Road Safety - Problem Based Learning Module

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2008-09-18
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Examensarbete utfört i kommunikations- och transportsystem vid Tekniska Högskolan vid Linköpings universitet

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Norrköping 2008-09-18
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Abstract

Road traffic safety has increasingly become in need of educated road safety professionals, as the number of accidents in the World Health Organization member countries exceeds one million. The profession itself is transitioning from experience based decision making to empirical, theoretical and mathematical based solutions. However, road traffic safety is a multidiscipline, crossing over many fields and requiring a high degree of communication between different institutions. There are very few institutions that provide programs in the field; furthermore, they employ traditional lecture-based teaching methods. The traditional teaching environment does not fulfill the educational needs of future traffic safety professionals due to its rigidity and lack of problem solving exercises.

An alternative method, namely problem based learning, is recommended as an alternative teaching method in this paper. The thesis is constructed in such a way as to develop a complete road traffic safety educational module at graduate and post graduate level.

The theoretical basis on which a road traffic safety module is later built is presented in the first part of the thesis. Major concepts in road traffic safety, as well as problem based learning methods are investigated. In addition, a literature review SWOT analysis based on literature is conducted.

The module development consists of establishing the road traffic safety learning goals for each segment in the module, appropriate assessment criteria and group work format. The module contains gradual difficulty level problems, starting from the easiest topic and easiest format (closed ended problem) and ending with the hardest topic and hardest format (open ended problem).

The last section employs the SWOT analysis findings in the theoretical section to develop a SWOT analysis of the road traffic safety module presented in the thesis.
Acknowledgements

I would like to express my gratitude to all the various people that have provided me with useful and helpful assistance during the completion of this thesis.

I would like to thank my University of Linkoping supervisor Ghazwan Al-Haji and Professor Kenneth Asp for giving me the opportunity to explore further into a fascinating topic for me. In addition, I am grateful to Petru Eles and his family for offering me the support needed throughout my stay in Sweden.

My parents have been a constant source of courage and love during these months. As well, my grandparents have encouraged me to reach my full potential, no matter the obstacles. For Bebe, I am so happy to have you in my life. Lastly, to the one person that I owe the most, my Muți, I am forever grateful for your love and support.
Contents

List of Figures .................................................................................................................................. I
List of Tables .................................................................................................................................. II
List of Abbreviations ..................................................................................................................... III

1 Introduction............................................................................................................................. 1

1.1 Background ...................................................................................................................... 1
  1.1.1 Road Traffic Safety Educational Programs ...................................................... 1
  1.1.2 Road Traffic Safety Educational Methods...................................................... 2
1.2 Purpose of study ............................................................................................................... 3
1.3 Dimensions of study ......................................................................................................... 3
1.4 Definitions ........................................................................................................................ 3
  1.4.1 Traffic Safety ............................................................................................................ 3
  1.4.2 Problem Based Learning ........................................................................................... 4

2 Investigation Description ........................................................................................................ 5

2.1 Importance of Traffic Safety PBL Course ................................................................. 5
2.2 Nature of Study ................................................................................................................ 7
  2.2.1 Approach................................................................................................................... 7
  2.2.2 Collecting Information .............................................................................................. 7
  2.2.3 Limitations ................................................................................................................ 8
  2.2.4 Mapping of work sequence (with chapter references) .............................................. 9

3 Theoretical description ......................................................................................................... 10

3.1 Road Traffic Safety Education ....................................................................................... 10
3.2 PBL as a Teaching Method ............................................................................................ 10
  3.2.1 PBL Design Decisions ............................................................................................ 11
  3.2.2 Learning in PBL ...................................................................................................... 17
  3.2.3 PBL Staff Problems ............................................................................................... 18
3.3 PBL-SWOT According to Literature ............................................................................. 19
3.3.1 Potential Internal Strength ................................................................. 20
3.3.2 Potential Internal Weaknesses ............................................................ 20
3.3.3 Potential External Opportunity ......................................................... 21
3.3.4 Potential External Threat ................................................................. 21
3.3.5 SWOT Summary ............................................................................... 21
3.3.6 Generating Strategies ...................................................................... 22

4 PBL Module Development ........................................................................ 24
4.1 Road Traffic Safety PBL Module Structure ........................................... 24
4.2 Road Traffic Safety PBL Problem Template Design ............................... 27
4.3 Learning Goals ................................................................................... 29
  4.3.1 Chapter One Learning Goals ............................................................ 29
  4.3.2 Chapter Two Learning Goals ........................................................... 30
  4.3.3 Chapter Three Learning Goals ....................................................... 31
  4.3.4 Chapter Four Learning Goals ......................................................... 31
  4.3.5 Chapter Five Learning Goals ........................................................... 32
  4.3.6 Chapter Six Learning Goals ............................................................ 32
4.4 PBL Development ............................................................................... 32
  4.4.1 Chapter One Problems ................................................................. 33
  4.4.2 Chapter Two Problems ................................................................. 34
  4.4.3 Chapter Three Problems ............................................................... 35
  4.4.4 Chapter Four Problem ................................................................. 35
  4.4.5 Chapter Five Problem ............................................................... 36
  4.4.6 Chapter Six Problem ................................................................. 36
4.5 Assessment Plan ................................................................................. 37
  4.5.1 Formative Assessment Plan ........................................................... 37
  4.5.2 Summative Assessment Plan .......................................................... 39
  4.5.3 Summative and formative assessment proposal ............................. 41
4.6 Overall PBL Module Structure ............................................................ 42
4.7 Student Groups .................................................................................. 44

5 Road Traffic Safety PBL Module SWOT ................................................... 45
List of Figures

2-1  FLOW DIAGRAM OF RESEARCH PROCESS (ADAPTED FROM REED (1998)) ................................................................. 8
2-2  MAPPING OF WORK SEQUENCE WITH CHAPTER REFERENCES .................................................................................. 9
3-1  TWO DIMENSIONS OF SUMMATIVE AND FORMATIVE ASSESSMENT (ADAPTED FROM BROWN AND KNIGHT (1998)) .................................................. 14
4-1  OVERALL PBL DIFFICULTY LEVEL VERSUS TIME GRAPH ............................................................................................. 25
4-2  DETAILED PBL TOTAL DIFFICULTY LEVEL VERSUS TIME ......................................................................................... 26
4-3  PBL FORMAT DIFFICULTY LEVEL VERSUS ROAD TRAFFIC SAFETY TOPIC DIFFICULTY LEVEL GRAPH ................................................................. 27
4-4  ROAD TRAFFIC SAFETY PBL PROBLEM DESIGN TEMPLATE ........................................................................................... 28
4-5  SELF ASSESSMENT OF COMPETENCY GAIN .................................................................................................................... 38
4-6  SELF ASSESSMENT OF PBL PROBLEM ............................................................................................................................... 39
4-7  DIVISION OF SUMMATIVE ASSESSMENT IN ROAD TRAFFIC SAFETY PBL MODULE .................................................. 40
4-8  ROAD TRAFFIC SAFETY PBL MODULE FLOWCHART OF GRADING SEQUENCE ........................................................... 41
4-9  ROAD TRAFFIC SAFETY PBL MODULE PROPOSED SUMMATIVE AND FORMATIVE SEQUENCE ........................................... 42
4-10 PBL PROBLEM DIFFICULTY LEVEL VERSUS COMPLETION TIME WITH ASSESSMENT POINTS ........................................... 43
List of Tables

3-1  COMPARISON OF FORMS OF ACTIVE LEARNING (ADAPTED FROM SAVIN-BADEN (2004))  .................................................................11
3-2  TYPES OF KNOWLEDGE AND ASSOCIATED PROBLEMS (ADAPTED FROM SCHMIDT AND MOUST (2000))  ........................................12
3-3  PBL AS A TEACHING TECHNIQUE SWOT ANALYSIS  ..............................................................................................................22
4-1  ROAD TRAFFIC SAFETY PBL MODULE TIME ALLOCATION  ........................................................................................................44
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBL</td>
<td>Problem based learning</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>LIU</td>
<td>Linköping University</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strength Weakness Opportunity Threat</td>
</tr>
<tr>
<td>TRB</td>
<td>Transport Research Board</td>
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1 Introduction

This chapter represents an introduction to the thesis and it includes a brief description of the background, namely an account of current available road traffic safety education in graduate programs and the teaching methods employed in the existing programs, as well as a presentation of the purpose of this thesis. The introduction also includes the dimensions of the study and the definitions of specialized terms encountered throughout the paper.

1.1 Background

The road traffic safety discipline does not require formal training programs that are provided by most of the other existing professional associations representing its members. On the other hand, the road safety is gaining in importance as road crashes present one of the world’s largest public health and injury prevention problems. The World Health Organization (WHO) estimated in 2002 that road traffic injuries are the eleventh cause of total deaths in its member states, with over one million victims in total in that year alone. These statistics identify the need for qualified professionals to address road safety in a systematic, qualified way. The current programs in graduate studies are scarce and they employ traditional teaching techniques. Thus, Section 1.1.1 contains a brief description of the current available programs, while Section 1.1.2 the teaching methods employed in these programs are identified.

1.1.1 Road Traffic Safety Educational Programs

The available road traffic safety educational programs at a graduate level (Master or PhD) are mainly composed of one or more courses inserted in a related subject degree. For example, at Linköping University (LIU) there is one course concerning road traffic safety entitled Traffic Safety Management. However, the course is embedded in a Master degree in Intelligent Transportation Systems. The world demand for road traffic safety professionals far exceeds the offered programs, and very often one course is not sufficient in creating a qualified professional. The increasing interest in road traffic safety as a profession has generated a real need for educational modules that satisfy the professional requirements in the real-world. This paper was motivated by the belief that part of the problem of lack of educational programs stems
from the inappropriateness of current teaching methods when applied to the requirements of the road traffic safety profession.

1.1.2 Road Traffic Safety Educational Methods

The road traffic safety field is multi-disciplinary, requiring simultaneous collaboration and, or joint effort from individuals involved in two or more disciplines. This translates into a need for the presence of networking and collaboration skills in road safety professionals’ qualifications. The courses currently offered in road traffic safety, as well as the whole curriculum programs, are based on conventional teaching methods. The aim is to provide students with the basic theoretical and practical knowledge about traffic safety theories, causes, problems and countermeasures. The teaching method through which this aim is to be met is comprised of lecturing and group work supervision. The professor is the knowledge disseminator, with the students expected to apply this knowledge in completing the given project. Oral skills are developed through the oral presentations, as well as team work skills through project work. The examination is usually comprised of written project work and oral presentations, with little emphasis on feedback assessment means. The multi-disciplinary, collaborative characteristic of the discipline cannot be properly addressed in the context of conventional classroom learning.

In addition, the overall requirements of future employers in all fields are shifting from pure analytical skills to people-skils and problem solving. Conventional teaching methods in a changed real-world environment with different requirements do not properly prepare the students for their future profession. Combining the requirements derived from the changing environment with the multi-disciplinary attribute of road traffic safety, it is clear that factual knowledge must be complemented with great flexibility, communication and problem solving skills. These are not encouraged or developed in conventionally-taught courses or programs. Thus, the value of the education received by a graduate is diminished and there is a decreased interest in road traffic safety profession. As mentioned before, however, there is a real, growing need for road safety professionals.
1.2 Purpose of study

The purpose of this study is: to develop an improved road traffic safety educational module that will satisfy the professional requirements in the real world by employing the problem based learning (PBL) approach as an educational method.

