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PROBLEM-BASED LEARNING TRAINING AND IMPLEMENTATION: AN ANALYSIS USING SEMANTICS IN LEGITIMATION CODE THEORY

ABSTRACT

This article reports on the analysis of problem-based learning (PBL) training within a teaching development programme (TDP) and the subsequent experiences of implementing PBL by respondents who participated in the training. The semantic dimension of legitimation code theory (LCT) was applied as a conceptual tool in the study.

The data for the study was gathered through face-to-face interviews with 10 respondents who were alumni of the TDP; document analysis and reflective journal entries of the researcher. The findings are explained in terms of strengthening and weakening the organising principles of semantics, namely, semantic density (SD) and semantic gravity (SG).

It was found that the adoption of the medical model for PBL training might have been overly contextualised within the medical field. As a result, it was often challenging for the respondents from other disciplinary backgrounds to transfer knowledge gained during the PBL training to their respective disciplines. The findings also showed that respondents found it challenging to implement PBL in its pure form and needed to adapt the application of PBL to meet the unique requirements of their discipline. Therefore, it is important to consider the diverse nature of disciplines when implementing PBL training. The PBL training should be designed and implemented specifically for the discipline concerned. Also, semantic waves that pertain to the movements between context-dependent knowledge and condensed meaning, should be addressed during PBL training to expedite the transfer of knowledge of PBL.

Keywords: *Problem-based learning, semantics, legitimation code theory, teaching in higher education, academic staff development*

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1. INTRODUCTION

This article reports on the implementation of problem-based learning (PBL) by respondents who had received training in PBL through a teaching development programme (TDP). The TDP is underpinned by constructive alignment (see Biggs and Tang, 2011: 104–107) with a specific focus on

social constructivism. Thus, social constructivist methods of teaching and learning, such as PBL, are promoted (Biggs & Tang 2011:178–184). It has been argued that for many academics accustomed to traditional methods of teaching and learning, the implementation of PBL poses a challenge because of its constructivist nature (Lim & Choy, 2014: 64, 53; Bouhuijs, 2011: 19; Coffin, 2013: 206). Therefore, in the TDP, PBL training was intended to provide respondents with the knowledge and skills to facilitate learning and promote student-centred, self-directed learning, which, according to the meta-analysis of PBL conducted by Hung, Jonassen and Liu (2008: 486–500) are the hallmarks of PBL. The other predominant feature of the PBL environment is small group discussions that promote collaborative learning (Hung *et al.,* 2008: 493). In the PBL training for this study, respondents were also trained in the management of small group discussions.

The aforementioned training was undertaken because it was acknowledged that it would have been unlikely that the competencies required to implement PBL would have come naturally to the respondents who were new to PBL. Endorsing this, Farmer (2004: 59–66) explains that academic staff development is an important aspect of curriculum change (to PBL), especially since many faculty members might be unfamiliar with the PBL process. The role of the teacher within a PBL environment is so disparate from their role within a traditional teaching environment that academic staff development is deemed necessary when shifting to PBL (Nayer, 2010:138–148). Irby (1996: 76–79) argues that it is difficult for academics to learn an innovative method of teaching, such as PBL, because assumptions about learning might be at odds with their existing beliefs. In the Irby (1996: 76–79) study, medical models for academic staff development on PBL, derived from medical schools that implement PBL, are addressed. Hitchcock and Mylona (2009: 52), whose study is centred around training academics to implement PBL, posit that the success of a PBL initiative depends on availability of academics who are skilled in PBL. They added that re-training to PBL is a challenging transition for many academics.

Bouhuijs (2011: 22), who discusses the importance of academic staff development with respect to medical teachers, points out that the role of the teacher is shifted from a presenter of knowledge to promoter of learning, when shifting towards PBL. Teachers and learners alike need to understand PBL from the perspective of "why" and "how" so that they are able to work effectively in a PBL environment: "Teacher training provides an initiation in PBL" and the 'culture shock' can be addressed directly. Coffin (2013: 195) reports on the importance of developing staff for PBL from the findings of a needs analysis study that involved universities on a global level, such as Aalborg University, Maastricht, Central University of Queensland and McMaster. These findings helped inform the design of a framework for PBL for academic staff development. Lim and Choy (2014:64) advise that in order for PBL implementation to be successful it is important to address the essential elements of PBL, in particular helping the PBL facilitator adapt to the constructivist notions of teaching and learning that underpin PBL.

