FRAMEWORK FOR STRUCTURING LEARNING IN PROBLEM-BASED LEARNING

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Problem-based learning often involves the immersion of the learner in a situation where the learner applies acquired skills and knowledge towards the satisfactory resolution of the particular problem situation. The experience of the learner frequently dictates the approach and method that is adopted towards the resolution of the problem situation. The learning that takes place within such a scenario is often reactive and experiential, where mental images of past problem situations are matched with the current situation and solutions that were successful in previous situations are applied to the new situation based on the belief that they will lead to a successful outcome. Potential dangers of this "solution-looking-for-a-problem" approaches are (a) inappropriate solutions for the situation (b) lack of recognition of the significant features of the situation and (c) the reduction in the capacity of the learner to develop enhanced problem identification and solving capabilities. To facilitate increased learning from the experience and to develop increased knowledge in problem solving, a reflective approach to learning is required. Through a structured approach to critical reflection and evaluation of the experience valuable lessons can be abstracted to inform future actions. This paper discusses the adoption of NIMSAD (Normative Information Model-based Systems Analysis and Design) as a reflective framework for the structuring of the learning of potential problem solvers.

INTRODUCTION

The resolution of problems, both simulated and 'real-life', provides a valuable learning opportunity to the individual, group or organisation (herewith called the 'learner'). Through the application of skills and knowledge in the active or 'academic' participation in problem resolution, the learner acquires meaningful knowledge that enhances the learner's capability to

deal with comparable/similar problems that may arise. Hence, problem-based learning is an essential and useful learning mechanism for developing the learner in problem solving and knowledge acquisition and transference.

However, problem-based learning does not always ensure that the learner will necessarily be able to successfully apply this increased knowledge within different problem scenarios. This can be attributed to the limitations of the learning models adopted to facilitate and guide the problem solving and learning process. Lessons learnt from these problem-based learning scenarios often takes the form of 'ready-made solutions' to be applied to other potential problem scenarios. The explication of knowledge derived from these learning experiences is principally focused on the 'how to', without necessarily understanding the reasons 'why it succeeded or failed'.

Many problem-based learning scenarios also fail to address some of the hidden obstacles to learning and the acquisition and transference of this knowledge. For example, different potential problem solver will develop different possible solutions to the same problem or arrive at the proposed solution at different points in time. The experience and learning style of the learner, which greatly influence the outcome of the problem solving process and the lessons learnt, is often ignored in many problem-based learning scenarios and learning models.

This paper proposes the adoption of a reflective framework that provides a structure to the problem-based learning experience. The framework will facilitate the critical evaluation of the key elements of the problem situation, the problem solving process and the intended problem solver, and provide a reflective approach to the learning process.

PROBLEM-BASED LEARNING

'Learning by doing' provides a valuable opportunity for the learner to apply acquired sets of skills and knowledge to particular situations of concern. The 'trial and error' experiences affirm or disconfirm the usefulness/applicability of the acquired skills and knowledge set employed (Kolb, 1984). Through continual 'experimentation', the learner develops an enhanced understanding of the particular skills and knowledge set, which soon becomes a typical solution that is applied in similar situations of concern. Further success in the application of this solution reinforces the view that the typical solution can be considered to be applicable across a wider range of possible scenarios. This leads to a situation where standard solutions are developed, refined and fine-tuned to increase its proficiency, and applied without due recognition of the circumstances of the individual situations of concern – a 'solution-looking-for-a-problem' approach to problem resolution.

The selection of the initial skills and knowledge set, which forms the resultant standard solution, is greatly influenced by the experience level of the learner. Similarly, the experiences and learning style of the learner dictate the reaction of the learner to the outcome of the process and the lessons to be drawn for it. Where the learner is not exposed to a broad range of experiences, the experiential learning that takes place is often restrictive and delimiting. This can steer the learner into applying inappropriate solutions to problems without recognizing weaknesses and deficiencies in the applied solution and significant diversity in the different situations of concern.

If this is not corrected, it can lead to a reduction in the capacity of the learner to develop enhanced problem identification and solving capabilities.