1.3 Dimensions of study

The dimensions of the thesis can be divided into limitations and boundaries to the study. A limitation can be considered as a future avenue of study, whereas a boundary delimits the system under study.

Limitations

- The module will be exclusively devoted to road traffic safety
- The testing of the PBL traffic safety training module will not be included in this research paper
- The staff preparation for the PBL traffic safety training module will not be covered

Boundaries

- The research paper will be concerned with the PBL approach exclusively

1.4 Definitions

This section introduces the definitions of the two specialized terms used throughout this thesis, namely traffic safety and problem based learning (PBL). The description of these terms will be expanded later on. Nevertheless, the core definitions will remain the same as presented bellow.

1.4.1 Traffic Safety

The term traffic safety is used in many instances, both by specialists and the general public. Evans (2004) observes that the term is misused or misunderstood in very few instances, although there is no precise, quantitative definition. The general idea is as follows: the elimination of unintended harm or damage to living creatures or inanimate objects. Quantitative
safety measures nearly always focus on the magnitudes of departures from a total absence of some type of harm, rather than directly on safety as such. Depending on the specific subject and on available data, many measures are used.

1.4.2 Problem Based Learning

Problem Based Learning (PBL) was first developed in mid-1970s for the medicine department at McMaster University. According to Barrows and Tamblyn (1980) PBL is the learning that results from the process of working toward the understanding or resolution of a problem. Savin-Baden (2004) observes that this is different from the classical problem-solving learning, as the learners have to engage themselves in the learning process. In the classical teaching approach the learners have to answer individually a series of questions supplied by the lecturer.

According to Dahlgren et al. (1998), PBL has three distinctive features:

- Real life situations as starting point for the learning
- Self-directed learning
- Work in groups

PBL presents real life situations as short descriptive literature focusing on a particular moment or person. This is done to help the students get an idea of the context in which the knowledge is to be applied in the future real-life situation.
2 Investigation Description

This thesis proposes to study the PBL process in the context of traffic safety training, as well as develop a sample PBL course outline including problems, learning goals and assessment methods. This chapter will present some reasons why studying these topics presents interest.

2.1 Importance of Traffic Safety PBL Course

The Transport Research Board (TRB) has established a sponsoring committee in 2007 named Task Force on Highway Safety Workforce Development for the purpose of documenting the lack of formal training available to road safety professionals from the U.S. perspective. The level of urgency assigned to this project is high, as an urgent need exists for trained road safety professionals. They have also established that, assuming methods for correcting this situation are, or will soon be, available, it will be a recurring problem unless the next generation of trained professionals includes those interested in a road safety career. Similarly, Tay (2006) has argued that in road safety there is no requirement or formal training programs provided by most of the other professional associations representing its members. In addition, there are few road safety courses being offered in any tertiary education institutions in the world. Thus, there is a clear need for formal training in the road safety discipline, so that the next generation of professionals includes road safety specialized human resources.

The multi-disciplinary reality of road safety, although a major strength, is also a source of weakness, according to Allen (2004-05). He argues that the organizational culture unique to each sector creates institutional barriers that limit the level of inter-agency information sharing and program coordination. As such, the links between the agencies and professions involved in road safety are often erratic and temporary, as well as partially motivated by a desire to minimize inter-agency friction rather than a genuine interest for collaboration. This situation can lead to poor financial sponsorship choices, task redundancy, conflicting agendas and lost opportunities to optimize both the quality and delivery of the products and services vital to improving road safety. Hauer (2002) also argues that the practice of road safety management is in transition, from action based on experience, intuition, judgment (often political) and tradition to action based on empirical evidence, science and technology. The trends seem to indicate that there is a
clear need for an explicit and quantitative, high level education, multi-disciplinary training for road safety professionals.

The need to change from traditional lecture-based programs in undergraduate and graduate studies has become necessary due to the change in skills and abilities required post-graduation. According to the findings of the Wingspread Conference (1994), the following characteristics of quality performance are important:

- High level skills in communication, computation, technological literacy, and informational retrieval to enable individuals to acquire and apply new knowledge and skills, as needed
- The ability to arrive at informed judgments: to effectively define problems, gather and evaluate information related to these problems and develop solutions
- The ability to function in a global community through the manipulation of different aptitudes, such as flexibility, adaptability, ease with diversity, motivation and persistence, ethical and civil behavior, creativity and resourcefulness, and the ability to work with others, especially in a team setting
- Technical competence in a given field
- Demonstrated ability to deploy all the previous characteristics to address specific problems in complex, real-world settings, in which the development of workable solutions is required

Czujko (1994) confirms the above findings through his physics graduates’ study results. The participants were asked which skills were most useful in the real-work setting; eighty percent indicated that these skills are problem-solving, interpersonal skills, technical writing and management skills. By comparison, the physical knowledge was designated as most useful by over sixty percent less respondents as most important.

The findings seem to indicate that problem based learning is a viable solution to the requirements established by the current trends in road safety training. The need for future
professionals that are able to work with multi-disciplinary problems suggests that PBL is an important research area.

2.2 Nature of Study

This section identifies the study approach, as well as the method employed in collecting necessary information. It is important to be aware of how the study was conducted, so that the results are better understood.

2.2.1 Approach

The study paper is constructed in such a way as to offer the rationale behind the constructed PBL scenarios, as well as to organize the PBL scenarios in an increasing difficulty way. The difficulty level is measured by the learning material, as well as by the PBL formulation, so that the easier traffic safety learning topics are associated with the easier PBL formulation.

2.2.2 Collecting Information

The collection of information requires a systematic approach, so that the information has little or no bias and it is exhaustive. Thus, all the relevant LIU digital databases have been searched for the strings problem based learning, PBL, or a combination of both. In addition, the Google Scholar search engine has been used with the same strings. This has been conducted in accordance with the suggestions presented by Rowley and Slack (2004). Each article or book has been chosen on the level of relevancy to the topic at hand. For example, one of the PBL studies found through the search of the LIU database, although describing proper PBL problems in a medical situation in a hospital setting, has not been considered as it is outside the scope of this paper.

Reed (1998) has identified the research process as: identifying the topic of interest, generate related questions, state unsolved problems and find or develop solution. This process is important with respect to the literature review and the required amount. The beginning part of the document is mainly based on literature research, whereas the latter parts are increasingly based
on results. Figure 2-1 illustrates the research process, as described above. In this project, the collecting of information has been mainly conducted in the beginning stage.

2-1 Flow diagram of research process (adapted from Reed (1998))

2.2.3 Limitations

The PBL module developed in this study represents an introduction to traffic safety, in particular road safety. Thus, although part of the traffic safety issues, the air, rail and maritime forms of transportation will not be covered. This decision has been taken due to the high percentage of accidents in associated with road transportation; it is an area that can and should be improved the most.

Another limitation for this study has to do with the lack of real-life testing of the developed module. While the PBL course is developed in accordance with the theoretical recommendations, it is highly desirable to obtain an evaluation from the actual users.

Lastly, the specific training that the educators taking part in the module should undergo prior to the module implementation is not discussed in depth in this paper. It is assumed that the staff has already had some form of contact or knowledge of the problem based learning method.
Thus, the reaction of the staff to the proposed module will not be evaluated. However, one should be aware that the educators have a key role in the success or failure of the method and that it is imperative that their needs and concerns be addressed.

### 2.2.4 Mapping of work sequence (with chapter references)

This section presents the investigation steps, which are also a depiction of the master thesis structure. Figure 2-2 is an overview of the whole thesis structure, with chapter references.

The thesis can be divided into three distinctive parts: theoretical description, traffic safety PBL module development and SWOT analysis. The theoretical description establishes a basis that is later on used in the traffic safety PBL module development. The findings in road traffic safety training practices and PBL approach are used to create a whole traffic safety PBL module. The Strength Weakness Opportunity Threat (SWOT) analysis in the last part of the thesis incorporates the road traffic safety particulars in the theoretical PBL SWOT, as well as present a deployment strategy.

---

**Theoretical Description**

What is PBL and how can it be applied to road traffic safety management module?

What is the SWOT analysis for a PBL approach?

Sections 3.2, 3.3 & 3.4

**PBL Module Development**

What are the road traffic safety management module learning goals?

What are the PBL scenarios created in accordance to the goals and what is the rational behind their design?

What is the overall structure of the PBL module?

Sections 4.1-4.7

**Road Traffic Safety PBL Module SWOT**

What are the road traffic safety PBL module specific strengths, weaknesses, opportunities and threats?

What strategies can be generated based on the SWOT analysis, so that weaknesses and threats are neutralized and the strengths an opportunities are fully used?

Sections 5.1 & 5.2
3 Theoretical description

In this section the relevant information available in the literature on road traffic safety education and PBL as a teaching method are presented for the reader. This will create a valid and consistent basis on which the later parts of the thesis are built.

3.1 Road Traffic Safety Education

Road traffic safety training of professionals in graduate programs has received very little attention in the past. According to Allen (2004-05), there is no undergraduate or graduate program in North America that is designed to train road safety professionals. Queensland University of Technology in UK is offering a graduate diploma in road safety with duration of two semesters. The Road Safety Trust in New Zealand is offering scholarships each year at either Master or Doctoral level to those carrying out studies in areas directly related to road safety and consistent with the road safety priorities in the Road Safety to 2010 Strategy, published by the National Road Safety Committee. In addition, the study can be pursued at any New Zealand university. Nevertheless, the current situation shows that the education and training opportunities are disconnected from one another and from the safety research community, as highlighted in the TRB Special Report 289 (2007).

3.2 PBL as a Teaching Method

There is a clear need for road traffic safety professional education that can bring together multi-disciplinary fields. Lecture-based courses or programs do not satisfy the skills and abilities that are required post graduation, particularly in a multi-disciplinary field. Thus, a comprehensive, effective road safety training module should be designed using a different teaching method. The proposed approach that will be applied in this paper is PBL.