When it comes to the challenges attributed to implementing PBL, Bouhuijs (2011: 20–22) also discusses organisational management issues such as number of hours for a course, preparation time to implement PBL and adaptations to infrastructure; cultural adaptations (to constructivist approaches to PBL and the importance of working across disciplines), and the importance of academic staff development in introducing the teaching implications of PBL. However, the study does not pay adequate attention to the actual process involved in training and the recontextualisation of PBL within disciplines**.**

There is some evidence of training academics for PBL in the literature (DalrylmpIe, Wuenschel & Shuler, 2006: 948; Creedy & Hand, 1994: 696; Hassan, 2010: 84–97, Murray & Savin-Baden, 2000: 111–113). Development of staff for PBL is predominantly located within the medical field. For example, DalrylmpIe *et al.* (2006: 948–955) refer to a staff development programme for PBL training of dental educators and Creedy and Hand (1994: 696), as well as Hassan, 2010: 84–97, refer to training for nurse educators. There are limited accounts, however, of PBL training of academics from contexts outside of the medical field. This article addresses that gap.

A further gap that is addressed by this article is the link between PBL training, PBL implementation and semantics in legitimation code theory (LCT). Thi Anh Phuong and co-workers (2018: 37, 41) explored the relationship between academic performance of nursing students within a PBL environment and the application of Kolb's learning styles (Kolb, 1984: 38). They found that learning is most effective when students move through the cycles between concrete experience and abstract conceptualisations using Kolb's learning styles. Their finding, that learning is most effective when students move through the cycles of concrete experience, observation, experience and abstract conceptualisations before drawing on tentative conclusions that can be transferred to new situations (Thi Anh Phuong *et al.,* 2018:41), is important for the arguments that are presented in this article.

Indeed, the literature provides limited examples of the enactment of semantics in the analysis of PBL training. Semantics superimposes well with PBL because PBL case studies demonstrate the continuous movement between abstract, conceptual knowledge and concrete, everyday experiences, thereby creating semantic waves, which is a hallmark of semantics. According to Maton (2014a:122) the application of semantics addresses the creation of semantic waves for cumulative learning to occur. It is for these reasons that semantics was chosen as a conceptual tool for the analysis of PBL training of academic staff within a teaching development programme.

The purpose of the study described in this article was to analyse the creation of semantic waves during PBL training, and to investigate the application of PBL by respondents who had participated in the training. The study was guided by the following research questions: 1) How is semantics in LCT addressed in PBL training within a TDP for cumulative knowledge building?; 2) What are the experiences of respondents regarding the implementation of PBL, within the context of their own practice, following PBL training in a TDP, from the perspective of semantics in LCT?

The next subsection provides a brief explication of the theoretical framework (semantics) that underpinned the study. Thereafter, a semantic analysis of PBL training within the context of a teaching development programme is provided.

2. THEORETICAL FRAMEWORK

Semantics is a dimension of LCT and can be employed to analyse how the context-dependence and complexity of meaning develops over time in a learning episode (Waite, Curzon, Maton & Tuttiett, 2019). Semantics conceives social fields of practice as semantic structures whose organising principles comprise the semantic codes of semantic gravity (SG) and semantic density (SD) (Maton 2014b:2; Maton 2014a:18). Semantic gravity (SG) refers to the degree to which meaning relates to its context and can be strengthened (SG+) or weakened (SG-) along a continuum where meaning is more related to its context in the former and less related

to its context in the latter. Semantic density (SD) pertains to the condensation of meaning and can be strengthened (SD+) or weakened (SD-) along a continuum where fewer meanings are condensed in the former and more meanings are condensed in the latter (Maton, 2014a:110). Therefore, the organising principles are SG+, SG- and SD+, SD- (Maton, 2014a: 130). When the continua of SG and SD are placed perpendicularly to each other a semantic plane is produced. The concepts transcend dichotomising categories to create differences between and within forms (Maton, 2014a:130).

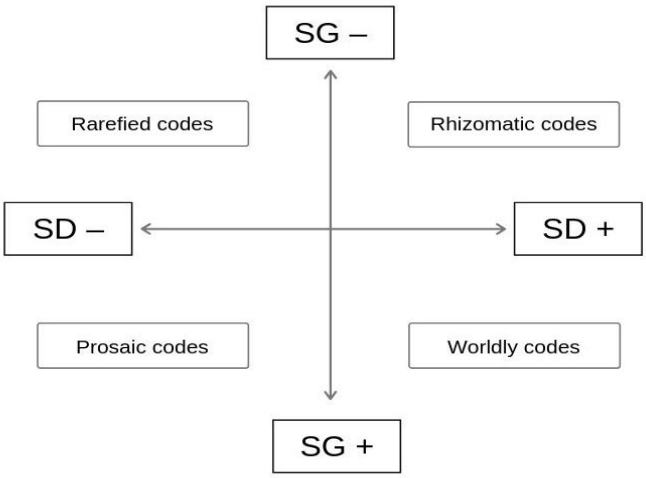

Figure 1: The semantic plane exhibiting semantic codes (adapted from Maton, 2014b: 3–4).