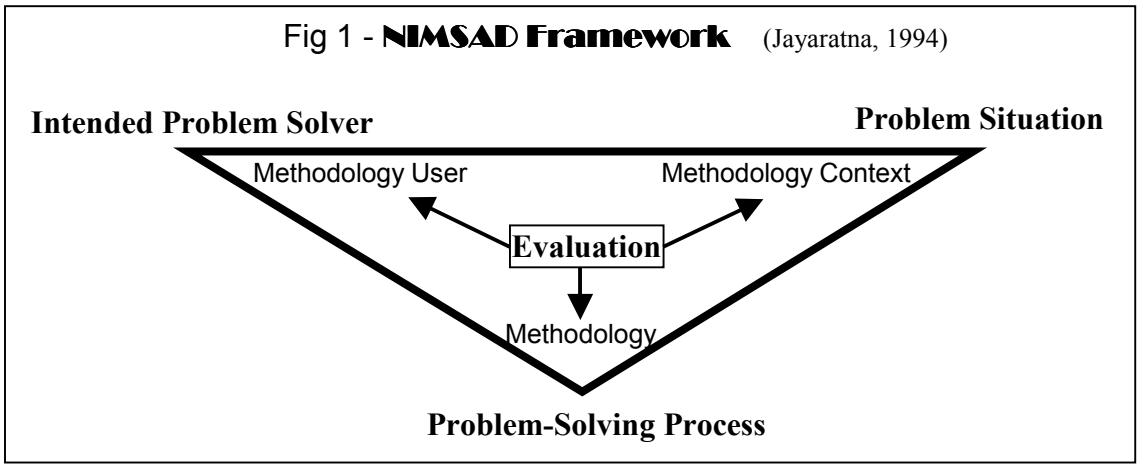
Limitations in problem-based learning can also be attributed to the learning models employed in many such problem-based/learning scenarios. Many of these learning models are principally focused upon the expected outcome of the situation resulting from the application of prescribed solutions/problem solving approaches. Their main emphasis is on the review of the actions taken which failed to result in a satisfactory resolution of the problem. Key lessons learnt from these learning models were concerned with 'what did we do wrong' and 'how can we do it better the next time', often ignoring the positive contribution of 'what was accomplished' and 'why they were successful or unsuccessful'. Many learning models also fail to address a number of issues surrounding the context of the situation, the perception of the problem and solution and the nature of the expected outcome. For example, what factors were taken into consideration in understanding the root cause of the problem and the development of the solution, who identified and determined the boundary of the problem to be dealt with and the solution to be implemented, and what is the appropriate measure of success or failure?

The learning that takes place under such circumstances is usually one-dimensional, single-loop learning (Argyris, 1982; Schon, 1983) conforming to one-half half of Kolb's (1984) learning cycle. It fails to provide a broad base upon which the learner is able to evaluate the whole problem solving experience in greater depth and understanding. To facilitate increased learning from the experience and to develop increased knowledge in problem solving, a reflective approach to learning is required. Through a structured approach to critical reflection and evaluation of the experience valuable lessons can be abstracted to inform future actions.

THE REFLECTIVE FRAMEWORK

NIMSAD (Normative Information Model-based Systems Analysis and Design) is a framework that serves as a way of understanding problem solving in general (Jayaratna, 1994). It draws upon systems theory and thinking (Leavitt, 1972; Checkland, 1981) in its consideration of the organizational context wherein problems exist, the logical and physical aspects of the problem solving process that takes place and the roles and contribution of the various stakeholders concerned. The problem-based evaluative framework helps in the evaluation of methodologies (systems analysis and design methodologies), their structure, steps, forms, nature, etc. Furthermore, it also helps the user to draw valuable conclusions/lessons from the critical evaluation of the whole experience.

The NIMSAD framework consists of four key interacting elements – the 'problem situation', the 'intended problem solver', the 'problem solving process', and 'evaluation' (see fig. 1). Application of the framework facilitates the clarification and increased understanding of the perceived problem within the particular problem situation and the development and implementation of an appropriate problem-solving process. Furthermore, it takes into consideration the contribution of the intended problem solver and the potential impact that he/she brings to the outcome of problem solving process.