According to Savin-Baden (2004), there are many ways in which the PBL is defined; in addition, the inter-relationships between PBL, project-based learning, problem-solving learning, action learning and work-based learning are also complex. Table 3.1, adapted after Savin-Baden (2004) offers an outline of the main differences between afore mentioned active teaching methods.
<table>
<thead>
<tr>
<th>Method</th>
<th>Organization of Knowledge</th>
<th>Forms of Knowledge</th>
<th>Role of Student</th>
<th>Role of Tutor</th>
<th>Type of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PBL</strong></td>
<td>Open ended situations and problems</td>
<td>Contingent and constructed</td>
<td>Active participants and independent critical inquiries who own their own learning experiences</td>
<td>Enabler of opportunities for learning</td>
<td>Development of strategies to facilitate team and individual learning</td>
</tr>
<tr>
<td><strong>Project-based learning</strong></td>
<td>Tutor-set, structure task</td>
<td>Peformative and practical</td>
<td>Completer of project or member of team that solves the problem or develops a strategy</td>
<td>Task setter and project supervisor</td>
<td>Problem solving and problem management</td>
</tr>
<tr>
<td><strong>Problem-solving learning</strong></td>
<td>Step-by-step logical problem-solving through knowledge supplied by lecturer</td>
<td>Largely propositional but may be practical</td>
<td>Problem solver who acquires knowledge through bounded problem solving</td>
<td>A guide to the right knowledge and solution</td>
<td>Finding solutions to given problems</td>
</tr>
<tr>
<td><strong>Action learning</strong></td>
<td>Group-led discussion and reflection on action</td>
<td>Personal and performative</td>
<td>Self-adviser who seeks to achieve own goals and help others achieve theirs through reflection and action</td>
<td>A facilitator of reflection and action</td>
<td>Achievement of individual goals</td>
</tr>
</tbody>
</table>

3-1 Comparison of forms of active learning (adapted from Savin-Baden (2004))

### 3.2.1 PBL Design Decisions

This section will introduce the three basic notions that are crucial when developing a PBL course: problem design, group work and assessment. The compilation of various sources allow for a deep understanding of the main design decisions and the reasoning behind them.
### 3.2.1.1 Problem Design

It is important to establish what qualifies as a problem and what level of complexity is acceptable. Schmidt and Moust (2000) have developed a useful taxonomy of problems, based on the following assumptions:

- Students acquire different types of knowledge during their study years
- Different types of problems will guide the students towards these different types of knowledge

According to these authors, there are four types of knowledge, and thus four types of problems. Table 3.2 contains the four types, as well as an example question associated with each problem. It is important to note that during the later stages of the curricula the complexity of the problems increases, and thus the there are more then one type of knowledge acquired by working through a problem.

<table>
<thead>
<tr>
<th>Types of Knowledge</th>
<th>Types of Problems</th>
<th>Example of Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory</td>
<td>Explanatory</td>
<td>Explain why</td>
</tr>
<tr>
<td>Descriptive</td>
<td>Fact-finding</td>
<td>What would this look like?</td>
</tr>
<tr>
<td>Procedural</td>
<td>Strategy</td>
<td>If you were in this situation, what would you do?</td>
</tr>
<tr>
<td>Personal</td>
<td>Moral dilemma</td>
<td>What should the person do?</td>
</tr>
</tbody>
</table>

Mauffette et al (2004) describe a study undertaken in the PBL biology program at UQAM including the answers of 117 students. The findings indicate that the two features a problem should posses are variety and challenge. Direct (structured) problems were favored by less experience students, while the upper year students preferred indirect (ill structured) problems. Advanced problems are extracted from real life and demand from the students to decide what details should be provided by themselves. In addition, the survey indicated that
advanced problems are more flexible, less directive problems without extensive reading lists; sometimes there is no direct reading related to the subject. Lastly, the educational goals might or might not be included in the description of the problem; rather, they are more likely stated in the tutor’s guide.

Mauffette et al (2004) suggest that the problems should be adapted from real life cases. A motivating problem is one that identifies a situation that students would actually encounter if they became a practitioner in the field.

There are two major difficulties involved in designing the problems, according to Savin-Baden (2004). The first difficulty rests in the fact that tutors design the problems around the knowledge they want the students to acquire. However, PBL is oriented more towards developing the knowledge retrieval and management capabilities, as well as cultivating new skills. During a study initiated by Mitchell and Smith (2008) at the department of electronic and electrical engineering at University Collage London, the problems were designed with a ‘likely’ solution in the facilitator’s plan. However, there was no full solution written for the problems on purpose; rather, the problem areas and issues that needed to be solved in the design were listed. The second difficulty stems from the tutors’ subjective measurement of difficulty. Thus, a tutor might consider a problem quite complex, while his/her peer might view it as simplistic.

### 3.2.1.2 Assessment

Traditional assessments, according to Bryan and Clegg (2006), still focus on testing knowledge and comprehension, rather than developing and assessing judgments. Waters and McCracken (1997) broadened this idea, by pointing out the tendency of traditional assessment methods to concentrate on isolated facts and techniques to the detriment of student’s understanding of the larger integrated concepts involved. In addition, the authors stress the need to incorporate the assessment in the learning process as an active part, rather than just an auxiliary activity.

Brown and Knight (1998) identify two assessment types by the purpose they serve, namely summative and formative. Summative judgments are simply communicated in the form of percentage, point grade, etc. Formative assessments are provisional, since they are discussed
and negotiated as part of the process of using the data to improve performance. Another way of making a distinction between the two is classifying summative judgments as counting towards a degree classification and the formative assessments as non-countable. This idea is illustrated in Figure 3-1, where the “Counts” side of the axis (positive y) represents the summative judgments and the “Does Not Count” side of the axis (negative y) represents the formative judgment. The “Feedback” side of the axis (negative x) emphasizes the formative way of assessing the student work, whereas the “No Feedback” side of the axis (positive x) emphasizes the summative way of assessing the student work. However, the authors underline the importance of acknowledging that these purposes can and do blend in practice. Additionally, the assessments are divided by their purpose, rather than by the methods that they employ.

![Figure 3-1: Two dimensions of summative and formative assessment (adapted from Brown and Knight (1998))](image)

3-1 Two dimensions of summative and formative assessment (adapted from Brown and Knight (1998))

When it comes to overall notions that should determine the devising assessment tools, the Mathematical Sciences Education Board (1993) identified three guiding principles:

- Content: assessment reflects what is most important for the students to learn
- Learning: assessment enhances learning and supports instructional practice
• Equity: assessment supports every student’s opportunity to learn.

The more broad-based assessment system allows for the students to demonstrate their strengths over a range of skills, knowledge and attitudes, as promoted by Knight (2002). Duckenfield and Stirner (1992) observed in a report for the UK Employment Department, that a solid assessment system will have some or all of these characteristics, depending on its purpose:

• It will a clarity of purpose
• It will enable the learner to review progress and plan further learning
• It will enable the provider to review progress and adjudge teaching effectiveness
• It is clear what is being assessed and how judgments are reached
• It will assess what it claims to assess (validity)
• It will appear credible to learners, tutors and institutions
• It will be cost efficient
• It will have clear records of the outcome which can be used by third parties
• It will be subjective to quality assurance procedures.

Waters and McCracken (1997) summarize the following two steps in designing the assessment for a PBL course:

Step 1: Develop a clear understanding of what the learning outcomes should be for the course

Step 2: Create a problem statement the solution of which requires the student to demonstrate the desired depth of understanding of the intended learning outcomes
3.2.1.3 Group Work

Bjørke (1996) states that systematic work in a small group structure can be characterized as the cornerstone in problem-based learning. Johnson et al (1998) further identify the essential components for effective team learning:

- Positive interdependence
- Promotive interactions
- Individual accountability
- Team work and social skills
- Team processing

Positive interdependence means that the members of the team need each other in order to succeed. Thus, all members of the team need to be involved and committed to the success of the project, although in bigger teams transient members are acceptable. Promotive interactions are required so that the team members promote each other and the team. This translates in members helping each other, offering positive feedback and keeping an atmosphere open to diverse ideas. Individual accountability means that, although the performance is assessed based on team results, the individual must be held accountable for their work and contributions to the team. The desired team work and social skills that keep the team functioning properly include decision-making, trust-building, communication and conflict management. Lastly, team processing refers to the reflective identification of strengths and weaknesses that the team should undertake at the end of the problem, so that improvement is achieved in the next problem.

An example of group work in PBL is described by Alvarstein and Johannesen (2001) in a lower level logistics and transportation course. The groups were completely responsible for their own learning. As well, the given topic was the same for all groups, but each had to come up with their own problem statement. Some of the problems encountered included poor group communication, pressure to achieve great results in the group and a demanding problem statement development process.
3.2.2 Learning in PBL

Massa (2008) identifies four basic stages in a PBL module scenario in photonic education: problem analysis, self-directed learning, brainstorming and solution testing. Massa et al. (2007) defines the problem analysis stage as the part in the process where the students collaboratively identify relevant facts, required resources and knowledge gaps, form hypotheses, and set learning objectives. Dahlgren and Öberg (2001) have found during the implementation of a PBL course in Environmental Science Education that this is the point where the students start to brainstorm and make free associations; after arranging the results certain themes emerge, as well as related questions. In the self-directed phase the students learn independently the specific context identified in the problem analysis stage. At this stage there is a check for the validity and accuracy of the solution, which leads to a reformulation of the solution or a presentation of the solution. Lastly, the solution assessment leads to a collaborative evaluation and testing of the alternative problem solution by the students. The process is iterative, until the validity and accuracy check confirms that an acceptable solution has been found.

As mentioned previously, Dahlgren and Öberg (2001) observed the formation of questions in relation to the brainstorming themes. These questions are used to set the learning goals; there are five different categories of questions that the students were formulating in the problem analysis stage: encyclopedic, meaning-oriented, relational, value-oriented and solution-oriented. The encyclopedic questions have an answer that is direct and/or not too complex, such as the lexical meaning of a criteria or phenomena. In addition, this category usually contains questions that are uni-dimensional, one-aspect of the problem and no deeper meaning searching. The phrasing often contain who, which, what and where? Meaning-oriented questions show that the students are not looking for a straight answer, as in the previous case. The terms are often defined or problematized in relation to other terms, with formulations such as: what is, why and what is the meaning of? Relational questions contain more than one aspect and the relationships between these aspects, both causal and general. The answer to these questions aims to explain causes and/or to understand the consequences of certain phenomena in complex context with multiple dimensions. Instead of question words, these questions relay on nouns such as: influence, effect, and consequence. Value-oriented questions are comparative in nature, thus
evaluating something in terms of better or worse. They sometimes extend beyond the learning context, including existential issues. Wording such as: what is good and what is bad is commune in these questions. Lastly, solution-oriented questions focus on the management of the overall learning issue, rather then different aspects of the problem. The question is on an abstract level, dealing with large and complex problems to which the students are trying to find a concrete solution. The typical phrasing includes verbs such as: diminish, change and distribute.

Self-directed learning results from the formulation of the PBL problems as goal-free. Verkoeijen et al. (2006) have compared, in a study comprising sixty psychology students, goal-specified problems and goal free-problems: the goal-free conditions initiated more article reading, longer studies and longer time spent on reporting the results.

3.2.3 PBL Staff Problems

During the first stage of incorporating the PBL approach into the doctoral training program in clinical psychology at the University of Hertfordshire, it was found by Nel et al (2008) that the trainees experienced strong experiential avoidance. The term is defined by Hayes (1994) and Hayes et al. (2004) as a process involving excessive negative evaluations of unwanted private thoughts, feelings, and sensations, an unwillingness to experience these private events, and deliberate efforts to control or escape from them. According to Mitchell and Smith (2008), students struggled with the learner autonomy implicit in PBL. The tension was especially pronounced during the incipient stages of the course. However, as the course drew to an end, it was apparent that some students recognizing the need to be more pro-active.

Nel et al. (2008) also found high levels of anxiety in the facilitators of the PBL course concerning the success of the approach overall. Mitchell and Smith (2008) discovered a strong concern over the reduction of the syllabus in favor of personal and transferrable skills acquisition. The same thing was observed at the University of Linköping during the introduction of PBL in environmental sciences courses by Dahlgren et al. (1998): teachers expressed concern over the loss of breadth for depth. In addition, there were some concerns over the proper assessment format for a PBL course.
The role of the university staff from the authority to an authority, as described by Jones (1999), is a challenging departure from the traditional academic mindset. Dahlgren et al. (1998) found that teachers felt their expertise was no longer fully exploited with the elimination of traditional, lecture-based teaching methods. In addition, they found it difficult to control the students’ factual knowledge. The teachers adopted two different kinds of roles in the context of PBL tutoring: directive and supportive. As the name suggests, the directive approach found the tutors seeing themselves as resources, planners for the students’ work and no emphasis on the group process. In contrast, the supportive approach comprises an integrated view of the tutors’ role, with the student activities, responsibilities and influences on the learning process as highly important. These teachers had extensive experience in the tutor role and viewed the process as stimulating and challenging.

