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Appropriateness of problem based learning in maritime education and training

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APPROPRIATENESS OF PROBLEM BASED LEARNING IN MARITIME EDUCATION AND TRAINING

By

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

Title of the dissertation: **Appropriateness of Problem Based Learning in Maritime Education and Training**

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The knowledge explosion and the social changes brought by the recent tremendous developments in technology placed the world of education in an uncomfortable and challenging position. The growing needs from society and industries for competent and up-to-date workforce, life-long learners and independent citizens forced educational institutions to rethink radically their instructional approaches. The worldwide growing tendency to shift toward Lerner-Centered approaches such as Problem Based Learning reflects the ineffectiveness of the traditional education to cope with the changes.

In the maritime perspective, the investigation of MET in relation to its changing environments lead to the same report. The competence-based concept brought by STCW 95 and the global changes require more than the optimal use of technology such as simulators and distance-learning; it calls for a radical rethinking of the instructional approach itself.

This work is an attempt to respond to this need. The appropriateness of Problem Based Learning in MET is discussed and an appropriate PBL model for application in marine engineering courses is elaborated as a benchmark for those interested in applying this approach in their specific programmes. Some recommendations are made to help addressing the unavoidable constraints arising from such paradigm shift.

Keywords: Learner-Centred Education, traditional education, PBL, skills, competence, knowledge, MET, marine engineering.

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ICT	Information and Communication Technology
IMO	International Maritime Organization
ISM	Institut Superieur Maritime
IT	Information Technology
LCE	Learner-Centred Education
MET	Maritime Education and Training
PBL	Problem Based Learning
STCW	Standards of Training, Certification and Watch-keeping
WMU	World Maritime University

Chapter 1

Introduction

1.1. General background

The international nature of MET and its close relationship with the shipping industry are the two main factors that made this system extremely sensitive to the dramatic and dynamic industrial and technological changes during these last decades. However, as Lewarn (2002) pointed out, the changes which have occurred to date through the impact of globalisation, the International Standards and the developments in technology are relatively minor compared to the major changes starting to emerge from the global world of higher education.

The knowledge explosion and the social changes brought by the recent tremendous developments in technology placed the world of education in an uncomfortable and challenging position. The growing needs from societies and industries for competent and up-to-date workforce, life-long learners and independent citizens forced educational institutions to rethink radically their instructional approaches. Instead of just being knowledge and information providers, educational institutions are required to provide creative environments for more active and participative students and to foster the development and acquisition of critical skills for life-long learning in evolving societies.

The traditional approach to education is increasingly reported as inefficient to respond to these new challenges. Lecturing methods which are the dominant instructional strategies under this approach are not the optimal vehicles for promoting students' learning that involves higher level thinking and professional skills acquisition. Thus, there is a growing need for an alternative to the traditional instruction and many voices within the educational milieu are calling for a radical paradigm shift since the core problem is the philosophy itself and not the procedural or technical aspects of the traditional education.

Consequently, more and more educational institutions are experiencing what is called a "paradigm shift" consisting on a quest for new teaching/learning approaches as alternatives to the traditional instruction. Pioneered by some medical schools since the 1950s, this paradigm shift phenomenon was increasingly spreading out worldwide to reach presently almost all disciplines in the higher education institutions. This shift consists mainly on the reappraisal of the straightforward transmission of information in the lecture form in favour of student-centred approaches.

Learner-Centred Education is a broad concept under which a myriad of models have been developed and their common denominator is the principle that students are the centre of focus and are actively involved in the teaching/learning process in contrast with the traditional education where teachers are the main active drivers and the students are passive receptacles of knowledge. The Learner-Centred approach is reported as providing high level skills, attitudes and behaviours increasingly requested in the modern context and which are beyond the reach of the traditional education.

It is beyond the scope of this work to identify and review all the various and numerous forms of Learner-Centered models. However, Problem Based Learning, which is one of the Learner-Centered methodologies, is the subject of this study which aims to investigate its appropriateness to the specific maritime educational field.

Problem Based Learning is expected to be a powerful tool which may help MET respond to the challenging needs of the shipping industry in this context of change. To this end, Learner-Centred Education and PBL will be investigated and their strengths and weaknesses will be discussed.

To link these concepts to the maritime sector, an investigation of MET in relation to its changing environments needs first to be conducted. The impact of the international maritime legislation and the development in technology will be particularly focused on. In the light of the findings, an appropriate PBL model will be elaborated for application in the specific context of marine engineering programmes.

1.2. Objectives

The main objective of this research work is to discuss the appropriateness of Problem Based Learning in MET and investigate the most appropriate forms of PBL for an effective implementation. An elaboration of a PBL model will be attempted for application in marine engineering courses. To this end, a specific programme will be chosen for the feasibility of such attempt. This latter is intended to be a benchmark for those interested in applying this approach in their specific programmes.

To assist in this process, the following objectives have been established for the study:

1. To investigate the trends within the global education at the dawn of the 21st century, with an emphasis on the higher education milieu.

2. To discuss the major learning schools of thoughts and investigate the history and the development of Learner-Centred Education.

3. To analyse the paradigm shift phenomenon from traditional towards Learner-Centred approaches and investigate the main reasons behind these new trends.

4. To investigate the Problem Based Learning model and discuss its history, principles, effectiveness and weaknesses.

5. To analyse the state of MET in this modern context and evaluate its internal trends towards pedagogical changes with regards to the constraints and the needs of the maritime world.

1.3. Research methodology and structure of the dissertation

The design of this research is primarily based on data collection, documentary review and comparative analysis.

The particular field of Learner-Centered Education in general and Problem Based Learning in particular is characterized by a prolific literature through internet. Related printed documentation is however scarce, particularly within the WMU library. Thus, considerable time and efforts were spent in filtering the online materials with the view of a selection based on the quality of both authors and publishers.

The elaboration of the proposed PBL model is done through a critical analysis of some well established PBL models such as those used at Aalborg University. A synthesis of their main features with the specificities of MET as a standard lead to the most appropriate scheme in the author’s opinion.

The dissertation is presented in six chapters.

Chapter 1 presents the background, objectives, research methodology and structure of this study.

In chapter 2, an overview of the main learning theories is presented and Learner-Centered Education is defined and discussed. A particular accent was put on the paradigm shift phenomenon from traditional to Learner-Centered education with the investigation of the core reasons for such changes.

In chapter 3, Problem Based Learning is introduced as a Learner-Centered approach and its principles are described and discussed. Effectiveness and weaknesses of this approach are investigated with an emphasis on the assessment issue.

Chapter 4 aims to provide an analysis about the appropriateness of PBL in MET systems. Thus, the major trends within these systems are investigated first with a consideration of the major influential factors such as STCW 95 and the developments in technology. The concept of hybrid PBL is investigated.

In chapter 5, a hybrid PBL model is proposed for implementation in marine engineering courses. Due to the lack of harmonized MET programmes and the differences between of MET systems worldwide, the Algerian MET programme is taken as a reference for the feasibility of such attempt.

Chapter 6 provides the main findings of this study and some recommendations for an effective implementation of PBL in MET.

Chapter 2

Learner-Centered Education

As Gilbert (2004) once stated, “The most important challenge facing higher education today is not technological, not political, not managerial, and not financial, although those are all important factors. The biggest, most important challenge is educational”(p. 39). These last decades, a great upheaval is taking place in the education arena and many voices are even warning about a revolution in education. So many well established educational principles and concepts are being reappraised. The philosophy of teaching methodologies, the relationship between teachers and students, the way in which a classroom is seen and structured, and the nature of curricula are some issues that are subject to a radical rethinking in the light of the recent developments. In the words of Hay (1999), “Recent challenges facing higher, tertiary and professional education and work, such as the impact of globalization and the emergence of new technologies, have called for a radical re-conceptualization of the teaching– learning nexus”.

The basic issues are mainly related to the concept of learning. The traditional teaching approach is defined as unidirectional (from teacher to student) and homogeneous (same content for all) (Tokoro, 2003). The new methodologies challenging the traditional approach can be described through many key words such as “self-directed,” “inquiry based”, "problem based," "experience based" and so on. All are based on the principles of Learner-Centered education. Through this approach to learning, students are considered as the main agents of the learning process. They have the control over their own learning by being actively involved in the determination of their own learning needs and how these needs should be met. Since it is a legitimate assumption that students are not the best judges of their own learning needs, assistance should be provided by faculties through mentors or facilitators who have to manage the learning tasks and to provide a suitable environment for the acquisition of the learning skills.

2.1. Definition and historical background

There are many definitions of Learner-Centered Education at the scale of the voluminous literature tackling this subject. Nevertheless, one of the most complete and simple definitions, in my point of view, is given by the Arizona Faculties Council of the Arizona University (2000). It states that:

> Learner-Centered education places the student at the center of education. It begins with understanding the educational contexts from which a student comes. It continues with the instructor evaluating the student's progress towards learning objectives. By helping the student acquire the basic skills to learn, it ultimately provides a basis for learning throughout life. It therefore places the responsibility for learning on the student, while the instructor assumes responsibility for facilitating the student's education. This approach strives to be individualistic, flexible, competency-based, varied in methodology and not always constrained by time or place.

In the traditional approach to teaching, which is often called teacher-centered model of education, the teacher has to handle all the responsibility for decision making about what is taught, how it is taught, when it is taught and how learner performance is measured and assessed. Teachers are viewed as the active contributors to the educational process and learners as passive receptacles of knowledge (Gunderman et al, 2003). Learner-Centered education, however, aims to produce educated learners and teaching is only a means for this purpose. In this context, effective teaching is not an end but a means for facilitating student learning which finally will promote positive learning outcomes.

Although it is often known as a modern approach to education, in fact, “Learner-Centered Education” is not at all a new paradigm propelled into the limelight by the recent and profound social changes. It has its roots going as far as the origins of the humankind’s earlier civilizations. Learner-Centered education is often seen from the psychologists’ and philosophers’ side as an emanation of the “natural education”. Its resurgence on the educational scene after a long eclipse can just be interpreted as a result of the present availability of the necessary and favorable conditions for its development.

According to Henson (2003) signs of Learner–Centered Education began appearing since the beginning of the formal education and the establishment of the first formal schools by Sumerians and Chinese around 3000 BC. The Chinese philosopher Confucius (551 BC - 479 BC) and the Greek philosopher Socrates (469 BC – 399 BC) are considered as the earliest teachers who marked deeply Learner-Centered Education. Confucius is well known for his thoughts focusing on character and citizenship. As Henson (2003) reported, one of the Confucius’s beliefs was that every individual should make unceasing efforts for the continual development of his self until excellence is achieved. Socrates from his side was always stressing on the individual through his famous maxim “know yourself”. His approach was to push his students to reach deeper and clearer ideas by questioning, disproving, and testing their thoughts. According to Ward (2002), it was reported in The Republic by Plato (360 B.C) that Socrates was guiding his students through inquiry to answer their own questions, search out answers to problems, and relate their knowledge to life applications.

The renaissance period was a scene for passionate debates between philosophical schools regarding approaches to education. Comenius, Locke, Rousseau among other liberal and radical reformers from that enlightenment period laid out the principles of "individual centered education" or "the education for the individual" where education should be a means of self-fulfillment of the individual. As reported by Gussie and Jingeleski (2001), Comenius, a British thinker, was advising teachers to call upon children's senses rather than memorization in instruction. Rousseau from his side was a supporter of an extremely permissive philosophy of education. In his famous book Emile, he was claiming for a natural education, child-centered and experience based. Inspired by Rousseau's ideas, Pestalozzi, a Swiss educator, opened a school with a Learner-Centered curriculum at the end of the 18^{th} century. However, as Henson (2003) reported, "Pestalozzi's school succeeded educationally but failed financially". These trends towards individualized education never expanded in larger movements and remained limited with regards to the lack of adequate means such as communication tools and the strong domination of the behaviorist philosophy heavily supported by the political and religious systems.