The principal modalities generated from SD and SG are integrated from Maton (2014b:3–4) and Shay (2013:572) as follows: 1) top right quadrant: Rhizomatic codes (SG-, SD+) which refer to context-independent, complex condensed meaning as in theoretical knowledge; 2) bottom left quadrant: Prosaic codes (SD-, SG+) which refer to context-dependent, simple meaning as in practical knowledge; 3) bottom right quadrant: Worldly codes (SG+, SD+) which refer to context-dependent, complex condensed meaning as in professional knowledge; and 4) top left quadrant: Rarefied codes (SD-, SG–) which refer to context-independent, simple meaning, as in everyday generalisations.

The main characteristics of knowledge building and achievement are semantic waves that encompass recurrent shifts in context-dependence and condensation of meaning that "weave" different forms of knowledge (Maton 2014b:1). A semantic wave is created by recurrent upward and downward movements on the semantic scale of the SD and SG of knowledge (Maton, 2013:12). Upward movements on the semantic scale encompass a shift from particular concrete contexts towards the condensing of meanings into abstract terms and concepts. On the other hand, downward movements would involve shifts from complex, condensed meaning towards concrete terms (Mcnaught, Maton, Martin & Matruglio, 2013:50).

According to Maton (2014a:122–123), the focus on decontextualised knowledge would result in a (high) flat line of weaker SG that would result in students being incapable of applying the knowledge within everyday life contexts.

Tracing the strengths of SG and SD of practices over a certain period would produce a semantic profile. In other words, semantic profiles show how context-dependence and complexity of meaning change over time. A semantic range is the region between the highest and lowest point of a semantic profile (Maton, Hood & Shay, 2016:17).

3. CONTEXT OF THE STUDY AND RESEARCH METHODS

This study was conducted at a University of Technology in the Western Cape. The respondents in the study had attended the TDP, which is a mandatory programme for all newly appointed academic staff. The programme provides knowledge and skills in teaching and learning as well as assessment. It runs for a year with weekly workshops on pedagogical topics being implemented in the first semester and the development of a teaching portfolio in the second semester. The training on PBL was one of the workshops conducted within the TDP.

A pure PBL medical model approach, as given by Barrows and Tamblyn (1980:13), (discussed in the introduction section) was followed. The respondents, who were part of a larger group, were randomly assigned to groups of six during the training to expedite small group discussions. Large group discussions involving the entire group were also employed.

The research design adopted for this study was an interpretative approach. In this regard, the following qualitative methods of data collection were applied: 1) document analysis, namely, course materials including reflective journal notes of the researcher and 2) face-to-face interviews with respondents. The course materials that were analysed were PowerPoint presentations of a PBL case study used by this researcher during the PBL training session. This document analysis was undertaken to determine how semantic waves were being created for cumulative knowledge building during the PBL training. This would have addressed the first research question. The face-to-face interviews were conducted in order to determine, from the viewpoint of semantics, respondents' experiences of implementing PBL within their own pedagogical practice and discipline after they had participated in PBL training as part of the TDP. This was done in order to answer the second research question.

For the face-to-face interviews, a purposive sample of ten participants in total was drawn from the TDP alumni. Only those participants who had completed the TDP could participate in the study. An email was sent to the participants inviting them to be interviewees in the study; 10 of them responded in the affirmative and became the respondents in this study. All interviews were audio recorded and handwritten notes taken. The duration of the interviews was between 20-45 minutes. The face-to-face interviews focused on questioning respondents about their experiences of implementing PBL within their respective disciplines. They were questioned about the case study they designed and employed, and how they facilitated learning among their students. All face-to-face interviews were transcribed manually. The data was coded according to the organising principles of semantics, namely semantic gravity and semantic density. These codes were categorised and themes were identified. The particular themes that emerged were the strengthening and weakening of SG and SD during the implementation of PBL by the respondents.

Ethics approval was obtained for the study at the university where the study was conducted. All respondents in this study were required to provide informed consent by signing a consent form that explained the purpose of the study and how the findings would be used. They were given the option of withdrawing from the study at any time. They were also assured that they would not be identified and that confidentiality would be guaranteed.

