attachment files**

Figure 6.17: Attachment files in a new generated lesson plan

After the customisation process, the new generated lesson plans should be saved to the system. The new lesson plans can also be saved as a document file or html file as well as being printed as shown in Figure 6.18.

Figure 6.18: The new generated lesson plan is saved

6.4 Case Revision

Lesson plans which have been customised and shared by authors can be revised in their next visit to the system. Therefore, users are required to login to the system to keep the session active. It is important to retain the session while they are using the system in order to identify the owner of the lesson plans. Here, their username will be displayed and all lesson plans generated by them will be listed as shown in Figure 6.19.

6.19: List of lesson plans constructed by a user

The content of a particular lesson plan can be revised by users by just clicking on the lesson ID. The details of that lesson plan will be presented to users and all fields in this lesson become editable. Figure 6.20 shows this process.
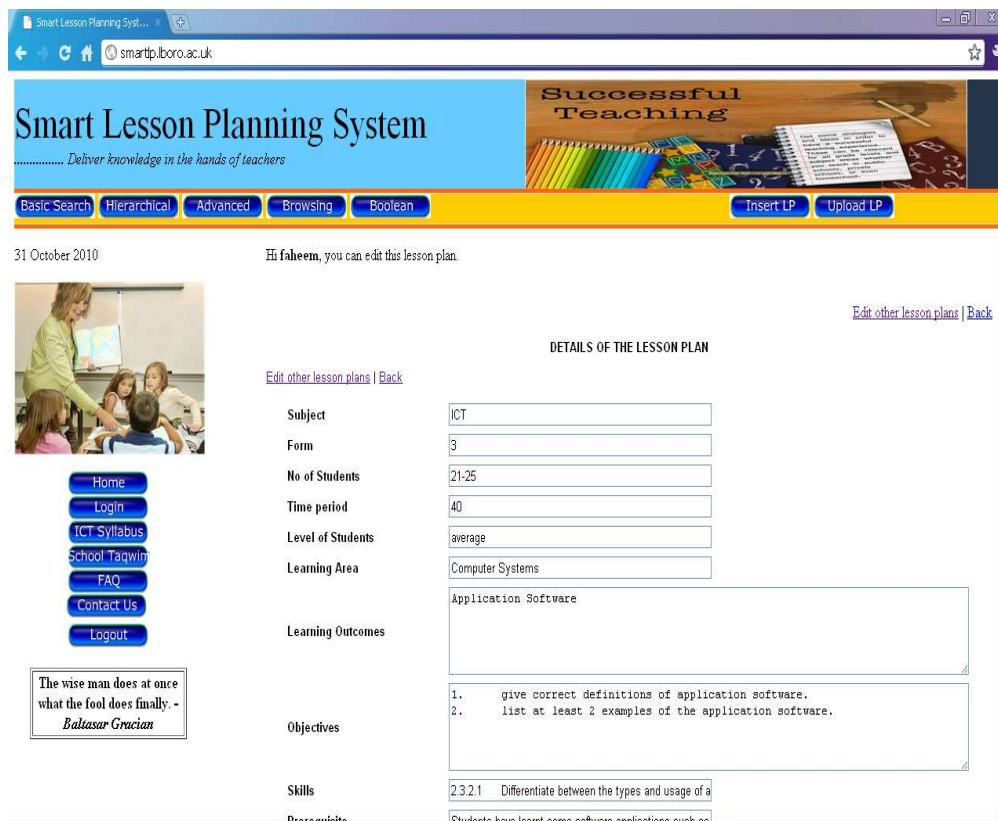
Figure 6.20: The chosen lesson plan which can be refined by the author

6.5   Case Validation and Retention

All cases that are shared and generated in the system are saved in the case base. By default all new lesson plans are saved as unverified and will not be considered for retrieval until they are verified by the system administrator. The list of unverified lesson plans that is only visible for the system administrator is shown in Figure 6.21. The status of the lesson plans are classified as 'yes' and 'no' to differentiate unverified lesson plans as oppose to verified lesson plans.

Figure 6.21: Unverified lesson plans

In order to assist the system administrator doing validation work, several methods are used. It is vital to make sure no similar cases, without any significant difference is stored in the case base which will only consume space. They are discussed in the following sections.

The list of unverified lesson plans comes with links to their parent, from which they are customised and generated. These new lesson plans will be compared with all the parents by referring to the parent ID. In addition, they will be compared to other lesson plans that have similar parent ID (siblings). In Figure 6.22, a newly generated lesson plan with lesson ID 202 is compared to its parents, lesson ID 80 and 81. Afterwards, these lesson plans can be compared thoroughly by using DiffDoc, free software used to compare two documents. Figure 6.23 shows a column, 'compare' with 'download' link to download the lesson plans before being compared using DiffDoc. After being verified, the lesson plans will be considered for case retrieval via the five types of search.

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Figure 6.22: New unverified lesson plan is compared side by side to its parents

Figure 6.23: Lesson plans can be downloaded as document files and be compared using DiffDoc software.

6.6 Lesson plan sharing

There are three types of lesson plan sharing mechanisms in the system; whether by saving the newly generated lesson plans, uploading or keying them into the system manually. Figure 6.24 illustrates the page to insert new lesson plans whereby the hierarchical drop-down menu was used to facilitate users in sharing lesson plans efficiently. Attachment of any files related to the lesson can be uploaded easily as discussed in the user interface design section in Chapter 5.

Figure 6.24: Hierarchical drop down menu help users in choosing only related keywords

In order to share lesson plans by uploading them, users are only required to enter the main fields. The contents of lesson plans can be uploaded as an attachment.

6.7 Conclusion

The implementation of SmartLP covers all important activities in the CBR cycle which are retrieval, reuse, revise and retain, after being represented using an attribute-value structure. Hybrid approach, which combines computational and representational technique, was used for case retrieval in the system. Hierarchical representation, based upon measures of similarity was used together with a computational approach, in terms of weighting. Query expansion and query weighting are used to give flexibility for users and to get a better search result. Similarity definitions and similarity characterisation (weighting/ranking) were implemented in an advanced search. In hierarchical search, the similarity is based on the curriculum and students' hierarchy of the term in their domain structure. Search by browsing utilises the same approach as hierarchical search. Free keywords are allowed in basic search (full text) while the Boolean Search applies Boolean concept. Manual adaptation can be made via smart interfaces offered in the system, based on one or multiple cases. The validation process assures that the retained cases are of a satisfactory quality. In summary, the representation, retrieval, adaptation and validation process is presented in Table 6.6.

Table 6.6: Summary of CBR process in SmartLP

No.of cases	Representation	Retrieval	Adaptation	Validation
60++	Structural (Attribute-value)	1.Nearest neighbour with terms weighting 2. Query terms expansion 3. Boolean 4. Basic 5. Browsing	Single or multiple adaptations. Apply comparison table from which several values can be selected and edited	Based on parent ID and Sibling. The new customised lesson plan will be compared to the parents' ID and siblings' ID (based on Similar parent ID) Use DiffDoc to compare siblings.

Later, evaluation of the system will be undertaken to examine whether the research questions itemised in Chapter 1 are answered. The overall hypothesis is that: "Teachers manage to construct quality lesson plans in a shorter period of time by using SmartLP, a case-based lesson planning system, as compared to manual method."

CHAPTER 7

EVALUATION DESIGN AND ANALYSIS OF RESULTS

7.1 Introduction

The purpose of an evaluation process is to assess a system with reference to some selected baseline to see whether the performance of the system is efficient. The overall objectives of the SmartLP system evaluation are to assess whether the user's needs are properly met, the system is suitable for the required tasks and it enables users to take less time to construct quality lesson plans. It tests the usability, functionality and acceptability of this case-based lesson planning system. The process of evaluation and the analysis results are presented in this chapter.

Both quantitative and qualitative approaches were used in this research, as multiple methods permit a wider and more complete understanding of the phenomenon studied. The two main techniques used are experiment and interview. This is particularly important, because each data collection method is limited with regard to what it can measure effectively. The qualities of data are also enhanced because triangulation is possible. A formative study, involving a small sample of new in-service teachers, was conducted to assess the acceptance and effects of SmartLP in assisting teachers with lesson preparation. A series of statistical tests within an experiment were handled with different aims and hypotheses. Statistical significance was tested in relation to predefined hypotheses. These experiments are supported by interviews to acquire information about first-hand experience of using SmartLP.

Section 7.2 describes the overall al process and testing. Section 7.3 presents the analysis results of lesson plan construction under three different independent situations (not using the system). This is followed in Section 7.4 by Analysis 2: lesson plan construction under four different matches, together with an analysis

of the adaptations made to each constructed lesson plan by the experimental group. The control lesson plans and the experimental lesson plans are evaluated and compared with respect to the time taken to construct them. The effects of SmartLP on the efficiency of constructing lesson plans and the quality of the lesson plans are summarized. Section 7.5 discusses the usability of SmartLP and is followed by the conclusions in Section 7.6.

7.2   The experiment

7.2.1 *Overview*

One benefit of an experimental approach is that it is possible to examine in detail the exact difference in time taken to construct quality lesson plans. In addition, all components of a lesson plan can be inspected thoroughly. Therefore, the criteria of a good lesson plan, as discussed in Chapter 4, were used as the baseline to measure quality.

The cases in the prototype system were set for ICT in form 4's syllabus. Thus, the experiment involves teachers who teach ICT to form 4 students (age 16). Since not all schools in Malaysia offer ICT, new ICT teachers in scattered locations were identified. A list of ICT teachers was acquired from the State Education Department. Participants were then contacted by email and phone. The data were collected over a period of five weeks. An overview of the study was provided to the participants along with the details of the experimental procedure.

There are two main analyses in the experiment. A comparison of lesson plans constructed independently under three different conditions were set up for Analysis 1 to make sure that the three tasks are at the same level of difficulty. The criteria of the three tasks to construct lesson plans were selected from the National Curriculum syllabus for ICT. This is followed by Analysis 2, whereby the same tasks, which have different match criteria from the cases in the system, were compared. All the lesson plans, including those constructed by the experimental and control group, were assessed along two dimensions: time taken to construct the plan and its quality, using a similar process to that used by

examiners for teacher training in Malaysian schools. The detailed evaluation of each lesson plan involves ten measures. The holistic measures are objectives, teaching materials, contents, introduction, learning activities, teaching development, time management, enrichment, assessment and closure.

The results of the evaluation are presented in the following sections. The lesson plans produced by the control group are discussed first. The lesson plans constructed with different match criteria are presented with the adaptation made to each lesson plan by the experimental group.

7.2.2 Mann-Whitney U test

To test if there is a significant difference between the time spent on tasks, a non-parametric Mann-Whitney U test was used. The test compares the means of two variables to establish if there is a significant difference between them and if the average difference is significantly different.

The Mann-Whitney U test, is used to compare two population means that come from the same population. Non-parametric tests were used for all analyses, as the experiment involved a small number of teachers and it does not assume that the difference between the samples is normally distributed. Some assumptions that are assumed in the Mann-Whitney U test are that the sample drawn from the population is random, that there is independence within the samples, the sample are mutual, independent, and that there is an ordinal measurement scale.

Calculation of the Mann-Whitney U test:

To calculate the value of the Mann-Whitney U test, the following formula is used:

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

Where:
U =Mann-Whitney U test R_i: Rank of the sample size
n_1 = Sample size one
n_2 = Sample size two

In this research, the variables under consideration were the time taken to construct lesson plans referring to the system with different match criteria versus independent lesson plan construction. In addition, the null (H0) and alternate (H1) hypotheses were formulated. H0 is that there is no significant difference between the means of the time taken to construct the lesson plans across the two groups, and H1 is that there is a significant difference between the means of the two groups.

7.3   Analysis 1 (control group): Lesson plan construction under three different independent situations

7.3.1 *Overview*

The subjects, variables and hypothesis of this analysis are as follows:

Subjects: Five participants consisting of new teachers who have taught form 4 ICT for less than two years.

Variables: Independent variables are the different criteria of the three lesson plans, while the dependant variables are the time taken and the quality of the constructed lesson plans.

Hypothesis: There is no significant difference in the time taken to construct the three lesson plans in the control group.

A guideline to the experiment was emailed to the respondents. A template of a lesson plan was provided to them so that the final output would be the same as in the experimental group, which is generated by the system. This is important, as lesson plans from both groups are compared in Analysis 2. Thus, anything that might differentiate the lesson plans from each group was eliminated.

The times taken to construct lesson plans for the three tasks in the control group were identified before being used in the experimental group. This is crucial, as the three lesson plans with different matches are compared in the context of the time taken to construct them. Therefore, the time taken to construct those lesson plans is one mechanism to ensure that they are within the same level of difficulty. The three tasks with different criteria are outlined below in Table 7.1.