The staff has to transit from the lecturer role to the facilitator role. Savin-Baden (2003) has identified this transition as one of the conflicts in PBL; more precisely, the tutors must allow the students to manage their knowledge for themselves, rather than control and patrol what is being considered as mandatory knowledge. The author underlines the need for developing and supporting PBL facilitators, so that they become a central component in any PBL implementation strategy.

3.3 PBL-SWOT According to Literature

This section will present the main strengths, weaknesses, opportunities and threats, or SWOT analysis, that are associated with introduction PBL as a form of education. The SWOT analysis, according to Johnson et al. (1989) and Bartol and Martin (1991), is a general tool designed to be used in the preliminary stages of decision making and as a precursor to strategic planning in various kinds of applications. The strengths and weaknesses are internal factors, and thus they can be used to determine how to best implement PBL within the study system. The opportunities and threats are external factors, so the aim is to take advantage of the opportunities and avoid the threats to PBL.
3.3.1 Potential Internal Strength

The strengths related to implementing a PBL module relate to the long term retention of knowledge, critical and creative thinking skills, communication and problem-solving proficiency, project management skills, and lastly adaptation competence. These strengths, including the references from literature, are summarized as follows:

- Improves student capability of retaining ideas long term (Barrow (1986), Kellar et al. (2000), Perrenet et al. (2000), Zubaidah (2005))
- Fosters critical thinking and creativity (Barrow (1986), Barrett et al. (2005), Cowan (1999), Kellar et al. (2000), Perrenet et al. (2000), Zubaidah (2005))
- Develops communication and problem-solving skills (Barrow (1986), Kellar et al. (2000), Perrenet et al. (2000), Zubaidah (2005))
- Provides students with project management skills (Barrett et al. (2005), Cowan (1999))
- Trains students in how to adapt learning to new situations (Barrow (1986), Kellar et al. (2000), Perrenet et al. (2000), Zubaidah (2005))

3.3.2 Potential Internal Weaknesses

In contrast, the weaknesses inherent in the implementation of a PBL module relate to the assessment criteria, syllabus breath and depth, false beliefs and time constrains. A compilation of these weaknesses and the researchers that have identified them is as follows:

- Increased difficulty in finding assessment criteria (Dahlgren et al. (1998))
- Challenging balance between depth and breath of syllabus (Dahlgren et al. (1998))
- False belief on the educators’ side in the impossibility of controlling de factual knowledge in students (Dahlgren et al. (1998), Gallagher and Stepieen (1996), Lieux (1996), Schlundt et al. (1999))
• Constrained by longer time required to cover the same material (Mc Carthy Hintz (2005))

3.3.3 Potential External Opportunity

The external opportunities should be exploited by the PBL implementers, so that the module and its advantages are fully utilized. The three trends in the environment that can be considered as opportunities, as well as their references, are as follows:

• Fast changing of the business environment and industry, thus demanding new qualifications from the labor force (Wingspread Conference (1994), Czujko (1994))
• Desired employer skills, as presented by managers, are the ability to identify problems, analyze them and solve them (Alvarstein and Johannesen (2001))
• Multi-disciplinary nature of traffic safety in real life situations (Allen (2004-05))

3.3.4 Potential External Threat

Lastly, the potential threats should be acknowledged and counteracted as much as possible. The main threats stem from the faculty and its staff, and they are summarized as follows:

• Stressful situation in the faculty as a result of switching educational methods (Massa et al. (2007), Dixon (2000), Walker et al. (1996))
• Little or no formal training of staff in pedagogy and education (Wankat (1991), Savin-Badin (2003))

3.3.5 SWOT Summary

The following Table 3-3 summarizes the findings in a clear, concise way. It can be used later on, before and during the actual implementation of the PBL module, in constructing a
strategic plan (Formisano (2003)). It is meant to provide an overall picture, but it should not be considered as exhaustive of all possibilities, as it tends to oversimplify the situation.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term idea retention</td>
<td>Assessment criteria</td>
</tr>
<tr>
<td>Critical thinking and creativity</td>
<td>Depth/bread syllabus balance</td>
</tr>
<tr>
<td>Communication and problem solving</td>
<td>Educator's beliefs</td>
</tr>
<tr>
<td>Project management skills</td>
<td></td>
</tr>
<tr>
<td>New situation adaptation skills</td>
<td>Time requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business environment changes</td>
<td>Faculty Stress</td>
</tr>
<tr>
<td>Manager requirements</td>
<td></td>
</tr>
<tr>
<td>Traffic safety module multi-disciplinary</td>
<td>Staff little/no formal pedagogical education</td>
</tr>
</tbody>
</table>

3.3 PBL as a teaching technique SWOT analysis

3.3.6 Generating Strategies

According to Hisrich and Peters (1989), responding to internal strengths and weaknesses is an essential component of the strategic management process. In addition, success can only be achieved if one is familiar with the opportunities and threats resulting from the external environment. Hax and Majluf (1991) state that strategic management includes three basic elements, namely:

- The formulation of a strategy
- The implementation of a strategy
- The control and evaluation of the strategy
Dyson (2004) studied the strategic development and SWOT analysis at the University of Warwick; the identified strengths, weaknesses, opportunities and threats were used in developing strategies. The questions used to develop these strategies are as follows:

- How can we use each Strength?
- How can we stop each Weakness?
- How can we exploit each Opportunity?
- How can we defend against each Threat?
4 PBL Module Development

This section covers the structure of the road traffic safety PBL module, the design template of all PBL problems developed later on, the road traffic safety topics and their associated learning goals and the actual PBL problems developed from these goals according to the design template and arranged according to the developed structure. For each scenario the rational behind choosing the specific problem, the formulation and the suggested presentation format will be included.

4.1 Road Traffic Safety PBL Module Structure

From the literature study it is apparent that pure PBL problems do not have a template (ill-defined), they are not designed around the learning goals solely and they are taken from real-life (or contain a real life element). The PBL module designed in this paper can be considered a hybrid in this respect, as it starts with well-defined problems and it progresses to ill-defined problems. This approach has been chosen due to the intended target, the available time and the predictably reluctant reaction of staff to PBL. The intended target consists of students that might or might not have been in contact with PBL. Thus, it is designed to satisfy the requirements of both groups: the easy start-up problems for the needs of the novice and the difficult problems for everybody. It is assumed that after the middle of the module all the students have become familiar with PBL. The available time dictates that it is not possible to cover all desired topics at the same level of difficulty. The first chapters in road traffic safety will be covered faster than the later chapters, and the overall time requirement will be balanced. Lastly, the staff will be reluctant to relinquish control; to eliminate some of the downfalls that emerge from this situation the first PBLs will afford a high level of control, whereas the latter PBLs will be open ended with little or no control.

Figure 4-1 illustrates the gradual increase in the overall difficulty level of PBLs versus time. It can be observed that the difficulty level net increase $d_{x,y} = d_y - d_x$ between PBL$_x$ and PBL$_y$, where $x$ represents the previous learning chapter number and $y$ represents the current learning chapter number, is increasing faster as the PBL problem belongs to a chapter that is later in the module. For example, the difficulty level net increase between a PBL in chapter one and a PBL in chapter two is smaller than the net increase between a PBL in chapter two and a PBL in
chapter 3. The net difficulty level augment is not increasing in a uniform way, where all $d_{xy}$ are equal between each other. Rather, it is increasing variably, where $d_{x-1,y-1} \leq d_{x,y}$ for all $x$ and $y$. This means that the problems become more difficult in an increasing, non-linear way. Similarly, the time that it takes for a PBL problem to be completed is increasing in variable manner, with all $t_{x-1,y-1} \leq t_{x,y}$. This is necessary, since a higher difficulty level indicates the need for more time reserved for the problem solving process.

The overall difficulty level is itself a composite variable, where $d_y = ts_y + pbl_y$; $ts_y$ represents the road traffic safety topic difficulty at point $y$ and $pbl_y$ denotes the difficulty level of the PBL problem formulation belonging to learning chapter $y$. A low $ts_y$ value has a low $pbl_y$ value, thus adding up to a low total $d_y$ value. What this means is that when the road traffic topic is low in its difficulty level the PBL problem format will be closed ended, with clear learning goals. In contrast, when the road traffic topic is high in difficulty the PBL problem format will be open ended, without specified learning goals. For example, the basic road traffic safety concepts
are learnt through a closed ended problem format. In contrast, the policy making in road traffic safety at a national level is assimilated through solving an open ended problem. This concept is illustrated in Figure 4-2 for added clarity.

The difference in difficulty between two adjacent road traffic safety topics $x$ and $y$ is denoted by $ts_{x,y}$ and the difference in difficulty between two adjacent PBL problem formulations $x$ and $y$ is denoted by $pbl_{x,y}$. The road traffic safety net increase in the difficulty of the topic according to the relation $ts_{x-1,y-1} \leq ts_{x,y}$. Similarly, the PBL problem format net increase in difficulty follows the relation $pbl_{x-1,y-1} \leq pbl_{x,y}$. In other words, a problem belonging to the next chapter is always more complex in terms of learning goals and format as compared to the problem belonging to the current chapter. This is illustrated in Figure 4-3.
The three graphs are not drawn to scale in relation to the PBL problems developed later on in this paper. Rather, they are meant as an illustration of the underlying concepts used in the design of the overall road traffic safety PBL module.

### 4.2 Road Traffic Safety PBL Problem Template Design

The template for road traffic safety PBL problems has been developed in order to ensure that consistency was preserved throughout the educational module. Parts of the template should be used or ignored based on the difficulty level $d$, discussed in the previous section. Figure 4-4 illustrates the general format. It can be observed that the template is divided into two distinct sections, which will be explained below.
The first section contains the parts that will be common to all problems: the number of the problem in the module, a title, an illustration, if available, and a perspective. When composing the problems, the perspective is given by the role that the group of students has to assume, such as police officer, health care provider, engineering team etc. This part does not influence the value of \( d_y \) in any significant way.

The second section contains the body of the problem, the optional material and helpful reading material, if appropriate. This is the section where \( d_y \) is affected in a significant way.

The reading material is a short list of suggested readings related to the scenario, so that the students are provided with a research starting point. The reading material is included in the first three PBL scenarios out of the total of six. Their presence directly affects the value of the variable \( d_y \) by making it smaller. In effect, the value of the pbl\_y component of the variable is reduced. The specific reading list is left for the individual supervisor to decide, so that it is up to date and relevant.
The optional material includes a list of specific learning goals, as well as a learning list acting as a checklist. The optional material can be included or excluded, depending on the index of learning chapter in which the PBL problem is. Thus, the first four chapters contain problems that have this section in the student version, whereas the last two chapters do not; if the index of the chapter is five or six the optional material is available for the facilitator only. As expected, the removal of this section in the last two scenarios increases the value of pbl\(_y\) and as a result of \(d_y\).