Problem situation

The context of the particular problem scenario is represented by the 'problem situation' element of the framework. Within this context many possible factors contribute to the perception of the attributes and characteristics of the situation of concern and the environment within which it operates. These factors also, directly or indirectly, influence the identification and definition of the problem in question. The factors are categorized under the following elements:

- People
- Processes
- Information
- Technology
- Material flows
- Structures

Together, these elements present a 'rich picture' or model of the situation that confronts the intended problem solver and wherein a variety of problems exist. Due to the dynamic nature of the formal and informal interactions and interrelationships between these different elements, many possible interpretations of the context, or 'action world', can be formed. The explication and clarification of these different interpretations provide an avenue for increased understanding of the environment and circumstances affecting problem formulation and solutions recommendation. The richer the knowledge, the better the position of the intended problem solver in understanding the 'real' problem of the client.

Problem solving process

How the problem is to be resolved, or the method/approach adopted by the intended problem solver in the transformation of the situation, is represented by the 'problem solving process' element of the framework. This problem solving process comprises of three essential phases, with corresponding stages of intervention:

Phases	Stages
1. Problem formulation	• Understanding the situation of concern • Performing the diagnosis • Defining the prognosis outline • Defining problems • Deriving notional systems
2. Solution design	• Performing logical design • Performing physical design
3. Design implementation	• Implementing the design

These three phases and eight stages of the problem solving process provide a structured approach to the complex activity of problem solving. This element of the framework facilitates the 'systemic' analysis of the situation and the determination and construction of 'problem boundaries' and models of reality and desired outcome. Through the explication and communication of these findings, in the form of notional systems, the appropriate solutions can be identified and formulated into suitable course of action, with timely intervention by the intended problem solver.

Intended problem solver

Another element of the NIMSAD framework can be found in the 'intended problem solver'. This element of the framework represents a role that is assumed by an individual or group, within or external to the problem situation, responsible for the formulation of an agreed problem and the recommendation of possible solutions. The intended problem solver may also be involved in the implementation and evaluation of the selected solution or problem solving process, together with the problem stakeholders, e.g. the client, the problem owner, and the beneficiary or victim of the problem solving process.

Within the dynamic context of the problem situation, many possible problems can be found. The identification and definition of these problems and the suggestion and formulation of potential solutions is greatly influenced, amongst other things, by the personal characteristics of the intended problem solver. Some of the key personal characteristics of the intended problem solver include:

- Perceptual process
- Values and ethics
- Motives and prejudices
- Reasoning ability
- Experiences
- Skills and knowledge sets
- Structuring process (including methodologies)
- Roles
- Models and frameworks

These personal characteristics constitute the mental constructs of the intended problem solver, dictating the preferred course of action to be taken in order to deal with the perceived problem

situation. It forms an implicit baseline or benchmark that enables the intended problem solver to filter, judge, reason, decide, explain, abstract and learn, at the conscious and unconscious level, from the experiences encountered.

Evaluation

The fourth and last element of the NIMSAD frameworks is concerned with the critical evaluation of the other three elements of the framework. Evaluation provides a measure of the effectiveness of the 'problem solving process' and the 'intended problem solver' within the particular 'problem situation', and the degree of success achieved in resolving the perceived problem. This evaluated is carried out at three stages – before, during and after intervention. Clarification and maximisation of efforts and effectiveness is the aim of the evaluation before intervention. Evaluation during intervention facilitates the management of the dynamic nature of the elements. After intervention, evaluation provides the opportunity to draw valuable lessons from the experience that will contribute to increased knowledge and inform future actions. In the evaluation, questions are directed at the application of the three elements of the framework to determine the potential impact of the transformation upon the context of the organization, the potential impact of the problem solver upon the outcome of the transformation and the content, rationale and direction of the transformation process.

STRUCTURING LEARNING

Problems do not occur in a vacuum. The context of the particular problem scenario, which is often organizational in nature, is both complex and dynamic. Perception and identification of the problem and potential solution is influenced not only by the obvious disparity between 'what is happening' and 'what should be happening' as observed and described by the client. It is also affected by the characteristics and dynamic interactions between the different constituent parts of the particular situation wherein many possible problems exist. This area of the problem solving process is often given superficial coverage, or ignored, in preference to the static problem definition provided by the client.

