Research
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STRATEGIES TO INCREASE CLINICAL REASONING AND CRITICAL THINKING IN PHYSIOTHERAPY EDUCATION

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ABSTRACT *Physiotherapists require clinical reasoning and critical thinking skills in order to perform as effective, first-line practitioners. Concept maps were incorporated into an existing hybrid-PBL module in a Physiotherapy curriculum to address these skills. The aim of this study was to identify whether a change in the third year PBL feedback sessions would have an impact on the critical thinking / clinical reasoning skills of undergraduate students before they enter the final (4th) year clinical rotation.*

In this cross-sectional descriptive study the clinical reasoning / diagnostic thinking skills of two fourth year cohorts of students were compared pre and post intervention. The Diagnostic Thinking Inventory (DTI) and Self-Assessment Clinical Reflection and Reasoning (SACRR) instruments were used.

This cohort of students scored high on both measurement instruments both pre and post-implementation. While there were no differences in composite score between the groups, individual items on the SACRR had a tendency to differ. No statistical difference in pre and post-scores was observed.

The findings of this study have highlighted the need for investigation into the implementation of these strategies as well as the method of application. Comparison to similar cohorts in other South African universities could further highlight methods for improving strategies to enhance clinical reasoning and critical thinking.

KEY WORDS*: CRITICAL THINKING, PHYSIO-THERAPY EDUCATION, PROBLEM-BASED LEARNING*

BACKGROUND

Clinical reasoning (CR) is the cornerstone of an effective health professions practice but presents both educators and students with challenges during training (Charlin, Lubarsky, Millette, Crevier, Audet, Charbonneau, Fon, Hoff & Bourdy, 2012; Jones, 1997). In the context of Physiotherapy, CR is the process whereby physiotherapists gather and evaluate patient information, accurately assign a physiotherapy diagnosis and develop and implement a physiotherapy management plan in order to improve patient outcome (Eva, 2004). Embedded in the CR process is the diagnostic process (Eva, 2004) which requires critical thinking (CT) skills from health professionals (Rochmawati & Wiechula, 2010). Critical thinking is the ability of a clinician to analyse complex data and situations in order to implement appropriate strategies or actions and is necessary for effective problem solving and decision making in the clinical arena (Athari, Sharif, Nasr & Nematbakhsh, 2012). This diagnostic process requires health professionals to recognize relevant information. This relevant information is the key to unlocking the clinician's memory structure, which is not merely a list of signs and symptoms, but rather a network of knowledge and associations which have developed over time (Bordage, Grant & Marsden, 1990). The development of these skills is one of the driving forces behind the choice of educational strategies for the Division of Physiotherapy at Stellenbosch University (SU). As part of a curriculum change in 2007, one of the new educational strategies used was a Problem Based Learning (PBL) approach to teaching and learning for third year students in the Physiotherapy programme at SU.

Within health professions education (HPE), a variety of educational strategies, including PBL, have been proposed to develop clinical reasoning and critical thinking skills of undergraduate students (Rochmawati & Wiechula, 2010). PBL is defined as "an instructional (and curricular) learner-centred approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery, 2006). This strategy has been reported to provide benefits to professionals in the social and cognitive dimensions after graduation (Koh, Khoo, Wong & Koh, 2008). The four competencies which presented with the strongest evidence of benefit when comparing PBL to lecture based curricula include: coping with uncertainty; appreciation of legal and ethical aspects of health care; communication skills and self-directed continuing learning. The authors, along with their colleagues within the Division of Physiotherapy at SU questioned these benefits 3 years after implementation based on their students' performance and participation in the PBL process. These concerns were supported by research where, due to an often poor methodological quality of studies as well as the lack of clearly defined outcomes (Polyzois,

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Claffey & Mattheos, 2010) the value of this educational strategy is increasingly being questioned (Hartling, Spooner, Tjosvold & Oswald, 2010).

A decision was taken at programme level to attempt to address the anecdotal evidence of poor CT and CR skills through additional educational interventions. Concept mapping was selected as a method that could potentially aid in this attempt. Concept mapping as a strategy aims to serve as a means of developing CT (Novak & Canas, 2006). When creating concept maps, students develop concepts and identify relationships (of hierarchical nature) between those concepts. This method has been advocated to assist students in bridging the gap between theory and clinical practice (McMillan, 2010). Through the development of concept maps the identification of new knowledge is facilitated. In addition students are provided the opportunity to understand this knowledge as well as integrate this new knowledge into individual existing knowledge bases (Senita, 2008). There is evidence to support the use of concept maps to promote meaningful learning, to guide student feedback, as a resource for learning and as an assessment strategy in HPE (Daley, 2010).