Table 7.1: Criteria of the three tasks in the experiment

	Independent variables		
	Control Group		
Criteria	Task 1	Task 2	Task 3
Form	4	4	4
Subject	ICT	ICT	ICT
Learning area	Computer systems	Multimedia	Computer systems
Topic	Computer systems' current and future development	Multimedia concept	Software
Learning outcome	Latest open source software available	Multimedia in various fields	Operating systems
Number of students	26–30	26–30	26–30
Time period (in minutes)	40	40	40
Students' ability	Average	Average	Average

7.3.2 *Results of time taken*

Respondents were asked for the time in minutes spent to complete lesson plans for the three tasks. The five respondents in this group are known as TC1, TC2, TC3, TC4 and TC5. The times taken by the five respondents are shown in Table 7.2.

Table 7.2: Time taken in minutes to complete tasks

	TIME TAKEN BY 5 RESPONDENTS		
	Task 1	Task 2	Task 3
TC 1	35	40	35
TC 2	35	35	40
TC 3	38	40	40
TC 4	35	40	35
TC 5	35	35	40

The null hypothesis is that there is no difference in the time taken to construct lesson plans between Task 1 and Task 2, Task 2 and Task 3 and Task 1 and Task 3. Three separate Mann-Whitney U tests were run with the significance level at 0.05. Two sets of lesson plans for Tasks 1 and 2, Tasks 2 and 3, and Tasks 1 and 3 were compared. The dataset and the analysed results are presented in Tables 7.3 and 7.4. The mean rank of each pair of tests, Task 1 and Task 2, Task 1 and Task 3, and Task 2 and Task 3, are shown in Table 7.3.

Table 7.3: Mean rank for control group

	N	Mean Rank	Sum of Ranks
	Minutes		
Task 1-2	5	4.20	21.00
	5	6.80	34.00
Task 1-3	5	4.20	21.00
	5	6.80	34.00
Task 2-3	5	5.50	27.50
	5	5.50	27.50

The results in Table 7.3 show that the first two pairs, Task 1 compared with Tasks 2 and 3, have differences in the average time taken, with values of 4.20 and 6.80 respectively. Hence, further testing is needed to see whether the differences are significant or not. A statistical test for the three pairs of tasks is shown in Table 7.4 with the significance value; the p-value based on the normal approximation is highlighted.

Table 7.4: Statistical results for control group

Tasks (Minutes)	Tasks 1-2	Tasks 1-3	Tasks 2-3
Mann-Whitney U	6.000	6.000	12.500
Wilcoxon W	21.000	21.000	27.500
Z	-1.554	-1.554	.000
Asymp. Sig. (2-tailed)	**.120**	**.120**	**1.000**

The significance value for Tasks 1-2 and Tasks 1-3 is 0.120, while Tasks 2-3 is 1.000, which are all >0.05. Therefore, the null hypothesis that there is no significant difference in the times taken to construct lesson plans in this group can be accepted. This means that the distribution of the times taken to construct lesson plans is the same across the group.

7.3.3 *Results of quality analysis*

Although the times taken to construct the three sets of lesson plans by respondents in the control group are the same, the quality of those lesson plans needs to be assessed. Thus, the lesson plans were sent to be evaluated by an expert in teaching, specifically in lesson plan construction. The expert is a

university lecturer who has 20 years' experience in teaching courses related to teaching methodology, especially for ICT. The expert was given a shuffled and unnamed set of 30 lesson plans consisting of all the lesson plans constructed by each respondent, including those in the experimental group. Code numbers were used to identify each lesson plan that was constructed by referring to the system (with their matching percentage) and those constructed by the control group.

The ten elements of a lesson plan stated earlier were given marks from 1 to 5. A mark of 1 indicates very weak, 2 weak, 3 average, 4 good and 5 excellent. The marks obtained by the five respondents in this group for the ten elements for Task 1, Task 2 and Task3 are shown in Table 7.5.

Table 7.5: Marks for ten elements in the lesson plan for Task 1, 2 and 3 in control group

	TC1			TC2			TC3			TC4			TC5		
Task	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Objectives	3	3	3	3	5	3	3	3	4	3	4	3	2	3	3
Teaching materials	4	4	3	1	4	1	3	4	3	4	5	4	2	3	3
Contents	4	3	2	1	5	1	4	4	4	2	5	2	4	4	3
Introduction	4	3	4	4	5	4	4	5	3	2	5	2	3	5	5
Learning activities	3	3	2	2	3	2	2	2	3	2	3	2	3	5	3
Teaching development	2	4	2	4	4	4	3	4	3	3	5	2	4	4	3
Time management	2	4	2	1	3	1	4	4	3	2	4	3	2	1	3
Enrichment	1	3	1	4	4	4	1	3	1	2	4	2	4	4	2
Assessment	2	2	2	3	3	3	3	3	3	1	3	2	3	5	3
Closure	3	2	3	3	4	3	5	3	4	1	3	3	3	3	3
Total marks	**28**	**31**	**23**	**26**	**40**	**26**	**32**	**35**	**31**	**22**	**41**	**25**	**32**	**37**	**31**

7.4 Analysis 2: Lesson plan construction under four different criteria

7.4.1 *Overview*

This experiment aims to discover the effectiveness of the CBR approach in SmartLP via the retrieval and adaptation process. All participants in the experimental group were required to construct lesson plans under three different conditions. Lesson plans were produced in three different situations; the criteria that matched with the cases in SmartLP were compared to each other. In addition, these experimental lesson plans were compared with the independent lesson plans under the same criteria. Participants were required to construct lesson plans by referring to the SmartLP system. They were given details of the experimental procedures, including the system URL: http://smartlp.lboro.ac.uk. Although the constructed lesson plans might be highly dependent on cases already in the case base, the participants were reminded that the SmartLP system provides support as a baseline. They could make adaptations to the retrieved cases by referring to other resources. Users can customise those lesson plans to match the criteria. Adaptations made by users to the retrieved lesson plans were inspected to discover whether they were simply used as they stood, or used with minor or major changes. The subjects, variables and hypothesis of the analysis are as follows:

> **Subjects:** As for the control group, participants in the experimental group also consist of five new ICT teachers with less than two years' teaching experience in ICT.
>
> **Variables:** The independent variables are lesson plans that match by different criteria with the contents in the system.
>
> **Hypothesis:** The times taken to construct lesson plans with different criteria are the same.

The criteria that match criteria A, B and C are shown in Table 7.6. The checked elements mean that there exists at least one lesson plan in the system that has those criteria, while the unchecked elements do not.

Table 7.6: Matching criteria in the three tasks to the SmartLP System

	Task 1 (A)	Task 2 (B)	Task 3 (C)
Form	√	√	√
Subject	√	√	√
Learning area	√	√	√
Topic		√	√
Learning outcome			√
No. of students			√
Time period (in minutes)			
Students' ability			
Teaching materials		√	√
Attachments of the materials		√	√

The matching criteria for the three tasks are simplified as a set-subset in Figure 7.1. Task 1 (A) has fewer matching criteria compared to Task 2 (B) and Task 3 (C), which only have matches in form, subject and learning area. Task 3 (C) matches in form, subject, learning area, topic, learning outcome, number of students per class, teaching materials and attachments to materials. Task 2 (B) contains the same criteria as for Task 3 (C) except learning outcomes and the number of students, which are not included.
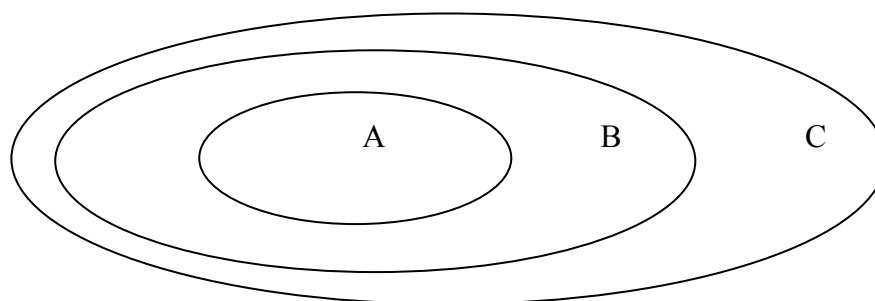
Figure 7.1: Different match criteria in Task 1, Task 2 and Task 3

The three tasks that were considered are the same as in Table 7.1. The criteria of the lesson plans in terms of curriculum and students' constraints are all the same. The learning areas, topics and learning outcomes are part of the curriculum, while student ability and the number of students are part of students' constraints. Time period and resources are both part of the facilities available.

The independent variable in this case is the different tasks with different criteria values. The dependent variable is the time taken to construct quality lesson plans, the observed result of the independent variable being manipulated. These

three lesson plans were also compared to the lesson plans constructed by teachers from the control group who did not have access to the system. The other dependent variables are the adaptations made to those retrieved lesson plans.

7.4.2 *Time taken*

Like the respondents in the control group, those in the experimental group were also asked to rate the time spent to complete the tasks. Table 7.7 presents the comparison of the results obtained in minutes. Those lesson plans constructed independently (A1, B1, C1) for Task 1, 2 and 3 were compared to their pairs with respective criteria (A, B, C).

Table 7.7: The times taken to construct lesson plans with different matches

Similarity match	Time taken by 5 respondents in minutes					
	A	A1	B	B1	C	C1
Respondents 1	12	35	15	40	18	35
Respondents 2	7	40	8	35	10	35
Respondents 3	8	40	10	40	15	38
Respondents 4	5	35	7	40	12	35
Respondents 5	8	40	10	35	12	35

Three different analyses were done to analyse the time taken to construct the three lesson plans with different matches in the experimental group, as follows:

i. Lesson plans with A similarity criteria are compared to those with B similarity.

ii. Lesson plans with B similarity criteria are compared to those with C similarity.

iii. Lesson plans with A similarity criteria are compared to those with C similarity

In addition, another three analyses were done to compare lesson plans from the control group, which have no similarity criteria, with those in experimental group with A, B and C similarity criteria.

The mean ranks for the six pairs are shown in Table 7.8.

Table 7.8: Mean rank for the control group

Minutes			
Task	N	Mean Rank	Sum of Ranks
Task 1-2	5	7.10	35.50
(A-B)	5	3.90	19.50
Task 1-3	5	7.60	38.00
(A-C)	5	3.40	17.00
Task 2-3	5	6.50	32.50
(B-C)	5	4.50	22.50
Task 0-1	5	8.00	40.00
(A-A1)	5	3.00	15.00
Task 0-2	5	8.00	40.00
(B-B1)	5	3.00	15.00
Task 0-3	5	8.00	40.00
(C-C1)	5	3.00	15.00

From Table 7.8, it can be seen that all six pairs show differences in mean rank. The first set of Task 1 and Task 2 has a mean rank of 7.10 and 3.90. The pair Task 1 and Task 3 has a value of 7.60 and 3.40. The third pair, Tasks 2 and 3, has an average rank of 6.50 and 4.50. For the other three sets, compared to the control group, the mean ranks are the same at 8.00 for 0 criteria and 3.00 for their pairs. The difference between the means for the two sets of data warrants further investigation to test the statistical significance of the difference. The significant differences for the six sets of data are shown by significant two tails, which are highlighted in Table 7.9.

Table 7.9: Statistical result for six pairs of data

Similarity	A- B	A-C	B-C	A1-A	B1-B	C1-C
Mann-Whitney U	4.500	2.000	7.500	.000	.000	000
Wilcoxon W	19.500	17.000	22.500	15.000	15.000	15.000
Z	-1.702	-2.227	-1.064	-2.703	-2.660	-2.660
Asymp. Sig. (2-tailed)	**.089**	**.026**	**.287**	**.007**	**.008**	**.008**
Null hypothesis.	Retain	Reject	Retain	Reject	Reject	Reject

In the Mann-Whitney U test, p values for the two-tailed test help us to decide whether or not the mean of the two populations is equal. If the asymptotic significance is less than 0.05, the null hypothesis that the distributions of minutes are the same across the groups should be rejected. This means that there is a significant difference in the time taken to construct the lesson plans between the two tasks. According to the results in Table 7.9, two sets of pairs, A–B and B–C, show values of 0.089 and 0.287 respectively, which are more than 0.05. Hence, the null hypothesis should be accepted; there is no significant difference in the time taken to construct those lesson plans. The pair A and C has a significant value of 0.026, while the pair C1 and C has a significant value of 0.007. Significant values of 0.008 were shown for the two pairs B1–B and A1–A. Thus, these four pairs have a significant difference in the time taken to construct the lesson plans.

