Competency Intelligence

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Abstract

Recent research, undertaken at the University of Sunshine Coast in Queensland, on the evaluation of the Competency Theory and Double Heuristic Method (DHM) in the Training Packages context (Azemikhah, 2006), confirms the findings of High Level Review that Competence is seen as "*being held by individuals through the possession of a suite of knowledge, skills and attributes"* (Schofield & McDonald, 2003, p 20). It is anticipated that the evaluation process that involves a selected group of VET teachers in Queensland, will facilitate understanding of pedagogical complexities of competency in the context of Training Packages. Building on previous work, on DHM and Competency Theory (Azemikhah, 2005b) the paper will report on research in progress that the mere possession of a suite of knowledge, skills and attributes is not sufficiently adequate. The learners, in addition, need to be able to develop what is referred to as "Competency Intelligence". That is, the learners need to be able to adopt the required skills in the right sequence, demonstrate the required attributes at the right moment, while performing in the appropriate context, underpinned by the required knowledge. The paper will attempt to demonstrate how the development of "Competency Intelligence" is an important catalyst and co -requisite in the competency development process.

Introduction

This paper argues that, for learners, without "Competency Intelligence", the possession of a set of skills, knowledge and attributes is of itself of no avail. A competent individual, in addition needs to possess the intelligence of putting them all together by integrating and coordinating the constituents of competence in unison, and objectively, and with due regard to, and in congruence with, the timing, the sequence as well as the purpose of the unit of competency. In other words, without Competency Intelligence, the attainment of competence is subject to a question of certainty, i.e., as to whether the competency in reality does eventuate and attain excellence.

Intelligent Direction

Dewey (1933, p 3) in the "Question of Certainty" has pointed out that, " *in spite of great changes in detail, the notion of a separation between knowledge and action, theory and practice, has been perpetuated, and that the beliefs connected with action are taken to be uncertain and inferior to value compared with those inherently connected with objects of knowledge*". Dewey was concerned with the inferiority placed on activity and the lower value attributed to it. On this ground, Dewey (1933, p 4) further asserts by referring to the point where, "*the arts of intelligently directed action are the means by which security of values are to be attained*." And in order to secure these values, he asserts that "*the chief consideration in achieving concrete security of values lies in the perfecting of*

methods *of action*". He points out, further, "*more activity, blind striving, gets nothing forward.*" And, finally, the impetus of Dewey's assertions culminates by his stating that "*regulation of conditions upon which results depend is possible only by doing, yet only by doing which has intelligent direction."* Given that the intelligent direction invests value in the activity, suggests that securing value in the competency development process requires intelligent direction.

This is why Dewey (1933) so vehemently emphasized intelligent direction in the "Question of Certainty". He has further pointed out that intelligent direction is "*the doing which takes cognisance of conditions, observe relations of sequence, and which plans and executes in the light of this knowledge*"(Dewey 1933, p 7). Dewey's assertions suggest that competency development process requires a direction that takes cognisance of prescribed conditions, such as required knowledge, skills and attributes, as specified in the unit of competency, as well as observance of the sequence for example in the performance criteria. Brown (2002, p 2) points out that "*John Dewey's early twentieth century instrumentalism is devoted to restoring practical action to the forefront of human intelligence*." In other words, Dewey "*confers new intellectual status on the crafts and trades*" (Brown, 2002, p 2). Before pursuing further in this article, it seems appropriate to examine the definition of 'Intelligent Direction' to better understand Dewey's perspectives. The Oxford Dictionary has defined 'intelligence' as, "The faculty of understanding or intellect", and intelligent as, "Having the faculty of understanding" or "showing high degree of understanding" (The University of Oxford, 2002, p 1395). Again, Oxford defines direction as "the action or function of directing, guidance, an instruction on what to do, how to proceed and where to go"(The University of Oxford, 2002, p 688). The above definitions suggest that intelligent direction practically, is how to proceed with a high degree of understanding which is possible through the faculty of understanding, i.e., human intelligence.