The Physiotherapy Division at SU made the decision to integrate concept maps, based on the evidence of its' benefits, into the PBL module which forms part of the mixed-method four-year undergraduate curriculum. The curriculum includes lecture based modules (presented over four years of study), as well as a problem based module presented in the 3rd year of study. The stated aim of the PBL module, Applied Physiotherapy (APT), was to provide students the opportunity to integrate and expand the knowledge, concepts and skills acquired in Physiotherapy Science (year I and II) with the pathology, social context of a patient and different levels/ structures of heath care. This integration was regarded as a building block in the CR process.

While there is limited evidence of the success of PBL as an individual strategy in improving CR (Coker, 2010), it is not clear whether a combination of these two strategies could result in further improvements in this skill (Daley, 2010). It was considered necessary by the authors to provide data to the Division on the effectiveness of the newly integrated strategies employed to improve the CR and CT skills of undergraduate students. This study aimed to inform both the divisional process related to curricular design in its aim to deliver first-contact practitioners to the profession proficient in CR and CT. We also intended to contribute to the wider understanding of the value of concept maps in fostering the CR & CT skills of undergraduate physiotherapy students. We set out to determine whether the addition of a collaborative concept map to a hybrid PBL feedback session would impact on the CR and CT ability of undergraduate students before they enter the final year clinical rotation.

	Group A (PBL cohort)	Group B (Concept map cohort)
Learning material	The group scribe was responsible for collating the learning material in preparation of the feedback session	A concept map was developed by the group during the feedback session. The group scribe was required to finalize the concept map after the feedback session.
Learning outcomes	Students were allocated a single learning outcome during the case introduction Information was prepared individually and submitted to the scribe	All students gathered the relevant information pertaining to each of the learning outcomes which were formulated during the case introduction.
Feedback session format	Each student presented the information related to the specific learning outcome for which they were responsible to the rest of the group	Students participated in a discussion of their findings with the rest of the group.

Table 1: Comparison of PBL sessions in cohort A and B

METHODS

This study received ethical clearance from the Human Research Ethics Committee (SU) prior to commencement (N11/01/019). We used a cross sectional study design with students registered for the BSc Physiotherapy degree at SU who had successfully completed the APT III module in 2010 or 2011. Students were excluded if they repeated the APT III module in 2010 or 2011 or did not provide informed consent.

The students completed the Diagnostic Thinking Inventory (DTI) which has been validated in physiotherapy populations (Jones, 1997) as a measure of CT skills. The DTI consists of 41 questions divided into two sub-scales measuring 1) Flexibility in thinking and 2) Structure of memory (Bordage, et al., 1990). Flexibility in thinking is the ability to include both deterministic and responsive modes of enquiry during the clinical interview. Structure of memory refers to a network of knowledge which is held together by abstract relationships and not a general list of medical information.

To determine the students' CR skills, the Self-Assessment of Clinical Reflection and Reasoning (SACRR) instrument was used. The SACRR instrument was developed specifically for physiotherapy and occupational therapy students and clinicians (Royeen, Mu, Barrett, & Luebben, 2001). The 26 items included in this instrument are based on Roth's (Roth, 1989) hierarchy of the reflective process and addresses various aspects of the CR and reflection process (Dasari, 2006).

A third data collection instrument, a specifically designed datasheet was developed to ensure comparability of the two student cohorts and included matriculation year; year of first entry to program and tertiary courses completed.

STUDY CONTEXT:

The APT module is structured so that students are presented with various cases/ problems relative to clinical situations and building on subject matter learnt in their previous two years of study. The Seven-Jump Process (Schmidt & Moust, 1998) was used within the small groups of approximately 10 students to formulate learning outcomes in the first of three sessions for each of the 45 cases. Their research and discussion from session one, under the guidance of a facilitator (staff member) guides the activity

in the second session. The APT module is considered to follow a hybrid-PBL format as it includes a practical technique practice session. In this session, the students practice the assessment and treatment techniques as determined by their brainstorming and outcomes as being relevant to the case. The third and final session was the feedback session.

This study investigated the alteration of the feedback session to include concept maps for Group B. Differences and similarities between the two groups PBL feedback sessions are presented in Table 1.

