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Improving Project Management Teaching Using Scaffolding Based on Cladistics Parsimony Analysis

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Abstract

There are numerous educational paradigms each with their advocates and critics. The cognitive science approach is based on modelling memory as short term and long term each with their different characteristics. All learning consists of an iterative cycle of assimilate and retrieve between these two types of memory. The objective is the construction of an ordered mental structure called a schema in long term memory. With this approach it is possible to define schemas according to an optimal learning sequence. An optimum sequence has minimal cognitive load and hence the ideal teaching sequence. Previous work has clearly demonstrated that this method may be applied to network technology education. This paper applies the same method of teaching financial instruments in project management. Results to date demonstrate that scaffolding, based on cladistics parsimony analysis is a generic method and can be applied to different disciplines. Using this method an optimal learning sequence for project management financial instruments may be produced.

Keywords: teaching, project management, contracts, pedagogy, scaffolding

1. Introduction

1.1 Project Management

Project management is considered an essential body of knowledge for engineers in all disciplines at all course levels: diploma, undergraduate and postgraduate. Project management at its core consists of topics that include: systems development life cycle, planning, networks, scheduling, cost estimating, budgeting, quality, risk analysis and management. In a broader context topics such as organizational behavior (teamwork, conflict etc.) and corporate strategy (project portfolio, international project management etc.) may also be taught. There are a wide range of textbooks that may include power point slides and supporting materials such as questions with sample answers. Project management of itself is a broad discipline. Hence in order to facilitate teaching project management to engineers a textbook with an engineering perspective was chosen (Nicholas, 2014). A project is initiated by a Request for Proposal from a client followed by Proposals from contracts resulting in a contract between the client and the chosen contractor. Projects are fundamentally different from routine production in that they are: goal oriented, temporary, unique, constrained (resources), multidisciplinary and risky. Given that risk is an essential aspect of project management there is a wide range of financial instruments to choose from that variously apportions risk between the client and contractor such as: firm fixed price, cost plus fixed fee, cost plus incentive fee etc. The problem to be addressed is to determine the optimum method of teaching these different financial instruments.

1.2 Pedagogy

There is a wide range of educational approaches that include: behaviorism (Skinner, 1948), cognitive (Dick, 1990) and constructivism (Piaget, 1954). Each approach has its strengths and weaknesses; advocates and critics. These three educational paradigms are complemented by a wide range of different methods for representing, conveying and acquiring knowledge that include: tree construction and cognitive maps (Diekhoff, 1983), content structures (Meyer, 1985), frames and slots (Minsky, 1975), semantic maps (Fisher, 1990), causal interaction maps (Jonassen, 1993), concept maps (Ausbel, 1963) etc. Allied to all these different teaching methods are the associated taxonomies used to evaluate the effectiveness of learning namely: Bloom (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), and Structure of Observation of Learning Outcomes (SOLO) (Biggs & Collis, 1989).

Regardless of the teaching method or taxonomy used quality teaching is based on high levels of teacher-student interaction.

1.4 State Hypotheses and Their Correspondence to Research Design

The approach taken by this study is based on the cognitive paradigm along with the SOLO educational taxonomy. The cognitive science approach may be enhanced by employing a quantitative approach in order to define the optimum learning sequence. According to Maj, '*This paper suggests that it is possible to quantifiably minimize the complexity of the material being taught and hence minimize the cognitive load using parsimony analysis. Using parsimony analysis it is possible to define the optimum learning sequence* (S. P. Maj, Veal, D., 2010)'. Further work supports this hypothesis (McIlwain, 2017), (S. P. Maj, Ohtsuki, K., Akamatsu, T., Mackay, S., 2016), (S.P. Maj & Veal, 2007). It has been demonstrated that a cognitive science approach aligns with the SOLO taxonomy (S. P Maj, 2017). This is important because SOLO defines a learning hierarchy of: uni-structural, multi-structural, relational and extended abstract which align with how cognitive science models how students learn. There are two types of memory – short term and long term. Short term memory is of limited capacity, duration and bandwidth; long term memory is of limitless capacity and duration. Learning is the process of presenting new material to short term memory and an iterative cycle of assimilation and retrieval with long term memory. The objective is the construction of a schema in long term memory. A schema is ideally an ordered, coherent structure that aligns with the SOLO definition of relational knowledge. A schema that is poorly structured with relational links represents learning that is incomplete, inconsistent and possibly incorrect. Teaching and learning is therefore best facilitated by the identification of the material to be taught in terms of a well-defined schema. Such a schema defines the sequence of teaching from the simplest to the more complex learning outcomes figure 1 (S. P Maj, 2017).