4. RESULTS

The findings of the study are reported in terms of: 1) the analysis of the PBL training using semantics and 2) the results of the face-to face interviews that reveal the manner in which respondents weakened and strengthened SG and SD when implementing PBL within their respective disciplines following training.

4.1 Analysis of PBL training through the lens of semantics

This sub-section is concerned with the description of the PBL training and analysis thereof from the perspective of semantics. The latter is in answer to the first research question.

The PBL training was premised on the hypothetical medical model designed by Barrows and Tamblyn (1980). With this model, students must develop problem-solving, diagnostic or clinical reasoning skills. They must obtain information, synthesise the data available, generate hypotheses and apply deductive reasoning to the medical problem at hand (Barrows & Tamblyn, 1980:13). The medical model was chosen by virtue of this researcher's expertise in medical education and PBL. This allowed this researcher to address the PBL case study in sufficient detail, which might not have been possible had she used a generic, non-technical case study or a case study in another discipline.

This researcher took on the role of "PBL facilitator" while the respondents assumed the role of "PBL students" in the PBL training. The facilitation of PBL entailed the asking of probing questions related to the PBL case study so that respondents, as PBL students, could identify learning needs or learning issues for self-directed learning. The respondents had to rely on their everyday medical knowledge in order to answer questions related to the PBL case study.

The PBL training was analysed using the organising principles of semantics, namely semantic density and semantic gravity. The analysis started at the beginning of the PBL training with the presentation of a medical case study that entailed progressive disclosure of information regarding the treatment of a patient. Initially, context-rich information was provided: A patient comes in presenting with particular symptoms (SG+, SD-). The patient's medical history summary is built up and data is collected through laboratory analysis. Concomitantly, hypotheses around the patient's probable illness are generated and motivated for, alongside the derivation of relevant learning issues that would help better understand the medical problem. In the process of analysing the medical problem, there is a shift towards greater abstraction and a move away from concrete knowledge (SD+, SG-). This allows for the testing of hypotheses and the generation of a differential diagnosis. The treatment plan for the patient would see the move towards weaker SD and stronger SG (SD-, SG+) as the case study moves back to the concrete level where the patient's problem is managed (for example, through medication).

Everyday medical examples applied in PBL are complex rather than simple. For example, a scenario that depicts a patient with a deep cough and complaining of fever (SG+) is laden with information pertaining to an abnormal functioning of the lungs. To understand this

problem, one needs to strengthen SD so that the Anatomy, Physiology and Biochemistry of the lungs can be better understood for a resolution of the problem (diagnosis and treatment). When these subjects are studied individually, the structure and function of the lungs will be addressed independently of each other.

The context provided in a scenario (SG+) gives the bigger picture, the whole, which is not always easy for students to assimilate at first, but helps to integrate the relevant disciplines, thereby increasing the complexity of knowledge. When SD is strengthened in a PBL environment, that is, when one aims for deeper understanding of the pertinent knowledge in Anatomy, Physiology and Biochemistry, the problem gets disassembled. This knowledge can then be applied to the context of the patient's medical problem, for assigning meaning to the medical condition, which will assist in the arrival of a differential diagnosis.

Within a PBL setting, multiple disciplines would co-exist within a particular context (see figure 2). When moving towards greater abstraction (strengthening SD), each discipline is addressed separately (see figure 2). Therefore, although semantic gravity is multi-disciplinary, SD is not because abstraction can only exist in a uni-disciplinary manner, as demonstrated in figure 2.

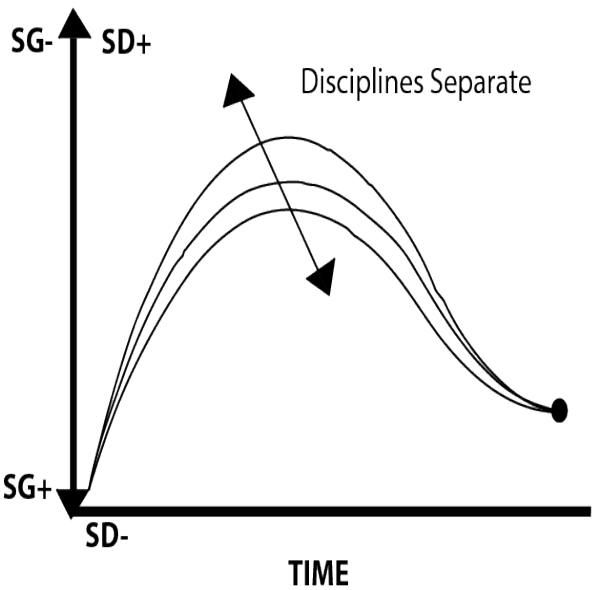

Figure 2: Increasing SD and decreasing SG for various disciplines with respect to a PBL case study (Adaptation of semantic waves by Maton 2013:12)