In summary, at the 0.05 level of significance, there is enough evidence to conclude that there is a significant difference in the time taken by the two groups, the experimental group (A, B and C), who use the system to construct lesson plans, and the control groups (A1, A2 and A3), who construct the system independently. In addition, there is a significant difference in the time taken to construct lesson plans with matching criteria A and C. On the other hand, there is no significant difference in the time taken to construct those lesson plans with matching criteria A to B and B to C.

7.4.3   *Adaptation*

Lesson plans constructed by teachers in the experimental group were scrutinized. Any adaptations made to the retrieved lesson plans were examined

to determine whether they were used straight away or with modifications. The changes made were explored and the original lessons from which the lesson plans were adapted are presented in case numbers as shown in Table 7.10.

Table 7.10: Adaptation made to the retrieved case

Respondent	The original lessons from which the lesson plans were adapted		
	Task 1 (A)	**Task 2 (B)**	**Task 3 (C)**
TE1	-	88 and 113	155
TE2	-	113 and 112	155
TE3	-	88	155
TE4	-	113 and 88	155
TE5	-	113	173

Task 1

The five respondents constructed lesson plans for Task 1 by not specifically referring to any lesson plan in SmartLP. None of the lesson plans in SmartLP has the learning outcome 'latest open source software available' as defined in Task 1. The same topic of 'software' in the computer system learning area is also unavailable in the system. Although there are some lesson plans in the computer system learning area, they are too broad and not related to the specified learning outcome.

Task 2

All constructed lesson plans for Task 2 were adapted based either on one or multiple cases. Multiple customisations using lessons 88 and 113 were applied by respondent TE1 to generate a new lesson plan based on the criteria for Task 2. The lesson plan for Task 2 was constructed by respondent TE2 by customising lessons 113 and 112 in the SmartLP system, dominated by elements from lesson 113. Most of the elements from the original lesson were retained, with a few changes. The time period, level, learning area, topic, learning outcome, prerequisites and closure remain the same. One step from the original learning activities was dropped and the assessment takes longer with the addition of a list of questions.

Respondent TE3 used lesson 88 as a baseline to plan Task 2. The original lesson differs in time period and students' ability. Learning outcomes are the same, but this respondent defined her own learning objectives and redefined the skills. The learning steps are different but use the same approach: group activity. The closure and assessment in the newly generated lesson are also different.

Respondent TE4 constructed Task 2 based on multiple customisations: lesson 88 in addition to 113. Time period, level and number of students have been changed, while the prerequisites, learning area, topic, learning outcome and objectives are retained. There is a slight different in the planned timing for each activity. The lesson plan of respondent TE5 was constructed based on lesson 113 in the SmartLP System. As the criteria for time period, level, learning area, topic, learning outcome and prerequisites are the same the elements are retained. Step 1 was dropped and another step planned. For assessment, students are required to answer questions on an answer sheet. The planned closure is also different. Overall, respondents used 70% of the content of the original lesson plans to produce new lesson plans.

Task 3

A single adaptation for the retrieved lesson plans was used by all respondents for Task 3.   Almost all lesson plans for Task 3 were used as they stood, by the respondents. This might be because the most specified criteria in this task match to the cases in the SmartLP System.

The lesson plan for Task 3 was constructed by respondent TE1 based on lesson 155. The number of students and time period were modified according to the features in Task 3. Almost all of the elements were retained, with the defined skills slightly changed. Respondent TE2 also used lesson 155 as a baseline to construct lesson plans for Task 3. The number of students and time period were changed to match the stated criteria. There is not much difference in overall content from the original file. Furthermore, all learning steps remain the same. Again, lesson 155 was chosen by respondent TE3 to plan a lesson for Task 3. The group task was implemented for learning activities. The skills are redefined and the objectives are reduced. The planned resources and prerequisites are

different from the original file. The introduction is not the same but uses the same technique, which is to recall previous lessons. The learning activities are aimed more at the students in contrast to being teacher-centred in the original file, lesson 155. In addition, the learning activities apply different steps. However, time management is not written into the newly generated lesson plan.

Lesson 173 was referred to by respondent TE5 to construct a lesson plan for Task 3. The level of student ability was changed from excellent to average. The time period, number of students, learning area, learning outcomes and objectives remained the same. Prerequisites, resources and learning steps and closure are also the same. The newly generated lesson is slightly different in timing for each step. Respondent TE5 also used lesson 155 as a baseline to construct a lesson plan for Task 3. The defined skills were slightly changed. As with the other lesson plans that use lesson 155 as a baseline, the number of students and time period were modified according to the features in Task 3. Generally, respondents applied 85% of the content of the original lesson plans to generate new lesson plans.

7.4.4 *Results of the quality*

The constructed lesson plans under three different matching criteria, A, B and C, were evaluated by an expert to ensure that they are 'quality' lesson plans. The expert is the same examiner that evaluated the control group. Comments given by the expert to the control and experimental lesson plans are attached in Appendix D. Tables 7.11 present the marks allocated for Task 1, Task 2 and Task 3, which have A, B and C matching criteria. Each table has details of the marks for the ten elements, as itemised. The five teachers in this group are referred to as TE1, TE2, TE3, TE4 and TE5.

Table 7.11: Marks for ten elements in the lesson plans for Task 1, 2 and 3 (Experimental group)

	TE1			TE2			TE3			TE4			TE5		
Task	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Objectives	3	4	4	4	4	2	4	3	2	2	3	4	2	4	5
Teaching materials	5	4	3	5	4	3	3	3	3	3	3	3	3	4	5
Contents	4	4	4	4	3	2	3	4	2	3	4	4	3	4	5
Introduction	5	5	3	5	4	3	2	3	2	2	2	3	3	5	5
Learning activities	4	3	4	3	3	3	3	4	3	3	3	4	3	3	4
Teaching development	4	4	4	3	4	4	3	4	4	2	3	4	3	4	4
Time management	2	4	4	2	3	2	1	1	2	3	3	4	3	4	3
Enrichment	2	5	2	1	3	1	2	4	1	2	2	4	3	3	4
Assessment	2	3	3	2	5	3	2	2	1	2	1	3	2	5	4
Closure	4	4	4	3	1	5	3	3	3	3	3	5	3	4	5
Total marks	**35**	**40**	**35**	**32**	**33**	**28**	**26**	**31**	**23**	**25**	**27**	**38**	**28**	**40**	**44**

The average mark of the experimental group for Task 1 is 29 out of 50, with all scores above 25. This indicates that the constructed lesson plans are of a reasonable standard. All experimental lesson plans for Task 2 show marks above 25. The average mark of the five respondents for Task 2 is 37, which is good. The marks scored by all respondents are 25 and above except for one respondent who gained 23 marks. The average mark of the five respondents for Task 3 is 33, which is in the good range of quality. The total marks for each task of all respondents in the control and experimental groups are shown in Table 7.12.

Table 7.12: Marks for the three tasks by respondents in the experimental and control groups

RESPONDENTS	Task 1		Task 2		Task 3	
	Experimental	Control	Experimental	Control	Experimental	Control
Teacher 1	35	28	40	31	35	23
Teacher 2	32	26	33	40	28	26
Teacher 3	26	32	31	35	23	31
Teacher 4	25	32	27	41	38	25
Teacher 5	26	32	40	37	44	31

The subjects, variables and hypothesis for analysis of quality are as follows:

Subjects: Ten ICT teachers with less than two years' teaching experience in ICT for both the control group and experimental group.

Variable: The independent variable is the users' dependence on the SmartLP system. Participants in the experimental group have access to the system while those in the control group do not.

Hypothesis: The quality of the constructed lesson plans of the two groups is the same.

A Mann-Whitney U test was used in this analysis. In the Mann-Whitney U test, p values for the two-tailed test were used to decide whether or not the mean of these two groups, experimental and control, are equal. If the asymptotic significance is less than 0.05, the null hypothesis, that the quality of the constructed lesson plans are the same across the groups, should be rejected. This means that there is a significant difference in the quality of the constructed lesson plans in the two tasks. Table 7.13 presents the mean rank for both the control and experimental group.

Table 7.13: Mean rank of the score marks for control and experimental group

Task	Group	N	Mean Rank	Sum of Ranks
Task 1	Control	5	5.20	26.00
	Experimental	5	5.80	29.00
Task 2	Control	5	6.30	31.50
	Experimental	5	4.70	23.50
Task 3	Control	5	4.30	21.50
	Experimental	5	6.70	33.50

Table 7.13 clearly shows differences in average rank for the three tasks. Task 1 for the control group has a value of 5.20, while the experimental group has a mean rank of 5.80. Task 2 for the control and experimental groups has values of 6.30 and 4.70 respectively. Task 3 of the control and experimental group has an average rank of 4.30 and 6.70 respectively. The difference between the means for the two sets of data for the control and experimental groups has led to a statistically significant difference. The significant differences for the three tasks are shown by significant two tails, which are highlighted in Table 7.14.

Table 7.14: Statistical results for the three tasks of both the experimental and control groups

Task	1	2	3
Mann-Whitney U	11.000	8.500	6.500
Wilcoxon W	26.000	23.500	21.500
Z	-.319	-.849	-1.261
Asymp. Sig. (2-tailed)	**.750**	**.396**	**.207**
Null hypothesis.	Retain	Retain	Retain

All three tasks show Asymp Sig. (2-tailed) values more than 0.05. Hence, it can be concluded that, at the 0.05 level of significance, there is enough evidence to indicate that there is no significant difference in the quality of the constructed lesson plans produced by the two groups – the experimental group, who used the system to construct lesson plans, and the control group, who constructed the lesson plans independently.

7.5   Usability of SmartLP: interviews with respondents

The usability of SmartLP was synthesised from participants' feedback about their experience of using this system, to know whether the SmartLP system has features of a good lesson planning system. A series of online interview sessions was conducted with the teachers who constructed lesson plans using SmartLP. The aim of the interviews was to discover the users' views about the usability of SmartLP and their suggestions about how it could be improved. After the experiment took place, several interview sessions were carried out to compare

teachers' experiences from several perspectives. This was done by telephone due to the distance issue. The teachers were expected to describe their experience of creating a particular lesson plan using the SmartLP system and the interviews were recorded.

7.5.1 *Retrieval: Types of search*

There are five types of search in the SmartLP system: advanced, hierarchical, Boolean, browsing and basic. Respondents were asked which types of search they preferred in case retrieval. The answers vary. Two respondents preferred the advanced search, due to the hierarchical menu of the searched keywords offered. One respondent preferred to search by browsing, because the learning area and the lower levels are arranged systematically. Another respondent chose the hierarchical search, which applied term expansion with related terms presented for upper level, lower level and the same level. This is because the terms presented in the hierarchical search helped them to find specific lesson plans based on the chosen context. Basic search was chosen by one respondent because free keywords can be keyed in. This means that both searches using 'nearest neighbour' in advanced search and 'exact match' in the other searches were useful for the respondents.

As all respondents have experience of using the advanced search, their preference to use default values as opposed to specifying their own rating to the searched keywords was revealed. Four out of five respondents prefer to use default values on the searched keywords rather than to specify their own values. All five respondents agree that the hierarchical search in SmartLP has exploratory capability. All used the syllabus domain to search relevant lesson plans as compared to the student domain available in SmartLP. The respondents were also asked about their interest in using the menu-based search (in advanced search, browsing) compared with the free search (basic search, Boolean and hierarchical). Four respondents preferred the menu-based search and one respondent preferred the free search.

The respondents were asked about the presentation of the returned result. Four respondents preferred the results to be presented in ranked percentages (from

advance search) as opposed to randomly (in other searches). They agree that the results presented in percentages helped them to determine the similarity of the constraints to the lesson plans (cases) in the system. One respondent suggested that the result should be presented in learning area order. The results page, which shows the searched keywords and the number of results, was useful to all the respondents. Furthermore, pagination features offer choices to users to select the number of results to be displayed on one page with back and forward links.

7.5.2   *Terms and keywords*

The respondents were asked the terms or keywords that they used to find related cases. The majority of the respondents use learning outcome, which is the lowest level in the curriculum hierarchy, as a keyword to retrieve related lesson plans. For example, the users used Operating System (OS) instead of Software as the topic and Computer System as the learning area. Only one respondent selected the topic of the lesson plan for case retrieval, namely Multimedia Concept and Software. The learning area, such as Multimedia and Computer Systems, was the most related keyword by a respondent. This shows the dominancy of the curriculum domain as the preferred terms for case retrieval.