American educators started to take seriously the issue of Learner-Centered education at the end of the nineteenth century. Disappointed by the rote memorization characterizing American schools, Francis Parker (1837-1902) pioneered the use of the Learner-Centered approach and spent his whole life advocating and promoting this new approach to education. By replacing drills by inquiry activities and memorization of facts by understanding, Parker succeeded in improving qualitatively both the studying conditions and the outputs of his classes and thus, raising the American educational world's interest towards this approach. In 1901, the University of Chicago established a School of Education applying the Learner-Centered approach and made Parker as its first dean.

From the same University, John Dewey, whose thoughts and ideas have been greatly influential in the American educational world, took over Parker's concepts in conjugation with a critical synthesis of some European philosophies such as those of Rousseau, and Bacon. He deepened them and elaborated a pragmatic vision of education which is the basis of what is known nowadays as the Problem-Based learning. The core concept of Dewey's philosophy, called constructivism, was that greater importance should be given to the broadening of intellect and development of problem solving and critical thinking skills, rather than to the rote memorization of facts and instructions. He was considering the school's relation to society like that of a repair organ to the organism. Henson (2003) reported that "at the University of Chicago, he created the nation's first laboratory school, whose curriculum was a series of problem-solving activities" and further, "Dewey's laboratory schools became so popular that eventually every state has one or more laboratory schools. Unfortunately, to cut back on expenses, most of these highly successful learning communities have been eliminated". His writings are still a reference in the modern debates concerning the Learner-Centered concept.

Until the end of the 1960s, USA was leading the worldwide educational community towards this revolution in education. There was a growing interest and increasing support from the public opinion with regards to the sound arguments and the convincing results shown by the pioneering schools at that time. Unfortunately, the year 1957 sounded the death knell of that tremendous momentum. The launching of Sputnik by the Russian in October 1957 generated fierce critics blaming the "progressive" Learner-Centered Education for the poor performance of the American schools letting Russia lead the space race. The consequence was a sudden and blind renouncement of those new educational principles and the return back to the traditional basic education represented by the pavlovist current. It was the second birth of this school of thoughts.

2.2. Major learning theories

The Learner-Centered construct is supported by three modern schools of thoughts: behaviorism, cognitivism and constructivism. There are many overlaps in the principles of the three schools when they are investigated closely. An overview of these three learning theories is important in order to understand the diversity of learning approaches and methodologies under the umbrella of the Learner-Centered education. Problem-Based Learning, Experience-Based Learning and Inquiry-Based Learning are some examples among many of those different approaches deriving from the Learner-Centered concept. Each of those approaches has its principles emanating from one of these theories or a combination of them.

2.2.1. Behavioral learning

Behaviorism is primarily associated with the works of the Russian psychologist I. P. Pavlov (1849-1936) and the Americans J. B. Watson (1878-1958) and B. B. Skinner (1904-1990). In the learning context, it is a theory based upon the concept that all the future behaviors of learners are acquired through conditioning. Pavlov is representing the “classic conditioning” and the Americans the “operant conditioning” schools. The latter is based on the principle of reinforcement which consists on positive reinforcement (rewards) and negative ones (punishments).

In behavioral learning, the goal is to arouse the desired response from the learner in response to a stimulus. The learner’s ability to modify and interpret differently information is simply ignored. When it happens that different responses occur for a same stimulus, the cause is always linked to the conditioning process rather than to the learner’s input or mediation in the learning process. The learner is adopting a purely reactive position towards the learning environment; there is no room for him to take an active role in discovering or modifying it. As Uden (2005) reported, "behavioral learning is generally effective in facilitating learning that involves discriminations (recalling of facts), generalizations (defining and illustrating concepts), associations (applying explanations) and chaining (automatically performing a specific procedure)". It is worth precising that memory is not an important factor, even not addressed at all, in behavioral learning. The weakest link of this theory is that there is no possibility to acquire higher-order thinking skills, the higher levels in Bloom's taxonomy, such as analysis and synthesis. However, the biggest advantage is that it is easier for educators to set goals, to express the outcomes the students have to achieve and to manage and control the instructional process. The traditional approach to learning is one of the most vivid examples of behavioral learning.

The best quotation expressing the philosophy of behavior learning is that one from John Watson, as reported by K. V. Wagner (2007):

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select -- doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.

2.2.2. Cognitive learning

According to Uden (2005), the starting point of the cognitive theory was in the early 1960s. At that time, the world of education was starting its quest for an alternative to the behavioral learning. This latter was showing serious weaknesses with regard to its limited outcomes on the one hand and the advances made by cognitive sciences on the other. There was an increasing need to investigate and understand processes such as thinking, reasoning and problem solving which are outside the scope of the behaviorism.

Divergent from the behavioral theory that takes in account only the external conditions (stimuli) affecting the learner, the cognitive theory is mainly concerned with his mental activity. Moreover, memory which is the missing element in the behavioral theory became the cornerstone of the cognitive learning. In this theory, it is given an utmost importance to the process through which information is received, organized, stored and retrieved by the mind (Uden, 2005). The cognitive theory deals mainly with cognition which is defined as the “mental process or faculty of knowing”(Harris, 1995).

Cognitivism considers learning as information processing. Learning occurs when information as input are processed and stored and then externalized as output in the form of learned capability. As reported by Uden (2005), “learning is concerned not so much with what learners do, but with what they know and how they came to acquire that knowledge”. That is why the importance of the prior knowledge cannot be over-estimated in this theory. To be able to assimilate new information meaningfully and restructure knowledge accordingly, learners use the compare and contrast process. Prior knowledge is the entity used as reference, thus the importance of memory in this context.

Effective learning is reached when information, or prior knowledge, is stored and organized in the memory in a meaningful manner. The way it is organized is seen in this theory as profoundly dependent of the learner's thoughts, beliefs, attitudes and values. Thus, as reported by Uden (2005), "the real focus of the cognitive approach is on changing the learner by encouraging him/her to use appropriate learning strategies" and that "the main role of the teacher is to arrange external conditions that will help the student attend to, encode, and retrieve information". To be effective, the learning process should be based upon the learner's existing mental content and structure.

2.2.3. Constructivist learning

As divergent as they seem to be, behavioral and cognitive approaches however have a common criterion: they are both seen and defined as "objectivist" theories and the constructivist theory is challenging them in this specific area. From the objectivist point of view, knowledge exists "outside" and independently of the learner. Learning is a process helping to transfer that knowledge from outside to the learner's mental structures (Uden, 2005). From the constructivist point of view, however, the only knowledge than can be understood by the learners is that one which they construct through their experiences; knowledge is constructed rather than transmitted. Meaning is created by the learner rather than existing in the outside world. "Whilst objectivism emphasizes the object of our knowledge, constructivism is concerned with how we construct knowledge. The construction of knowledge is a function of the prior experience, mental structures and beliefs that one uses to interpret objects and events" reported Uden (2005). Problems and authentic and meaningful tasks are the main catalysts for knowledge construction and meaning creation.

> Although seen as an individualistic approach, the constructivist learning depends on collaboration between learners and between learners and their teachers. Interaction with others is vital to compare, test and refine ideas and understandings. In this context, teachers serve as guides and models facilitating the investigation processes in case of difficulties and providing motivating learning environments. As emphasized by Uden (2005), "thinking activities are central to constructivism… problem solving, reasoning, critical thinking, and active use of knowledge constitute the goals of constructivist instructions".

What can be drawn from this succinct overview of the three main currents of thoughts in the educational arena is that it is useful to use the behavioral theory to teach the "what" (facts), cognitivism to teach the "how" (principles) and constructivism to teach the "why" (higher level of thinking).

2.3. The paradigm shift: facts and reasons

According to Ward (2002), growing academic researches reveal a need for change if society's workforce is to be appropriately educated to respond to the challenges of the changing technology. Presently, there is a growing tendency from many educational institutions worldwide to undertake a radical shift from the traditional teaching methods towards these new approaches which all have in common the learner as a centre of focus. The delivery of higher education in particular is going through what is called "a paradigm shift" whereby the straightforward transmission of information in the lecture form is being reappraised in favor of student-centered approaches. Barr & Tagg (1995) are well expressing this phenomenon while stipulating that:

> A paradigm shift is taking hold in American higher education… A college is an institution that exists to provide instruction. Subtly but profoundly we are shifting to a new paradigm: A college is an institution that exists to produce learning. This shift changes everything. It is both needed and wanted. (p. 1)

The University of Southern California (USC) is a typical example among many other numerous US institutions that proceeded to this paradigm shift. In its plan for increasing academic excellence, it is stipulated that "The Learner-Centered university of the 21st century will focus on the educational needs of the student rather than the structure and needs of the teaching institution" (http://www.usc.edu).

In their report of 2005 about the restructuring project of Arizona's universities, the Arizona Board of Regents stated that:

> This report assumes the primary purpose of a university is learning… The Arizona board of Regents (ABOR) began a focus on Learner-Centered Education (LCE) in 1999 by "anticipating that the universities will become more effective in meeting their traditional missions and additionally responsive to the needs of the New Economy and challenges for the 21st Century through LCE (p. 1).

European Universities are not passive witnesses of such dynamic. According to Calvo (2007), "From the agreements of Bologna the European universities professors are beginning to revise all their formative processes looking for a bigger competitiveness in order to increase the quality of the teaching"(p. 1). In his explanation of the formative processes, he argued that "Perhaps one of the most important transformations in the formation process is that we should pass from "teaching" to "learning""(p.1).

This shift towards learner–centered education approaches was increasingly spreading out to reach presently all segments of the worldwide educational systems. What are the root causes for such snow ball phenomenon? What are the new conditions favoring this coming back on the educational scene of quite old learning philosophies?

There is still a lack of consensus within the educational arena in answering these questions. However, three main factors are unanimously seen as the root causes for the growing interest for Learner-Centered Education: the development in Information Technology, the inefficiencies of the traditional education and the development of the cognitive sciences. There are many overlaps between these factors. Actually, all of them are influential at different degrees depending on the place and the context.

2.3.1. Inefficiencies of the traditional education

In this approach, teachers are known to be the authoritarian directors of the learning process; they decide and assume the responsibility for what, how and when things will be learned. As mentioned in the former paragraphs, the great teachers of the ancient times, such as Confucius, Socrates and Plato were not following such authoritarian methods.

Most of theories traced back the roots of this teacher-centered approach to the religious indoctrination during the middle age. This indoctrination was seen as an effective method to prepare children for the priesthood by instilling beliefs, faith and ritual. As stated by Tokoro (2003), “Today’s education is still an emanation of this period… the basic educational system is still a form of indoctrination to prepare individuals to become obedient citizens and efficient workers”.

The behaviorist theory provided valuable arguments and a great support which made this vision of education a dominant paradigm for quite a long time. However, the profound and multi-dimensional changes brought by the recent development in technology drawn to the public scenes strong and sound debates about the weaknesses and shortcomings of this approach to education. Growing voices are calling for a move towards new educational approaches, whatever they are, since they serve best to prompt learning, and the information era is providing them with sound arguments.

The traditional education or teacher-centered approach is increasingly recognized as ineffective. Yet in the 1930^{th}, a massive evaluation of the Learner-Centered Education took place in the USA. This evaluation, known as the “Eight Year Study”, was conducted from 1932 until 1940 by the Progressive Education Association formed in 1919 to support the impetus towards new concepts for education (Henson, 2003). In its conclusions, the evaluation report claimed the ineffectiveness of the traditional approach compared to the Learner-Centered approach. Many advantages of this latter over the traditional approach were pointed out in this report. Through the Learner-Centered approach, students were found developing, among many other skills that the traditional schools were unable to inculcate, superior intellectual curiosity, creativity, drive, leadership skills and objectivity (Henson, 2003).