Lastly, the body of the problem can have a closed ended and structured makeup, an open ended and ill-structured makeup or a combination of both. The structure depends on the index of the chapter which contains the PBL problem, with lower indexes tending towards the closed ended, well structured make-up and higher indexes becoming open ended and ill structured. The lower indexed chapters will contain problems with a lower value of pbl\(_y\) and as a result of \(d_y\), while the higher indexed chapters will have problems with a higher value for pbl\(_y\) and as a result of \(d_y\).

### 4.3 Learning Goals

The PBL traffic safety module is split into six parts, each one with its own set of learning goals. The division of learning material has been done in accordance with the traffic safety booklet developed by Ghazwan al-Haji, Postdoktor in the ITN department at the University of Linköping. The learning goals have been developed in accordance with the same booklet, as well as the course organization in the traffic safety diploma work at the Queensland University of Technology. The two sources complemented each other, so that the learning goals cover the main topics in traffic safety education for professionals.

The learning goals are the direct indicator of the value of the variable ts\(_y\) introduced in Section 4.1. As the index of the PBL problems increases the value of ts\(_y\) increases; in effect, the learning goals become more complex and harder to acquire.

#### 4.3.1 Chapter One Learning Goals

The content of this section aims to introduce the learner to the development of transportation throughout history, and the relationships that can be inferred between
transportation and society. In addition, the development of road safety in connection to the
development of transportation should be understood through the society context. Thus, the
learning goals can be summarized as follows:

- Understand the relationship throughout history between society and
  transportation by specifically:
  - Identifying the economic/social and transportation relationships
  - Understanding each one of the identified relationships

- Understand the relationship throughout history between road safety and
  transportation

- Be able to connect road safety, transportation and society (economic and
  social aspects) through meaningful relationships

### 4.3.2 Chapter Two Learning Goals

The second section of the course aims to introduce the students to what constitutes a road
traffic related accident, as well as the dimensions that affect the road safety from the point of
view of public health. In addition, the human factors should be identified and understood. Lastly,
the students should become familiar with different traffic accident theories and models; the aim
is to not only know the techniques and principles, but also when it is appropriate to use each one.
An enumeration of the above goals is as follows:

- Understand what constitutes a road traffic related accident

- Be able to identify the dimensions that influence safety from the point of view
  of public health, as well as the relationship between them:
  - Be able to relate human factors to accident risk

- Explore and acquire an understanding of the common traffic accident theories
  and models:
  - Know which technique is more appropriate, depending on the context
4.3.3 Chapter Three Learning Goals

Once the students become familiar with the basics in traffic safety, they are introduced to a wider view of the economic and social implications of a road crash. In order to accomplish this, current road safety data systems should be explored, including definitions, data collection, problems and the different levels of aggregation. In addition, methods of comparison for different systems at an international level should become familiar. The goals of this section are summarized as follows:

- Understand the various existing road safety data systems and their role in traffic safety, namely the:
  - Process of accident data system, definitions, collection, problems, levels
  - Comparison methods at an international level

4.3.4 Chapter Four Learning Goals

In the fourth section the students should be able to distinguish the road accident causes as obvious, revealed by deeper analysis and almost undetectable. From a different perspective, they should also identify and understand the three dimensions associated with accidents, namely behavior of road users, road construction and traffic management and vehicle design. The last learning goal aims to have students understand the possible relationships between these macro-factors and identify viable models.

- Be able to identify the causes of an accident as obvious, revealed or almost undetectable
- Determine the three dimensions associated with road traffic safety problems:
  - Identify and understand the accident causes due to road user behavior, road design and traffic management and vehicle design
- Explore the correlation between national level macro-factors influencing the three safety dimensions and possible models of these relationships
4.3.5  Chapter Five Learning Goals

This section in the module aims to provide the student with an understanding of available accident countermeasures developed over the years. They should be able to determine proper evaluation techniques, so that the effectiveness of a countermeasure can be monitored and improved. There is continuity between these learning goals and the ones in the previous section, so that the student must be aware of the relationship between different micro-factors before proceeding in choosing a countermeasure.

- Know and apply countermeasures to the road traffic safety problems
- Determine proper evaluation techniques for the effectiveness of any implemented countermeasures

4.3.6  Chapter Six Learning Goals

The last section in the module proposes to explore the national road safety programs in road traffic safety, both existing and resulting from future initiatives. The learning scope is wide through the macro view of the traffic issues at a national level. In addition, the students have to develop strategy plans, as well as valid and accurate assessment plans. This part is the most challenging in terms of the learning goals, as they require varied skills and proficiencies from the students.

- Investigate existing national road safety organizations, both governmental and non-governmental
- Be proficient in establishing a road traffic safety action plan at a national level
- Be able to construct national strategic deployment plans and built assessment techniques

4.4  PBL Development

According to the literature review, the design of the problems is extremely important. In addition, it is important to introduce students to the PBL process, give them an understanding of the reasoning behind adopting such a method and warn them of common experiences in the
beginning of the module. This short introductory paper is presented in Appendix A, and it addresses the areas mentioned above.

The PBL problems have all been created from real life cases and chosen based on satisfying certain learning requirements and the format presented in Chapter 4. The full problems are attached to this document in Appendix B.

The student material is added for each PBL problem, with problems one through four after the problem body. It consists of three parts: learning list, learning goals and reading material. The learning list is a check list that allows the students to check specific learning objectives. The learning goals are different, in that they address the skills that the students should acquire after the exercise, for use in a possible future job. The reading material is meant to provide a starting place for the research.

4.4.1 Chapter One Problems

There are two problems developed for chapter one, based on the learning goals stated in Section 4.3.1. Overall, in support of these learning goals, the problem has to explore the relationship between transportation, society (social needs and economy) and road traffic safety. The students must explain what the significance of the key words (transportation, road traffic safety, social needs, and economy) is, as well as their relationships. The body of the problem contains all the key words, with an extra sentence highlighting the desired focus on road traffic safety specifically, rather than all the transportation risks. The values for \( p_b s_y \) and \( t_s y \) are at their minimum, as the format is closed ended and well defined and the traffic safety topic is basic.

The first problem is an explanatory type of problem, thus the students are expected to gain explanatory knowledge. The choice of knowledge has been based on the level of difficulty desired for an introductory problem. The students are identified with a group of urban planners, confronted with the tradeoffs that are inherent between transportation levels and road safety, as well as the interdependence of transportation and society as a whole. In other words, road safety is also interdependent with economic growth and social needs. Lastly, the safety is placed in a global perspective by the last sentence, since no specific location is given for the urban study.
The second problem has the same format, thus it is explanatory in nature and students are expected to gain explanatory knowledge. Once again, this has been chosen based on the introductory level required. The students are identified with members of a road traffic safety in China. The scenario is adapted from a real case, with the requirements for the group being fictitious, but the background real. In the winter of 2008 the Chinese authorities were confronted with a massive snowstorm, which blocked most traffic in the country. In addition to the natural element that can not be controlled, there were two other factors that increased the impact. Thus, a large number of migrant workers was preparing to go home for the new year and the road infrastructure was suboptimal. The relationships between transportation, road safety and society are highlighted by the blockage of society due to the blockage of transportation and the increase of accidents due to poor road infrastructure. The snow storm is seen as catalysis, rather than the main factor in this problem.

### 4.4.2 Chapter Two Problems

As in the previous section, there are two problems developed for chapter two, based on the learning goals stated in Section 4.3.2. Overall, in support of these learning goals, the problem has to explore the meaning of road traffic accidents, as well as understand the different accident models and theories available and their usefulness depending on the situation. The values for $p_{bs}$ and $t_{s}$ have increased, as the format is more open ended, yet still well defined, and the traffic safety topic is harder to cover.

The first problem designed for chapter two targets descriptive knowledge, by asking the students to explain what models exist and why they would be appropriate in different situations. In addition, students are identified with researchers and will also acquire explanatory knowledge when exploring different models. The level of difficulty based on the PBL problem format pbl, is thus raised at this point. The problem consists of summary of the factors that influence car insurance based on a Canadian government site. The students are asked to make the connection between these factors and the different traffic safety models and theories. It is intended to show that traffic safety professionals can and should diversify their outlook: a seemingly unrelated subject is just a different viewpoint of the same issues. The problem is also meant to develop associative skills, by the connections it is suggesting.
The second problem designed for this chapter targets the same type of knowledge as the previous problems. The student is asked to conduct fact finding investigations and describe the relevance based on the situation and end goal. The real situation presented to the students, as a group of independent observers, reports the high level initiative to curb accidents involving young people in South Africa. The problem continues with the task the group has, as independent observers, to widen the horizon of the approach. Thus, rather than just blaming age for the accident situation, the group should find the available models and indicate what situations they are most appropriate for.

### 4.4.3 Chapter Three Problems

The first problem based on the learning goals designed for the third chapter is aimed at the same type of knowledge as the previous problems, namely descriptive. The format of the PBL problem is increasing the pbl value, as the students do not have an exact description of what is expected of them. The traffic safety variable ts is also increased due to the various issues related to databases that are not immediately apparent. The students are members of the International Traffic Safety Data and Analysis, which is an actual organization. The hypothetical circumstances presented consist of a probable situation in which a new country wants to become a member of the international data organization. This can and does take place in real life, so it is possible the students will be faced with a similar situation in their line of work as safety professionals. The role of the group becomes one of information dissimulators, thus they play the role of experts in database creation. In addition, they must convince the country of the importance of such a database, so they are also advocates for traffic safety in a scientific and statistically sound way. The task is to provide a comprehensive view of traffic accident databases, both in terms of benefits and important issues.

### 4.4.4 Chapter Four Problem

The problem based on the learning goals outlined in the fourth learning chapter focuses on descriptive knowledge. The format of the PBL problem is increasing the pbl value, as the correlation between macro-factors is not mentioned as a key word in the body. The traffic safety variable ts is also increased due to the lack of data and models relating to the correlation
between the macro-factors. It is a problem taken from real life, namely the European Union effort to improve safety on its roads. The students are presented with an introduction to the PIN (Road Safety Performance Index) initiative, summarized directly from the official website of European Transport Safety Council. They play the role of members of this initiative, trying to create awareness for non-traffic safety individuals. In addition, they are given the hint that the Index might not be complete, and that the supervisor would welcome suggestions of improvement. This creates two audiences: the non-safety professionals that need to be educated and the safety professional that needs to be introduced to new ideas. The improvements to the Index deriving from adding correlation models makes the same group of students transform in researchers and advisers of change.

4.4.5 Chapter Five Problem

The PBL problem for the fifth chapter learning goals has a change in the format, so that the knowledge it generates is procedural. This change increases the value of pbl_y, as the students must generate a strategy, based on the knowledge they self-acquire. The traffic safety difficulty variable ts_y increases as well, as the basic knowledge has to be applied in a scientific way in a traffic safety plan. The group members take on different roles that a traffic safety professional might specialize in. There is little data as to what the learning outcomes should be from this problem, so it is open ended. In addition, the data on the city X has to be researched and true. This implies a high level of ill-structured material that the group will have to organize. Based on the knowledge they decide to acquire and the data they find on the city of their choice, they have to create a plan for the authorities. The results from the different teams are expected to be different, with some areas covered more than others, and some areas missing. The focus of this problem is shifted from mostly traffic safety oriented to other skills needed by a professional.