7.5.3   *The content and activity*

The respondents were asked whether the retrieved results from the system were relevant to their search. All five respondents gave positive feedback and one respondent specified that it is 70% relevant. This is due to case limitation in the case base to evaluate the system based on matching criteria. To further determine the relevancy, the respondents were asked if they used the suggested activities. All respondents used them to a certain extent. Teachers definitely need to modify learning activities according to the constraints in hand, the students' ability, time period, resources available and many more. One respondent claimed that he used 80%; another used 70%. On the other hand, one respondent explained that it depended on the topic taught. Due to coursework assessment, teachers sometimes need to proceed with the coursework activities. Overall, the

activities suggested were relevant and they had used them. This indicates that the cases are reliable. An important role is played by the verification process to validate new lesson plans.

7.5.4 *Adaptation*

Adaptations made to the retrieved lesson plans were revealed as discussed in section 4.4.3. Respondents were asked whether they used the retrieved lesson plans with or without modification. In addition, adaptation based on multiple or single lesson plans via case customisation were disclosed. All five respondents customised the retrieved case before using the lesson plans. This is because none of the given tasks have 100% similarity. The proportion of customisation based on one or multiple lesson plans are almost the same. Two respondents preferred to make modifications based on multiple lesson plans, while the other three made modifications based on just one lesson plan. The customisation process was said to be easy to understand and use. All the respondents stated that the attachments are easy to include and exclude from the list in the newly generated lesson plans. Four of the five respondents have experience in using the attachment. 80% of the newly generated lesson plans were saved in the system before being verified by the system administrator.

7.5.5 *User acceptance*

All respondents claim that with SmartLP assistance, the time taken to construct lesson plans is certainly reduced. This is not only due to the availability of the lesson plans with learning activities suggestions, but also the materials that can be easily downloaded. Another respondent suggested using the learning area as a baseline for most functionality, from case searching to the presented result. According to this respondent, teachers will get more choice of related cases by implementing this approach. For lesson assessment, it was suggested that the standard exam assessment based on each learning area be used. Besides the customisation of the retrieved content, one respondent proposed that the interface be customised as well, according to the users' preference. The functionalities provided in the system were defined as excellent, but the interface

needs to be upgraded. The layout should be more attractive and better organized.

7.6   Conclusion

An evaluation study was carried out to determine the effectiveness of the implemented SmartLP system in lesson plan construction. The effects of the SmartLP system upon the effectiveness of lesson plan construction of five ICT teachers with less than two years' experience were carefully evaluated and compared to a control group of another five teachers who prepared lesson plans without SmartLP's assistance. The results presented in Sections 7.2 to 7.5 confirm that with SmartLP assistance, there is a significant difference in the time taken to construct lesson plans (shorter), with no significant difference in the quality, evidenced by the obtained score. Adaptations made by the respondents are varied and both single and multiple case adaptations were adopted. The usability of the system was revealed by a series of interviews; all respondents found that SmartLP undoubtedly assisted them to construct lesson plans efficiently.

CHAPTER 8

CONCLUSION

8.1 Review of the Thesis

Planning for teaching is compulsory for all teachers, and past research shows that teachers spend a lot of time on lesson planning. This contributes to stress among teachers. The lesson plans constructed by teachers need to be tailored to accommodate student differences in various aspects such as the students' ability, previous knowledge and a variety of curriculum constraints. Statistical evidence suggests that online resources that can be accessed on a 24/7 basis are preferred by teachers to overcome these problems in lesson planning. Therefore, a web-based system, SmartLP, which has CBR features, has been implemented to assist teachers in customising lesson plans based on existing cases in the case base. The SmartLP system can be classified as a synthesis type of CBR system, whereby synthesis tasks attempt to create a new solution by combining parts of previous solutions in the adaptation process. The inputs are the constraints of the curriculum, students and facilities, while the outputs are appropriate elements that match the constraints in the constructed lesson plan. A research methodology that combines both system development and knowledge acquisition provides a guideline in this research.

The complete and detailed requirements of the proposed system are specified in knowledge analysis. The modelled knowledge is presented as cases, followed by case acquisition, which is then stored in a case base for retrieval. Lesson plan ontology in taxonomy form was built based on semantic networks. A case in the SmartLP system, which consists of a problem description and solution pair, was described. Attribute-value representation for the case is defined, with several indexing elements to accelerate the retrieval process. The system design was followed by system implementation of the main modules in SmartLP. The implementation of the SmartLP system was completed with a working prototype and involves iterative analysis, design and implementation before an evaluation

takes place to measure the efficiency of the SmartLP system to assist teachers in lesson plan construction.

8.2   Contributions of the research

The objectives of this research have been realised through the following contributions.

- ***Results from a formative study investigating the effects of the case-based lesson planning system upon the time taken to construct a quality lesson plan***

SmartLP's effectiveness upon the times taken to construct lesson plans were carefully evaluated and compared with those controlled lesson plans without SmartLP's assistance. The results revealed that all the lesson plans constructed with SmartLP assistance took significantly less time than the controlled lesson plans. No significant difference in writing quality was noticed for the control group who constructed lesson plans on the same tasks without receiving any assistance. The experimental group scored higher than the control group for Task 1 and Task 3. The marks for Task 2 are equal for both groups. The findings have been presented in-depth in the previous chapters. In addition, there is a significant difference in the time taken to construct lesson plans with A (least matching criteria) and C (most matching criteria). However, pairs A and B, B and C do not show any difference.

The time taken to construct lesson plans by using the SmartLP system is shorter, as most were customised from old lesson plans stored in the case base. The degree of adaptation made depends on the retrieved lesson plan. If the retrieved case meets most of the criteria in a particular task, only minor changes were made. For fewer match cases, major changes can be seen. With SmartLP's assistance, all the lesson plans can be produced in a significantly shorter time.

- *The implementation of a web-based system to assist teachers in generating and constructing lesson plans in a time-efficient manner*

The SmartLP system is a web-based system which can be accessed anywhere, anytime on a 24/7 basis. It is a case-based system which uses past experience as the domain knowledge and can provide a reasonable solution, through appropriate adaptation, to match teachers' constraints in the students' profile and the facilities available. Not only can lesson plans be retrieved, but the resources related to a particular lesson plan are also downloadable.

Generating new lesson plans can be done easily, quickly and precisely based on the cases stored in the case base without the time and accessibility problem. With the cases available in the case base, the process of preparing lesson plans is speeded up. Teachers, especially new and inexperienced ones, may benefit from a case-based system where knowledge from others could contribute to the process of lesson planning, as it is not started from scratch. The CBR approach through its cycle – retrieves, reuse, revise and retain – assists teachers to construct lesson plans based on their constraints within a shorter time frame. The system helps teachers to select appropriate elements via the menu list and the hierarchical menu list rather than having to key them in manually. The new tool, SmartLP, has a customisation function that enables teachers to select only related elements to be included in the newly generated lesson plans and edit the content according to their constraints rather than to start everything from scratch.

The design of a lesson-planning system based on the CBR concept, which consists of case retrieval, reuse, revise, review and retain

Solving problems by CBR involves obtaining a problem description and making suggestions through the cycle. All main activities in the cycle – retrieval, reuse, revise, review and retain – are available in the SmartLP system. The retrieval module consists of five types of search: advanced search, hierarchical, Boolean, basic and browsing. Interview sessions with the respondents, who are teachers that use the SmartLP system, show that each teacher has their own preference of the type of search, and the preference varies. This is due to the support offers

by each type of search. The tolerance retrieval approach, which comprises query term expansion and query term weighting, are applied in hierarchical search and advanced search respectively. Term expansion is also applied in search by browsing.

Adaptation for single or multiple cases helps teachers to customise the retrieved plan to suit their constraints and ultimately be reused. SmartLP goes beyond the other systems outlined in Chapter 2, as the retrieved lesson plans can be customised by teachers according to their constraints. The experiment shows that all lesson plans constructed by using the SmartLP system took significantly less time than constructing them independently, even to least match criteria.

As not all retrieved lesson plans can be used straightaway due to constraint differences, the SmartLP system allows teachers to modify the content of the lesson plan to suit the constraints they have in the problem descriptions. Adaptation based on one or multiple lesson plans can be chosen to generate a new lesson plan before it is reused. An adaptation can be considered as a situation-action or problem description-solution pair. When users specify a new problem description, the new solution will be presented to them. The SmartLP system has a customisation function that enables teachers to select only related elements to be included in the newly generated lesson plans and edit the content according to their constraints. In SmartLP, manual adaptation via smart interfaces, which use a transformation technique that alters the retrieved solution by adding new values, deleting inappropriate values or updating parts of the retrieved solution to suit the new problem, was applied.

Analyses of the newly generated lesson plans show that the task with the most similar criteria (Task 3) was generated based on a single case adaptation with minor changes. Three out of five experimental lesson plans for Task 2, where half of the criteria match some cases in the case base, were generated using multiple adaptations. This means that both types of adaptation are applicable to users based on the constraints teachers have in hand.

This is followed by case refinement that allows users to access and revise their constructed lesson plans in the system. Validation mechanisms through case

verification, ensure that the retained cases are quality ones, after being reviewed by the system administrator.

The following designs were done:

a. Access to previously constructed lesson plans via any five types of search (retrieval).
b. The design of a lesson planning system that facilitates adaptation (reuse with or without adaptation).
c. The design of a tool to enable refinement of the constructed lesson plans (revise).
d. The design of a tool to validate cases to avoid two similar cases being stored in the case base (review).

Case representation of a lesson plan

A case in the lesson planning system was defined in a series of knowledge modelling. Components of a case in SmartLP consist of problem descriptions, the various constraints that teachers face in constructing lesson plans and their pair solution. This was explained in Chapter 4. The case is then represented using attribute-value representation.

a. Ontology

The core concepts to be organised in lesson plan ontology were derived from the semantic net, a directed graph causal network illustrating how elements in lesson plans relate to each other. Each concept was linked to other concepts by exploring the relationships, and the whole set of concepts was expressed according to a taxonomic representation. Lesson plan taxonomy consists of four main nodes, which are curriculum, students, facilities and content. Each node is then divided into detailed nodes.

b. The importance of elements in lesson plans contributing to the default weight applied in advanced search

All the important elements in the lesson-planning domain were identified, and the flow of preparing the lesson plans is shown as a flowchart.

Elements in a lesson plan are classified into five main categories: curriculum, students' constraints, teachers' details, facilities available and its contents. The sequence of contents in a lesson plan is based on the Gagne 9 commandments of learning activities, corresponding cognitive processes that can be used to support learning. The lesson can be presented in wide variety of ways using the theory of multiple intelligences, with regards to the six level of Bloom's Taxonomy. The importance of each element is then implied into a default weight for case retrieval in advanced search. This is essential for the similarity calculation between the problems (searched keywords) and cases in the case base. Interviews with respondents who use SmartLP revealed that all of them prefer to use default values rather than specifying the weight themselves.

c. **The similarity measure for the indexed attributes**

A similarity calculation is applied to find the most similar cases to the given problem in advanced search. In the SmartLP system, the similarity of two cases is calculated rather than the difference. The similarity value is in the range of 0 to 1, whereby 0 corresponds to totally dissimilar while 1 is a perfect match. Some attributes are based on hierarchical matching for similarity values and some on linear matching. Learning areas, topics, year and learning outcomes are attributes that use hierarchical matching concepts, while ability, knowledge, motivation and number of students per class use linear matching concepts.

To achieve the contribution stated, the following works were done.

1. **Proposal for a research methodology which provides guidelines to develop a case-based system**

The proposed methodology indicated a way to proceed in knowledge acquisition, designing and implementing a web case-based system to assist teachers in lesson plan construction. The methodology consists of five phases: Identification, Knowledge Analysis, System Design, System Implementation and Testing, and Evaluation.

The methodology integrates system development methodology to develop a case-based lesson planning system and knowledge acquisition methodology to gain understanding of various aspects of lesson planning. It covers methods and tools regarding the objective of the research, which is to investigate the effectiveness of a case-based system for lesson plan construction in a Malaysian context. This research is of a design-demonstration type, where a new system is constructed, tested and evaluated to answer the research questions.

2. **A review of current computer tools to assist teachers with lesson plan construction**

Prior to designing a new tool, SmartLP, three quite comprehensive online resources that focus on helping teachers to prepare lesson plans were analysed with respect to how they support teachers to develop lesson plans. The resources are InTime, KITE and lesson planner. These resources were scrutinised in terms of their main purpose, their target users, shared mechanisms and repository. The search methods and how they support lesson preparation were also evaluated. The holes found in the current systems were used as baselines to improve functionalities in the new system.