Although the disciplines separate (diverge) as knowledge moves upwards on the semantic scale, they converge when knowledge moves down the semantic scale, towards increasing semantic gravity, albeit at a different place on the graph. That is, additional contextual knowledge is provided in the form of a patient's physical examination summary, such as measurements of blood pressure, temperature and pulse. This contextual knowledge moves up the semantic

scale, in a uni-disciplinary fashion, towards greater abstraction and for meaning construction. It must be noted that when studied through the PBL route, some subjects, are more abstract than others (Hassan, 2013:48–64). Hence, SD is relative. Biochemistry and Physiology, for example, would require a higher level of abstraction during meaning making, that is, SD will have to be strengthened more in these subjects than in subjects such as Anatomy (Hassan, 2013:48–64).

Knowledge then returns down the semantic scale towards increasing SG, but on a different location on the semantic scale. It is at this point that more information relating to the context (which increases in complexity each time the wave comes back down) is provided in the form of laboratory test results, such as blood gas analysis, etc. Thereafter, the SD in each discipline is strengthened yet again during the upward movement. During the downward movement that follows, the context is revisited so that more sophisticated information in the form of X-rays, scans, etc. can be obtained. The upward movement occurs once again, followed by the downward movement towards another context that deals with the eventual diagnosis and treatment of the patient. These cycles of upward and downward movements occur as a series of waves.

In figure 3, the aforementioned recurring semantic waves are illustrated using an adaptation of the intersecting continua, depicted in figure 1. Movements occur from the Prosaic code (SG+, SD-) towards the Rhizomatic code (SG-, SD+) and back again. This process is repeated several times until a final movement is made towards the Worldly code (SG+, SD+), where treatment is rendered following a differential diagnosis (see figure 3).

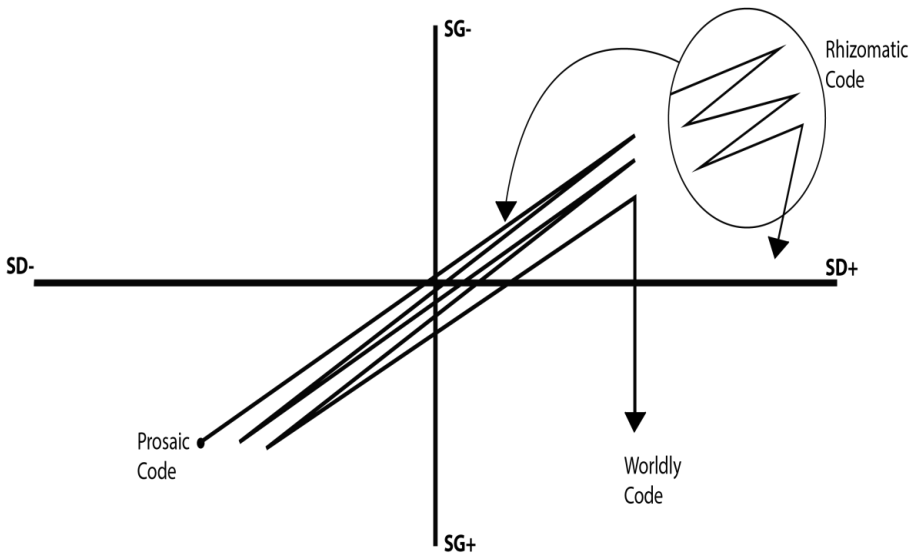

Figure 3: Semantic waves illustrated on the intersecting continua of SG and SD (Adaptation of the semantic plane by Maton 2014b:3-4)

4.2 Respondents' experiences of implementing PBL through the lens of semantics

This subsection addresses the finding related to the second research question in terms of the following themes:

- *Weakening SG and strengthening SD when implementing PBL (SG-, SD+)*
- *Weakening SG and SD during the application of PBL (SG-, SD-)*
- *Strengthening SD and SG during the implementation of PBL (SD+, SG+)*
- *Implementing PBL by weakening SD and strengthening SG (SD-, SG+)*

4.2.1 Weakening SG and strengthening SD when implementing PBL (SG-, SD+)

Although the context provided by the scenarios would have been wanting, respondents who were operating in this quadrant were able to apply the principles of PBL.