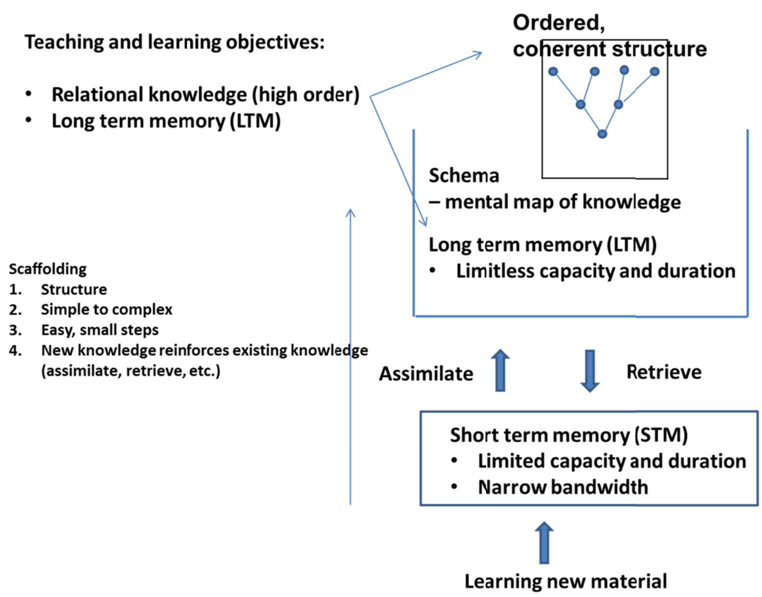

Figure 1. Teaching and learning objectives

2. Method

Four different financial instruments were selected –Firm Fixed Price (FFP), Cost Plus Fixed Fee (CPFF), Cost Plus Incentive Fee (CPIF) and Fixed Price Incentive Fee (FPIF). Material provided by the textbook (textbook explanations and power points slides) for these topics was analyzed based on the parsimony method. Parsimony analysis is based on cladistics which is a classification method to group taxa (groups with common characteristics). The output of cladistics is a cladogram (Henning, 1965). The relationship between taxa may be plesiomorphic (primitive) or apomorphic (advanced, derived). Cladistic analysis orders these items into a hierarchy representing the simplest and most parsimony manner i.e. from the most primitive (plesiomorphic) to the more advanced (apomorphic). A software tool is available – Phylogenetic Analysis Using Parsimony (PAUP). However with a small number of items it is possible to do this manually. An essential aspect of Cladistics is the identification of taxa which are the underlying concepts underpinning FFP, CPFF, CPIF and FPIF. According to Maj, '*The parsimony cladogram represents a structured and logical teaching sequence with a minimum* *cognitive load*' (S. P. Maj, Veal, D., 2010). Minimum cognitive load represents the most efficient learning path (S. P Maj, 2017). Price is defined as fee plus cost; budget is the agreed price. Clearly fee and cost are plesiomorphic to price and price is plesiomorphic budget i.e. they are derived. Projects are intrinsically risky in which the project may be on-budget or out of budget (over or under). Hence risk can be shared.

3. Results

The initial cladogram identifies the fundamental concepts (taxa) and be presented diagrammatically (figure 2).

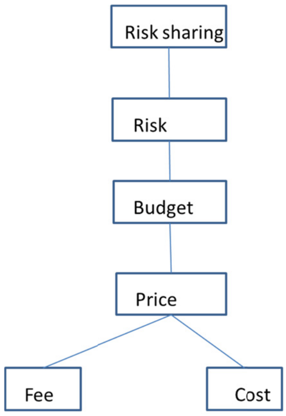

Figure 2. Cladogram 1

Taxa have characteristics which are used to define taxa and hence provide criteria used to define branching in a cladogram. For example, there is a risk that the project may be out of budget (under or over). This risk can be handled in two different ways i.e. risk sharing and no risk sharing. Similarly with no risk sharing the risk can be allocated entirely either to the contractor (FFP) or the client (CPFF) illustrated in figure 3.