8.3   Benefits of the research

The benefits of the research are realised through the proof that time is saved in preparing lesson plans by using SmartLP system, a case based lesson planning system based on CBR approach. The lesson plans ontology can be used by other researchers to develop lesson planning related systems. The other benefits that derive from the SmartLP system are as follows:

- *Avoid repeating all the steps that need to be taken to arrive at a solution, thus save time and effort*

Being able to customise new lesson plans rather than having to start from scratch would make constructing lesson plans easier for teachers. This is done by referring to the stored solutions and making changes to match the differences between the previous and the current problem. After being retrieved, the lesson plans can be customised and printed. The customised lesson plans are saved as newly generated lessons that contain a new problem-solution.

Manual adaptation based on one or multiple cases is offered via smart interfaces in the system, avoiding the time necessary to derive those answers from scratch, hence saving the time and effort of teachers to construct lesson plans. By getting resources that comes together with the lesson plans, the time to prepare material is reduced and more time can be allocated to explore pedagogical content knowledge and address the students' problems. In addition, all information related to lesson planning such as curriculum details and the school calendar can be retrieved in the system.

The alternative approach of modifying an earlier solution provided by the cases in the case base can reduce the processing requirement significantly. The workflow of many processes and tasks related to lesson preparation can be simplified. In addition, reusing a previous solution also allows the actual steps taken to reach that solution to be reused for solving other problems. The materials from the original files for a particular lesson plan can also be included and excluded easily in the newly generated lesson plans. Results from the evaluations prove that less time is taken to construct lesson plans by using SmartLP than the manual method.

The system is concerned with the adaptation process to match the constraints teachers have. Users can adapt the cases, after retrieving them using any type of search they prefer. Being able to customise the retrieved lesson plans in the case base rather than having to start writing lesson plans from scratch increases teachers' productivity and produces good lesson plans according to the constraints they have. Users can combine the elements from several retrieved plans to generate new lesson plan with different constraints. In addition, having indexing applied to the similarity values has an effect on the retrieval performance in advanced search. The school calendar is in the system to support

teachers in constructing their lesson plans. There is a quick search to the web content via Sphider, a lightweight web spider and search engine.

- ***Learning over time, as users can revise their own lesson plans and avoiding repeating mistakes made in the past***

As the SmartLP system used the CBR approach, more problem situations and solutions will be available with a wide variety of situation-actions in the case base. Users can access their previously constructed lesson plans and make modifications to the various elements to suit the new problem with different constraints. In addition, after the lesson takes place, the lesson plans can be reflected upon. Other teachers that access those lesson plans and with reflection, can amend certain criteria to match their constraints and avoid failure, and afterwards save it to the system as a new set of problem description-solutions.

In systems that record failures and successes, information about what caused failures in the past can be used to predict potential failures in the future. This is recorded in the reflection element of the lesson plan, which is completed after the lesson takes place. Basically, lesson reflection should report what happened when the lesson plan was implemented, what aspect should be improved and student outcomes from that lesson. This provides guidelines to other teachers about how to modify the lesson strategies to suit the constraints in hand. CBR systems can supply a previous case and its solution can help to convince the user of, or to justify, a proposed solution to the current problem. By explaining how a previous case was successful in a situation, the similarities between the cases and the adaptation involved in the SmartLP system can justify its solution to a user. SmartLP, as agreed by all respondents, has the capability to eliminate repetitive, time-consuming and error-prone work that is currently performed by human beings.

- ***Reliable lesson plans, as they are reviewed before released to be retrieved***

The newly generated lesson plans with different pairs of problems and solutions are reviewed by the system administrator before being retained in the case base. If no, or very minor changes are made to the lesson plans, they will not be saved. If the qualities of the lesson plans are acknowledged by the system administrator, they will be verified and retained in the case base. The list of unverified lesson plans comes with links to the parent from which they are customised and generated. These new lesson plans will be compared with all the parents by referring to the parent ID. In addition, they will be compared to other lesson plans that have a similar parent ID (siblings).

- ***Menu-based hierarchical interface for search and to generate lesson plans***

SmartLP allows users to concentrate on planning the content – introduction, learning activities, enrichment, assessment and closure, by taking over the task of remembering the related learning outcome, topic and learning area in the problem description part. A hierarchical drop-down menu assists users in selecting appropriate elements easily at the lower level. For example, if users select certain learning areas, only topics that are related to that learning area will be displayed in the following menu list. After a topic is chosen, only learning outcomes that are relevant to that topic will be presented. Other elements are also available in the menu list, enabling users to select appropriate elements without manually keying in the values. The hierarchical drop-down menu is also used in the advanced search. Here, the default values are shown next to the attribute's name and the values can be changed according to the user's priority.

The pages to upload and insert lesson plans were built based on users' prior knowledge, a text-based format that is similar to the manual method of constructing lesson plans. To upload a lesson plan, the 'problem description' elements in the case need to be keyed into the system. Other elements in lesson plans such as introduction, learning activity, enrichment, assessment, conclusion

and reflection can be typed in or they can be simply uploaded as the entire lesson plan. Otherwise, users can type in all the elements manually.

- ***Encounter more problem situations and create more solutions***

The cases give ideas about implementing certain approaches that match certain constraints of students' ability, previous knowledge and curriculum. From the analysis, although not exactly the same things are applied, users prefer to use the same approach to the same problem. For example, in the learning activities for Task 2, some respondents applied group activities when searching related information from the web even though the area of multimedia usage is different. All 15 experimental lesson plans were saved to the system. This means that more situations/actions are retained in the system after being verified by the system administrator.

The other potential benefits include the following:

- ***Easily generate new lesson plan by smart interfaces***

The interviews with the respondents prove that SmartLP's approach in generating new lesson plans based on the constraints is simple by easily selecting and removing the elements and the attachment files consisting of materials and resources for the lesson. The generated lesson plans are in a standard format that contains all the elements of standard lesson plans. Results are presented in a list and pagination gives flexibility for users to select the number of results to be presented per page. The generated lesson plans can be saved to the system, retrieved at any time and printed. Progress is constantly monitored; users are notified that the new lesson plans have been saved. The interview results indicate positive feedback about the ease of using the system. The evaluation of SmartLP's user interface has not yet been done in this research.

- *Overcome isolation in preparing lesson plans*

SmartLP offers a vehicle that teachers can use to find and share successful lesson plans. The knowledge of lesson planning by other teachers and teachers' experience is written in the reflection section after implementing the lesson and can be used as a guideline when planning their teaching. It may help to overcome the isolation in preparing lesson plans that prevails in Malaysian education.

- *The constructed lesson plans fulfil learning theories*

The six levels of Bloom's taxonomy, Gardner's multiple intelligence and Gagne 9 commandments are the popular educational theories among teachers in Malaysia. By using SmartLP system that divides contents of a lesson plan into several fields (introduction, steps in learning activities, assessment and closure), the nine steps of instructional design, which activates processes needed for effective learning, can easily be planned. Prior to planning the content, appropriate learning objectives need to be specified. Adaptation, based on multiple cases allows users to easily select or drop elements in each field. Although not all four steps allocated for learning activities need to be planned, it makes the process to encompass multiple intelligence easier.

8.4   Research questions revisited

The research questions addressed by the thesis were outlined in Chapter 1. This research answers the questions as discussed below.

1. **How effective is a case-based system for lesson plan construction in the Malaysian context?**
   The results from experiments show that all the lesson plans constructed with SmartLP assistance took significantly less time than the control lessons. This is contributed by the customisation function in the SmartLP system, whereby participants in experimental groups could make

adaptations to the retrieved lesson plan. The degree of adaptation made to the retrieved plans depends on the similarity of the tasks to the cases stored in the case base. Thus, it can be seen that Task 3, with more match criteria, took less time than Task 2, with fewer match criteria. Task 1, with the least match criteria, took the longest to prepare by the experimental group. There is a significant difference in the time taken to construct the experimental lesson plans of Task 1 compared to Task 3. On the other hand, no significant difference exists for Task 1 compared to Task 2, and the pair of Task 2 and Task 3. This is because the pair of Task 1 that has four matching criteria is only slightly different to Task 2 that has six matching criteria. The same scenario goes for the pair of Task 2 and Task 3 that has eight matching criteria. The pair of Task 1 with 4 matching criteria to Task 3 with 8 matching criteria sufficiently shows difference in the time taken to construct those lesson plans. Prior to this, all three controlled lesson plans were tested for the time taken to construct them. The results show no significant difference in the time taken to construct those lesson plans. The participants employed both single and multiple adaptations to the retrieved lesson plans, and this is reported in Chapter 7.

The detailed evaluation of the quality of each lesson plan involves ten criteria measured by a score, as explained earlier. No significant difference in writing quality was noticed for either group that constructed lesson plans on the same tasks without receiving any assistance. However, the average mark scored by the experimental lesson plans is higher than the control lesson plans in two tasks; Task 1 and Task 3. Out of 50 full marks, the marks scored by the experimental lesson plans for Task 1 is 29, one mark higher than the control lesson plans. However, both are at an average level. For Task 3, the difference is even higher, by 5 marks scored by the experimental lesson plans at 33 marks compared to 27 by the control lesson plans. There is no difference in the marks scored for Task 2 by the two groups at 37 marks.

2.   What makes a good lesson plan?

The literature review in Chapter 2 attempted to seek understanding about lesson plans, and this is validated from knowledge acquisition, the teach-back technique, with Malaysian teachers. The criteria for a quality lesson plan were identified. A good lesson plan is further characterised by the presence of all the important elements. The study found that a good lesson plan should include the following 12 elements: objectives, time constraint, introduction, learning activity, enrichment, assessment, closure, prerequisites, reward, content, material (teaching aids) and resources. The details of each criterion are elaborated upon in Chapter 4.

The study also demonstrates that Malaysian teachers apply Bloom's taxonomy model in constructing daily lessons and Gagne's nine commandments to plan the learning steps. The six levels in Bloom's taxonomy within the cognitive domain, together with the activities in ascending order, are knowledge (recall), comprehension (understanding), application (use, practice), analysis (dissection, generalization), synthesis (creating, combining) and evaluation (appraising, valuing). Gagne's nine events that activate processes needed for effective learning should include this sequence of events; gain attention, inform learner of objective, stimulate recall of prior knowledge, present the material, provide guidance for learning, elicit performance, provide feedback.

3. What are the features of a good lesson planning system required by teachers?

In order to implement a system that manages to assist teachers in lesson planning, the required features of the system were gathered. The analysed results from a survey shows that 96% of 25 respondents have a positive attitude towards web-based systems for lesson plan construction and look forward to using it.

The respondents also implied that a lesson planning system that manages to retrieve previously implemented lesson plans and teaching materials is more valuable to teachers than a system which merely explains how to

integrate technology in teaching, as offered by some online lesson planning systems.

Furthermore, the system should be dynamic, whereby the users can interact and change the elements of the retrieved lesson plans, not only view and print them. As a web-based system is required, the system should be made available on a 24/7 basis. Therefore, SmartLP allows users not only to retrieve previous implemented lesson plans by other teachers on the Internet, but also to generate their own lesson plans based on old cases with access to all related materials and teaching aids.

Teachers were given some choices of the final output from the lesson planning system that would assist them in constructing lesson plans such as videos about successfully implemented lesson plans, stories about how teachers implement the lesson plans and a text-based format (current style in manual process). The text-based format of successfully implemented lesson plans leads the rest, which was preferred by 64% of the respondents.

The results from the knowledge acquisition phase revealed lesson plan elements in rank, according to users' consideration for case retrieval. It starts with learning outcomes, followed by topic, learning area, students ability, students' previous knowledge, the number of students in the class, time period, year, subject, skills, attitude/value and students' motivation. The elements that teachers prefer to search in constructing lesson plans were considered. Also discussed were the keywords that they prefer to use to get the desired elements in lesson plans. These facts are important in determining the weight of each element in term weighting, which is applied to get the most similar cases in the retrieval process. The respondents were also asked what components of lesson plans they would like to get while searching. The results are listed and ranked as follows: resources/materials, short description, learning activities, learning objectives, introduction, enrichment, assessment, closure and reward.

4.   What are the important elements that need to be considered in preparing lesson plans?

Components of a lesson plan in Malaysia, the UK and the US were analysed and discussed in Chapter 2. Some of the similarities and differences in lesson plan elements in these three countries were compared. Although there are some variations in the standardised lesson plan formats by education departments from different countries, elements that need to be present in a lesson plan are principally the same: subject, topic, year /class, number of students, skills, attitude and moral value, ability range, time allotted, resources, short description of lesson, prerequisite skill, objectives, outcomes, timing of each activity, introduction, planned content/lesson outline, assessment, extension/homework, closure. Classroom layout, grouping of students and adaptation for special students are currently not included in the Malaysian lesson plans.

In general, elements in a lesson plan can be classified into five main categories: curriculum, student constraints, teachers' details, facilities available and its contents. The contents of a lesson plan are based on the Gagne 9 commandments of learning activities.