DATA COLLECTION

Data was collected during the preclinical module rotation at the start of the final year. Students completed each questionnaire separately. The researchers explained the process to the participants and any questions from students were answered. Data sheets were coded and entered into a specifically designed spread sheet by the research assistant and checked for reliability by the researchers.

STATISTICAL ANALYSIS

Data were analysed in consultation with a statistician. For categorical variables (gender, race and time after graduation) we used the X2 or Fisher Exact test (as indicated). The assumption of homogeneity of variance was tested using Levene's Test of Equality of Variances. We used the Student t test, ANOVA, or repeated measures ANOVA to compare the cohorts (age, DTI scores SACRR domains). Significant differences between cohorts are reported at the alpha level of 0.05. All reported P values are two-sided. In addition we calculated the effect size (Cohen's d) and interpreted the values as 0.2 =small; 0.5 = medium and 0.8 = large. We accepted a d=0.25 as indicating a positive trend in the data and could therefore be potentially significant for educational strategy decisions (Wilkinson, 1999).

RESULTS

Participants

Thirty eight (38) students were registered for the APT III module in 2010 and 40 students in 2011. A small sample of 14 (37%) students from the 2010 cohort (PBL) and 24 (60%) from the 2011 cohort, (combined PBL/concept map) agreed to participate in this study. The majority of students were female and only five (6%) of the participants classified themselves as mixed race which is indicative of the full student cohort. Four students had completed a tertiary qualification prior to registering for the BSc Physiotherapy degree. There was no difference in the student profile when compared at baseline (Table 2).

	2010 Cohort n=14 (37%)	2011 Cohort n=24 (60%)	P=
Age Years	21.64 +- 1.01	21.75 +- 1.67	0.83
Gender Male n (%)	1 (7%)	4 (17%)	0.38
Race White n (%)	12 (86%)	21 (88%)	0.88
Period of more than 2 years between matriculation and first year registration n (%)	5 (36%)	9 (38%)	0.91

Table 2: Comparison of student profile at baseline

CRITICAL THINKING

There was a difference in the aggregate DTI score and in the structure of memory subscales of the 2010 (PBL) cohort when compared to the combined PBL/concept map cohort. A medium effect size (d=0.5) was observed in the structure of memory subscale, and a small effect size (d=0.36) was observed in the aggregate DTI score. However, these differences did not reach statistical significance in this sample. Whether the observed differences were just by chance would need to be confirmed in a larger sample.

The combined SU cohort scored higher in both subscales as well as in the overall DTI score than physiotherapy students who participated in an earlier study used to validate this tool (Jones, 1997). The observed difference reached statistical significance (p=0.004) in the structure of memory subscale (Table 3).

CLINICAL REASONING

There was no statistical difference in the students' perceptions of their CR abilities (Table 4). Negligible effect sizes were observed in the aggregate score (d=0.14), knowledge and theory application (d=0.02) and dealing with uncertainty domains (d=0.07). The results showed a trend toward favouring the PBL cohort in the self-reflection and reasoning domain (d=0.36).

DISCUSSION

This study investigated the addition of a collaborative concept map to hybrid PBL feedback sessions in order to measure the impact on students' CR and CT scores. Though students scored highly on both instruments compared to reference values (Coker, 2010; Jones, 1997), the educational intervention initiated by the Division of Physiotherapy at SU did not result in a statistically significant increase in these scores. The expectation of the Division that concept mapping would enhance CR and CT was based on findings from literature indicating that these educational strategies could have these benefits (McMillan, 2010; Senita 2008). However, one of the factors not taken into consideration by the Division and the authors was the negative impact on learning that changing learning strategies could have on students in its initial implementation phase (Novak, 2010). The study cohort were faced with a new educational strategy in their third year through the introduction of PBL to their

	SU cohort n=37	Jones Cohort n=48	P=
Flexibility in thinking Mean SD	84.05 SD 9.33	81.5 SD 9.65	0.22
95%CI	80.94 – 87.0	78.77 – 84.23	
Structure of memory Mean SD	81.76 SD 8.81	75.58 SD 9.96	0.004
95%CI	78.82 – 84.69	72.76 – 78 40	
Total DTI Mean SD	161.45 SD 31.31	157.15 SD 17.53	0.42
95%CI	151.49 – 171.41	152.19 – 162.11	