As Barr and Tagg (1995) noted, “the fairly passive lecture-discussion where faculty talk and most students listen is contrary to almost every principle of optimal settings for students learning”(p. 1).In such process, students have hardly enough time to engage a reflective thinking and most of their note-taking is done in a reflexive and mindless manner (Cuseo, 2000). They spend most of the time engaged in a rote recording of the information-laden lectures. As it is commonly known that students’ attention tends to weaken dramatically after 20 minutes of a continuous teacher’s performance, the ineffectiveness of such methodology is obvious when we consider the standard of 50 minutes lectures.

In this approach, knowledge is essentially delivered in a unidirectional way by the teacher, the active element in the classroom whose authority and responsibility lie on almost all the learning process. He has full control of the teaching activities and knows which part of knowledge is most important and decides about the way to transfer it. He is the chief agent, usually called the “sage on the stage”. Students, from the other side are considered as passive vessels and empty receptacles ingesting knowledge for recall on tests (Barr & Tagg, 1995). This passive position generates in the students a perception that they are less involved and this perception affects deeply their motivation. The result is reflected through the high rate of absenteeism, inattention and even intentional negative reactions such as the violence phenomenon in the US schools.

The classroom under the traditional system is seen as an individualistic and a competitive place where the main rule is a win-lose proposition. Success is an individual accomplishment since students are required to achieve individually through their own efforts (Barr & Tagg, 1995). Consequently, all the collaborative and team-working skills required more and more from the professional side are hindered by such individualistic approach.

Knowledge in the traditional approach is atomized and consists of fragmented matters dispensed by the teacher who is the chief agent of the process. In its 1991 report, the US National Council on Vocational Education (1991) commented about this atomistic framing of the learning process as: “having to learn disconnected sub-routines, items and sub-skills without an understanding of the larger context into which they fit and which gives them meaning”. In the same report, it was reported that “Fractionated instruction maximizes forgetting, inattention and passivity… Today’s school programs could hardly have been better designed to prevent a child’s natural learning system from operating”.

To end this series of deficiencies of the traditional education, this quotation reported by Barr and Tagg (1995) and attributed to Howard Gardner sounds like a pertinent summary:

> Researchers at John Hopkins, MIT, and other well regarded universities have documented that students who receive honor grades in college-level physics courses are frequently unable to solve basic problems and questions encountered in a form slightly different from that on which they have been formally instructed and tested

These inefficiencies and weaknesses of the traditional education are seen as the main driver for change in the educational area and the leading forces for this shift are coming mainly from the professionals of education. Their profound experience of the learning issues conjugated with their awareness of what is at sake in the global changes is a sound argument for bringing something new in the educational arena.

2.3.2. The developments of Information Technology

Nowadays, the trends are towards important new changes in society induced by the tremendous development of Information Technology. The web and Broadband Networks Technologies developing from the last decade of the 20^{th} century have a great impact on society in general and on education in particular.

In the words of Tokoro, “the web has empowered individuals for the first time to acquire and provide information according to their desires”(p.25). This was the missing means for the inceptors of “education for the individual” concept during the enlightenment period and their supporters along the industrial revolution. There was no basic tool allowing the individuals to get their own information at their own choice.

The web, the Broadband Networks and wireless technology has finally allowed people to access and share tremendous amount of information anywhere and at any time. People have the power for the first time to engage in “individual-centered education” with an unlimited choice of sources and kind of information and with minimum time and space constraints.

Learner-Centered Education is very demanding for resources and this was one of the main hindering factors affecting its implementation in the past. Nowadays, these developments in Information and Communication Technology are providing those missing means for fulfilling the dreams of the Learner-Centered Education’s supporters.

2.3.3. The development of the cognitive sciences

The last five decades witnessed tremendous progress made by the psychological sociological and medical sciences in penetrating the secrets of the human brain. Complex processes such as how the brain works to solve problems, transfer and store information are quite demystified and these discoveries had sounded the death knell of the behaviorist theories. The consequence is the emerging of a plethora of new educational concepts that are all moving away from the predominant behavioral approach symbolized by the traditional education. Most of these new concepts advocate the Learner-Centered approach and are based on the principles of the cognitive learning which state that learner actively construct meanings in opposition to the “action and reaction” principle of the behaviorist theory (Putnam, 2001). McCombs (2000) has well illustrated this antinomy while stating that “Learning can be reduced to a purely physiological or behavioral process, but in doing so, we reduce human phenomena to the level of lower order animals”(p.1).

Chapter 3

Problem Based Learning

The PBL concept can be traced back to the works of John Dewey (1916) who stated that "students should have experiential, hands-on, direct learning. It is generally accepted that students learn best by doing and thinking through problems", as Uden (2005) reported. However, the first applications of this concept began 40 years later in the medical education field. The medical schools at Case Western Reserve University in the United States in the 1950s, followed by McMaster University in Canada in the 1960s were the first higher education institutions to adopt and apply PBL principles in their approaches to teaching.

PBL did not emerge in response to any educational theory although many similar views exist between PBL and the constructivist learning theory (White, 2001). In the case of McMaster University, PBL emerged following an initiative of a group of educators who crafted a program based on the Problem-Based principles in response to their disappointment at the outcomes of the traditional teaching approach, unable from their point of view of producing critical thinkers, complex problem solvers and skilled graduates able to cope with the information explosion (Burch, 2000). Howard Barrows, one of the pioneers and first developer of the original McMaster PBL curriculum, explained that he and his colleagues had no background in educational psychology or cognitive science and "They just thought that learning in small groups through the use of clinical problems would make medical education more interesting and relevant for their students" as reported by Newman (2003).

As Uden (2005) wrote, “the information-laden lectures, given by experts to large student audiences, seemed disconnected from the practice of medicine that required integration of knowledge, decision making, working with others and communicating with patients”. Three other medical schools soon followed the example of the two pioneers: the University of Limburg at Maastricht in the Netherlands, the University of New Mexico in the US and the University of New Castle in Australia (Uden, 2005).

The successful use of PBL in medical education has sparked the interests of educators in different fields who consider it as a major development and change in educational practice. There is a steady increase in the number of schools and institutions adopting this approach and these trends are favoured by a prolific literature giving publicity of its effectiveness. The Association of American Medical Colleges, the World Federation of Medical Education, the World Bank and the World Health Organization are some important national and international organizations that have adopted the PBL concept in their education and training programmes as asserted Newman (2003).

3.1. Concept and structure of PBL

Among the numerous definitions of PBL, the following two are chosen for their complete and explicit meanings. As reported by the Center for Teaching and Learning of Stanford University (http://www.samford.edu), and attributed to Barrows, the first PBL developer at Maastricht University:

> Problem Based Learning (PBL) is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving

> proficiency, self-directed learning strategies, and team participation skills. The process replicates the commonly used systemic approach to resolving problems or meeting challenges that are encountered in life and career. (Barrows & Kelson)

Another definition from the same source and attributed to Duch is:

> Problem-Based learning (PBL) is an instructional method that challenges students to "learn to learn," working cooperatively in groups to seek solutions to real world problems. These problems are used to engage students' curiosity and initiate learning the subject matter. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources (Duch, 1995)

With regard to the broad acceptance of this approach and the wide and increasing range of specializations where it is applied, PBL is far from being a dogmatic concept. It differs in various schools and specializations despite some voices advocating a “pure” concept and rigid principles. As Sponken-Smith (2007) confirmed, “PBL, despite its large number of sometimes over-zealous and even evangelical converts, has almost as many forms as places where it is used". Although a voluminous literature and long debates over what structure PBL has to take, there is a common agreement on four characteristics that have been considered as the four essential dimensions of PBL (Burch, 2000): problems as stimulus, students as self-directed learners, teachers as facilitators and groups as working style.

3.1.1. Problems as stimulus

As stimulus for learning, PBL uses complex, open-ended and real-life problems. As such, there should be no single right answer. “Real-life problems are used as the initial triggers for learning and to create a point at which new learning or critical thinking can be applied and reapplied until understanding is achieved” claimed Putnam (2001). Solutions are reached through generation of hypotheses, inquiry of more information and then refinement of the hypotheses before moving to the resolution. In striving to do so, students activate their prior knowledge, actively acquire new knowledge and develop the needed skills for a future application of that new knowledge. In PBL, problems are seen as the driven forces in the learning process. The development of knowledge and skill, or what is called in the PBL jargon the development of cognitive flexibility, is actually the main goal for learning. In PBL, knowledge and skills are developed and not acquired like in the traditional or behaviorist learning approaches.

Thus, in the PBL curricula, planning and setting up those problems is the most important step on which depends the effectiveness of the whole concept. Some parameters such as the choice of authentic contexts, open-ended forms and an accurate degree of complexity are essential to ensure optimal learning outcomes. Unlike the traditional teaching approach where problems are set at the end of the course in order to test understanding and skills, in PBL, problems are set as a first step before any activity and the content is introduced through them. Furthermore, problems are not aimed to test skills but to help in the development of those skills themselves and all the necessary qualities to do so such as critical thinking, open-mindedness, team working and communication skills. The problem solving process help students develop critical reasoning and problem solving skills and learn how to generalize these to everyday situations and thus life long learning and professional skills. In other words, the main objective is not solving the problem itself but acquiring the learning-to-learn skills and the ability to transfer those skills to find solutions for the future problems. As stated by Putnam (2001), “a PBL problem is designed to stimulate the need to know. As students work through the problem guided by the facilitator, they are continuously made aware of the need to know more”(p.5).

3.1.2. Students as center of the learning process

PBL is commonly defined as a student-centered approach to education. This concept is by far the most important one in this approach. According to Putnam (2001), the overriding goal of PBL is to produce students who are able to undertake responsibility for their improvement and the development of their community. Within the PBL process, the student’s responsibility is called on at every step. The determination of the learning needs, time and resources management and group dynamics management are some activities that involve a great part of the student responsibility. In addition to the personal side, students are responsible towards their groups by respecting the ground rules, being punctual, collaborative and mutually supportive. As Putnam (2001) accurately observed, “When the problem is being developed, it belongs to the faculty. Once it is given to the students, it is theirs”(p. 6).

From this dimension of student centeredness, two important aspects can be drawn:

- **Self-directed learning:** In PBL, students have a great control of their own learning and are expected and encouraged to be independent of their teachers (facilitators). Stimulated with a problem, they have to recognize from their own what their suitable learning method is (how to learn), what knowledge and skills are needed to solve the problem. Furthermore, it is their responsibility to define the required resources, to know how to acquire them, how to use them and how to construct and shape the new acquired knowledge in a most effective and efficient way. As individuals, students construct themselves their inquiries by tackling the learning issues such as exploration of the given problem, identification of the unknown information, and analysis and use of the newly acquired knowledge (Uden, 2005). Through these activities and their requirements, PBL helps students develop self-directed learning skills.

- **Self-assessment:** In addition to traditional assessment methods, PBL involve and give great importance to self and peer assessments. Setting realistic goals and self-assessing honestly the accuracy and depth of their knowledge are important skills and also a heavy responsibility lying on the student. For this goal, self-reflection and self-appraisal should be omnipresent habits in the student behaviors (Putnam, 2001). The facilitator is of a great help on this purpose by asking triggering questions that lead to this self-evaluation which should be enhanced by peer-assessments. As emphasized by Putnam (2001), “students are asked to cite evidence for their verbal self-evaluation at the end of each problem so that students will begin to internalize the habit of reviewing and reflecting on their performance” (p.7).

3.1.3. Teachers as facilitators

Unlike in the traditional lecture courses, teachers are no longer considered the main repository of knowledge or “sages on the stages”; they are the guides and facilitators of a collaborative learning and stimulators of the students towards self-directed learning. PBL involves less teacher domination and shifts more control, communication and responsibility to the students. This shift leads to yielding some of the traditional teachers’ authority even though there are still room for teaching through mini-lectures or teacher-led discussions that proved to be very effective with inexperienced learners in particular (Burch, 2000). At the initial stage of the PBL process, teachers have to organize learning objectives, pilot the learning activities and help students explore the problem and determine the unknown information by asking accurate questions. “Teachers provide guidance in the learning process through open-ended and triggering questions designed to get students to make their thinking visible and to keep all the students involved in the group process” commented Uden (2005). They have to decide on the degree of freedom given to the students struggling in the maze of the problem and how long they can let them wander before redirecting them (Burch, 2000).