Given that activity necessitates intelligent direction and intelligent direction is "*the doing which takes cognisance of conditions, observe relations of sequence, and which plans and executes in the light of this knowledge*"(Dewey 1933, p 7), and that poor understanding has been interpreted as reflecting a low level of intelligence (Soden 1994), the question that remains to be answered is whether poor achievement can be interpreted as the consequence of low level of intelligence. Sedon (1994, p 12) in response to the above question, on the subject of low level of understanding and intelligence has succinctly pointed out that, "*this view of intelligence and the evidence which supported it have been seriously undermined in the last twenty years*" (Soden 1994, P 12). The researchers now share the view that, "'intelligence' is learnable and consists of a repertoire of concepts and mental operations" (Soden 1994, P 13). This also includes, learning that focuses on "*The sequence of operations build up into procedures*" (Soden 1994, P 13). This view has been further confirmed by Jackins (1994, P xi) who has defined human intelligence concretely as "*the ability to construct a new, unique, accurate response to each new, unique experience which confront each human at each moment of his/her existence*." The question that remains to be answered is: what are the components of human intelligence? Soden (1994, p 92) has elucidated that "the components of intelligence are knowledge, organized into interconnected concepts structures and into

mental procedures which facilitate application of the concept structures to problem solving" that are stored in memory (Soden 1994, p 92). These assertions suggest that the vast repertoire of knowledge and procedure is stored in memory as information as well as mental operations/procedures that interact to solve problems (Soden 1994).

Such an argument confirms Dewey's (1933) view that the interaction between knowledge and practice needs intelligent direction. His view also is congruent with interaction between two aspects of memory proposed by (Soden 1994). In her own words, Soden (1994, p 24) has pointed out that, "there is a constant interaction between these two aspects of the memory which have been described as information and procedure". Azemikhah (2005b) has referred to this interaction in the context of Double Heuristic Method (DHM) as the interplay between the Conceptual side (Minds) that deals with knowledge and Physical side (Hands) that deals with procedure and performance criteria. Further research (Anderson, 1993,; Smedley G. & Sutton S., 2002) has also confirmed this view. Anderson's ACT and ACT-R theories, which are the theories of cognitive skill acquisition, describe that the mind is comprised of three types of memory, (working, declarative, and procedural), and that learners are constantly using all types in order to acquire certain facts in a new learning situation. The learners, after acquiring these facts (knowledge), convert them into a set of rules that are used to develop accurate problem solving skills. The above assertions indicate that one of the components of intelligence is the knowledge which is stored in the memory. The question is how the knowledge component is stored in the memory. The result of many experiments in recent research, for example (Anderson, 1993,; Smedley G. & Sutton S., 2002; Soden 1994), suggest that, knowledge is stored in the form of concepts in memory. However, on this basis, the"concepts which are meaningfully related to one another are stored in a structure which shows the relationships between the concepts in that structure" (Soden 1994, p 38). In other words, the meaning of any concept is derived from its relationship with other concepts.

This has been further confirmed, in 1996, in the studies undertaken by Ericsson (Ericsson, 1996). Richman and Staszewski (1996) in their research indicate that concepts are stored in memory in a network of associations called the EPAM net. EPAM stands for Elementary Perception And Memory process. EPAM model was initially built by Feigenbaum in 1961 to account for knowledge acquisition and recall and, since then, has been used and expanded to model a number of memory phenomenon (Richman & Staszewski, 1996). EPAM model functions in terms of both memories, the Short Term Memory (STM) and the Long Term Memory (LTM). The most important STM is called articulatory loop that holds the information that is subject to learning. This information will be gradually transferred to LTM (Richman & Staszewski, 1996). LTM operates as an indexed encyclopedia comprised of EPAM net as the index and semantic LTM that stores chunks of information. EPAM net is comprised of leaf nodes that provide access to semantic LTM through associational links to chunks of information that are held there. Each leaf node in the EPAM net contains the image of a stimulus, partial information about the stimulus, sorting information and the associational link to a chunk of information in the Long Term Memory (LTM). When a new stimulus (not existing in the present EPAM) is sensed, its features are compared against features of existing leaf nodes.

EPAM constructs a test node to test the non-identical features to construct a new leaf node to accommodate the new stimulus.