4.4.6 Chapter Six Problem

The last PBL problem is the most complex, in accordance with the plan presented in Section 4.3.6. The road traffic safety topic difficulty level is given by the sheer complexity in developing a nation wide program. The PBL problem format is open ended and ill structured, giving the variable pbs_y a high value. The ts_y value is also increased, as the previous knowledge
has to be organized and applied; in addition, new knowledge is needed for the specifics of a national traffic safety program. As in the previous scenario, the data is missing, so that the group of students, impersonating full time road safety professionals, has to research and choose which data is relevant and which is not. The requirement is vague, with the constraint of minimizing the budget and maximizing the impact. At this stage the students are completely responsible for the knowledge they acquire, with no leading questions or statements in the problem body.

4.5 Assessment Plan

From the literature review conducted in Section 3.2.1, it is apparent that one of the biggest challenges of PBL is defining a relevant knowledge assessment method. One way of minimizing this difficulty is to create a distinction between summative and formative assessment methods. Thus, for the traffic safety PBL module these two different assessment categories are proposed. The assessment that students are asked to make of the different parts of the module is included in formative assessments, although it does not directly assess the student’s knowledge. However, it was included in this section as it is an integral part of the formative assessment method, if its full potential is to be explored.

4.5.1 Formative Assessment Plan

A formative assessment does not reflect on the final grade that the student receives and it is used mainly for feedback purposes between the tutor, groups and among group members. One of the main methods of formative assessment in the traffic safety PBL module should be planned seminars, through which the students can present what they have accomplished up to date and the problems encountered. A certain percentage of the final grade can be set aside for the quality of participation for each group, but this is not mandatory. However, the seminars attendance should be mandatory for the completion of the course.

The work of the group should be provided with frequent feedback in different forms such as individual feedback, self assessment forms, group feedback. Individual feedback is suggested on a need basis, either requested by the student or by the tutor. A clear schedule can set fixed dates for the feedback, with the possibility of appointments in between sessions. Self assessment forms challenge the student to take a critical look at the positive and negative behaviors and
attitudes. Figure 4-5 and Figure 4-6 show the proposed self assessment form for the traffic safety PBL module. This form should be completed after each problem, so that the insights can be applied to the next task. The form is composed of two parts, one assessing the skills that the individual acquired and the second one assessing the perspective of the individual of the problem design. Group feedback should be provided on the basis of formal appointments, much like the individual feedback. However, due to the nature of PBL learning, precedence has to be given to the group feedback times over individual times. The feedback should be formatted, when appropriate, in the form of questions rather than statements. This means that the tutor fulfills his/her role as mentor, not as a source of information. Putting the feedback in question format stimulates discussion in the group and suggests new angles of tackling the problem.

<table>
<thead>
<tr>
<th>Competency Shown</th>
<th>Give examples of situations that helped you develop this competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiative</td>
<td></td>
</tr>
<tr>
<td>Leadership</td>
<td></td>
</tr>
<tr>
<td>Critical thinking</td>
<td></td>
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<tr>
<td>Problem solving skills</td>
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<tr>
<td>Interpersonal skills</td>
<td></td>
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<tr>
<td>Presentation skills</td>
<td></td>
</tr>
<tr>
<td>Report writing skills</td>
<td></td>
</tr>
</tbody>
</table>

4-5 Self assessment of competency gain
4-6 Self assessment of PBL problem

The tutor has the opportunity to evaluate the effectiveness of the PBL problems and improve on the following sections in the module. This can be accomplished by asking for journals from the groups between seminars, focusing on reflections of the learning process. Each group can discuss such things as how they managed to facilitate discussion in their group, to find the appropriate knowledge, to decide on which knowledge to focus on, etc. There should also be a section focusing on the assessment of the problem itself, exploring such issues as the wording, the direction, the interest generated, etc.

4.5.2 Summative Assessment Plan

The summative assessments are used to grade a student, and thus they are summarizing the overall performance. In the traffic safety PBL module the proposed assessment contains three parts: written performance, oral presentation performance and individual interview. The first two have a group grade, meaning that everybody in the group receives the same grade. The individual interview is conducted so that all students demonstrate individual knowledge as well. The interview is an individual percentage grade, with the requisite that the student must obtain a percentage above a preset value; this means that a person that obtains a grade bellow the threshold in the interview fails the course. The format is designed to underline the importance of
group work, as well as the need to have a fair individual judgment. Figure 4-7 shows the three forms of assessment: the group work provides the group percentage grade, whereas the individual interview gives an individual percentage grade. The weighted average of the three grades will be recorded officially.

![Diagram of summative assessment](image)

**Division of summative assessment in road traffic safety PBL module**

To better understand the process of the summative assessment, Figure 4-8 presents it as a flowchart. Thus, the student first receives a percent grade composed of the report and the presentation. The presentation grade cannot fail the group, but it can highly reduce the score. In contrast, the report grade can be a failing grade for the group. In order to be able to conduct the individual interview the overall percentage for group work in the four sections of the traffic safety PBL module has to be above a certain predetermined percent. If this is not the case, then the group must redo the faulty reports and increase their grade above the predetermined pass percentage. Once this requirement is met each group member must have an individual interview with the tutor, so that no member of the group is passing due to other members’ contribution. In the case of a fail, the student cannot pass the course. A new interview can be re-scheduled for a latter date, so that the student has time to acquire the omitted knowledge.
4.5.3 Summative and formative assessment proposal

This section is a description of the proposed sequence of summative and formative assessments, based on the four sections in the traffic safety PBL module. It is intended to give the order and the timing of the various assessments, but it does not include specific time intervals. This is done to ensure that the proposal is flexible and can be adapted to the specific particulars of a module’s implementation. Figure 4-9 is an illustration of the proposed summative and formative assessment points in a time-sequential arrangement.
4.6 Overall PBL Module Structure

In this section all the elements described in Chapter 4 are summarized in a chronological order. This is the timeline in which the PBL problems and their assessment should be fitted into. Depending on the situation, time variations are possible; however, the order of the elements is not interchangeable.

The illustration in Figure 4-10 depicts the order of the PBL problems, the amount of time allocated for each problem, the difficulty level that determines the amount of time and the assessment points. The first two chapters contain two problems each, as the difficulty level is low and thus the time allocated per problem is also low. The problems for chapter three and four consume an equal amount of time, although the difficulty level is increased in chapter four. This is understandable, as one of the skills students must acquire is time management skills and being
able to do more in less time. The same principle applies to the problems in chapters five and six, although the time allocated is increased compared to problems three and four. The blue dots represent important assessment points: report, oral presentation and self assessment questionnaire. The last star shaped dot represents the individual interview that all students must pass in order to pass the course. The summative assessments (other than the self assessment form), are placed somewhere in the time allocated to the problem, according to the facilitator’s judgment.
As for the actual time devoted per problem, the following Table 4-1 presents estimated times. However, these are guideline only and they are flexible according to the needs of the facilitator.

<table>
<thead>
<tr>
<th>Chapter Number</th>
<th>Problem Number</th>
<th>Allocated time (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
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<td>2</td>
<td>1</td>
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</tr>
<tr>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>14 weeks</strong></td>
</tr>
</tbody>
</table>

4.7 **Student Groups**

The final number of students per group should be dependent on the number of students registered for the course. For example, if there are only six students registered, then it is logical to have two groups of three students. The optimal range of number of students in a group is four to five. This would assure the time allocated for the PBL module is sufficient, with enough students doing the work. On the other hand, there are not too many students, so that the interactions between different team members are easy to perform; this minimizes the chance of non-lucrative team members, scheduling conflicts and slow decisions.
5 Road Traffic Safety PBL Module SWOT

The implementation of any new program or initiative requires a careful analysis of the strengths, weaknesses, opportunities and threats. Once these are understood, a strategy of deployment can be created, so that the program or initiative is a success. The road traffic safety PBL module is no exception to this rule; the current section will discuss the specific SWOT analysis, as well as recommend a success strategy. The strengths and opportunities will be exploited to generate a successful program, whereas the weaknesses and threats will be eliminated or neutralized.

5.1 SWOT Analysis

In this section, with the input of facts outlines in the theoretical Section 3.3., a specific SWOT will be generated for the road traffic safety module. The general facts will be applied to this specific case, so that the identifiable characteristics of road traffic safety discipline are incorporated.

5.1.1 Road Traffic Safety PBL Module Internal Strengths

The strengths identified in the theoretical Section 3.3.1 with respect to PBL as a teaching technique solely are as follows:

- Long term idea retention
- Critical thinking and creativity
- Communication and problem solving
- Project management skills
- New situation adaptation skills

In turn, these strengths can be applied to the road traffic safety profession requirements and their relevancy can be demonstrated. Starting with the first strength, namely long term idea retention, and applying it to the safety field, it is clear that it is significant. The students educated through this module will have a higher accuracy in the first months of employment, before practice becomes more relevant. The learning on the job approach is thus minimized, with students applying the knowledge and skills acquired faster, easier and more accurately.
Road traffic safety is a complex discipline, involving various disciplines and theoretical models. The workers in the field will need to identify and try to correct current and potential road safety problems using appropriate scientific methods. For example, when studying an accident, there are numerous theories and models that one can apply. The professional has to make a judgment based on the evidence, the context, the relevant criteria and scientific knowledge as to which model to use. Creativity plays a role as well, although less pronounced than critical thinking: it is important to bring innovative solutions to safety problems encountered during one’s career.

Traffic professionals need to identify opportunities of safety improvement through collaboration with individuals from diverse cultural, disciplinary, and educational backgrounds and institutions. The communication skills provided by the intense group work required in the PBL module will facilitate the interaction between individuals in their future safety career. The problem solving skill which students acquire through working out the problems included in the PBL module will later help them identify the interactions between different accident causing factors, develop suitable countermeasures, evaluate the results of the implemented countermeasure plan through accident databases and related data, establish priorities among many countermeasures, etc.

Project management skills are essential for a road traffic professional that is involved in creating strategies, implementing them and finally evaluating them. National and even local road safety programs can be defined as projects divided in smaller sub-projects. The experts must complete these projects on schedule, within budget and with maximum results.

New situations are very common in road traffic safety: professionals must interact in a multidisciplinary field, with each situation being unique in its mix of accident factors. Although the basic scientific tools are the same, the situations in which they have to be applied constantly change.

### 5.1.2 Road Traffic Safety PBL Module Internal Weaknesses

The internal weaknesses of a PBL taught module are defined as follows, according to Section 3.3.2:

- Assessment criteria
• Depth/breath syllabus balance
• Educator's beliefs
• Time requirements

These weaknesses are not readily transferable to the road traffic discipline. They can lead to an improper implementation of the PBL module, thus minimizing or even cancelling the strengths mentioned in the previous section. The neutralization of these weaknesses will be presented later, in Section 5.2.2.