One of the important tasks of the facilitators is to promote a favorable, pleasant and effective learning environment that fosters students’ efforts and bring motivation and commitment. This objective can be achieved through encouraging diverse opinions and styles, insuring the participation of all and lowering possible tensions in the groups. Wilkerson (1996) believes that the facilitator’s role is to “facilitate rather than deliver, observe rather than act, coach rather than command, offer constructive feedback rather than direction and challenge to excel rather than criticize shortcomings”(p. 38).

3.1.4. Learners work in groups

In PBL, learning takes place in classes organized in small groups of 4 to 8 students. This helps provide a collaborative learning environment where students learn through interaction with each other and learn how to work with each other. Fisher and Muirhead (2001) described small groups as effective means in enhancing problem solving skills in students. According to these two authors, “many educators believe that small groups activities are a most effective way to develop in students improved attitudes towards their studies, as such, self-confidence, working with others, insight into self and others, and managing personal learning” (p.43).

Group working environment brings effectiveness and time saving in the problem solving process. Subramaniam (2006) believes that “cooperative efforts result in higher quality problem solving than competition. In cooperative efforts, learners exchange ideas and correct each others errors more frequently and effectively than individuals competing against each other” (p. 340). This gives PBL its important advantage of fostering collaborative skills or team-working skills.

In the group environment, students set up a collaborative atmosphere where ideas are communicated, developed and refined, information searched out and gathered and where assistance is mutually offered. To this end, students establish their own ground rules addressing issues such as attendance, decision making, distribution of tasks and rotating roles (Burch, 2000).

This working environment offers PBL one of its major strengths: preparing effectively students to face the future real life situations where most of problems can only be solved through collaborative efforts of individuals from diverse perspectives, knowledge and skills. In the words of Putnam (2001), "the PBL process is designed to encourage development of skills necessary to work and learn effectively as members of a collaborative team working toward a common goal without sacrificing the development of the individual…"(p. 6).

3.2. The PBL process

When the problem is given and after the first briefing from the facilitator, the first step is the exploration of the problem and the identification of a maximum of facts through brainstorming and discussions. The second step consists on generating hypotheses and over viewing some possible solutions. To this end, students will have recourse to their prior knowledge while generating their ideas.

The third step is the organization of the hypotheses and the selection and the record of the most accurate ones through debates and comparisons. The fourth step, called the self-directed learning step, is the most important one and consists on the identification of the learning issues that need to be studied, that is to say new information and appropriate resources. After insuring the relevance of the determined needs to the objectives, students shift then to self-learning. Each student take responsibility for the search related to his individual learning issue. It is worth precising that students should choose unfamiliar areas and avoid fields in which they are knowledgeable and experienced. In this step, students determine the most appropriate questions which should support their hypotheses and guide their future searches. Organization and record of the identified learning needs is the fifth and following step.

After identification and organization of their learning needs, students start their research activity. The maximum of information is gathered through any possible means such as the use of libraries, internet, and asking people. The sixth and next step is data analysis which is an important phase in the PBL process. All new information related to the problem should be analyzed against the hypotheses in order to discern the valuable and accurate ones from the inappropriate ones which should be rejected. In other words, it is the resource critique in terms of accuracy and value of the information found. If not enough information are found accurate, the students should step back and conduct a new research activity again. Otherwise, the analyzed data and the new knowledge are put in application in the seventh step in an attempt to provide the definitive and most complete solution to the problem.

The eighth step consists on an evaluation through discussions of work done and the tests of the provided solutions. If the evaluation gave negative results, meaning that the problem is not satisfactorily solved, the students have to start the problem again from the beginning after deep critique and assessment of their prior knowledge and approaches during the past sessions. If the evaluation is positive and satisfactory results were obtained, the students start then to tackle the next and last step which consists of the summary and conclusions of the whole process.

The last step which consists of the summary and the integration of what has been learned is of an utmost importance in the PBL process with regards to the importance given to the self and peer assessments. In this phase, students are asked to make their self-evaluation in three areas: problem solving, self-directed learning and collaborative learning. After that, the whole group is asked to evaluate that self-assessment and to give constructive comments about the student’s performance during the process.

In addition to these assessments, a debriefing session will be conducted to evaluate the outcomes and identify what is gained in terms of new knowledge and skills and how to tackle the future problems using the experience gained.

The PBL process is illustrated in figure 1.

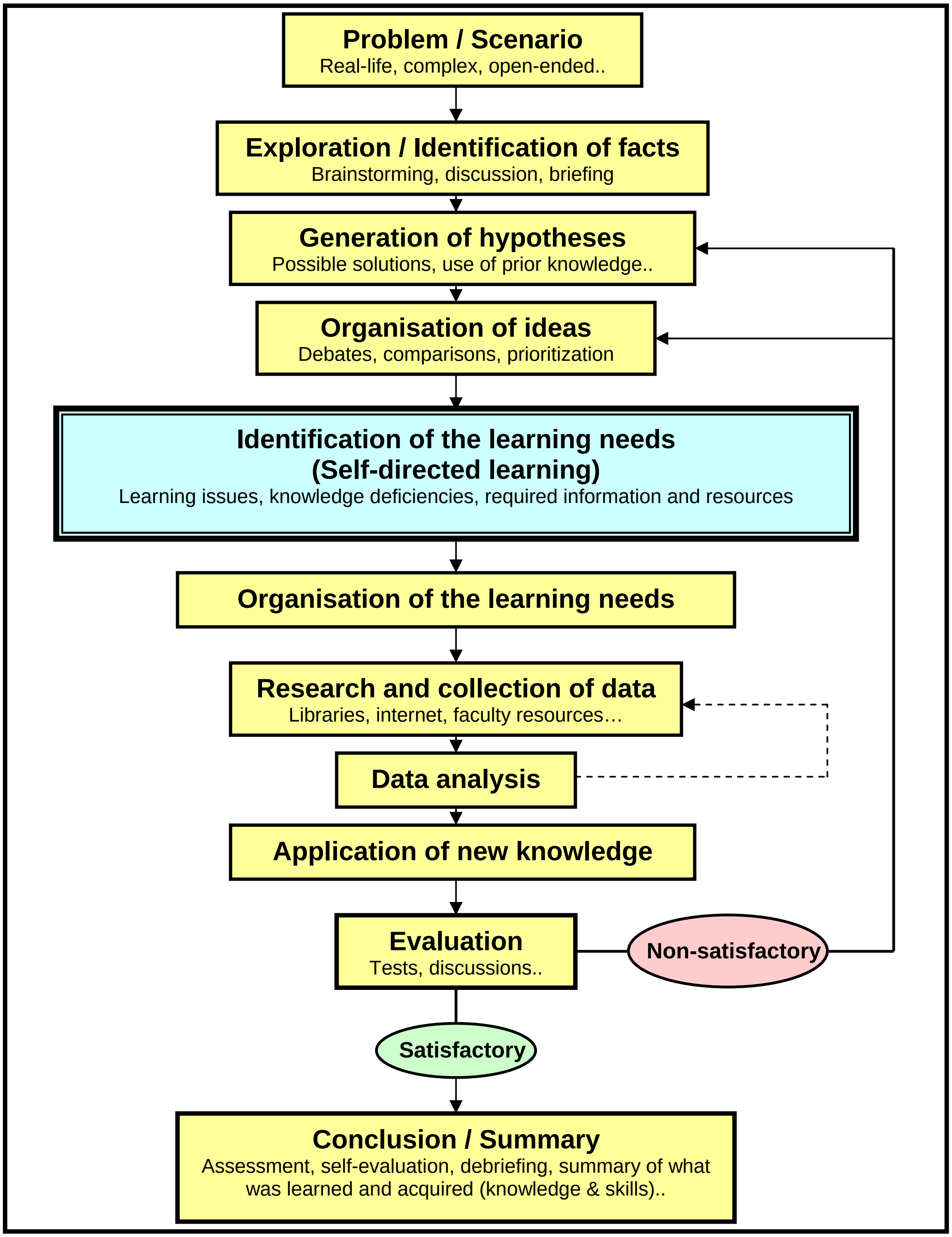

Figure 1: The PBL process.

3.3. Effectiveness of PBL

PBL has undoubtedly been one of the most scrutinized and researched innovations in professional education. Not less than five important reviews have been conducted with the aim of providing evidence about the effectiveness of PBL in comparison with other approaches, particularly the traditional education (Newman, 2003).

However, most of the researchers recognized that analyzing and reviewing PBL effectiveness is a very complex process with regards to the extreme difficulty to measure and interpret some of its main outcomes such as critical thinking, problem solving and collaborative skills. PBL seems very difficult to quickly assess and analyze through testing. Moreover, measures and assessments are conducted through traditional methods that are reported as incompatible with the principles of PBL itself. According to Ward (2002), “the preferred modes for standardized testing Multiple-choice questions, are not readily adapted to measuring the process skills needed for critical thinking”. Overall, despite these constraints, the results of most analysis support more or less the superiority of the PBL approach over traditional methods in many of the outcome measures examined (Major & Palmer, 2001).

Through the different reviews, overall, the following measured outcomes were the most reported. It is worth precising that comparisons were always made against the traditional instruction.

3.3.1. Change in knowledge

Most analysis reported no big differences between the knowledge acquired through the two approaches. However, the knowledge acquired through PBL is considered as more likely to be spontaneously used to solve new and unseen problems in contrast with the knowledge acquired through the traditional instruction. PBL students show more ability to use their acquired knowledge.

Retention of knowledge is another positive outcome pointed out by the reviews. Compared to non-PBL students, PBL students were seen as more capable of retaining knowledge and information for longer time. This fact confirms the constructivist theory stating that knowledge is better retained when it is structured by the learner himself (self-directed learning) so that acquisition and recall are optimized.

3.3.2. Change in attitude towards learning

Generally, unlike the students from the traditional approach, PBL students show more satisfaction and more positive attitudes towards their learning environment. PBL students often report their studies to be more engaging, useful and difficult whereas the students from the traditional instruction describe them as boring and irrelevant (Major & Palmer, 2001).

The most important impacts of such attitudes are related to motivation and retention. On the one hand, it is commonly agreed that the effectiveness of any learning process depends essentially on the students' motivation. In this case, the PBL approach is by far challenging the traditional instruction. One of the most characteristic factors illustrating this issue is the absenteeism rates. Motivated students are more likely to show higher attendance and that is exactly what happens in the PBL schools in contrast with the traditional ones.

On the other hand, a positive attitude towards the learning environment is the most important causal factor of the students' retention. In this context, PBL schools are reported to be the institutions experiencing the lowest dropout rates in comparison to the traditional institutions.

3.3.3. Change in behaviors

The reviews reported that PBL students show more tendencies to use broader and meaningful learning styles rather than non-PBL students who often limit their approaches to reproduction. PBL students have been observed using wider range of materials and more alternative sources such as informal discussions with their colleagues and the faculty. Unlike them, non-PBL students generally limit their investigations to the traditional libraries and rely mainly on lectures notes.

3.3.4. Development of an integrated knowledge base

PBL is inherently an interdisciplinary approach. During the problem solving process, students go through as many disciplines as necessary to find their solutions. This integrated approach allows them to broaden their knowledge and to understand the larger context into which the different disciplines fit and how they are interacting. PBL students have a more holistic approach to their subject and this skill is very important for the future where a broad vision is essential in solving effectively professional problems.

In contrast, the traditional approach is known for its fragmented and disconnected instructions which make it difficult for the students to have a global understanding in addition to many drawbacks such as forgetting, inattention and passivity.