According to this model, the learners' "EPAM net and the corresponding set of leaf nodes grow continually as they learn new patterns". In addition, each new pattern that is discriminated gains its own leaf node, as well as identifying a new chunk. This suggests that by applying the model to competency development, when a learner confronts a new concept, it is sorted against EPAM net, and a new leaf node is constructed. The information that is learned is stored in the long term memory (LTM) in the form of a new chunk. Richman and Staszewski (1996) point out that EPAM's indexed memory and the body of knowledge stored in it can be used for efficient problem solving by providing superior abilities in memory retrieval. During the process of problem solving, new chunks are constructed, stored in LTM and indexed. This confirms Soden's (1994, p 28) view that information should not be entered in memory haphazardly, as retrieval of information for problem solving becomes difficult. Hence, the concepts are to be sorted in memory in the way that the problem demands and learning occurs in such order. This is how human intelligence works in its relation to memory (Soden 1994). This view is in line with constructivist principle that problem solving derives learning (Boud, 2005). The above assertions and discussions provide at least three important educational levers:

- Problem solving derives learning;
- Learning is concerned with the learning of concepts embedded in the problem; and
- The meanings of the concepts so derived are defined in terms of their relationships to other concepts in a structure in memory that is constantly expanding.

Clearly, if the concepts are defined in terms of their relationships, then human intelligence stores these concepts in memory more efficiently. Soden (1994, p 38) has pointed out that, "*an efficient system for organizing knowledge in human memory is based on meaning, in that concepts which are meaningfully related to one another are stored together*" In vocational education, a system of concepts can be constructed, by the professionals that has special meaning in that vocation. The concepts that are meaningfully related are stored in such structure that is constantly developing, "as more information is received and connected to an existing concept structure" (Soden 1994, p 39). This suggests that understanding increases as the concept structure grows larger. In other words the intelligence which is based on deep understanding will be achieved when this concept structure has been fully developed and has established the most meaningful links to existing concepts (Soden 1994) . Weber (1960), in referring to Bertrand Russell, states that "Russell regards the cultivation of knowledge and intelligence as one of the major aims of education" hence for the learner, having developed intelligence, and having acquired a range of knowledge, independent thinking becomes possible, leading the learner, by using the intelligence to achieve independence. This thinking reflects Weber's conclusion that "knowledge is glorious but intelligence which discovers it is still greater" (Weber, 1960, p 299). Dewy (1933) regarded intelligence as power, and that it is sufficient in most situations to think and act as we have done in the past, habitually,

but some situations present problems that require new responses. He emphasized that learners must use intelligence as an instrument to solve problems (Dewey, 1944, 1958).

Jackins (1994) points out that the human being is totally different from other creatures. While other creatures respond to new situations on the basis of pre-set patterns of response, humans have different ways of responding which are qualitatively different to other creatures. And he adds that "*whether this essential difference was acquired by evolution or by creation makes no difference in understanding and using it*", and that, "*human ability seems to consists precisely of an ability to create and use brand new, unique response to each new, unique situation*". The essential difference is that, "*human being can and does continuously create new responses all through the lifetime of the individual, we usually call this human ability of ours, our intelligence*" (Jackins, 1994, p 13). Dewey's (1933) assertions confirm the notion of human beings' (unique) response to new situations or problems.