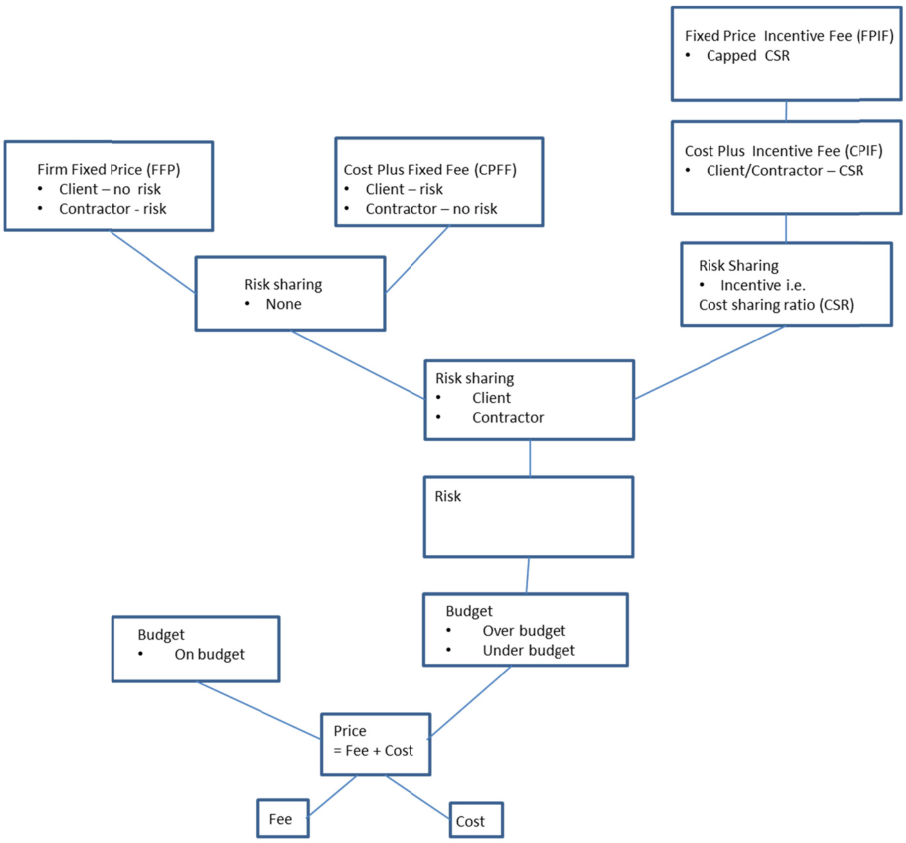

Figure 3. Cladogram 2

This cladogram may then be used as the basis of constructing educational material such as diagrams and associated text based explanations. Diagrams are important because they provide a simple method of representing relational knowledge. For example the relationship between fee, cost and price and be illustrated diagrammatically (figure 4). The next level of the cladogram uses this diagram but modified to include the higher level learning concepts of budget (on, over/under) figure 5. Using the cladogram it is possible to produce learning material based on an optimal learning sequence.