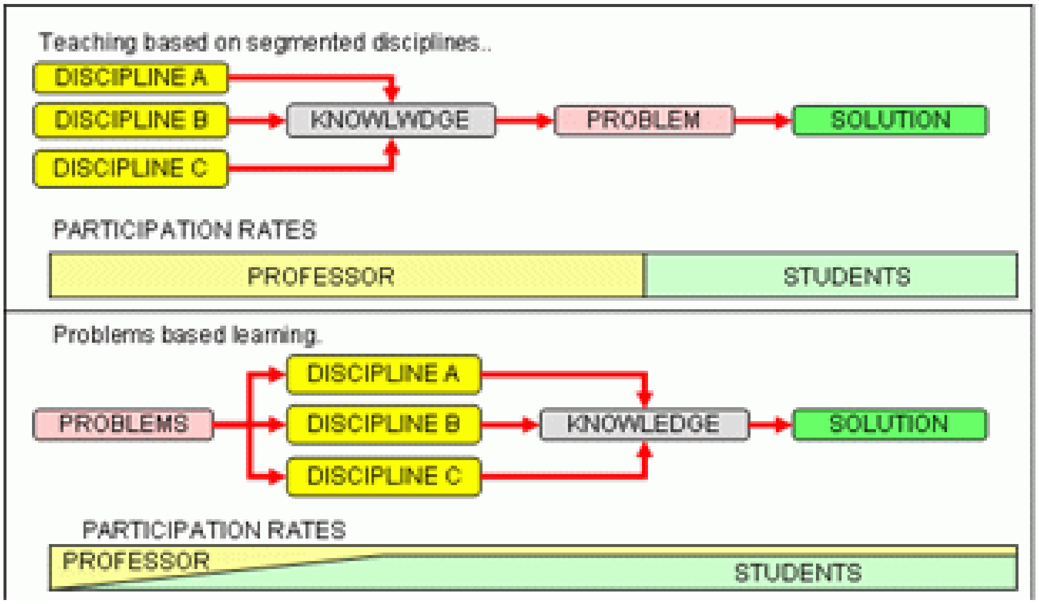

Figure 2: Traditional teaching and PBL processes (Calvo Melero, 2003)

3.3.5. Development of life-long study skills

PBL empowers students to become self-directed and independent learners. Thus, as it is often reported, PBL students are more frequent users of libraries and other information resources, which promote the acquisition of life long study skills. This latter is more and more requested by the professional world in order to cope with the technologic changes. As stated by Camp (1996) ,"faculty who want students to learn, to remember, to apply, and to continue to learn once out from under their tutelage have, under the traditional format, often been disappointed"(p. 2).

3.3.6. Achievement of competencies

Today's education is faced by the challenging needs of the modern workforce which requires from individuals collaborative, team-working, problem solving skills and critical thinking skills in order to be able to tackle a rapidly changing and highly technical environments. The major reason for the increasing popularity of PBL is that it is a particularly efficient approach that helps developing such skills which are outside the scope of the traditional approach to education. That is why this approach is proved inefficient in linking the students with their professional real world.

In short, PBL is seen as a coherent new approach to education, bridging the gap between educational and professional worlds and thus influencing its increasing adoption. The following factors are considered as the main reasons for this success:

- perceived ineffectiveness of the traditional approach in coping with the demands of the information explosion in many areas of the professional field
- the need for professionals having the ability to adapt to change and communication skills
- the need for lifelong learning, problem solving and team working skills

3.4. Weaknesses of PBL

It is always difficult and challenging to move from a deeply embedded system to a completely new one, especially when change requires a radical rethinking of well established and dominant concepts. The traditional instructional approach was a dominant paradigm for centuries and has conditioned deeply all the actors involved in the educational area. Teachers are the most affected by this conditioning. Even facing the same constraints, the present student’s generations are less affected than teachers and are more prompt to stick to change due to their adaptation to the changing environment brought by the development in ICT; most of them are younger than the computer.

Thus, modifying traditional instructional schemes and implementing new methods are often constraining tasks, particularly for faculties. In this present case consisting on a radical paradigm shift, the extent of change will draw undoubtedly major constraints and reluctance to change is one non-negligible factor that makes the task more arduous. The transition to self-directed learning is often reported as difficult. Teachers and students alike need time and favorable environment for a smooth transition.

In addition to the mental constraints, the literature highlighted several perceived inherent weaknesses of PBL as reported by educators. They relate mainly to the assessment, implementation costs and time constraints.

3.4.1. Assessment

Besides the big challenge of shifting from information main provider role to facilitator role, instructors are facing another constraint consisting on how to evaluate PBL effectiveness and how to assess whether students have achieved the overall objectives of the courses.

Evaluating the success of PBL, as compared to the traditional instruction approach, present a serious challenge because the focus of this pedagogy is primarily on learning to learn rather than on mastery of a specific body of knowledge. According to Ward (2002), a major problem in PBL programs evaluation is the difficulty to find and to interpret valid acceptable measures of PBL curricula outcomes. Multiple-choice questionnaires, which are the preferred mode for standardized testing, are seen as not appropriate to measuring the skills needed for some outcomes such as critical thinking and communication. Problem solving skills assessment, even if possible to measure with structured short answer questions, is quite a time consuming process.

These traditional assessment techniques are criticized for being inappropriate in truly evaluating students' understanding and the most important skills inculcated through PBL. For the supporters of this approach, there should be an alternative assessment continuing the learning process and not as a disjoint activity; peer and self assessments are corresponding to this criterion.

In the maritime perspective, the same constraint was faced following the difficulties emerging from the need to assess competencies according to STCW 95 Convention. Traditional assessment through examinations is unanimously recognized as an inefficient and inappropriate method to assessing competence and even the use of simulators for such objective is still lacking of standard assessment measures (Muirhead, 2005).

3.4.2. Implementation costs

According to Uden (2005), the most constraining factor is the implementation cost of this system when compared to the traditional instruction. PBL is very demanding in facilities and resources such as rooms, library materials and equipment. Working in small groups needs larger facilities and students, as self-learners, are very demanding for resources such as efficient and well equipped information services, laboratories, simulators (in the maritime context) and information and communication equipment.

3.4.3. Time constraint

Time is another constraint pointed out by educators. It is a general opinion that PBL courses need more time to be covered compared to traditional ones. Consequently, more pressure is put on faculty, students and support staffs in

PBL environments. The longer time needed to master a course taught by PBL may be explained by the fact that PBL requires the development of other skills apart from the acquisition of knowledge.

Chapter 4

Problem Based Learning in MET

4.1. The MET context

The maritime world as the oldest arena for global human interactions is particularly affected by the tremendous and fast pace of change occurring these last decades. Since Maritime Education and Training (MET) is the common core concept influencing all the maritime activities, it was then obviously subject to the strongest constraints which are beyond the capabilities of individual entities or institutions, hence the need for global responses. Among those influencing factors, one can distinguish between the internal factors related to the evolution and changes within the maritime field itself, changes expressed particularly by the related international instruments developed by IMO, and the external factors such as the High Education milieu and the technology revolution.

The impacts of these influencing factors on MET will be analysed in this sub-chapter and future trends and challenges will be investigated in order to point out the weaknesses and needs of this system.

4.1.1. The impact of STCW 95

During the 1980s, the impact of the STCW 78 Convention began to be considered below the expectations of the international shipping community headed by IMO. The shortcomings and ineffectiveness of that Convention, conjugated with the spate of maritime casualties and pollution incidents forced

IMO to seriously consider the option of amending this Convention. At that time, human error was recognized as one of the main causes to those maritime incidents and the absence of specific standards of competence, the poorly monitored maritime training facilities with poor standards and the lack for uniform implementation, application and enforcement of the requirements of STCW 78 were seen as the underpinning causal factors that needed to be addressed. Consequently, IMO called for an International Conference of Parties to the Convention STCW 78 which ended on 07 July 1995 with a complete revision and rewriting of that convention which brought major changes and had a deep impact on the maritime administrations, MET institutions and shipowners.

One of the most important changes brought by the new amendment and challenging both administrations and MET institutions is the requirement to put in place a standard quality system. This new tool was introduced through the 1995 amendment (regulation I/8) in order to insure that STCW certificates are a faithful evidence of the competency of their holders and that common minimum standards are effectively applied and shared by all the Parties within well structured maritime education and certification systems; in a few words, it forces these institutions to show that they are doing what they are claiming to do. The implementation of the requirements of regulation I/8 is based on two key elements: quality and accountability.

On the one hand, quality is related to the quality of education and training, reflected through competence and qualification of seafarers, trained and assessed by highly qualified instructors and assessors. The main goal is to train seafarers to be able to perform their duties and to carry out their responsibilities effectively. The main objective is to demonstrate achievement of the stated objectives through a quality standards system which involves four important steps:

documentation processes, compliance with procedures, self assessment and independent evaluation by an approved quality authority (Muirhead, 2002).

On the other hand, accountability is related to the requirements for the administrations to satisfy themselves and to satisfy others (IMO and other administrations and recognized Parties) that the quality of their certification and training activities at all levels meet the requirements of the Convention. To satisfy others, administrations should be subject to independent evaluations carried out by third parties and to satisfy themselves, administrations have to conduct self evaluation processes as well as independent evaluations.

Another major change brought by STW95 to MET systems was the shift from predominant knowledge based learning to competence based training with a great emphasis on the importance of assessing competencies. The seafaring profession is then described from a competence based point of view rather than from a knowledge based approach as that of STCW 78 (Cross, 2002). The knowledge requirements of STCW 78 were transferred into a new mandatory code (part A) specifying the minimum standards of competence and their associated knowledge, understanding and proficiency in what are called tables of competency. A great importance is given to the skills acquisition which has to be achieved through various methods such as the use of simulators and onboard training (Muirhead, 2002). Accordingly, the qualification, experience and competence of the personnel in charge of education, training, evaluation and assessment within MET institutions are the underpinning conditions for an effective response to these requirements.

The extent of the tasks required by the implementation processes was so important that an international assistance was unavoidable to help many developing countries take up the challenge. National laws have to be amended. Training programmes, examination systems, use of simulators and quality standards systems have to be established and documented and the report on all these activities has to be prepared and sent to IMO by the Administrations (Muirhead, 2002). For many MET institutions, their whole curricula have to be restructured in order to meet the new requirements in addition to the financial constraints drawn by the need to invest in new equipment such as simulators and teaching laboratories. The major constraint, which is not confined to the developing countries only but affected the whole MET institutions worldwide, was certainly the lack of qualified instructors and assessors.

These changes brought by the amended convention had a deep impact on MET institutions and raised important challenges that are still not taken up ten years after its entry into force. At this time when some institutions, mainly from developed countries, are looking for standards beyond those of STCW 95, many others are still struggling to finance facilities and equipment to maintain their quality standard systems and to find qualified personnel to meet their objectives. This latter is by far the most challenging issue facing the entire MET world for the coming years, even in developing countries.

4.1.2. The impact of new technology

Technology deeply influenced the quality of seafarers and developments in ship design were more and more calling for the acquisition of new skills and development of new working methods. Today ships are becoming extremely complex and sophisticated and require highly educated and trained people endowed with high knowledge, experience and skills necessary for the operation of such vessels in the most environmental-friendly, safe and efficient ways.

As engines and auxiliary machinery became more sophisticated and powerful, so the needs for more specialized and advanced engineering skills increased. On the deck side, the use of modern navigational systems and equipment also requires highly skilled and trained operators for interpretation of data displays and the induced decision making processes (Muirhead, 2002). Shipboard operation was also subject to tremendous changes requiring more specialized training in order to cope with the diversity and complexity of equipment and procedures for the carriage of specific cargoes such as dangerous liquids and hazardous materials.

The development and use of advanced communication technology in the maritime industry also lead to the fact that the ship at sea is no longer seen as an isolated entity but a continuously connected part of the company's structure, thus there was deep impacts on the traditional role of captains, their responsibilities and their relationships with their companies.

Lastly, the growing international legal instruments with all their induced binding aspects and the frequent related controls through different structures such as Port State Control, which are often leading to stiff penalties for non-compliance, raised the need for a continuous enhancement and up grading of the related knowledge. Seafarers are expected to be life-long learners.