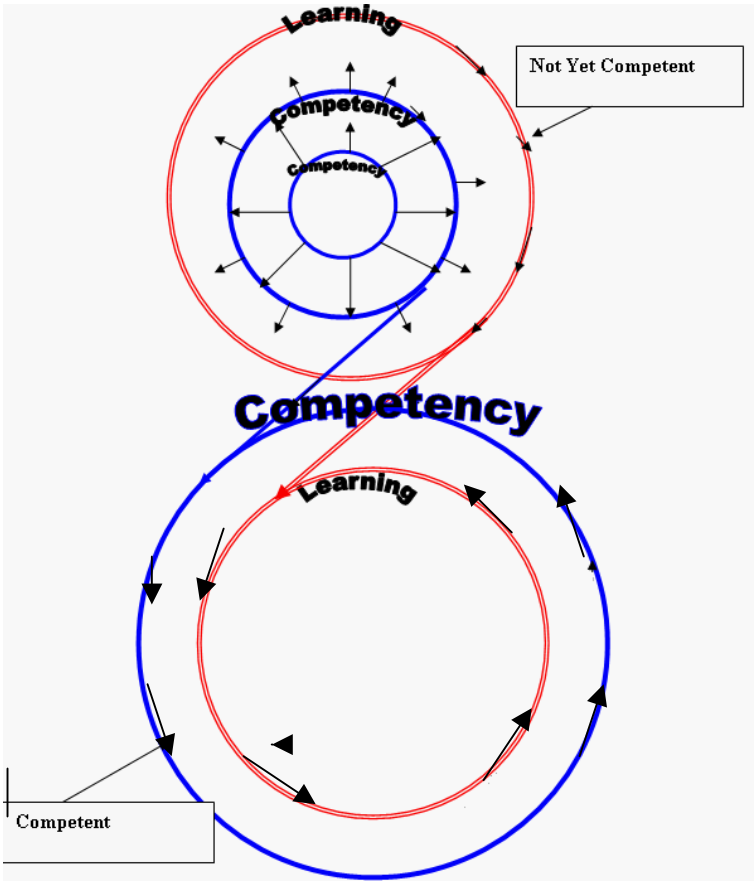
Learning is concerned about new cases and new concepts

Given that we use this human ability of ours, our intelligence, to create an endless supply of new, tailored-to-fit responses to endless series of new situations and problems (Jackins, 1994) and that the notion of human being's (unique) response to new situations or problems was confirmed by Dewey (1933) and that according to competency theory, explained next, "when the learner arrives at the points of transposition of the competency and learning, the learner becomes self-sufficient to learn independently of the facilitator when confronted with new cases or concepts (Azemikhah, 2005b). These assertions suggest that the learner is continuously learning new concepts and new cases before the point of transposition, while being facilitated, and that the facilitation ceases at the point of transposition.

Competency theory

According to Competency Theory, the learners need to go through a number of problem cases from simple to complex. At each iteration (illustrated by expanding circles in the competency theory), the learner's level of competency and professionalism elevates to a higher level, where the level of problem solving sophistication increases, and the level of competency of the learner elevates. This process continues until the learner attains mastery and arrives at the point of transposition (Azemikhah, 2005b). At the point of transposition (POT) the learner moves from the 'Not Yet Competent' position to the 'Competent' position. Throughout the 'not yet competent' stage, the learner is developing both his/her competency and competency intelligence. Given that the learners are developing their competencies they need to exercise their intelligence to achieve the intended results. During this stage, the learners are constructing the relevant conceptual structure or network of concepts in their memory. Every new concept they start to learn is given a leaf node in the EPAM net that is connected by associational link to other concepts as well as to a new chunk that holds the necessary information about the concept. This process continues as the learners' network of concepts become larger and more sophisticated to assist the learner to cross the point of transposition and move to the

competent stage. The competent stage is a new stage or cycle of learning where learning depends entirely on the learner's competency and thus learning becomes the function of the competency itself (Azemikhah, 2005b). Learner's competency denotes that the learner has already developed the infrastructure for his/her competency in terms of fully grown network of concepts, and is able to use this conceptual structure or network within the context of Double Heuristic Method (DHM). In this cycle, the learner who has turned into a fully fledged independent learner at the point of transposition is able to learn new concepts and face new problems independently while at the same time his/her EPAM net is growing into higher levels of sophistication.