One of the respondents explained that she had applied the principles of PBL when adopting a flipped classroom approach to her teaching, which proved to be useful in transitioning from teacher-centred to student-centred approaches. She added that in the past she simply "delivered the content" and that there was little interaction between herself and the students:

> Previously, I would do most of the teaching and try to control students but now I am able to better manage the class and give students an opportunity to explore. I incorporate research activities in the teaching and learning and give students research assignments.

4.2.2 Weakening SG and SD during the application of PBL (SG-, SD-)

A respondent (from the Faculty of Informatics and Design) indicated that when she tried to implement PBL she found it challenging. She explained that she had given her students a scenario and tried to facilitate learning using PBL principles:

> I immediately tried to implement it in my teaching and learning but I really struggled with it…it's difficult. We were just copying you…its hard with PBL…you come from the students' perspective.

She explained further that PBL is difficult to apply in large classes with 120 students: "Some students sit at the back and don't want to participate. They want notes to learn from and there is resistance when you ask them to explore for themselves."

Another respondent was of the opinion that PBL would work best at the Bachelor of Technology level. Students could start with case-based learning and traditional methods of teaching and learning at the first- and second-year levels, and later apply that knowledge at the (final) fourth year of study. She also felt that she needed more training in PBL in order to be able to implement it effectively.

Some lecturers, who had worked in the industry sector prior to joining the university, had capitalised on their workplace knowledge to develop case studies, while other lecturers, who lacked industry experience in their field, found it challenging to develop case studies.

In this category, respondents were neither able to design real-life scenarios to contextualise knowledge (which would have weakened SG), nor were they able to apply the hallmarks of PBL such as problem solving (which would have weakened SD).

4.2.3 Strengthening SD and SG during the implementation of PBL (SD+, SG+)

One respondent explained how he had linked the medical problem adopted during the training, to his discipline (which is business). He reported: "I looked at the problem in business. In marketing it is all about problem solving and I came up with a potential problem…all fields have problems…PBL can be applied in any field." When it came to acquiring the necessary facilitation of learning techniques he reported: "I learnt from you…I learnt how to facilitate PBL from you. You didn't just give us the answers…I approached it the same way". He stated that he employed small group discussions to promote engagement with a case study related to a coffee shop that was losing customers. Students were required to generate hypotheses as to the cause of this problem. His students' perceptions of PBL were positive and they "loved PBL".

Another respondent from the Business Faculty (Tourism and Events) explained that she drew on her experience of travelling to develop scenarios for the implementation of PBL. By way of illustration, she provided an example of a scenario of a couple who were on a cruise and experienced a problem that had to be addressed. Her experience with PBL was positive, as could be gleaned from this comment: "I enjoyed PBL. It forces students to think critically and to have a problem-solving thought pattern; to think what is happening in real life."

A respondent from the Engineering Faculty, who taught Electrical Engineering, developed programming problems, which he had presented to students, cold (that is, they had not seen the problem before). He commented that he would identify components of a problem, such as capture records, new records, sort captured records and calculate averages. In general, although he felt he could apply PBL effectively, he sometimes noticed that only one student would be working whilst the others simply looked on.

One of the respondents indicated that it was possible to address the language barrier within a PBL environment. That is, in the PBL groups the use of the students' mother-tongue and not English, was evident. English was not the mother-tongue of the majority of students, as can be established from her explication: "Most students (70%) speak Xhosa; only 5–10% are bilingual and speak English and Afrikaans while the others speak Venda." By being given the opportunity to speak in their mother-tongue, she observed that: "students understand better and the commonality helps them".

The aforementioned respondents were able to strengthen SG by providing real-life scenarios and expecting their students to generate hypotheses as to the cause of the problem and coming up with learning issues. Thus, these respondents were successful in strengthening the SD of the PBL process. Hence, the hallmarks of PBL, such as critical thinking and problem-solving, were attended to.

4.2.4 Implementing PBL by weakening SD and strengthening SG (SD−/SG+)

One of the respondents from the Faculty of Business explained how, as a chef, she was able to apply everyday life experiences in her teaching. For example, her students were given two ingredients and asked to prepare a dish of the day for two people. She then assessed them on food handling procedures, consistency, taste and the texture of the dish.

This pedagogical method demonstrates a strong context (SG+) but weak SD (SD-) in terms of applying the principles of PBL. That is, scenarios, the generation of hypotheses and the derivation of learning issues, were absent.

The respondent positioned in this quadrant applied everyday life experiences in her teaching without aligning them with the principles and methods of PBL. Therefore, in terms of the implementation of PBL, the context was strong (SG+) while SD was weak (SD-).