5.1.3 Road Traffic Safety PBL Module External Opportunities

The external opportunities derived from PBL as a teaching technique alone, as described in Section 3.3.3, are as follows:

• Business environment changes
• Manager requirements
• Traffic safety module multi-disciplinary

The road traffic safety as a discipline has been transitioning from an intuition, judgment and tradition based to empirical evidence, science and technology based. In addition, the number of vehicles present on the roads is continuing to grow, thus requiring a higher reduction in accident rates for any noticeable decrease in fatalities and injuries. The view of safety has changed as well, with the safe system approach replacing the element specific measures. This means that the factors that play a role in road traffic safety are considered as a whole, and the safety performance is monitored by road safety professionals. The number of road traffic safety educational programs available, however, is scarce at best. Thus, there is a great opportunity in developing new, innovative educational programs that promote traffic safety. The changes in the environment also underline the need for educated professionals that are able to work in a complex, multidimensional field. The skills required by such an environment have been covered in Section 5.1.1.

There is little on the subject relating the managerial requirements with road traffic safety. It can be assumed that they are following the general trend, which implies that the employees have to be highly qualified and in possession of multiple skills. As the pace of change is high,
employees are expected to learn new skills fast and independently. In other words, they must be adaptable and self-learning. These skills coincide with the strengths described in Section 5.1.1.

Road traffic safety is a multidisciplinary field; there is a high level of communication and exchange of ideas between individuals belonging to different fields. In addition, the professional has to be able to have an overview of the whole system, in a cohesive way. PBL as a teaching technique is focused on self-learning, thus self research, communication and skills acquirement. Traditional teaching methods do not address the complexity inherent in road traffic safety.

**5.1.4 Road Traffic Safety PBL Module External Threats**

The threats identified in Section 3.3.4 are related to the actual implementation of the program:

- Faculty Stress
- Staff little/no formal pedagogical education

The threats do not relate to traffic safety and thus they will be further discussed in Section 5.2.4.

**5.2 SWOT Generated Strategy**

In this section the general strategy generated through the SWOT analysis will be presented. This will minimize the risk of an ineffective implementation of the PBL module.

**5.2.1 Internal Strengths Strategy**

The strengths that are internal to the PBL method reflect in the quality of education received by the students. The question associated with generating a strategy in relation to these internal strengths is: How can we use each Strength? The answer to this question will indicate the avenue by which the PBL module can become a success.

Before the PBL module is implemented the strengths can only be used by citing literature and existing success stories. A power point module presenting the strengths mentioned in Section 5.1.1 should be employed in convincing the faculty of the benefits of the change.
Post PBL module implementation there should be an emphasis of connecting the expected strengths with the actual strengths. This translates in confirming the strengths through the results obtained through the PBL module. An important part should be a self-assessment of the students involved in the course. In addition to this, it would be useful to continue having a communication line with the students that completed the module. Of these, the ones that follow a carrier related to traffic safety should be asked at a later date to re-rate the course. The perspective of actual professionals working in the field on the usefulness of the module will validate the strengths of the module. These results can then be used to extend the module to more modules and even a full post graduate degree.

Another useful link is the industry itself; in the literature review it was apparent that the skills acquired through PBL correspond to the requirements of future employers. Thus, another way to explore the strengths of the program is to interview traffic safety professionals and future employers. The compiled answers can be matched with the PBL strengths, thus creating a correlation between the industry needs and the skills acquired through PBL. The three suggested ways of emphasizing the strengths of PBL:

- Questionnaire for graduates of the PBL module
- Questionnaire for traffic safety professionals, previous graduates of PBL module
- Questionnaire for traffic safety professionals

The strengths can be used to attract students at the teaching institution, namely the road traffic safety module. It can be used to create an innovative, effective program. Thus, the strengths of PBL should be focused in attracting new talent in the filed of road traffic safety. In addition, the strengths will produce students better equipped for the real-world.

### 5.2.2 Internal Weakness Strategy

The internal weaknesses of the PBL module are related to the assessment criteria, the depth and breath of the syllabus, lack of factual knowledge control and time constrains. In contrast to the strengths presented above, the weaknesses are more varied in nature. Thus, they
have to be addressed individually for a better understanding and depth. The question that one needs to answer in connection to these weaknesses is: How can we stop each weakness?

1.1.1.1 Assessment Criteria

The assessment criteria weakness is something that can be controlled by the faculty. Thus, it can be transformed from a weakness to a strength, or at least it can be neutralized. In the PBL module constructed in this paper the assessment methods have been chosen based on their variety. This implies that both summative and formative assessments are used in equal measure; the summative assessments tend to lack the communication level implicit in PBL, but they are required by the faculty grading structure. Formative assessments, on the other hand, are PBL oriented in nature, as they foster equal communication between the tutor and the students, including feedback and suggestions. Another important element is the consistency in the grading of reports: when the student or the group is graded on the work there should be no emphasis on whether the student covered all the learning goals or the right goals. This will invalidate the whole concept behind PBL, where the group constructs its own learning goals. As a word of caution, if the optional material is used, then the students should be held accountable over the learning goals covered by the questions. Rather, the group should be graded on the level of depth and understanding it reached over the specific topic as well as the approach used.

In conclusion, the assessment criteria must fit into the PBL concept: not all learning goals will be covered, others might be added. In addition, the formative assessments should balance the summative assessments, as they reflect the PBL concepts. Lastly, the approach used to solve the problem, the skills acquired should be equally important in grading the group and the student.

1.1.1.2 Depth and Breath of Syllabus

The depth acquired in a PBL module is higher than that acquired in a conventionally-taught module. In contrast, the breath of a conventional course is higher than what most PBL modules can cover. Thus, there is a trade-off between the depth in PBL and the breath in conventional teaching. Upon a closer examination, the breath generated in conventional programs is a direct result of the surface approach used by students. Although more material is covered, the retention rate is lower and the motivation is mostly due to fear of failure of the exam
or course. Directly related to this is the fact that one of the strengths of PBL is idea retention: this is generated by the intrinsic motivation that students exhibit in the course. With intrinsic motivation comes a desire to spend more time on a topic and explore deeper in an independent manner, hence generating depth in the learning process.

The weakness of lower coverage can be seen as a strength of deeper knowledge. It can be neutralized if the emphasis is placed on the changing needs of the working world and the importance of skill versus fact retention. The requirements in the real world tend to require some basic knowledge in the field and a high ability to acquire and apply new knowledge and skills.

1.1.1.3 Educator’s Beliefs

Lack of factual knowledge control is cited as one of the main reasons of being skeptical of the PBL results. In reality, this is just perceived idea from the educators’ side; the sudden loss of control can generate this belief.

The PBL module eliminates this fear by allowing a high degree of control in the beginning part, and slowly decreasing it. This is accomplished through the design of the problems in each chapter, starting with clear learning goals and check points and ending with an open ended format. The gradual surrender of control on the educator’s part will eliminate or minimize the fear of inefficient factual knowledge acquisition.

In addition, as a side effect, the students will feel more comfortable with the PBL method. It is possible that the skills acquired in the module will be lower than in a pure PBL program. However, it is believed that the initial encounter with the technique should be less threatening.

1.1.1.4 Time Requirements

To minimize the time requirements the problems were designed according to a gradual format. Thus, the starting problems are closed ended and structured, whereas the end problems are open ended and ill structured. As a result, the problems in the first half require less time than the ones in the second half. The time constrain is thus neutralized.
5.2.3 External Opportunity Strategy

The opportunities can be divided into two categories: PBL related and traffic safety related. Each will be discussed bellow.

The PBL related opportunities derive from matching the industry requirements with the knowledge and skills derived from this teaching method. As already discussed in Section 3.1, the traffic safety is changing into a real profession. The module is a real opportunity in generating new, young professionals for the industry. Publicizing this can generate considerable interest in the road traffic safety field.

The road traffic safety opportunity arises from the multidisciplinary structure of the field. Whereas traditional methods do not incorporate this element, PBL has it as one of its main attributes. Students learn how to address issues across disciplines in a self-managed fashion.

5.2.4 External Threat Strategy

The two threats are directly managed by the PBL format discussed in the previous sections. The faculty feels less stress if the format is only gradually becoming pure PBL, and the professors have more time to accommodate themselves to the new teaching technique.
6 Conclusion

Road traffic safety has just recently been considered as an actual profession. The change is generating a need for educational programs that prepare young, educated professionals for the real-world requirements. An extra difficulty in creating such a program is caused by the multidisciplinary character of the road traffic safety field. PBL is particularly useful in this case, as it promotes soft skills such as communication, problem solving, creative thinking etc. The road traffic safety module introduced in this study has aimed at producing a solid, scientific based educational program that addresses the multidiscipline aspect of the field.

The inclusion in the study of a SWOT analysis, as well as a SWOT strategy for the actual implementation of the module ensures the strengths of the module are fully exploited. In the same time, the weaknesses are minimized or neutralized. As a conclusion, even if the actual module has not yet been tested, the expected value that it will provide has been underlined.

A future avenue of research ties directly to the point mentioned above: namely, the module is not tested in this paper within an actual learning environment. Thus, it is of high interest to test the module through the students’ and educators’ experiences. This should be constructed in a scientific, empirical way, with qualitative observations as well. The actual reactions to the module, as well as the level of knowledge retention should be closely observed.

The SWOT strategy developed within this paper indicates a need for continuous improvement to the format of the module based on underwent experiences and industry requirements. Thus, the PBL module is dynamic in nature and it is part of the PBL problem format to change according to the needs of the users. An interesting research area would be to document these changes to better understand the specific requirements of a road traffic safety PBL educational module.

As a last research area, the need of road traffic safety for a fully developed curriculum can be investigated. This paper can be the starting point for the development of a comprehensive university level traffic safety program based on the PBL method.
Appendix A - Introduction to PBL Handout

What is PBL?

PBL is the learning that results from the process of working toward the understanding or resolution of a problem.

What does it mean for you?

Rather than having a professor give you the knowledge through lectures, you will be responsible for your own learning process. During the course you will be given different problems, and by solving or understanding them you will gain the necessary knowledge.

Why PBL?

There has been a change in the skills and abilities required post-graduation by your future employers or in your future business. Thus, in addition to technical knowledge, it is important to have communication skills, to be able to make informed judgments, to work in a global community, and deploy these characteristics to address specific, complex, and real-world problems.

How does PBL work?

1. You will be presented with a problem, which can be an article, pictures, real-life situation etc.

2. The following questions need to be answered in your group, and consequently in a class discussion:
   a. What do we know? (facts)
   b. What do we need to know? (facts missing)
   c. What do we need to learn about? (the concepts that need more research, evaluation or definition)

3. Your group will then create an action plan which details where and how you plan to get the information
4. You will carry your investigation as a group, following the action plan. You may be involved in additional activities with the facilitator in order to elaborate on the underlying concepts found in the question phase.

5. After the independent work is completed, your group will get together with the other groups to report on work done and revisit the questions. It is very possible that you will have to make a new action plan.

6. You will present your results in a presentation and report.

7. You will have to evaluate your own performance, the group’s performance, as well as the quality of the problem.

Initial things you might experience

- You might find it hard to cope with the autonomy that comes with PBL. However, this will diminish as you go along in the course.