"At the points of transposition of the competency and learning, the learner becomes self-sufficient to learn independently of the facilitator when confronted with new cases or concepts within the precincts or boundaries of the unit of competency. At the point of transposition, the learner enters into the new stage or cycle of learning where the learning depends entirely on the learner's competency and thus learning becomes the function of the competency itself."(Azemikhah, 2005b, p 5)

Figure 1 –The transposition of competency and learning (Competency theory) ©

Expanding Circles

Each iteration during the, Not Yet Competent, stage of the Competency Theory, is illustrated as an expanding circle leading to the next in the process. The power that expands these circles is the learner's 'Competency Intelligence' as illustrated in the following diagram. The learner's progress to autonomy and independency, in this first stage of the competency theory is a cumulative and developmental process where the learner's EPAM net is constantly growing in sophistication leading to learner's autonomy

and independency. In this cycle, as Candy (1991) asserts, "*many researchers into autonomous learning have identified the phenomenon of learners' growing independence with respect to the subject of their study"* . Hence, the expanding circles in Competency Theory represent the phenomenon of learner's growing independence which means the expansion in the conceptual structures of the learner's memory.

In other words, as the EPAM net in the learner's LTM grows larger which represents the learner's network of concepts sophistication, the learner's level of professionalism elevates and the learner, as Candy (1991) has emphasized, moves closer to autonomy in this developmental stage. To give this developmental stage (Candy, 1991) the intelligent direction as prescribed by (Dewey 1933) the learner requires to develop and use the power of (competency) intelligence as prescribed by earlier researchers (Dewey 1933; Jackins, 1994; Soden 1994; Weber, 1960). The research in progress indicates that this power or ability is a necessary part of competency development process in the Training Packages context. Hence it is important to give recognition to this ability, which the learner needs to develop, as 'Competency Intelligence'.

In the context of developing this ability, the learner is engaged in the process of understanding how to work with requirements of the units of competency in a Problem Based Learning (PBL) context using Double Heuristic Method and Competency Theory. By working in such multiple contexts in unison, the learner's Competency Intelligence (CI), as a learned capability is developed. Such developmental process has the potential to enable the learner to construct a new, unique, accurate and sophisticated response for each new, unique problem in the context of training. In this integrated approach, the learner needs to adopt the required skills at the right sequence, demonstrate the required attributes at the right moment, while performing in the appropriate context based on performance criteria, underpinned by the required knowledge. During the development of competency intelligence each of the constituents of competence will be stored in the long term memory (LTM), and indexed in the EPAM net with associational link/s to one or a number of chunks in the semantic LTM. The Competency intelligence (CI) together with Competency Theory (CT), Double Heuristic

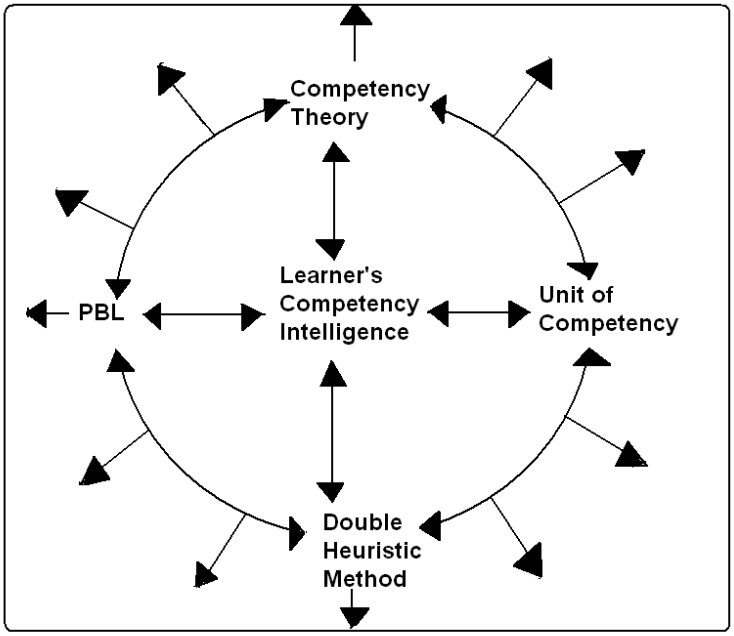


Figure 2 - Competency Intelligence Diagram - The Expanding Circle

Method (DHM), Unit of Competency (UC) and Problem Based Learning (PBL), as contextual objects, form the conceptual and theoretical framework comprised of the contextual quadrants to empower learners to develop their desired competencies in the context of Competency Based Training.