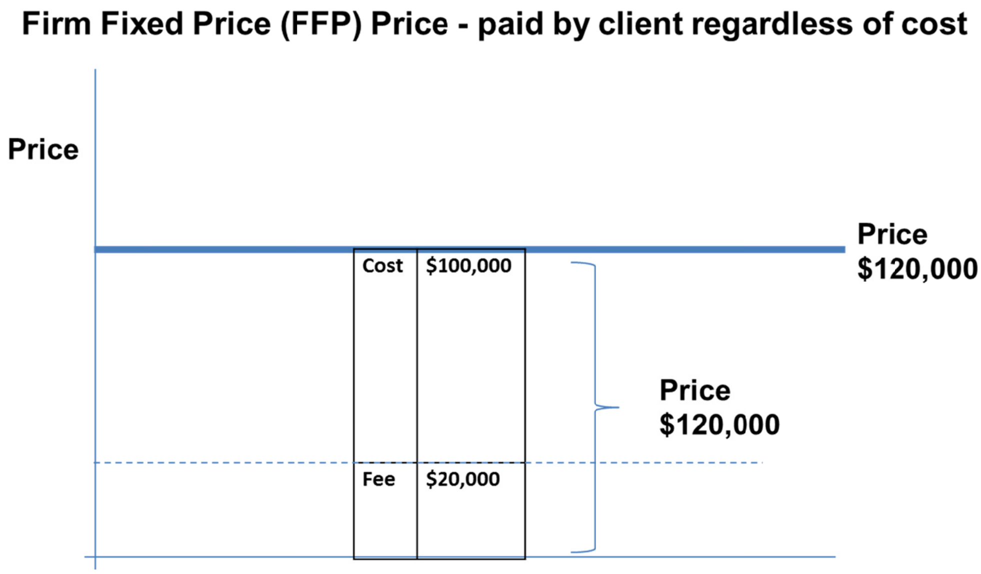

Figure 4. Fee, cost and price

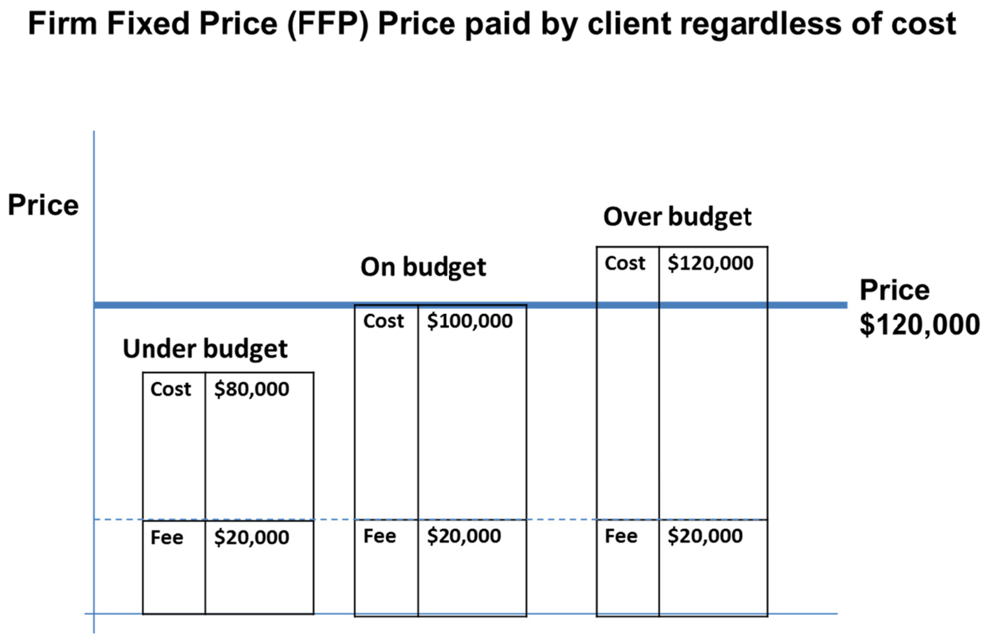

Figure 5. Budget

4. Discussion

Further work is needed, but this preliminary study strongly suggests that scaffolding, based on cladistics parsimony analysis is a generic method that can be applied not only to technical subjects such as network technology but also project management subjects. Using this method an optimal learning sequence can be defined for teaching financial instruments. This sequence can then be used as the basis of producing educational materials such as diagrams and the associated textual explanations.

References

Ausbel, D. P. (1963). Psychology of Meaningful Verbal Learning: An Introduction to School Learning. London: Grune and Stratton.

Biggs, J., & Collis, K. (1989). Towards a Model of School-based Curriculum Development and Assessment Using the SOLO Taxonomy. Australian Journal of Education, 33(2), 151-163.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of Educational Objectives - The Classification of Educational Goals. New York: David McKay Company, Inc.

Dick, W. C. L. (1990). The Systematic Design of Instruction (3rd ed.). New York: Harper Collins.

Diekhoff, G. M. (1983). Relationship judgements in the evaluation of structural understanding. Journal of Educational Psychology, 75, 227-233.

Fisher, K. M. (1990). Semantic Networking: The new kid on the block. Journal of Research in Science Teaching, 27(11), 1001-1018.

Henning, W. (1965). Phylogenetic Systematics. Annual Review of Entemology, 10, 97-116.

Jonassen, D., Beissner, K., Yacci, M. (1993). Structural Knowledge: Techniques for Representing, Conveying and Acquiring Structural Knowledge. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Maj, S. P. (2017). Improving Teaching and Learning Outcomes - A novel cogntive science approach. Modern Applied Science, 11(1), 264-269.

Maj, S. P., Ohtsuki, K., Akamatsu, T., & Mackay, S. (2016). State Model Diagrams for Teaching Networking - a SOLO based evaluation. Modern Applied Science, 10(10), 231-240.

Maj, S. P., & Veal, D. (2007). State Model Diagrams as a Pedagogical Tool - An International Evaluation. IEEE Transactions on Education, 50(3), 204-207.

Maj, S. P., Veal, D. (2010). Parsimony Analysis - a novel method for structured knowledge representation for teaching computer science. Modern Applied Science, 4(11), 3-12.

McIlwain, J., McIlwain, O., Maj, S. P. (2017). Facilitating Network Technology Training in the Australian Vocational Education Sector. Modern Applied Science, 11(1), 242-252.

Meyer, B. J. F. (1985). Signalling the structure of text. In D. H. Jonassen (Ed.), Technology of Text (Vol. 2). Englewood Cliffs: NJ: Educational Technology Publications.

Minsky, M. (1975). A framework for representing knowledge. In P. H. Winston (Ed.), The psychology of computer vision. New York: McGraw-Hill.

Nicholas, J. M., Steyn, H. (2014). Project Management for Engineering, Business and Technology. Abingdon, Oxon: Routledge.

Piaget, J. (1954). The construction of reality on the child. New York: Basic Books.

Skinner, B. F. (1948). Walden II. New York: Macmillan.

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