- You might be resistant to the whole process, with deliberate efforts to control and escape certain events. You must be aware of these feelings and attitudes and try to find solutions, discuss with your group and/or the facilitator. Remember that this is a new experience, and that experience will make these feelings decrease.
Appendix B – *Road Traffic Safety PBL module problems*

**PBL Scenario One – Chapter One**

*Society or Transportation, which comes first?*

You are a group of urban planners deciding the design for a new area in the city of Toronto. One of the concerns that you have is that the transportation levels will increase if the roads are too wide and easily accessible, thus creating pollution, noise and road accidents. On the other hand, the economic growth is dependent on the road accessibility. To make matters worse, the future residents need to keep their mobility level that they are accustomed to, or the value of the properties will go down. In order to make an informed decision, you have decided to study the relationship between transportation, road traffic safety, economy and social needs throughout history, so that you can determine what would be the best solution. In addition, you would like to know how big the road traffic safety problem is anyway, as some members have stated that it is really not that relevant.

**Learning list:**

- The importance of transport
- The risk of transportation
  - Road traffic safety in particular
- Evolution of transportation, economy and social needs
- Global road traffic safety problem

**Learning goals:**

- Understand the relationship throughout history between society and transportation by specifically:
  - Identifying the economic/social and transportation relationships
  - Understanding each one of the identified relationships
- Understand the relationship throughout history between road safety and transportation
- Be able to connect road safety, transportation and society (economic and social aspects) through meaningful relationships

**Reading Suggestions:**
You are part of a road traffic safety council in China. In January 2008 one of the greatest snowstorms hit the country, causing chaos. A large number of migrant workers were trying to return home for the Lunar New Year. Highways were blocked; the icy conditions caused numerous accidents on the roads that did remain open. The economic policies of were affected, with more money diverted for transport infrastructure and prices rising from supply shortages. The snowstorm had such an impact in great part due to the blockage of the transportation network. You have decided to investigate the relationships that exist between transport, economic and social factors. Understanding the relationships can help you determine why transportation risk exists and how much is road traffic safety relevant to today’s society. Your boss is not so convinced of the relevancy of traffic safety, so perhaps some global figures might help convince her.

Learning list:

- The importance of transport
- The risk of transportation
- Road traffic safety in particular
- Evolution of transportation, economy and social needs
- Global road traffic safety problem

Learning goals:

- Understand the relationship throughout history between society and transportation by specifically:
  - Identifying the economic/social and transportation relationships
  - Understanding each one of the identified relationships
- Understand the relationship throughout history between road safety and transportation
- Be able to connect road safety, transportation and society (economic and social aspects) through meaningful relationships

Reading Suggestions:
You are a group of researchers in traffic safety and related accident theories. Recently you came across a website for car insurance and noticed that many policies are familiar. The cost of the car insurance will increase based on the vehicle type, the time spent on the road, any previous driving record and the statistical group the driver belongs to. The insurance companies try to obtain a profit from the insured person, even if they happen to get involved in an accident. You are curious to see how these same factors are incorporated in different accident theories and models. Along your previous research you came across different views, with some experts advocating exposure risk consequences models, others saying that behavioral models explain the most, while a third group promoting human vehicle road theories. Your agreed upon task is to determine when a certain model is more appropriate based on the situation and the end goal.

**Learning list:**

- Exposure risk consequences models
- Human vehicle road models
- Human behavioral models
- Classify the models based on their application

**Learning goals:**

- Understand what constitutes a road traffic related accident
- Be able to identify the dimensions that influence safety from the point of view of public health, as well as the relationship between them
  - Be able to relate human factors to accident risk
- Explore and acquire an understanding of the common traffic accident theories and models
  - Know which technique is more appropriate, depending on the context

**Reading Suggestions:**
PBL Scenario Four – Chapter Two

Who or what is to blame?

You are an independent observer group of the Road Traffic Management Corporation in South Africa. In the month of June, 2008 over 150 youth representative from all over the country met for the National Road Safety Convention in Mpumalanga, organized by the corporation. Its aim was to come up with safety strategies for road users, especially the youth. Transport authorities say the youth, being the most affected by road carnage, have an obligation to uphold road safety. As an independent observer, you are not entirely convinced that focusing only on age issues will generate sound policies. In the past, you heard some theories present accidents as a health problem, others focus on the human behavior, while still others underline the human vehicle road relationships. So you have decided to conduct your own research into the available models and theories related to accidents and present them to your colleagues at the Road Traffic Management Corporation. Specifically, you want to explain why a certain model should be used in certain initiatives, but not in others.

Learning list:

- Exposure risk consequences models
- Human vehicle road models
- Human behavioral models
- Classify the models based on their application

Learning goals:

- Understand what constitutes a road traffic related accident
- Be able to identify the dimensions that influence safety from the point of view of public health, as well as the relationship between them
  - Be able to relate human factors to accident risk
- Explore and acquire an understanding of the common traffic accident theories and models
  - Know which technique is more appropriate, depending on the context, and be able to explain why

Reading Suggestions:
You are all members of the International Traffic Safety Data and Analysis Group, established in 1988 by the Organization for Economic Cooperation and Development. The function of the organization is to provide a mechanism for providing an aggregated database, in which international accident and victim as well as exposure data are collected on a continuous basis. Your department will hold an information session and present a report to country X, which is interested in joining the database program. You are aware that the country representatives are interested in all levels of data collection and aggregation, from the police officers recording the accident to the aggregation methods. Validity and accuracy are of high concern for them and you, as well.

Learning list:

- National accident databases
  - Data collection importance
  - Police accident form
  - Contributory factors and elements
- International accident database
- International comparison of national databases

Learning goals:

- What types of road traffic (especially road traffic accidents) databases currently exist worldwide?
  - What is the importance of such databases and their format?
  - What are the issues related to the accuracy and validity of such databases?
  - What are the factors that determine if a database can be compared internationally?

Reading Suggestions:
PBL Scenario Six – Chapter Four

How could that happen?

You are a group of professionals working with the ETSC’s Road Safety Performance Index, which is a new policy instrument to help EU Member States in improving road safety. By comparing Member States' performance, it serves to identify and promote Best Practice in Europe. Started in June 2006, the Index covers all relevant areas of road safety including road user behavior, infrastructure and vehicles. You are asked to develop a comprehensive report on the Index coverage that will be presented to non-traffic safety professionals, in a bid to create awareness. You are free to add a part recommending improvements to the Index, but this is addressed to your supervisor (a competent traffic safety professional).

**Learning list:**

- Three categories of accident causes
  - Road users
  - Vehicle
  - Road design and
- Correlation models of accident causes (macro-factors)

**Learning goals:**

- Determine the three dimensions associated with road traffic safety problems
  - Identify and understand the accident causes due to road user behavior, road design and traffic management and vehicle design
- Be able to identify the causes of an accident as obvious, revealed or almost undetectable
- Explore the correlation between national level macro-factors influencing the three safety dimensions and possible models of these relationships

**Reading Suggestions:**
PBL Scenario Seven – Chapter Five

Is there science in road traffic safety?

You are a team of road safety professionals, each representing an area of expertise (engineers, enforcement, education and emergency response). You part of an organization aiming at improving road traffic safety in city X*. The city council has asked your organization for a proposed plan of countermeasures, based on scientific methods and statistical techniques.

* You may choose any city X that you like, given that there is enough data online for you to base your report on.

Facilitator Part

Learning goals:

- Know and apply countermeasures to the road traffic safety problems
- Determine proper evaluation techniques for the effectiveness of any implemented one or set of countermeasures
You are a group of road safety professionals working full time at a national level in Country X*. Due to public pressure, the Transportation Minister has promised the public that it will deploy a comprehensive National Road Safety program to make the roads a safer place. Since you are the safety experts, the Minister has asked you to come up with proposal that will cost the least money and will have the biggest impact.

*Country X can be any country, but you cannot copy the previous road safety plans, if existent

Facilitator Part

Learning goals:

- Investigate existing national road safety organizations, both governmental and non-governmental
- Be proficient in establishing a road traffic safety action plan at a national level
- Be able to construct national strategic deployment plans and built assessment techniques
Bibliography

Allen, P., Improving Road Safety through Integration-The Missing Link, Canadian Civil Engineer, Volume 21, Number 5, 2004-05


Barrett, T., Understanding Problem-based Learning, In Barrett, MacLabhrainn, and Fallon (Eds.) Handbook of enquiry and problem-based learning: Irish case studies and international perspectives, CELT, National University of Ireland Galway and All Ireland Society for Higher Education, 2005

Barrow, H. S., A Taxonomy of Problem Based Learning Methods, Medical Education, Volume 20, 1986


Bjørke, G., Problembasert læring – Ein praksisner studiemodell, Tano Aschehoug, Oslo, 1996


Cowan, J., On becoming an innovative university teacher, Higher Education, Volume37, Number 4, 1999

Czujko, R., Physics job market: a statistical overview, AAPT Announcer 24-62, 1994

Dahlgren, M. A., Öberg, G., Questioning to Learn and Learning to Question: Structure and Function of Problem-Based Learning Scenarios in Environmental Science Education, Higher Education, Volume 41, Number 3, 2001

Dixon, A., Problem-based learning: old wine in new bottles?, In Tan, O. S., Little, P., Hee, S. Y. and Conway, J. (Eds), Problem-Based Learning: Educational Innovation Across Disciplines – a Collection of Selected Papers, Temasek Centre for Problem-Based Learning, 2000

Dyson, R. G., Strategic development and SWOT analysis at the University of Warwick, European Journal of Operational Research, Volume 152, Number 3, 2004


Evans, L., Traffic Safety, Science Serving Society, 2004


Hauer, E., Workforce for road safety management, Highway Safety Workforce Planning Workshop San Antonio, 2002


Hayes, S. C., Strosahl, K., Wilson, K. G., Acceptance and commitment therapy: An experiential approach to behavior change, Guilford Press, 2004


Jones, C., From the sage on the stage to what exactly? Description and the place of the moderator in cooperative and collaborative learning, ALT-J, Research in Learning Technology Journal, Volume 7, Number 2, 1999


Mathematical Sciences Education Board, Measuring what counts – A conceptual guide for mathematical assessment, National Academy Press, 1993


Mc Carthy Hintz, M., Can problem-based learning address content and process?, Biochemistry and Molecular Biology Education, Volume 33, Number 5, 2005


Murray, K., MacDonald, R., The disjunction between lecturers' conceptions of teaching and their claimed educational practice, Higher Education, Volume 33, Number 3, 1997

Nel, P. W., Keville, S., Ford, D., McCarney, R., Jeffrey, S., Adams, S., Uprichard, S., Close encounters of the uncertain kind: reflections on doing problem-based learning (PBL) for the first time, Reflective Practice, Volume 9, Number 2, 2008

Reed, L. E., Performing a literature review, Frontiers in Education Conference, FIE ’98, 28th Annual, Volume 1, November 4-7, 1998


Rowley, J., Slack, F., Conducting a literature review, Management Research News, Volume 27, Number 6, 2004

Savin-Baden, M., Foundations of Problem Based Learning, McGrawHill Education, 2004


Tay, R., Road Safety Workforce Education in Canadian Universities, Proceedings of the Canadian Multidisciplinary Road Safety Conference, Winnipeg, 2006


Duckenfield, M., Stirner, P., Higher Education developments: Learning through work, Sheffield - UK Employment Department, 1992


Waters, R., McCracken, M., Assessment and Evaluation in Problem-Based Learning, ASEE/IEEE Frontiers in Education Conference Proceedings, 1997

Wingspread Conference, Quality Assurance in Undergraduate Education, Boulder, Colorado, 1994


Zubaidah, S., Problem–Based Learning: Literature Review, Singapore Nursing Journal, Volume 32, Number 4, 2005