Furthermore, seafarers are often called to perform more than just the job they were trained for. With the dramatic changes and developments of the shipping industry keeping pace with the technological boom, there was a need for a wide scope of knowledge including new disciplines such as management, economics, logistics, marine environment protection, maritime safety sciences and maritime administration (Schroeder et al, 2001).

This increasing trend towards more and more qualified, skilled and "up to date" seafarers was the main causal factor of the upheavals concerning MET and calling for important and deep changes in these systems. The STCW95 Convention as analyzed before offered to the global MET institutions a helpful structure and a logical methodology for addressing the specific requirements of knowledge, skills and competencies. Making mandatory the use of some categories of simulators is a further step taken by IMO towards a general use of modern technology in the training institutions, leading by this way the global MET to keep up with the technological changes.

However, MET institutions are facing non negligible other difficulties related to not only "what" to do to cope with the growing needs of the seafarers' labor market but also "how" to do it and "which" means are suitable and affordable to do it in an effective way. In this context, the plethora of teaching aids and teaching methods generated by the development in computerization and the communication technology are making difficult the decision making process within these institutions which are often facing scarcity of both financial and human resources.

This latter is by far the most important constraint facing the majority of MET institutions. The continuously increasing demands for specialized and up to date knowledge and skills from the seafarers' labor market are leading to the same or even higher requirements from the teaching and training staffs who are asked to keep up with the technological changes in addition to the basic requirements of experience and competence in their specific fields. In addition to the scarcity of qualified and experienced maritime instructors resulting from the non attractiveness of such jobs, the existing staff are often described as reluctant to change and unaware of the dramatic developments in the shipping industry (Muirhead, 2002).

The predisposition of the shipping industry as a truly global market to quickly adapt with the changes in technology is seen as another challenge facing MET systems. In this context, one can say that MET is often dawdling behind the shipping industry when adaptation to new technology matters. The shipping industry is an important incentive and a strong driver that obliges MET to continuously change and improve its strategies in order to cope with the pace of change.

Today ships are built and fitted with the latest equipment while many of MET institutions are often dawdling two steps behind, struggling to achieve the basic minimum requirements of the international instruments often through obsolete and out of date pedagogic equipment. This situation lead to the emergence of a new kind of “fit for purpose” maritime training centers under the authorities of shipowners in order to address the lack of qualified seafarers able to cope with the new technology. These new trends are putting more pressure on the traditional MET institutions, usually under public authorities, leading to extremely difficult situations where political decisions are often the last recourse. For many of those institutions, special funds for new equipment’ acquisition and the review of the wages policies are often the key responses helping to cope with the changes.

4.1.3. The impact of the high education milieu

Education witnessed tremendous paces of change during the last decades of the 20th century and the higher education milieu was one of the most affected areas.

Globalization, interdependence of national economies, advances in technology and the democratization of higher education lead to a radical redefinition of the university's purpose. Economically driven, universities became service institutions defined in terms of output, productivity and efficiency in transforming students into human resources to fulfill mainly the skills requirements of economies and industries. "Education institutions have found themselves acting like businesses… post-secondary institutions have had to rethink their own organizational strategies in the face of decreased funding, increased global competition, increased access to new information technologies and increased emphasis on industry-related research" claims John Hay (1999). From the society side, education is seen everywhere as an important means for economic and personal advancement and the key to success.

There is a growing and global awareness on the future of higher education in the context of the information technology revolution and the associated emergence of global, competitive and knowledge-based economies (Atkins, 2004). In this new context, this latter is demanding thoughtful workforce and new types of learners. Consequently, institutional and pedagogical innovations are needed to confront these dynamics. As investigated in the former chapters, more and more educational institutions are experiencing the paradigm shift in the quest for more effective approaches to education in response to these new challenges.

4.2. Appropriateness of PBL in MET

The STCW 95 Convention expressed the awareness of the international community regarding the human factors issue and defined in its Resolution 8 competent seafarers as "personnel exhibiting the highest practicable standards of practical knowledge, skills and professionalism”(p. 60). As a consequence, MET institutions should ideally provide seafarers with consistent practical knowledge, highest skills and attitudes from the broadest point of view.

The recent shift toward the competence-based concept turned upside down MET systems by discrediting one of their main dogmas: the traditional knowledge-based approach to training. In response to this challenge brought by STCW 95, survival reactions took place in MET arena to fill the gap left by an old paradigm which is well embedded in the minds. It was quite difficult for many instructors to realize for example that traditional examination systems are becoming useless in the new competence-based context. Even STCW 95 itself lacks of clarity when assessment of competencies matters. The general trends in MET institutions were to rely on the well advanced simulation technology to fill the gaps and to mitigate the ineffectiveness of a training philosophy.

However, many sensitive questions are still in need to be answered by MET systems. How can attitudes and competence be inculcated and assessed? How can professional skills, such as communication, problem-solving, leadership and team-working skills, be acquired? What kind of curricula is appropriate for such objectives? Is the over-reliance on simulation technology an appropriate choice in the quest for such skills?

The following paragraphs describe a trial to answer some of these questions from the PBL perspective. The main points are selected from the STCW 95 definitions of competent seafarers.

4.2.1. Practical knowledge

A thorough understanding of “how” things work, interact and react within the seafarer’s professional environment. The term “things” involves in the broader sense equipment, people, environment and policies. In addition, this knowledge should be easily, spontaneously and effectively put in practice for efficient operations and to respond adequately to emergency situations.

It is specific in the modern maritime environment that the scope of knowledge is continuously widening to embrace as many disciplines as involved in the shipping business. Since the latter is essentially global and multidimensional (Integrated Transport for example), the amount and diversity of knowledge required to respond effectively to the needs of the profession are continuously growing and might exceed the capabilities of MET institutions facing time and resources constraints.

Using the traditional approach to education, this tremendous amount of “dynamic knowledge” has to be inculcated by the faculty alone since teaching methods are unidirectional. The fast growing aspect of the maritime knowledge will lead over the time to an accumulation of information that are impossible to communicate without extending accordingly the time and the content of curricula. It will obviously reach a limit where the time needed to educate and train a seafarer will meet neither the interests of theses institutions nor those of the shipping industry. Contrarily, the trends are for lesser training periods due to the dynamism of the shipping industry conjugated with the growing needs from the seafarers’ global market. PBL is inherently an interdisciplinary approach.

Furthermore, PBL through its integrated approach allows students to broaden their knowledge by embracing as many disciplines as necessary and to understand the larger context into which different disciplines fit and interact. This holistic approach provides a broad vision that is essential in solving effectively professional problems.

PBL can help in releasing this faculties' burden by shifting the responsibility for knowledge acquisition to the students' side. As a student-centered approach, MET institutions will provide only guidance and resources. Furthermore, the knowledge acquired this way is likely to be up to date and there will be a natural filter eliminating all the obsolete concepts that are still wasting time and energies in many of the present MET institutions.

Seafaring profession is very demanding in up to date knowledge. The shipbuilding industry and international regulations among other factors are continuously changing and call for adaptation from the personnel in charge of operating ships in such dynamic environments. Seafarers, in addition to the very wide knowledge required from them have to be prepared to be long term students during their whole professional life.

Yet with the development of ICT technologies, onboard training is seen as a palliative measure in bridging the gap between the seafarers' social needs and the professional requirements. "Studying while doing" is a formula found to cope with this issue and to take over the weaknesses of MET institutions in providing such dynamic services. In this context, the life-long learning skills that can be acquired through the PBL approach, conjugated with the availability of communication means, can play an important role in keeping the seafarer in phase with the continuous changes. PBL promotes self-directed learning and the skills acquired through this process are likely to help satisfy the needs of the maritime industry for life-long learners.

Lastly, as investigated in the former chapter, the knowledge gained through PBL is likely to be retained for a long time and also to be easily put in practice as shown by the different reviews of PBL.

4.2.2. Skills and professionalism:

Seafarers were always expected to demonstrate their competence through basic skills such as technical and team-working skills. However, with the recent developments affecting the shipping industry such as the advances in technology, the complexity of the tasks and the internationalization of the crews, more skills are needed to face the new challenges. In addition to the basic skills, communication, problem solving and life-long learning skills are some important ones brought by these new developments.

Yet in its amendment of 1995, the STCW Convention attempted to address these aspects through a shift from the knowledge-based to competence-based training. However, many of these skills lack of accurate definition and appropriate means to inculcate them. In the former definition from STCW 95, terms such as "professionalism" are quite vague and there is a need for concise and measurable concepts. To be able to respond to this need, it would be necessary to think "outside the box" of the traditional training concepts.

In fact, if the traditional training approaches are capable of inculcating some basic competences, skills such as problem-solving, communication, leadership, critical thinking, team-working and life-long learning skills are out of the reach of this approach. These are the skills that are often lacking and that STCW 95 implied while using the "professionalism" term and it is in this context that PBL will play an important role if adopted by MET systems.

As it was investigated in the former chapter, Learner-Centered approaches in general and PBL in particular are the most appropriate methodologies capable of inculcating such skills. Self-directed learning, collaborative learning and autoassessment are some specific PBL processes through which students acquire, construct and nurture those skills. The traditional approach is obviously lacking these dimensions and that is the reason why it is difficult to define and provide such abilities through this approach.

4.2.3. Attitude

The development of positive attitudes is an important learning outcome. As Fisher and Muirhead claimed, these attitudes relate to “interests and values, motivation and willingness to use knowledge and skills” (p.24).

As highlighted in the PBL analysis, PBL students are more likely to acquire positive attitudes towards their studies and their careers than the students from the traditional systems. The inability of the traditional approach to training to inculcate such values is reflected through the high drop out rates in the profession even though the social factor plays an important role in this situation.

However, since PBL is able to bring motivation and the “love of the job” and to reduce the drop out rates during the study life, it is likely to bring the same values to their professional career. How to attract and retain seafarers is one of the biggest problems facing the shipping industry nowadays. In addition to incentives such as attractive wages, improved socio-professional conditions and respect of their rights, positives attitudes towards their future careers can be fostered yet during the first steps of the future seafarers in their training institutions. Shifting to a “seafarer-centered” approach in MET is likely to bring some solutions and PBL is the most appropriate Learner-Centered methodology with regard to the specific needs of the maritime industry: competence and professional skills.

4.3. Hybrid PBL models

Implementation of PBL in the first year courses for new students seems to be very challenging. Students have often been reported as being uncomfortable with PBL and one of the given reasons is that they are more used to the traditional methods (Moens, 2000). Furthermore, there are many subjects about which students have absolutely no knowledge and have yet to discover and develop their own learning skills. The use of prior knowledge to solve the problem, which is an important principle of PBL, might prove to be impossible in such circumstances. Thus, adopting a purist approach to PBL, whereby students have to find out on their own what they need to know, will surely lead to disastrous results and even rejection from both instructors and students.

Since PBL is far from being a narrow dogmatic approach, there are many different forms of PBL according to the specificities of the disciplines adopting it. This adaptable aspect of PBL allows avoiding the drawbacks of the radical shifts through incorporation of traditional lectures that still show some efficiency when applied in specific topics.

Traditional lectures, although their well established inefficiencies as a means for transmitting knowledge for students can insure some positive outcomes when applied in some specific subjects and in particular ways. They can help clarifying the underlying structures of curricula and provide some basic knowledge necessary to catalyze the PBL process(Van Berckel & Schmidt, 2005). They can provide guidance for students to tackle the learning activities in an appropriate direction and even arouse their interest. Traditional lectures and examinations are often successfully incorporated within the

PBL process itself as a tool for facilitating the transitional period and fostering the problem solving activities (Tan & Tay, 2003).

Such methods are called hybrid PBL models and have shown noticeable success in many institutions where they are applied. They can respond effectively to the needs for comfort of the students making the transition between the two systems by providing a kind of scaffolding. This option might have to be considered, at least at the introductory phase in order to gradually reduce the gap between students' previous learning experience and the PBL approach.