5.   How can knowledge be represented in the lesson plan domain?

A semantic net of lesson plan domain, a directed graph illustrating how elements in a lesson plan relate to each other, was constructed. It shows how elements in a lesson plan influence/determine other elements in a causal network. For example, learning outcome, ability and prerequisites determine the learning objectives to be implemented. Learning objectives, on the other hand, determine the introduction, activities, enrichment, assessment, extension/homework and closure. They also can be read the other way around: those elements are determined by the learning objectives. Learning outcomes to be achieved in a class vary, depending on several factors, namely students' ability, class period and students' previous knowledge. In order to get a suitable introduction to one topic,

users need to know the learning objectives, students' ability and students' motivation.

Lesson plan ontology in a taxonomy form was constructed based on the semantic net. It consists of four main nodes, which are curriculum, students, facilities and content. Each node is then divided into detailed nodes.

6. How can a case in lesson plan domain be represented?

In SmartLP, attribute-value representation was used to represent a case due to its support for case searching and matching. By using this representation, new cases can easily be integrated into the existing memory. It allows structured data in web applications, thus giving support to query a relational database. Furthermore, organising and indexing cases can be done efficiently using MySQL, resulting in effective retrieval and reuse of the cases. In the Matrix-based technique in knowledge acquisition, attributes and values for elements in the lesson plan domain were presented to teachers. It is then established whether the pairs of attributes and values are correct.

7. What are the contents of a case in the lesson plan?

Components of a case in SmartLP consist of problem descriptions, the various constraints that teachers face in constructing lesson plans and their pair solution. The three categories of constraints are students, facilities and curriculum. The constraint elements for students are ability, previous knowledge, motivation and the number of student per class. Resources, material (teaching aids), venue and time period are constraint elements in facilities. Curriculum constraints comprise year, subjects, learning areas, topics and learning outcomes. The solution is a lesson plan content consisting of appropriate objectives, teaching material, skills, learning objectives, short description, introduction, learning activities, timing of each activity, enrichment, extension and conclusion.

8.5 Limitations and Recommendations for Future Research

During these three years of work, several research issues have emerged, some of which were addressed because they are within the scope of this Thesis; others were left to be pursued in future work. The limitations of this research are explained in each recommendation for future research as below:

8.5.1 *Wider studies*

The study has been conducted primarily within the context of Malaysia, and the interviews and surveys have focused on Malaysian teachers. Although a comparison of elements in UK and US were compared to Malaysia, the elements from UK and US were gathered from a literature review, not directly from teachers in school. In addition, the survey about lesson planning only involved teachers in Malaysia. Thus, the importance of attributes for case retrieval and the desired contents of a lesson plan are strongly influenced by the Malaysian education system. In the event that the default values of the attributes importance is to be implemented or utilised in other countries, further research would be needed to modify the default weight to suit the conditions in that country or a more universal importance of elements in lesson plan should be considered.

During the knowledge acquisition process, the researcher encountered some non-responsive respondents who were reluctant to share their real lesson plans, which they perceived to be not very good or not appropriately prepared. Thus, some of the lesson plans stored in the case based, were acquired from university students, prepared for their teaching pedagogy class.

8.5.2 *Wider evaluation*

This study has provided useful findings on how SmartLP supports teachers in constructing lesson plans in shorter time. The study has been conducted primarily within the context of Malaysia. Although the study was sufficient for a qualitative design, the number of respondents involved in the study is not large. Further studies to seek feedback from a larger number of respondents from

Malaysia and other countries could provide more accurate perspectives in terms of the SmartLP users, with different experiences and from different cultures. More respondents should be involved in experiments to ensure that the results are generalised.

To see the effect of a case based system, only experiment and interview are applied. Observation of the teaching sessions that apply particular lesson plans should be done. However, as teachers' workload is an issue among Malaysian teachers, such a method like observation might impose further burdens on them.

8.5.3 *Wider application*

SmartLP system was developed as a tool to measure case base system effectiveness in supporting teachers to construct lesson plans. The system has a complete cycle of CBR, but there are also some limitations as follows:

a. Customisation of the lesson plans is made individually without support from other people.

b. The customised lesson plans will be verified if the solution is appropriate based on the administrator's view. No suggestions are given on how to improve the lesson plans after being reviewed. There is no notification for users about whether their lesson plans have been verified and stored in the case base or not. The overall percentage of changes made to newly customised lesson plans are not measured automatically.

c. No automatic adaptation where the user can select and edit each element separately.

d. Some lesson plans elements like the students' socio-economic background are not considered in SmartLP. This is due to the number of students per class, which may be up to 40, and their background varies. This has been realised by the Ministry of Education in their planning to reduce teachers' workload by the first suggestion to reduce the number of students per class.

To make the SmartLP system even more effective, critical aspects which need to be looked into and improved in the future are listed. This will provide guidance to help researchers improving the system.

a. Provide prompt feedback concerning the composing features such as objectives, introduction and learning activities in each step, so that earlier mistakes can be corrected. For example, lesson objectives should be stated appropriately before continuing with learning activities and the time range for each step. Teachers, especially new ones, may benefit from a clearer indication of the stage they have reached in lesson plan construction. SmartLP could demonstrate the structure of a lesson plan more clearly and the stage the teacher is at- for example by providing a status bar indicating which sections of the lesson plan have been completed and which remain.

b. A portal-like system may benefit teachers in various aspects. A forum, a medium where teachers can discuss various issues of constructing lesson plans, should be made available. This will bring together multiple perspectives and expertise. In addition, it facilitates communication among teachers, and makes it faster, clearer and more persuasive. Groups with common interests could be formed and ultimately social capital would be built among teachers with different expertise in different locations. Private messaging (messages to dedicated members) would enable new modes of communication within the system, thus enabling anonymous interchanges or structured interactions.

c. More leisure features could be made available in the system. Efficiency in disseminating news and knowledge among teachers could be made more easily via the SmartLP system. New teachers would not need to be informed about everything related to lesson plan preparation if they are made available in this system.

d. Holistic elements of a lesson plan should be considered and all elements should be made available in the system. Then users can select whatever elements they intend to include. By offering this feature, the system can be used worldwide.

e. Group problem solving, that enables other teachers to help to produce lesson plans, would be good to help teachers to customise lesson plans rather than do it individually.

f. A reward system within SmartLP should motivate teachers to share their knowledge in lesson planning by retaining the generated lesson plans after retrieving, reusing and revising those lesson plans.

g. Suggestions should be given to teachers, if appropriate, about how to improve the lesson plans after being reviewed by the system administrator.

h. For case verification, the final stage of comparing lesson plans after being compared to their parents and siblings is to use DiffDoc, free document comparison software, but it is done independently from the system. This free software should be integrated into the SmartLP system to increase the efficiency of the review process. In addition, a new lesson plan that is not customised from any available case in the system can be compared to the other lesson plan with the same, learning outcome; the most specific elements in curriculum hierarchy. It is not yet implemented in the system.

8.5.4 *Selecting cases*

This study has provided useful findings on how SmartLP supports teachers in constructing lesson plans in a shorter time. However, the experimental lesson plans do not show much difference in quality. The adaptation investigation shows that teachers tend to use as much of the content of the matched, retrieved lesson plans. This shows that the newly generated lesson plans are highly influenced by the cases available in the case base. Therefore, more high quality cases should be stored in the case base. The case base needs to be large enough to support case retrieval for diverse and various subjects and years. The real cases implemented in the class are more suitable that the constructed lesson plans for teaching pedagogy class.

8.6 Conclusion

This research has successfully addressed the research questions that were established in Chapter One. The findings also indicate the potential to undertake further research subsequent to this study. This Thesis detailed the design, implementation and evaluation of a case-based lesson-planning system called SmartLP upon teachers' efficiency in lesson plans construction. Comprehensive knowledge acquisition was handled to gain understanding of the lesson plan domain and to gather cases from teachers to be stored in the case base. It provides a basis for case retrieval, followed by case reuse, revision, review and retention in the CBR cycle.

The study supplied qualitative and quantitative evidence to suggest that using SmartLP positively reduced the time taken to construct lesson plans without decreasing the quality. The adaptation mechanism in the system, via the customisation function, accelerated the time taken to construct lesson plans compared with starting from scratch. It helped the teachers to produce good lesson plans according to Bloom taxonomy and Gagne's 9 commandments in instructional design.

The implemented case based lesson planning system can be used by all teachers, from novice to experienced teachers. It is not restricted to only ICT subject, as the preliminary investigation involves teachers who teach various subjects. The system is applicable all over the world as the elements in lesson plans from different countries are about the same although there are some variations.

This formative study demonstrated that the SmartLP system indicates the potential of conducting future research concerned with further improving the system's functionalities via automatic adaptation an thus increase the effectiveness of the system to quickly propose solutions to a problem. The limitations addressed in the current SmartLP system can be improved, as outlined in the suggested future development of the system.

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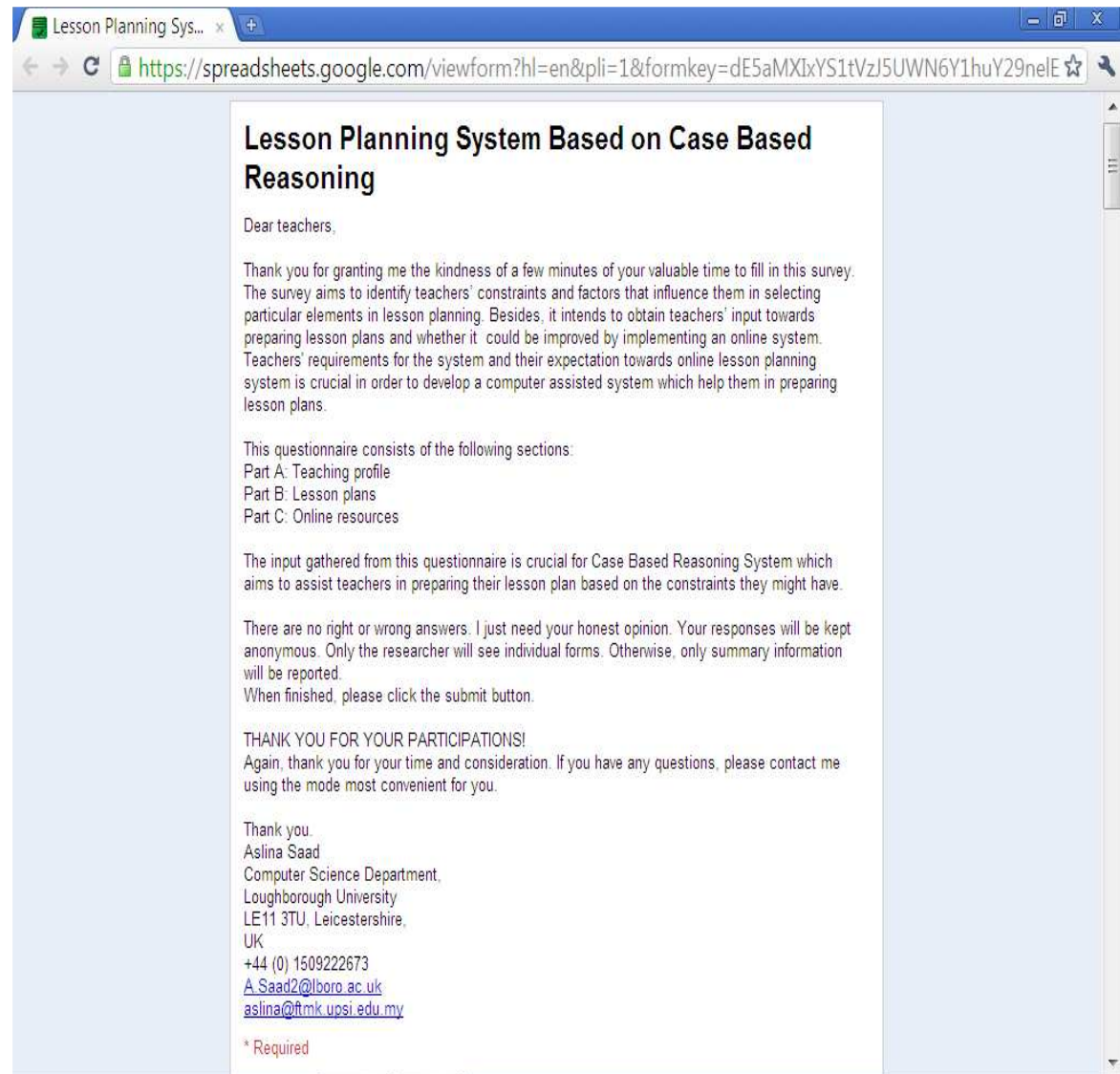Simon, H.A. et al. (1986). *Decision Making and Problem Solving*. Retrieved February 5, 2008 from http://dieoff.org/page163.htm

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APPENDIX A

Some publications regarding the research are listed below:

1. **Saad, A.**, **Dawson, C.W.** and **Chung, P.W.H.** (2011). "Case Adaptation and Representation in SmartLP: a Case Based Lesson Planning System". Proceeding of ICAART 2011, January 28th – 30th 2011, Rome, Italy. SciTePress.