Table 3: DTI scores of Stellenbosch University Cohort and Jones et al cohort

	PBL Cohort N=13	PBL/concept map Cohort N=24	P=	Effect size Cohen's d	95%CI of d
Knowledge and theory application (Mean SD) TOTAL 25	16.00 ±1.95	16.04 ±1.98	0.92	0.02	
Decision making based on experience and evidence (Mean SD) TOTAL 50	36.75 ± 3.25	37.5 ± 3.95	0.61	0.2	-1.37 – 1.91
Dealing with uncertainty (Mean SD) TOTAL 35	24.62 ± 3.60	24.36 ± 3.35	0.82	0.07	
Self reflection and reasoning (Mean SD) TOTAL 20	15.15 ± 2.23	14.58 ±1.82	0.34	0.3	-0.87 – 1.02
TOTAL SCORE TOTAL 130	91.00 ± 7.51	92.36 ± 8.95	0.65	0.2	-3.42 – 4.10

Table 4: SACRR scores of Stellenbosch Cohort

programme which could potentially have had a negative impact on their ability to make the adjustment from didactic learning to self-directed reasoning and engagement with learning material as required by the APT module (Keiller & Louw; 2013). Over time, it could be reasonable to assume that refinement of the method of implementation and preparation of students for these changes could have a positive influence on the aforementioned skills (Novak, 2010).

Our findings suggest that participation in PBL feedback sessions could have a positive educational effect on the self -reflection and reasoning domains of the SACRR as well as the aggregate DTI score when compared to participation in the combined PBL/concept feedback sessions. The improvement in the aggregate DTI score was largely due to improvements in the structure of memory subscales. The structure of memory subscale reflects the development of a knowledge network, through linking of concepts rather than a mere repeat of basic knowledge. While this finding was encouraging and in line with the stated aim of the module it was surprising that students who participated in the combined PBL/concept map feedback session scored lower in this subscale. The notion that the addition of concept maps could have a negative impact on skill development is not supported by literature (Chabeli, 2010). We hypothesise that the PBL cohort scored higher on the afore mentioned domains compared to the PBL/ Concept Map cohort due to the change in the method by which information was collected for each case. This hypothesis is supported by evidence that concept maps have a greater impact when there are differences in the knowledge base of participants (Chabeli, 2010). The question has now been raised as to whether the ability of students to fully engage with and understand the content of each case is negatively impacted by asking students to each complete all outcomes for the case. It seems as if greater collaborative learning could occur when students are allowed to research a single outcome in depth. This is in keeping with evidence from other active, collaborative learning strategies in HPE such as Team-Based Learning (Haidet, Levine, Parmelee, Crow, Kennedy, Kelly, Perkowski, Michaelsen & Richards, 2012). The collaborative nature of these strategies lend themselves toward fostering complex reasoning (Haidet, et.al., 2012) which is needed for CR and CT. The Physiotherapy Division will need to investigate if the collaborative outcome research method of their PBL module might be more conducive to enhancing these skills.

Our findings must be interpreted with caution due to the small sample size and the fact that this investigation did not compare the results to similar local cohorts. The reluctance of students to participate in this study could be related to the rigorous evaluation of the revised curriculum implementation process. The revised curriculum was phased in over three years. The 2011 cohort was the first cohort of students who completed the entire revised curriculum. While it is important to obtain feedback during curriculum implementation, decisions related to which data to collect is important and should be made with care.

The data presented in this paper could be used to inform future studies. Often, within the HPE research environment, methodological issues limit the rigour and reliability of findings (Polyzois, et.al. 2010). The potential effect size could inform sample size calculations which will ensure sufficiently powered studies. This will enable researchers to collaborate across programs to ensure sufficient participant recruitment (Haung, Chen, Yeh, Chung, 2012). The potential value of a mixed methods approach to data collection in the investigation of educational strategies is also highlighted in this paper. While concept maps have been shown to accelerate the process of acquiring CR skill (Haung, et.al. 2012) this could not be confirmed in this study. Qualitative data could have contributed to our understanding of the reason for this finding within this cohort.

The findings of this study have led to recommendations for future practice within the Division of Physiotherapy. Further investigation into the method of achieving case outcomes is needed. It is also recommend that research should be conducted to determine if the achieved scores for CT and CR among this student cohort is a phenomenon that is evident in other local universities with similar programs.

CONCLUSIONS

PBL and Concept mapping as an educational strategy are reported to have benefits for CR and CT in literature. This was not statistically evident in this study. However, the findings have highlighted the need for investigation into the implementation of these strategies as well as the method of application. Comparison to similar cohorts in other South African universities could further highlight methods for improving strategies to enhance CR and CT.

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