Chapter 5

Application of PBL in MET

Despite the global aspect of shipping and well established international standards, MET varies widely depending on the different infrastructures, institutional frameworks and course programs. For the feasibility of this attempt to implementing a PBL hybrid approach in MET, the scope will be narrowed to the Algerian MET system and specifically to the marine engineering program.

5.1. MET systems

There are three main categories of MET institutions in the maritime educational framework: vocational training centers, technical or secondary colleges and tertiary polytechnics or universities (Muirhead, 2003). Due to more consistent harmonization at the international level due to globalization, the last category is selected to be the context for this attempt to implement the hybrid PBL approach.

In most of these higher institutions, the main objectives are to supply the industry with qualified officers and to provide courses for recognition regarding the issue of certificates under STCW 95. Apart from some few exceptional institutions such as those in the Netherlands and France which provides dual-purpose training integrating both deck and engine departments, most of the worldwide higher maritime institutions are adopting the traditional scheme. The latter consist of educating and training future engine and deck officers and providing short updating courses for those already at sea.

The overall programs structure of these institutions' consists of three or five years study interrupted with onboard training periods as cadets, either onboard training ships or onboard operating merchant vessels. It is quite a general rule to have a long onboard training period before the last year and short ones between each year. In many systems, students come back for their last year study as already officers in Charge of Watch (OCW).

Regarding the limits of the present work, there will be a focus on marine engineering programmes only. In general, these programmes are approximately structured as follows:

Table 1: General structure of marine engineering programmes

Fundamental subjects	- Mathematics - Physics - Chemistry - Computer - English
Basic specialized subjects	- Electronics - Electro technology - Thermodynamics - Technology of materials - Mechanics - Automatism
Specialized subjects (STCW 95 tables)	- Marine power plants (Diesel, steam, combined systems) - Auxiliary machinery - Control systems - Simulators - Maritime legislation - Safety and security

For practical reasons, only one specific marine engineering programme will be chosen to be the subject for this attempt. This programme is selected from the MET institutions providing 3 years programmes. The particularity of these programmes is that the fundamental subjects are supposed been acquired by students prior to their access to the maritime institution. In this case, the overall programme is run in 3 years with a consistent period of seagoing training before the last year. The Algerian MET programme falls under this scheme and the authors' personal experience in this specific context is the main reason for choosing this particular case as a scope for application of a hybrid PBL model.

5.2. The scope of application

Higher maritime education and training in Algeria falls under the joint responsibility of the Ministry of Transport and the Ministry of Higher Education. According to the Algerian specific regulation, the following MET programmes relevant to certification under STCW 95 Convention Regulations II/1, II/2, III/1 and III/2 are currently offered:

- **"Navigation sciences"**: 3 years of theoretical studies, 12 months of onboard training as cadet and 12 months as seagoing service as Officer in charge of navigational watch.
- **"Marine engineering"**: 3 years of theoretical studies, 12 months of on-board training as apprentice and 12 months of seagoing service as officer in charge of an engineering watch.

Appendix A shows the scheme of the "marine engineering" programme.

Access requirements consist on bachelor and 2 years of "common core of technology" which is a programme offered in most Algerian universities. Fundamental subjects such as mathematics, physics and chemistry are supposed to be successfully taken by students prior to their access to the maritime institute.

5.3. Proposal for application of a hybrid PBL model

In this sub-chapter, there will be an attempt to elaborate the principles of a most appropriate hybrid PBL curriculum for the marine engineering programme. The backbone of this curriculum is a combination of PBL, projects and lectures.

5.3.1. First year programme

Since the beginning, classes are split into small groups to which are given small projects to complete at the end of the year. These projects consist of making simple engineering products involving a maximum of disciplines such as electronics, electro-technology and mechanics.

The knowledge and skills needed to accomplish their tasks are obtained through mandatory theoretical courses conjugated with solving small problems using PBL. These problems should be set with the objective of:

- Integrating all the theoretical courses in order to allow students to link between the different disciplines and enable them to use holistic approaches in their learning process.
- Providing all the knowledge and skills needed to realize the students' projects.
- Train the students in resolution process developing. At the first stage, facilitators should provide students with the resolution process schemes in order to help save time and initiate them for problem solving activities.

In conjugation with the mandatory courses, these problem solving activities aim to help the students accommodate gradually with the principles of self-learning and provide them with the necessary skills for the realization of their projects. The problems should be set for short time periods of about two weeks and their solutions appropriately linked with the assigned projects.

Each group of students will be allocated its own workplace for the whole year and given all necessary resources for the accomplishment of their projects. The use of labs and workshops is important and unavoidable and should provide students with the hands-on skills necessary for their projects.

The content of the mandatory courses should be lightened and cover only the very basic principles and leave rooms for further deepening from the students. For the first year students, the mandatory courses are:

- Marine power plants
- Auxiliary machinery
- Technology of materials
- Ship construction
- Safety
- English
- Maritime regulations
- Computer technology

Disciplines such as electronics, automatisms, electro-technology and workshop technology should be conducted strictly within the corresponding labs and workshops. The goal is to allow students linking directly theory and practice for deeper understanding and efficient retention of knowledge and also to acquire the necessary hands-on skills. These activities should also provide maintenance and troubleshooting skills.

The assessment process is conducted as follows:

- Examinations related to the mandatory courses and aimed to assess the knowledge gained through.
- Evaluation of the project report at the end of the year which will be about 50 pages.
- Evaluation of PBL activities through self and peer assessments, and the evaluation of the groups' presentations.
- Evaluations of the labs and workshops activities.

The following figure provides the overall scheme of such programme.

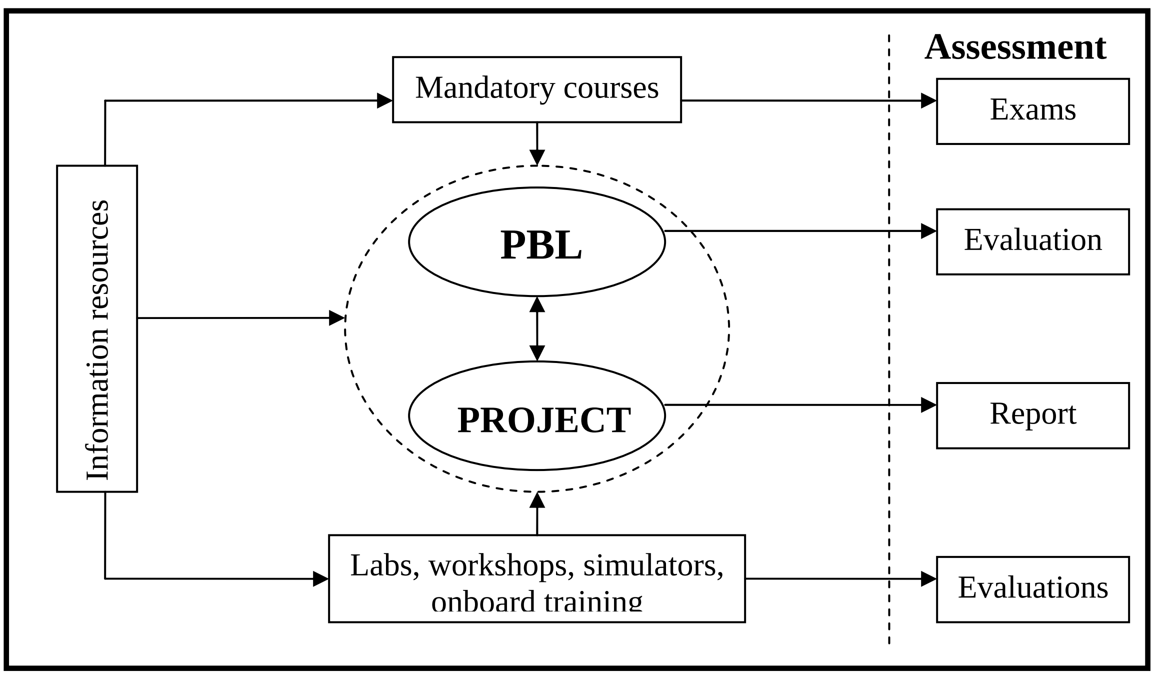

Figure 3: 1st and 2nd year programmes scheme.

Source: author, 2007

5.3.2. Second year programme

The main framework is the same as for the first year programme. However, the following changes are made:

- ☞ Number and frequency of the problems are reduced and their complexity enhanced. Instead of small twice-weekly problems, there will be monthly or twice-monthly problems with higher degree of complexity. The facilitators' assistance should be reduced to the limits of PBL principles.
- ☞ Size and complexity of the projects should be enhanced.
- ☞ The mandatory courses should cover more or less the same disciplines accordingly to the original programme provided in Appendix B.
- ☞ Workshops and labs works should concentrate more on maintenance and troubleshooting activities.

5.3.3. Third year programme

For this last year, the main changes are:

- ☞ The PBL programme should be phased out. There will be one project as the main problem for the whole year. It can consist either of developing an engineering product or of renovating old or broken equipment. The problem should have a great degree of complexity and end up with a consistent report of about 100 pages which will replace the traditional dissertation.
- ☞ Labs and workshops will be used only on the purpose of the students' projects and their problem solving activities.
- ☞ The mandatory courses should be reduced to this minimum:
    - Advanced maritime technology
    - Technical management

- Maritime regulations
- English
- Computer technology
- Human relations

☞ Each group is assigned a supervisor playing the role of a facilitator and not that of a problem solver. Regular meetings with him should be scheduled for guidance, consultation and discussions about the drafts and documentations. The supervisor is responsible for the final assessment of the project together with external assessors.

☞ At the end of the year, students will pass on a group basis oral examinations based on their reports and ending with individual marks. The overall evaluation will include the individual marks gained through the mandatory courses examinations, the evaluation of their performances within the PBL activities and the simulators sessions.

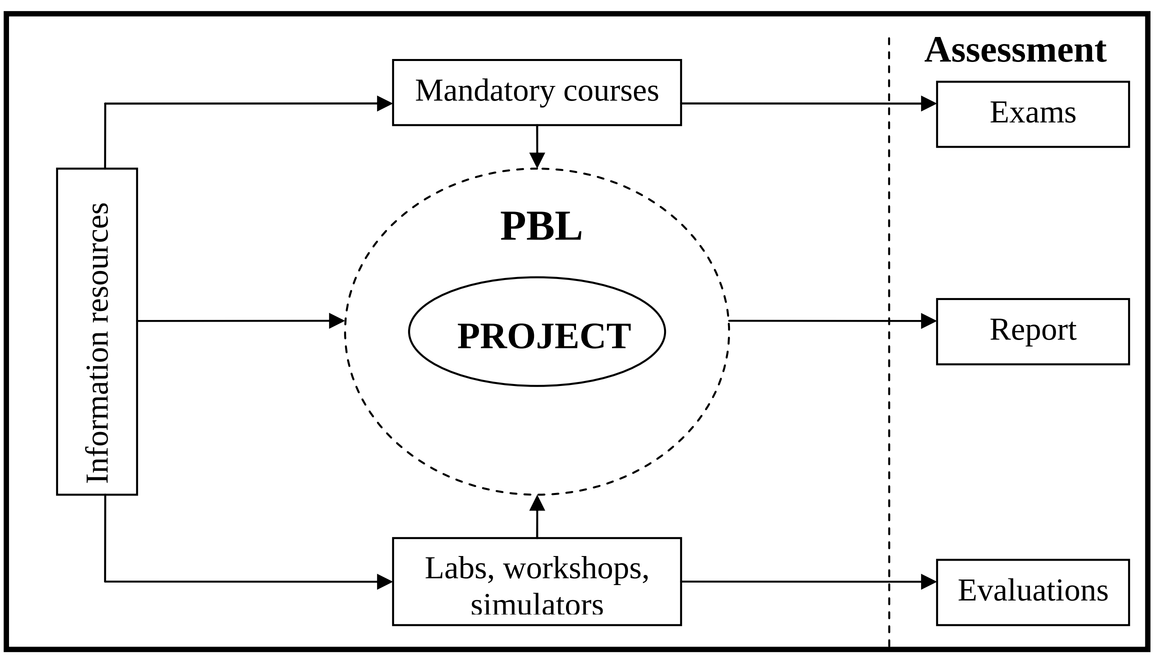

Figure 4: 3rd year programme scheme.