2. **Saad, A.**, **Chung, P.W.H.,** and **Dawson, C.W.** (2010). "A web based lesson planning system assistant based on case based reasoning (CBR)", *Proceedings of EDULEARN10 Conference*, EDULEARN 10, Barcelona, Spain, 2010, pp.2245-2254, ISBN:978-84-613-9386-2.

3. **Saad, A.**, **Chung, P.W.H.,** and **Dawson, C.W.** (2010). "The development of lesson planning system based on case based reasoning (CBR)", *Proceedings of Informatics 2010*, Informatics 2010, Freiburg, Germany, 2010, pp.231-234, ISBN:978-972-8939-19-9.

4. **Saad, A.**, **Dawson, C.W.** and **Chung, P.W.H.** (2008). "Pre-Service Teachers and Lesson Preparation Using Online Resources", International Conference on Teacher Education in the Muslim World (ICTEM2008), July 13th-15th 2008, Kuala Lumpur, Malaysia.

5. Joined three poster competitions organised by School of Informatics in 2008, 2009 and 2010.

APPENDIX B

Preliminary Questionnaire

PART A: TEACHING PROFILE

Instruction: Please tick in the appropriate circles

1. Age range *
- ○ 20-30
- ○ 30-40
- ○ 40-50
- ○ >50

2. Teaching experience *
in years
- ○ 0-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ >20

3. Is there any class streaming in your school?
- ○ Yes
- ○ No

4. Generally, the streaming is based on what aspects *
- ○ Ability
- ○ Learning style
- ○ Other: [_____]

5. Are these terms correct to describe your students' ability? *

---

5. Are these terms correct to describe your students' ability? *
Please choose all related terms you use
- ☐ Excellent
- ☐ Average
- ☐ Good
- ☐ Poor
- ☐ Other: [_____]

PART B: LESSON PLAN

Instruction: For the following questions, please choose appropriate answers. You can choose more than one answer and you are allowed to add you own points whenever possible

1. What are your perceptions towards lesson planning? *
- ☐ Time consuming
- ☐ Easy
- ☐ Boring
- ☐ Exciting
- ☐ Other: [_____]

2. How do you usually prepare lesson plans? *
- ☐ Individually
- ☐ Collectively
- ☐ Other: [_____]

3. Do you prepare different lesson plans (including the elements within them) for different classes *

○ yes
○ no

4. A good lesson plan is the one that, *
You can choose more than one answer

☐ divides learning task into manageable parts
☐ has appropriate learning activities to students' ability and need
☐ provides discouraged students with additional help
☐ relates past learning activities to the present
☐ has reasonable objectives to be achieved within the lesson period
☐ has appropriate learning activities to the lesson period
☐ has reasonable objectives to be achieved based on students ability
☐ Other: [_____]

5. Do you refer to the reflection of previous lesson plans to plan for future lessons *

○ yes
○ no

6. Do you discuss of what needs to be improved in each lesson plan with other colleagues after teaching session *

○ yes
○ no

7. Assuming that your time for teaching activities is 50 percent, what is the allocation for preparing lesson plans *
(in percent)

○ <=10

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7. Assuming that your time for teaching activities is 50 percent, what is the allocation for preparing lesson plans *
(in percent)

○ <=10
○ 11-20
○ 21-30
○ 31-40
○ 41-50

8. To what extend do you agree with the below statements? *
Choose the number according to the following scale 1. strongly disagree 5 . strongly agree

	1	2	3	4	5
lesson plan is crucial at the beginning of teaching career	○	○	○	○	○
lesson planning is important	○	○	○	○	○
the success of teaching depends on the preparation you made	○	○	○	○	○
lesson plan is important throughout the teaching career, not only during pre-service and early teaching	○	○	○	○	○
If teachers plan appropriately in terms of activities etc, class could be controlled, teaching and students can be managed effectively.	○	○	○	○	○
daily lesson plan is the key document in the process of teaching	○	○	○	○	○

Lesson planning.

9. In your opinion, how important is the following elements in lesson planning *
1. least important 5. most important

	1	2	3	4	5
subject	◎	◎	◎	◎	◎
year	◎	◎	◎	◎	◎
learning area	◎	◎	◎	◎	◎
topic	◎	◎	◎	◎	◎
learning objectives	◎	◎	◎	◎	◎
learning outcomes	◎	◎	◎	◎	◎
students' ability	◎	◎	◎	◎	◎
resources available	◎	◎	◎	◎	◎
pre requisites	◎	◎	◎	◎	◎
skills	◎	◎	◎	◎	◎
values	◎	◎	◎	◎	◎
activity	◎	◎	◎	◎	◎
enrichment	◎	◎	◎	◎	◎
extension	◎	◎	◎	◎	◎
closure	◎	◎	◎	◎	◎
reflection	◎	◎	◎	◎	◎
number of students in the class	◎	◎	◎	◎	◎
time period	◎	◎	◎	◎	◎

10. How do you choose particular elements in planning for teaching/ learning activities? According to *

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10. How do you choose particular elements in planning for teaching/ learning activities? According to *
- ☐ Students' ability
- ☐ Number of students
- ☐ Students' motivation
- ☐ Students' background
- ☐ Resources available
- ☐ Other: [_____]

11. For different students' ability, how do you prepare the teaching activities (introduction, activities,enrichment,closure etc) *
e.g: Good ability students- self exploration. Poor students: Step to step instruction with some demos.

[text box]

12. For different number of students per class, how do you prepare the teaching activities(introduction, activities,enrichment,closure etc) *
e.g: >=30 students- group activity.

[text box]

13. As an alternative to preparing the same lesson plans, what do you do? *
☐ Search for online lesson plans
☐ Refer to friends' lesson plans
☐ Refer to previous lesson plans
☐ Other: [_____]

14. What problems do you encounter whilst preparing your lesson plans? *

[text area]

PART C: ONLINE RESOURCES

Please choose appropriate answers

1. Do you have access to the Internet from your school?
○ yes
○ no

2. Do you have access to the Internet from your home?
○ yes
○ no

4. Do you know any mechanism to share lesson plans among Malaysian teachers or world

4. Do you know any mechanism to share lesson plans among Malaysian teachers or world wide? *
○ yes
○ no

5. If yes, could you please state their name or give the URL

[text area]

6. Have you ever used any online resources in preparing lesson plans? *
○ yes
○ no

7. Do you think a web based systems might help you in lesson planning? *
○ yes
○ no

8. Do you prefer to use online resources to assist you in preparing lesson plans *
○ yes
○ no

9. What kind of output do you expect from a lesson planning system? *
○ Successfully implemented lesson plans – text based
○ A story on how teachers implement the lesson plans
○ Teaching video for successfully implemented lesson plans

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9. What kind of output do you expect from a lesson planning system? *

○ Successfully implemented lesson plans – text based
○ A story on how teachers implement the lesson plans
○ Teaching video for successfully implemented lesson plans

10. Assuming there is a web based system in assisting teachers to find relevant lesson plans, how would you search for them? According to : *
1. least likely 5. most likely

	1	2	3	4	5
subject	○	○	○	○	○
year	○	○	○	○	○
learning area	○	○	○	○	○
topic	○	○	○	○	○
learning objectives	○	○	○	○	○
learning outcomes	○	○	○	○	○
students' ability	○	○	○	○	○
resources available	○	○	○	○	○
pre requisites	○	○	○	○	○
skills	○	○	○	○	○
values	○	○	○	○	○
teaching and learning activity	○	○	○	○	○
number of students	○	○	○	○	○
time period	○	○	○	○	○

11. Overall comment /input regarding online resources for lesson planning *

	1	2	3	4	5
learning outcomes	○	○	○	○	○
students' ability	○	○	○	○	○
resources available	○	○	○	○	○
pre requisites	○	○	○	○	○
skills	○	○	○	○	○
values	○	○	○	○	○
teaching and learning activity	○	○	○	○	○
number of students	○	○	○	○	○
time period	○	○	○	○	○

11. Overall comment /input regarding online resources for lesson planning *

THANK YOU!

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APPENDIX C

Subject	: Information and Communication Technology		
Date	: 20 October 2008	Form	: 5 Technology
Time	: 9.00 am – 9.40 am [40 minutes]		
Number of students	: 25	Attendances	: 25
Topic	: 5.1 Basic programming concepts		
Synopsis	: In this topic, student will learn about the explanation of program and programming language.		
Learning outcomes	: 5.1.1 Define program and programming language		
	5.1.1.3 State the definition of program.		
	5.1.1.4 State the definition of programming language.		
Learning objectives	: At the end of this lesson, the student should be able to:		
	d) Write correctly the definition of program using their own words.		
	e) Write correctly the definition of programming language using their own words.		
	f) Verbally list out at least three examples of programming language correctly.		
Pre-requisite knowledge	: The topic do not concern about the student's pre-requisite knowledge because it was the first topic for form five Information and Communication Technology's student. Despite, the basic knowledge of topic may be based on their experience in real life.		
Teaching materials	: 1. Dancing robot.flv (video)		
	5. Topic 5.1.ppt		
	6. Exercise.ppt		
	7. Recipe.jpg		
Teacher References	: 1. ICT Module Score A SPM		
	2. Timothy J. O'Leary & Linda I. O'Leary, 2006. Computing Essentials 2006 (Complete Edition). McGraw Hill International Edition, United State.		
Student References	: ICT Module Score A SPM		

STEPS	CONTENT	LEARNING ACTIVITIES	MATERIALS/NOTES
Induction Set 5 minutes (9:00 – 9:05 am)	Introduction of program and programming language	4. Teacher gives overall explanation about the topic. 5. Teacher presents a video. 6. Students watch the video and try to understand.	**CCTS:** Generate idea **Teaching aids:** 1. Topic 5.1.ppt 2. Dancing robot.flv **Note:** ICT Module Score A SPM
Step 1 10 minutes (9:05 – 9:15 am)	Definition of program Analogy Program is like a recipe. To make it, we have to list out the entire ingredient (list of variables). Then, follow the direction (list of statements) on how to make it.	1. Students read objective number one in the slideshow. 2. Student answer the question related to video shown video. Then, they explore the relation between the video and the meaning of program (shown in the slideshow). 3. Students explain program based on their understanding. 4. Teacher explain the analogy of a program 5. Students are chosen to give definition of program in their own word in front of class by writing on the white board.	**Model of instruction:** Concept attainment **CCTS:** Generate idea **Value:** Inquiry **Teaching aids:** 1. Topic 5.1.ppt 2. Exercise.ppt 3. Recipe.jpg **Note:** ICT Module Score A SPM

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STEPS	CONTENT/SKILL	LEARNING ACTIVITIES	MATERIALS/NOTES
Step 2 10 minutes (9:15 – 9:25 am)	Definition of programming language A programming language is a set of words, symbols and codes that enables humans to communicate with computer. It is a language used for writing computer programs that direct a computer to perform computation and to organize the flow of control between mechanical devices.	5. Students read objective two. 6. Student reads the definition of programming from the slideshow provided. Then discuss with teacher in order to understand the meaning of programming language. 7. Students explain the programming language based on their understanding. 8. Students read about career opportunity in programming field. 9. Students are chosen to give definition of programming language in their own word in front of class by writing it in white board.	**Model of instruction:** Concept attainment **CCTS:** Generate idea **Value:** Inquiry **Teaching aids:** 1. Topic 5.1.ppt 2. Exercise.ppt **Note:** ICT Module Score A SPM
Step 3 10 minutes (9:25 – 9:35 am)	Examples of programming language There are hundreds of programming language exist today. Each language has its own standard or rules for writing the commands and/or instructions. The examples of programming language are COBOL, Java, JavaScript, C, C++, HTML, Visual Basic, Delphi, Python, Pascal, FORTRAN, Perl and others.	1. Students read objective number three. 2. Students see the examples of programming language in the slideshow (in picture or coding form shown in slideshow). Then, groups of student search for the information of examples of programming language in the notes. 3. Students discuss and write a list of examples of programming language that they found. 4. Students are chosen to verbally list out the examples of programming language.	**Model of instruction:** Group investigation **CCTS:** Generate idea **Value:** Inquiry **Teaching aids:** 1. Topic 5.1.ppt 2. Exercise.ppt **Note:** ICT Module Score A SPM
Step 4 5 minutes (9:35 – 9:40 am)	Conclusion	Students explain the lesson learned.	