Competency intelligence can be defined also as the ability for understanding of competencies as the integrated constructs comprised of three clusters of knowledge, skills and attributes (constituents of competence) that needs to be developed as prescribed in the new theoretical framework comprised of the above contextual quadrants. The interaction of learner's competency intelligence, as illustrated in the above diagram, in all directions within contextual quadrants of the expanding circle enable the learner's competency to be developed, transforming the learner into a fully fledged competent individual.

Problem Based Learning (PBL) Context

The conceptual and theoretical models proposed in this research for competency development are constructed on the basis of the principles of constructivism where teaching "occurs using problems as the stimulus and focus for student activity" (Boud, 2005, p 6). On this basis, using constructivist pedagogy the learning becomes project-based (Jonassen, 1999) where learners manage and think as practitioners (Williams, 1992). Some research work (Richman & Staszewski, 1996) has confirmed the suitability of PBL on solving textbook problems in physics by indicating that, "*beginners with all the necessary knowledge, had to work backwards from problem to identify relevant formulas in a step-wise fashion*"(Richman & Staszewski, 1996, p 169). During this step, the learner needs to prepare a list of concepts embedded in the text of the problem. Teachers need to assist the learners to identify and list these concepts. Hence from PBL context point of view the learner is required to master the following functions:

- Understanding the problem
- Identifying the concepts within the problem
- Listing and prioritizing the concepts

Unit Context

Teachers are required to facilitate the learner's competency development by explaining the structure of the units of competency and in particular the list and sequence of performance criteria. However, in following this sequence the learner faces with some new terms (variables) as embedded in the text of performance criteria. Each variable refers to a number of concepts. Each of these concepts is applicable to certain problem contexts. These concepts are listed in the text of competency standard (unit of competency), the learner should be guided to identify and learn the relevant concepts. During this process the learners begin to think in terms of the concepts referred to in the units of competency. In this process, the relevant variables (concepts) from the unit of competency are listed by the learners. In addition, the learner should be assisted by a

facilitator to review the required skills in the unit of competency to prepare a list of them. In summary, the learner should perform the following tasks.

- Read and understand the structure of the Unit of Competency
- Read and Understand Performance Criteria
- Identify the Variables and Concepts embedded in the text of Performance Criteria and list them
- Identify and list the required skills
- Identify and list performance criteria

Double Heuristic Context (DHM)

DHM starts from a case or problem where the learners, who have been facilitated by the teacher and have already, identified and listed the problem concepts, variables, required Skills, and Performance criteria. The learners are then guided to copy these four lists to a DHM diagram format. The problem's concepts are listed at the foot of the diagram; the variables are listed on the left side of the diagram, the performance criteria at the right side and the skills at the middle of the big notch. The learners are then guided to identify and draw the relationship of the concepts from the problem to variables listed on the left as concepts (required knowledge), from the variables (required knowledge) to performance criteria using skills as the interplay elements or links, and finally from performance criteria to the problem. In the final stage, this process produces a customized competency map (CCM) that will be the basis for the teaching and learning of competencies constructed on the basis of the demand-driven principles (Mitchell J. Chappell C. Bateman A. and Roy S., 2005b). Using DHM, the teachers need to increase the level of difficulty at each iteration as specified by the Competency Theory (Azemikhah, 2005b, p 5) .

Conclusion

In the learning process, Dewey (1933) placed the emphasis on intelligence; Russell placed it on cultivation of knowledge and intelligence, and Weber (1960) on how, by using the intelligence, the learners are able to achieve independence in their developmental stages. Jackins (1994) called our attention to the point that intelligence is unique to humans and is learnable by providing unique solutions to new problems. The paper has given the title of "Competency Intelligence" to this ability in the context of competency based training, the principles of which have been advocated by Soden (1994) to be applied in Vocational Education, that are equally applicable to competency development in the Training Packages in Australia. This paper articulates that the competency intelligence (CI) is the central power (ability) for the development of competencies and that the learner's 'competency intelligence' interacts in all directions within the contextual quadrants of PBL, DHM, unit of competency and competency theory, leading to transformation of the learner into a fully fledged and competent individual.

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