Source: author, 2007

5.4. Summary

Through this proposed approach, group work and projects are the backbone of the programmes. From my point of view, projects are the most appropriate activities related to the engineering field. In addition to the competence, hands-on and practical skills gained through, projects teach students how to work in a team, how to organize teamwork and how to assimilate positive attitudes.

PBL is used as knowledge and skills acquiring approach. In combination with projects activities, it allows students to apply the theoretical elements from the courses in solving engineering problems and also to acquire the very important ability to integrate the different courses in a holistic approach. Furthermore, this combination enables students to develop excellent analytical and problem solving skills necessary to cope with complex engineering problems. Engineering is basically a problem solving discipline. In such context, newborn engineers graduating through traditional instruction are often criticized for asking more questions about what to do due to their inability to apply their academic knowledge in solving real-life engineering problems. This proposed scheme is intended to respond to such weaknesses.

PBL is introduced gradually in order to insure a smooth transition from the traditional instruction to Learner-Centered approach. Thus, it will be possible to cope with the time constraint which is an important shortcoming of PBL in its beginnings. The 3rd and last year is seen as the most appropriate context for phasing out the PBL process. In addition to their accommodation to the PBL approach, students involved in that programme have a consistent prior knowledge to activate through the PBL process. The importance of that prior knowledge in PBL has already been highlighted in the former paragraphs. Moreover, the sound professional experience gained from onboard training and watch-keeping is an important element that makes these students ideally fit for a more Learner-Centered approach.

Chapter 6

Conclusions and recommendations

6.1. Conclusions

The investigation of the Learner-Centered paradigm highlighted many positive outcomes which made this approach the most appropriate alternative to the traditional education. The literature review conducted in this work shown that Learner-Centered education was the original human approach to education and was developing for over thousands of years. Due to evolutions in societies, this concept has undergone accordingly many changes through history. Nowadays, the tremendous developments in Information and Communication Technology are just providing the missing opportunities to this challenging and promising approach to education.

A thorough review of the literature related to the evaluation of the PBL model shows that it is not an easy task to assess the PBL effectiveness. However, when compared with the traditional instruction, it is generally admitted that this approach brings positive changes in knowledge acquisition, attitudes, behaviors and professional and life-long learning skills. These elements are the most needed from the professional arena side and this is what makes PBL the most challenging alternative to the traditional approach.

Despite the many positive outcomes of PBL, this study reported several perceived inherent weaknesses of this model. They relate mainly to the assessment, implementation costs and time constraints. In addition, the shift from traditional curricula seems to be an arduous task and a very demanding process in time and resources. The well embedded traditional concepts in the educators' minds are another hindering factor to take in consideration.

In the maritime perspective, the investigation of MET with regards to its changing environments lead to the same report. The labor market for seafarers has acquired some very important new characteristics due to globalization, the dynamic shipping industry and the rapid development of technologies onboard ships. The higher requirements to the qualification of seafarers and the recent shift toward the competence-based concept brought by STCW 95 turned upside down MET systems by discrediting one of their main dogmas: the traditional knowledge-based approach to training. Competence-based training requires more than the optimal use of technology such as simulators and distance-learning; it calls for a radical rethinking of the instructional process itself.

With the development of onboard and information technologies, the information available is so plentiful and changing so rapidly that MET students will encounter only a small portion of it under the traditional training scheme. As future seafarers, they are required to make informed and effective decisions in an evolving environment. Thus, instead of just being facts collectors, they need to recognize what information is needed, have the necessary knowledge and skills to acquire it and the ability to use that information to solve the problems they face. As drawn from the former investigations, PBL is working according to these principles and this is the reason that makes it an appropriate and challenging alternative to the traditional knowledge-based approach of MET. This latter is largely proven as inadequate to meet these needs.

However, one of the most common mistakes generally made in such context of paradigm shifts is to have recourse to extreme positions by rejecting totally the traditional concept; in common words, it is called "throwing out the baby with the bath water". In this attempt to apply PBL principles in MET, the author is avoiding such radical positions for two main reasons. Firstly, the PBL concept itself, despite the view of its "purist" supporters, offers a high degree of flexibility according to the specific contexts where it is applied. Secondly, traditional lectures are still of a great relevance, particularly in the MET context where the experience, knowledge and "know-how" of the lecturers is a goldmine that has to be capitalized. In the author's view, a hybrid approach may foster the PBL process itself in addition to the benefit of a smooth transition in the implementation of this concept.

In the specific area of marine engineering, PBL is seen as the most appropriate approach capable of integrating and removing isolation between the different disciplines and academic departments and to inculcate the professional skills that are beyond the reach of the traditional courses. The core reason is that, firstly, engineering is basically a problem solving activity and, secondly, engineers onboard ships are expected to operate in a non-compartmentalized setting, integrating skills from many disciplines to solve problems. In addition, the conjugation of this concept with well planned lectures and projects may provide a powerful integrative tool that MET systems are presently lacking in their struggles to meet the challenging needs of the maritime sector.

6.2. Recommendations

Based on the findings of the present work, some recommendations need to be made. The author believes that their application may provide MET with an important missing tool for an effective response to the growing requirements of the shipping world.

- ☞ The PBL concept should be introduced through a gradual and smooth process. To this end, the mandatory courses should be carefully selected and structured as complementary tools with the objective of boosting the PBL process instead of being the main knowledge providers. The courses content should be limited to the core disciplinary concepts and leave room for further deepening from the students.

- An utmost importance should be given to the selection of projects and problems. They should embrace as many disciplines as possible in order to help students learn through a holistic approach. There should be very close links between projects and problems in order to optimize the learning process by facilitating application of the theoretical concepts through a holistic approach.

- In order to avoid the drawbacks of the paradigm shift, instructors should be familiarized with the PBL principles through short and intensive courses. The shift from teacher to facilitator roles requires deep rethinking of well embedded educational concepts and thus, needs sufficient time and favorable environment. Furthermore, faculties should be familiarized with the specific aspect of the assessment in the PBL context. Assessing skills and competences requires alternative methods in parallel with the traditional examinations which should be limited to the mandatory courses evaluation.

- In the marine engineering context, the proposed scheme combining projects and PBL is very demanding in resources. Important investments have to be made in order to provide appropriate facilities such as labs, workshops, libraries and simulators with up-to-date equipment. In addition, access and management of information need well structured and efficient networks (intranet) with full access to as much as possible information sources (internet). These networks are the backbone of any Learner-Centered approach since the quest for information is one of the most important tasks of students during their self-learning process. Quality and amount of knowledge gained by students depends mostly on such infrastructures.

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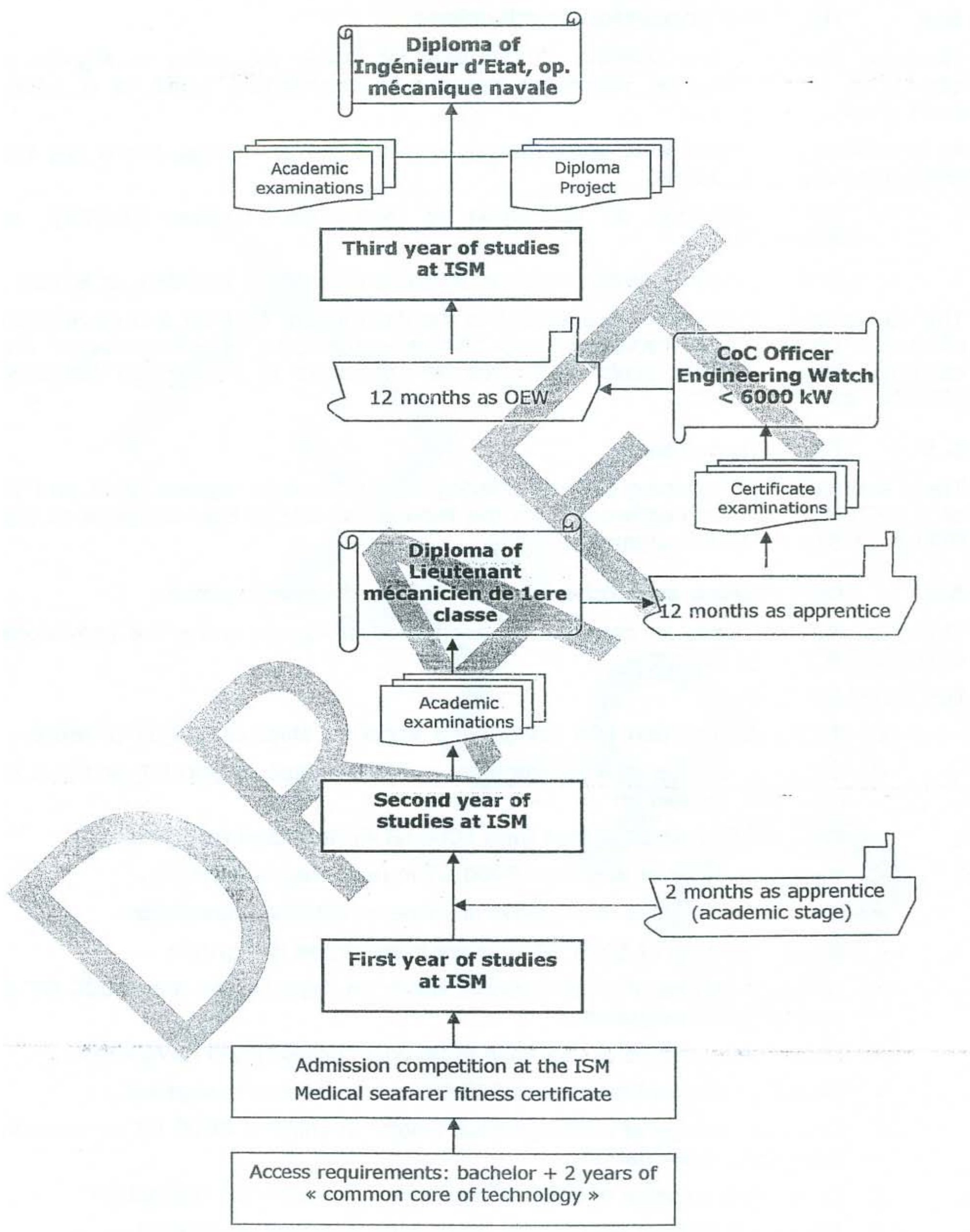
Appendix A Scheme of marine engineering programme (Algerian MET)

Source: ISM



Appendix B Marine engineering programme (Algerian MET)

Source: ISM

Courses	Time allocation (hours)		
	1st year	2nd year	3rd year
- Marine power plants	90	90	60
- Auxiliary Machinery	60	60	60
- Technology of materials	60	...	...
- Electro technology	60	60	60
- Electronic	60	60	60
- Automatism	60	60	60
- Mechanical Engineering	45	45	...
- Ship construction	45	...	...
- Ship theory	...	45	...
- Technical management	...	...	60
- Fire safety	30	...	...
- English	60	60	60
- Reporting	...	...	60
- Maritime regulations	45	...	45
- Computer technology	60	60	60
- Medical care	...	...	30
- Human Relations	...	...	30
- Methodology	30	...	...
- Hygiene / First aid	...	30	...
- Engineering drawing	90	90	…
Labs, simulators and workshops			
- Simulators	30	60	90
- Electro technology	60	60	60
- Automatism	60	60	60
- Electronic	60	60	60
- Engines and auxiliary Machinery	60	60	45
- Engineering workshops	60	60	45
- Nautical training	60	60	30
- Onboard training report	…	2 months	…
- Dissertation			6 months