5. DISCUSSION

This section is concerned with discussing the analysis of PBL training as well as the experiences of respondents regarding the implementation of PBL within their own pedagogical practice.

5.1 Analysis of PBL training using semantics

Within a PBL environment that is established around the medical model, the context is not drawn from everyday life experiences (SG-, SD-, prosaic code), but is located within the medical field (thus, it is more complex) and allows for the addressing of clinical reasoning skills or problem-solving skills that are paramount for a doctor in training. Context, which is related to the profession, is laden with condensed meaning and is used as a vehicle to make semantically dense knowledge more relevant and understandable.

During the PBL process, one needs to ascend the semantic scale towards greater abstraction (SD+) as well as descend towards greater contextualisation (SG+) in order to make a differential diagnosis and effect a treatment plan. If this is not addressed, one could risk operating on a low flat line, which is undesirable. By asking probing questions, and not simply covering content knowledge on a superficial level, the PBL facilitator can avoid a low flat line. It is advisable to handle complex information with condensed meaning (SD+) within a context-rich (SG+) environment so that the semantic range can be expanded. When designing case studies, the expansion of the semantic range can be achieved by providing sufficient cognitive complexity to enable students to engage with the knowledge at an abstract level. The semantic ranges will differ across various disciplines. This should be considered when planning and executing PBL.

5.2 Respondents' experiences of implementing PBL within own teaching

It became apparent that it was not feasible to provide a crash course in PBL and then expect candidates to apply it; further support was needed, as was alluded to by the respondents. In the Creedy and Hand (1994: 696) report, a seven-month professional development programme focused on introducing pedagogical transformation associated with the adoption of PBL. Coffin's (2013:208) study found that at least a year of staff development is required. Furthermore, a recommendation was made that PBL should not be regarded as an "add-on teaching approach" (Coffin, 2013:208).

Respondents in this study also felt that they needed buy-in from their line managers and other colleagues, and that it was not viable to implement PBL by themselves; the entire department or faculty needed to shift to PBL. Coffin (2013: 208) suggests that in order for PBL to be successfully implemented, formal support from executive managers is necessary from the outset.

Another drawback was the challenge faced by academics from other (non-medical) disciplines with respect to applying PBL within their respective contexts because PBL was presented to them from the perspective of the medical model. This researcher adopted the medical model, and therefore, it was contextualised within the medical field; as a result, some respondents from non-medical disciplines had difficulty understanding and applying PBL to

their disciplines. In addition, the contextualisation of knowledge within the medical field was too complex for most respondents from other disciplines to understand and transfer. Thus, although the medical model of PBL was contextualised within the field of medicine, it was actually decontextualised for other disciplines. Some respondents found this decontextualised knowledge difficult to apply and therefore, were unable to implement PBL in its pure form.

This researcher needed to have strengthened the SD of PBL which would have given respondents the necessary PBL principles for application within their own disciplines. This researcher did not possess knowledge of the context of other disciplines and assumed that by adopting the context of the medical field (with which she was more familiar) she was providing the (PBL) context for other disciplines. However, the PBL principles were not easily transferable and only some of the respondents managed to achieve the desired application of the PBL principles within their disciplinary contexts. Nevertheless, the hallmarks of PBL, such as the facilitation of learning and the promotion of self-directed learning were what respondents grasped from the training.

During the training, this researcher focused more on the implementation of PBL in terms of facilitating PBL tutorials (SG+) and understanding the principles of facilitation (SD+), than on case study design, which would have strengthened SD. This resulted in respondents struggling to design PBL case studies, as it was deemed to be too rigorous and sophisticated. Instead, they designed short case studies, which were used as tools to enhance active learning. Nevertheless, many respondents indicated that they were able to apply the facilitation techniques within their own teaching (whether they were adopting PBL or not).

The PBL facilitation techniques that they were exposed to during the training had an influence on the respondents' pedagogical styles. They shifted from traditional, didactic methods of teaching to student-centred, participatory learning that embraced authentic learning. Adjusting to the conceptual changes associated with the implementation of PBL has been explored by Creedy and Hand (1994:698–701). They discovered that by experimenting with new approaches to teaching and learning, receiving feedback, reflecting on practice and improving their skills, trainees were able to gain more confidence as they transitioned from teacher-centred instruction towards student-centred facilitation in an attempt to promote active learning. Lim and Choy (2014: 62) found that when it came to the facilitation of learning, participants were satisfied that they were able to incorporate more collaborative learning strategies, apply listening and questioning techniques and promote participation for active learning among students.