APPENDIX D

<u>Comments on the constructed lesson plans</u>

Some comments were made by the expert on the constructed lesson plans. TC1 TC2, TC3, TC4 and TC5 refer to respondent 1, 2, 3, 4 and 5 in control group while TE1, TE2, TE3, TE4 and TE5 are respondents in experimental group. Three lesson plans of good, average and poor lesson plan constructed using SmartLP are attached.

TASK 1

It was suggested that the objectives written by TC1 be split into two. In addition, there is no introduction to the lesson. Furthermore, steps 1 and 2 do not cover the objective, but only recall previous knowledge. There is also a comment regarding the lesson objectives written by TC2, which is that the two skills cannot be combined in one objective. The planned learning activities were good, but the teacher should provide guidelines about "what type of information" should be found from the Internet. The major comment about the lesson plan from this teacher is time management. The teacher should consider the time limit for each task. The expert advised that if five minutes are allocated to the introduction and 35 minutes for step 1 in a 40-minute lesson, there is no time for closure and assessment. The objectives stated by respondent TC3 can be divided into more detailed objectives. The planned learning activities are not interesting and do not stretch the students' minds. The expert also commented on the objectives and time management of respondent TC4's lesson plan: her lesson objective was quite general and no time management is stated in the lesson plan. The objectives planned by TC5 are too limited for a 40-minute lesson and thus do not cover the content. The introduction is not related to the content and the time is not stated for each step. It was suggested that mind mapping could be done as an enrichment activity.

The lesson plan of respondent TE1 does not cover all the content. In terms of time management, respondent TE1 should specify the time for each activity. Common closure was planned but no assessment is visible. On the other hand, the planned material and introduction are excellent. The first comment for

respondent TE2 is on the written objectives. Objective 2 should focus on the three differences of proprietary and open source software, not on three sentences about it, as stated. The planned introduction is interesting, but the sequence of lesson development is not properly written; it jumps straightaway to evaluation. Teaching development was properly developed by respondent TE3, on top of an interesting introduction. However, there is too much content for a 40-minute lesson. The planned assessment does not cover all the objectives and the time for each step is not stated. The assessment by respondent TE5 cannot be evaluated because it is not included in the lesson plan. The time management is confusing, as it is not 40 minutes, as required in Task 1. Respondent TE4 needs to be specific about the objectives. The planned learning activities are fine but very general. The teacher must elaborate on what type of information the students need to surf. In enrichment, students should present their work. No assessment was planned for in this lesson plan. Overall, the lesson plan is too simple and should be divided into small steps.

TASK 2
The overall comments on Task 2 are related to the written objectives in addition to the learning activities. Respondent TC1 was recommended to do brainstorming on learning activities. The objectives written by respondent TC2 are explicit but quite limited, which also affects the content. The introduction using a video of *Upin and Ipin*, a Malay cartoon movie, is interesting, but the second step, designing a storyboard, is not related. The expert recommended using the Internet if it is available for learning activities. Respondent TC3 was recommended to add one more objective: discuss the contributions of multimedia. The methodology of learning activity 2 should be changed. There is no specific comment about the lesson plan written by respondent TC4. It was suggested that the objectives written by respondent TC5 could be more specific. The introduction by respondent TC5 is interesting, but no time is specified for each step.

Respondent TE1 had too many objectives to achieve in a 40-minute lesson. However, the content is covered. Teaching development was not properly organised and the time allocated for each activity was not enough. Moreover, there are too many questions in the assessment. Respondent TE2 also had too

many objectives for a 40-minute lesson. The expert suggested that the learning activities employ a strategy that would engage the students' minds. The assessment strategy is interesting but only certain steps were specified within the time limit. There is too much content for closure and 40 minutes would not be long enough for the planned lesson. Respondent TE3 was recommended to specify how many usages there are of multimedia in various fields in objective 1 rather than just 'identify the uses of multimedia in various fields'. The planned introduction, which was to recall previous lessons, was not interesting. In addition, time management for each step was not stated. The planned assessment to gather examples of immersive multimedia in education, business and entertainment is not suitable for classroom assessment. Respondent TE4 did not plan anything for the induction set (introduction). Other than that, objectives 3 to 6, to correctly and verbally explain the use of multimedia in school, business, public places and at home, could be simplified into one objective rather than defining them separately. For learning activities, the teacher should give one field to each group. Suitable enrichment would be to ask the students to present their findings from discussion. No assessment was attached. The expert concludes that respondent TE4 is not creative. Respondent TE5 specified the time range for some steps but not for all. It was suggested that learning activities should use a strategy that can engage the students' minds, not just explain the concept to the students. The assessment strategy by this respondent was described as interesting.

TASK 3
It was commented that respondent TC1 has too many objectives for a 40-minute lesson. The same comment was made about respondent TC2. In addition, the learning activities are more to the teacher's orientation, which they should not be. It was suggested that the teacher should change the teaching methodology and make sure that the time is appropriate for the content. Furthermore, no enrichment was planned and the assessment does not evaluate all the objectives. According to the expert, the introduction planned by respondent TC3 is not interesting. Teaching methodology for step 3 by this respondent could be changed to brainstorming. The objectives of respondent TC4 were too general and enrichment was not stated. The objectives of respondent TC5 are fine, but the objectives should specify how many types and how many functions of the operating systems there are, for example state at least four functions. There is

also too much content for a 40-minute class. The introduction is interesting; however, more interesting activities could be planned for the learning activities. As for time management, 3–5 minutes for surfing is too little, thus it is not an appropriate task. Mind mapping was suggested for enrichment. The planned assessment evaluates the second objective only and does not cover all the objectives.

All respondents had too many objectives to achieve in the lesson. For example, the first objective alone of respondent TE1 is enough to fill the entire 40-minute lesson. The respondent should pay more attention to time management. Respondent TE2 states too many objectives for a 40-minute class, which thus also affects the content, which could not be implemented within this time. The planned introduction is fine but not interesting. The duration of the assessment was not stated. Furthermore, the assessment should be discussed after the students have answered the questions. There is no presentation of group work, thus no enrichment is visible. Respondent TE3 also planned too many objectives for a 40-minute lesson. In addition, the introduction is not related to the topic and is not interesting. The learning activities are fine but it would be better if students gave a presentation after each task. The duration for each step was not stated by respondent TE3. According to the expert, the closure could be simplified. The Introduction of respondent TE4 is fine but not interesting. Overall, the lesson plan of respondent TE5 is interesting. No comment is given about the constructed lesson plans.

The first comment for respondent TE2 is on the written objectives. Objective 2 should focus on the three differences of proprietary and open source software, not on three sentences about it, as stated. The planned introduction is interesting, but the sequence of lesson development is not properly written; it jumps straightaway to evaluation. Teaching development was properly developed by respondent TE3, on top of an interesting introduction. However, there is too much content for a 40-minute lesson. The planned assessment does not cover all the objectives and the time for each step is not stated. The assessment by respondent TE5 cannot be evaluated because it is not included in the lesson plan. The time management is confusing, as it is not 40 minutes, as required in

Task 1. Respondent TE4 needs to be specific about the objectives. The planned learning activities are fine but very general. The teacher must elaborate on what type of information the students need to surf. In enrichment, students should present their work. No assessment was planned for in this lesson plan. Overall, the lesson plan is too simple and should be divided into small steps.

Sample of good lesson plan

Subject	ICT
Year	4
No of Students	26-30
Time period	40
Level of Students	average
Learning Area	Multimedia
Objectives	By the end of the lesson, students should be able to: 1. Correctly and verbally explain the meaning of Multimedia 2. Identify at least two usages of multimedia in various fields correctly
Learning Outcome	Multimedia in Various Fields
Skills	Relating, Comparing & Contrasting, Generating Ideas
Prerequisite	The student have learnt about the definition of multimedia
Resources	Score A ICT, coursework assessment manual
Introduction (9.00-9.04)	Recall the previous lesson on: - the definition of multimedia - 5 main media elements in a complete multimedia system File A: multimedia.ppt (Slide 1 to Slide 3)
Step 1 (9.05-9.15)	Group activity: Discuss the uses of multimedia in the following fields: 1) Education (group 1) 2) Entertainment (group 2) 3) Scientific research/ Engineering (group 3) 4) Business (group 4) 5) Art/ Medicine (group 5) Students form a group of 4 people. Students discuss in group about multimedia usage in the specified fields. Students use mahjong paper to write down their finding
Step 2 (9.16-9.31)	The students are required to present the result of their Teachers give feedback and further explain the usage
Assessment	LA4.S09.1 Gather Examples of Immersive Multimedia In Education, Business or Entertainment (scrapbook)
Closure	Conclude today's lesson: Teacher call students randomly and asks - the uses of multimedia in various fields

Extension	-
Reflection	

Sample of average lesson plan

Subject	ICT
Year	5
No of Students	20
Time period	40
Level of Students	average
Learning Area	L.A. 4.0 Multimedia
Objectives	At the end of this lesson, students should be able to : 1. Correctly and verbally explain the meaning of Multimedia 2. Identify at least two usages of multimedia in various fields correctly
Learning Outcome	4.1.1 Definition of Multimedia 4.1.2 Multimedia in various Fields
Skills	Average
Prerequisite	a. Students can identify the use of any multimedia application in daily life b. Students know about multimedia such as usage of courseware, MMS and advertisement on internet.
Resources	Appendix 1: Question Sheet Evaluation: Multimedia Concepts
Introduction (8.10 -8.14 am) (5 minutes)	1. Students try to find what the presentation needs is. 2. Students will be asking for one word to describe the presentation. 3. Teacher generally explains for the Multimedia in a common life and relating the presentation and what they are going to learn today. File A: Induction.ppt

Step 1
(8.15-8.24 am)
(10 minutes)
	2. Multimedia Application in Various Fields
	    • Multimedia is used as a common source of reference.
	    • Multimedia is also use in education and training
	    • Learning has become more interesting and effective with educational programs such as edutainment that is a combination of education and entertainment
	    • Multimedia is greatly used in entertainment industry.
	    • Multimedia applications are also widely used in scientific research.
	
	    1. The students listen for the explanation the various uses of multimedia in various fields like common source of reference, edutainment, entertainment industry, and in scientific research.
	    2. Courseware CD will use to elaborate the Multimedia Application in education.
	    3. Student verbally explains the usage of Multimedia in various fields by their own knowledge.
	    4. Students give another example of Multimedia Application.

Step 2 (8.25-8.40 am) minutes)	1. Students sit in a big group for Poison Box activity 2. Student, who holding the box when the music stopped, should pick the piece of paper which have an alphabet and click the same alphabet on the

	computer screen,
	3. Then question based on the alphabet will appear on the slide show, and the student must answer the question
	• File B: Multimedia Concept.ppt
	• File C : Poison Box.ppt
	• Poison Box
	• Courseware CD of ICT
	File D : Music.mp3
Assessment (8.41-8.8.45 am) (5 minutes)	1. Students answer question sheet given and submit to teacher.
Closure (8.46-8.50 am) (5 minutes)	(9.05-9.15 am) (10 minutes) Student explains the lesson learned. 1. Students verbally explain the meaning of Multimedia 2. Students verbally describe the Multimedia Application in various fields. 3. Students exploiting to the extension of Multimedia for daily lives.
Extension	
Reflection	

Example of poor lesson plan

Subject	ICT
Year	4
No of Students	26-30
Time period	40
Level of Students	average
Learning Area	Computer Systems
Objectives	By the end of the lesson, students should be able to: - State the 3 types of OS used on different platforms. - State the 5 functions of OS. - State 3 different interfaces of OS.
Learning Outcome	Operating System (OS)
Skills	Communicating, identifying, categorizing
Prerequisite	The students have learnt about the meaning of software
Resources	Score A ICT, coursework assessment manual
Introduction	Recall the previous lesson on : - what is primary storage (RAM, ROM) - what is secondary storage (magnetic medium optical medium, flash memory)
Step 1	Teacher explains on the meaning of Operating System and the functions of Operating System.
Step 2	Teacher explains on 3 types of OS platform which are PC-Platform, Cross-Platform and Apple-Platform
Step 3	Group task: - The students are required to search for examples of OS used on different platforms through the internet

Step 4	Group task: - The students are required to differentiate between Graphical user interface, command-line interface and menu driven interface
Assessment	-
Closure	Teachers ask the students to explain on the following verbally: - types of OS - functions of OS - differences between 3 interfaces of OS
Extension	-
Reflection	