The use of the NIMSAD framework provides a structure for understanding and documenting the richness of this problem situation and keeping abreast of the changes that take place within this dynamic environment. It enables a variety of perspectives on the likely cause and manifestation of the problem to be captured and investigated, leading to an agreed definition of the 'problem' and 'problem boundary'. It also encourages deliberation of both implicit and explicit elements of the situation that may directly or indirectly contribute to the perceived problem. By considering the situation from a 'systems' perspective, i.e. looking at organizations as purposeful systems (Checkland, 1981), the analysis of the problem situation will be holistic and comprehensive. The framework facilitates the ongoing evaluation of the likely impact that changes in the environment might have upon the outcome of the selected solution or problem solving process, and vice versa. It provides not only answers to what is going on, but also why things happen. Knowledge gained from the evaluation can be transferred to other situations to provide a mechanism for recognizing significant features of the problem situation and deciding on the appropriate course of action.

Selection and formulation of the potential solution, based on the perception of the problem and situation by the problem solver, is not an exact science. Often, the decision is based on personal preferences and experiences that dictate the desired course of action. Justification of these decisions is seldom made explicit and/or subject to critical evaluation. NIMSAD emphasizes the need to consider the personal attributes and characteristics of the role of the intended problem solver, assumed by any individual or group, as an important factor in the problem solving process. In so doing, it brings to the forefront the possible biases and underlying principles that influence the perceptual and decision making process. The critical evaluation of these personal characteristics of the intended problem solver provides an avenue for exploring the potential impact of the problem solver upon the outcome of the problem solving process. It enables the intended problem solver to be made aware of their predisposition, the consequences of their actions, recognize and learn from the experience and adapt their future behaviour accordingly.

A variety of problem solving approaches are often employed by problem solvers in the resolution of problems. Some provide clear structure and guidance to the whole problem solving process. Others, emphasise limited areas of the problem solving process focusing mainly on the application of prescribed solutions to defined problem definitions. Many of the problem solving processes adopted by problem solvers are also subjected to personal experiences and preferences. The systematic exploration of the problem solving process, advocated by the NIMSAD framework, provides an instrument for clarification of how the problem was identified and defined. The diagnosis and prognosis of the current situation draws on a particular perception of the characteristics of the situation of concern. This provides an opportunity for the communication and determination of an agreed definition of the problem to be resolved, amongst the various stakeholders. It also dictates the information needed to arrive at that agreement and creates a sense of objectivity in the problem formulation phase. The separation between logical and physical design of the potential solution provides an avenue for the conceptual development of a range of possible solutions to the problem, followed by the determination of the underlying issues and constraints that influence the selection and formulation of the proposed solution to the problem. Consequently, the probability of effective implementation of the proposed solution and resolution of the problem is increased. Evaluation of the adopted problem solving process ensures transparency in the different stages of the process and awareness of the dynamic constraints affecting the outcome of the process.

In summary, the NIMSAD framework provides a handle for the learner to wrestle with the validity and reliability of the decisions made throughout the problem solving process. The attribution of blame and acclaim, and the adoption of remedial actions, can be carried out in the light of explicit information and knowledge.