Arguably, those respondents who had prior experience in implementing case studies in their teaching might have found it easier to apply PBL than those who did not normally use case studies. Therefore, even though she operated predominantly from a low flat line (SG+, SD-) and did not make sufficient semantic waves with respect to PBL case study design, the respondents were still able to apply the knowledge gained during the PBL training.

Another aspect of PBL transfer had to do with the fact that the respondents were implementing PBL within their own (single) discipline, as opposed to the manner in which PBL was presented to them (as multi-disciplinary). Multi-disciplinary contexts did not necessarily exist in their faculties, which made it challenging to implement PBL. In offering an explanation as to why PBL implementation can be so difficult, Bouhuijs (2011:19) refers to a culture clash of professionalism. Within academia professionals usually work individually and independently within their respective fields and with little collaboration across disciplines. This is at odds

with the culture of PBL, which crosses disciplines and calls for an integrated curriculum that demands teamwork and cooperation amongst university teachers.

Consequently, when strengthening SD during PBL training it is important to do so within a discipline-specific context, if that is the manner in which it will be applied by the recipients of the training. This argument corroborates other findings. For example, Macdonald and Isaacs (2001: 315) describe PBL implementation within a single course, which was successful in helping students engage in problems relevant to their profession. Referring to the application of PBL at departmental level, Raine and Symons (2005:73–74) describe how PBL has been successfully incorporated into undergraduate Physics teaching, using various modes of implementation that involved the entire programme or aspects thereof, as well as the entire module or parts of the module .

Perrenet, Bouhuijs and Smits (2000: 356–357) undertook a comparison between PBL implementation in medical education (following the Maastricht model) and PBL application in Engineering education, with a specific focus on the feasibility of teaching Mathematics and Physics. They conclude that the hierarchical nature of Mathematics would render it difficult to be administered through a PBL route that does not follow a particular sequence of meaning or knowledge creation. Separate direct instruction and supervised practise, which involves teacher-guided discussions, problem-solving tutorials and structured group work, are required. A further limitation of the application of the medical model of PBL within Engineering Education is the emphasis on short cycle problem analysis and problem-solving, which does not adequately address the nature of the professional work of engineers. In this regard, Ramsden (1991:159–184) warns that teachers in scientific and professional fields would tend to lean more towards didactic teaching methods than student-centred teaching and learning approaches. Lahtinen (2005:93), on the other hand, gives an account of the successful implementation of PBL within Engineering Education, which is described as “very challenging but rewarding…” This success is attributed to the contextualisation of knowledge drawn from everyday life experiences and the conceptualisation of knowledge based on theory.

During the PBL training this researcher operated too heavily from the Rarefied code (SD-, SG-). The SG was weak because she used a medical context that might not have been relevant to the respondents’ disciplines. The SD was also weak since she did not focus on the discussion of PBL principles, that is, condensed meaning. In future, this researcher will need to shift towards the Worldly code in the bottom right quadrant (SG+, SD+) by offering further training in PBL related to the development and implementation of PBL case studies and the discussion of PBL principles. Hung *et al.* (2008: 497) lament that research pertaining to PBL problem design is wanting, especially when it comes to problems across disciplines. The problem is exacerbated when individual teachers have to independently design PBL case studies without resources and support (Angeli, 2002). The aforementioned limitations concerning PBL case study design could provide an avenue for future research.

6. CONCLUSION

This article focused on analysing PBL training of academics within a TDP and through the framework of semantics. It was reported that the medical model was applied during the training, which allowed for the creation of semantic waves within the context of that model. In general, however, the training might have been over-contextualised for the medical field as it did not address the generation of abstract principles for the application of PBL within other

discipline-specific contexts. To a large extent, the findings demonstrated that respondents found it challenging to implement PBL in its pure (medical model) form and needed to adapt it (PBL) to meet the unique characteristics of their discipline. Therefore, it is important to consider the diverse disciplinary backgrounds of participants when it comes to PBL training.

It is this researcher's recommendation that these principles be addressed when training academics from multiple disciplines so that the transfer of knowledge in PBL is possible within their respective disciplines. A limitation of this study is that it focused on the training of academics at one institution. The involvement of academics at additional institutions might also be useful. Future studies could involve peer observation of teaching to analyse respondents' capability to address semantic wave construction when applying PBL within their discipline, that is, the weakening and strengthening of SD and SG using PBL case studies. There should be a balance between SG-, SD+ and SD-, SG+, that is, an avoidance of too much context at the expense of conceptual understanding and/or an over emphasis on abstract knowledge with a limited focus on contextual understanding.

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