CONCLUSION

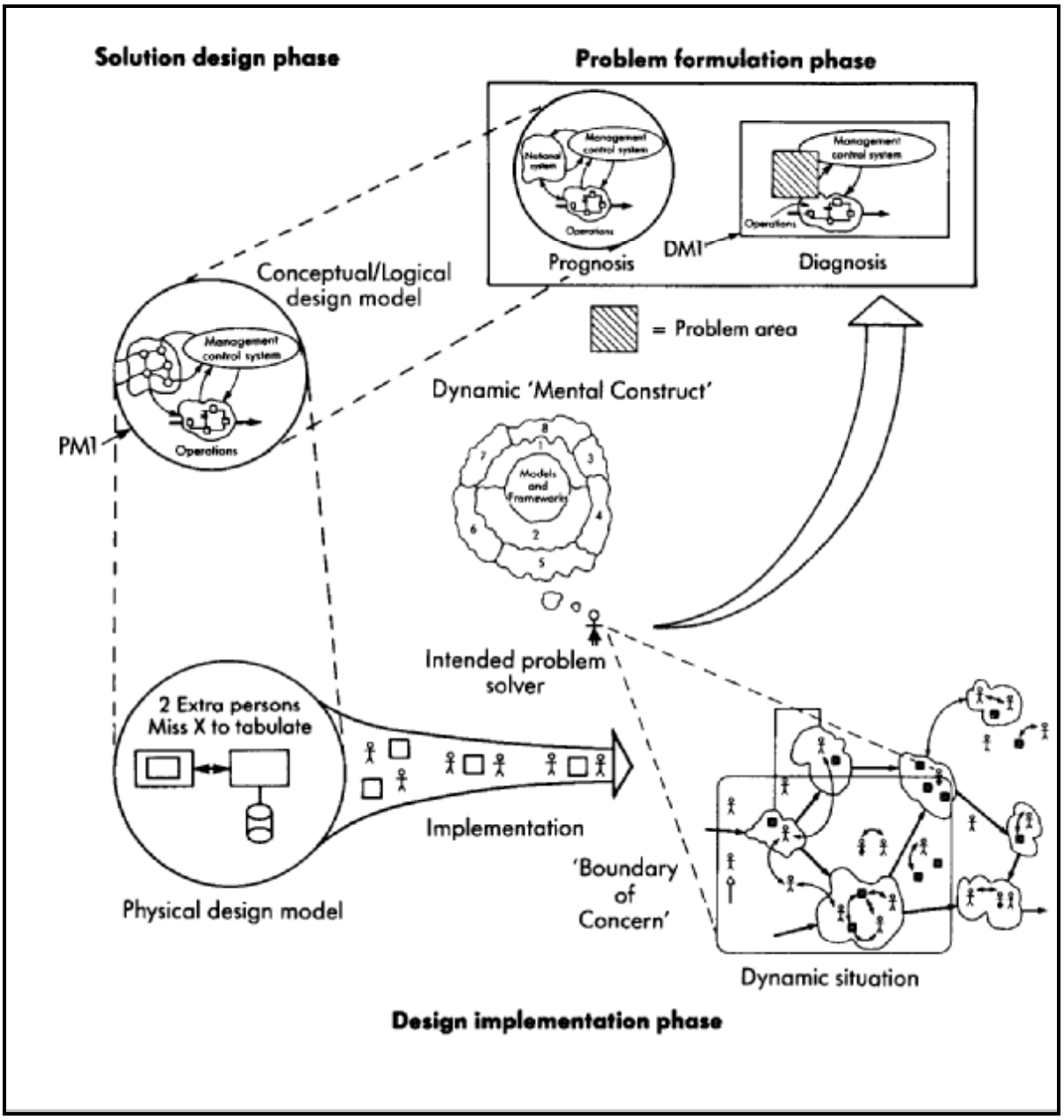
The use of the NIMSAD framework provides a mechanism for the structured and critical evaluation of the problem solving process adopted in the resolution of the identified/perceived problem. It provides a valuable tool for the identification and clarification of the key attributes and characteristics of the problem and the problem situation, including the interactions and contributions of the various stakeholders within that particular problem situation. Furthermore, it

enables the explication of the role and contribution that the intended problem solver brings to the situation and his/her potential impact upon the outcome of the problem solving process (see Fig. 2).

Through this process of reflective evaluation of the three key elements within any problem solving scenario, the problem solver is able to develop a dynamic learning model that facilitates the explication and transference of knowledge, not just on the process but also on the circumstances of any situation and nuances of the stakeholders within it. The NIMSAD framework facilitates double-loop learning (Argyris & Schon, 1974) to take place, where the learner not only draws valuable lesson from the experience itself but also draws valuable lessons from the critical evaluation of the whole problem solving/learning experience. Increased understanding of the dynamic nature of the problem solving process increases the chances of the problem solver at developing appropriate solutions to a range of perceived problems.

Although the framework provides an essential learning model to the evaluation of the key elements of any problem solving scenario, it is important to realize that the demands of the 'real world' often inhibits the full application of such a tool. The application of this framework also raises many sensitive issues of a political and organizational nature which requires a great deal of attention and expertise to resolve. However, if we are to truly benefit from our experiences, it is essential that valuable lessons are not lost in the push for quick returns and hurried resolutions of problems, where emphasis is predominantly given to the rapid implementation of *inappropriate* ready-made solutions to restrictively defined problems.

Fig 2 – **The complete NIMSAD framework**



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