Attitudes to concept maps as a teaching/learning activity in undergraduate health professional education: influence of preferred learning style

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SUMMARY *Concept maps that integrate and relate concepts in a non-linear fashion are widely accepted as an educational tool that can underpin meaningful learning in medical education. However, student take-up may be affected by a number of cognitive and non-cognitive influences. In the present study, student attitudes to pre-prepared concept maps introduced in Stage 2 conjoint MPharm and BSc Pharmacology lectures were examined in relation to preferred learning styles according to the Felder-Silverman model.*

There was no statistically significant influence of dichotomous learning style dimension (sensing/intuitive; visual/verbal; active/reflector; sequential/global) on the self-reported utility of such concept maps to learning. However, when strength of preference was analysed within each dimension, moderate/strong verbal learners were found significantly less likely to self-report concept maps as useful relative to mild verbal learners. With this important exception, these data now suggest that student attitudes to concept maps are broadly not influenced by preferred learning styles and furthermore highlight the potential of concept maps to address a variety of different learning styles and thereby facilitate 'teaching to all types'. Concept maps could therefore potentially assist motivation, engagement and deep learning in medical and biomedical science education when used as a supplement to more traditional teaching/learning activities.

INTRODUCTION

Concept maps constitute a flexible learning device (Novak, 1979) that have been developed to support meaningful learning, especially within medical education (Watson, 1989; Gaines, 1996; Pinto & Zeitz, 1997; Novak, 1990; Southern *et al.*, 1998; Wilkes *et al.*, 1999), by presenting information in a visual format using hierarchical tree-like branching structures (Watson, 1989; Southern *et al.*, 1998; Buzan & Buzan, 2000). Since an entire lecture topic, unit, course or even curriculum can be treated in this format, the holistic relatedness of ideas can readily be illustrated. Furthermore, the use of concept maps in large class teaching represents varied instruction that might be expected to enrich lectures, inspire interest and attention and promote receptivity and cooperation (Biggs, 1999a; Buzan & Buzan, 2000).

Recent reports examining student attitudes to concept maps have indicated important non-cognitive influences such as academic workload, motivation and contextual institutional issues (Santhanam *et al.*, 1998; Farrand *et al.*, 2002) but less information is available concerning the impact of preferred learning styles or approaches to learning. Indeed, learning style is an important student diagnostic target that has prognostic implications for student engagement and motivation to learn (Martinez-Pons, 2001). Hence, with regard to Keller's attention-relevance-confidence-satisfaction (ARCS) model of motivation, accommodating various learning styles using a variety of teaching/learning activities can be expected to ensure relevance to the individual learner by facilitating ownership of and thereby engagement with learning content (Keller, 1987). Preferred learning styles or those combinations of learning style dimensions that a student will seek to apply in a subject- or task-dependent fashion (see Felder & Silverman, 1988) therefore represent a key component of a student's motivational profile which will inform the design of a relevant motivational teaching/learning strategy and shape receptivity to it.

Cognitive information-processing theories of learning styles (see Martinez-Pons, 2001), such as the Felder-Silverman model of dichotomous learning dimensions (Felder & Silverman, 1988), are concerned with how students preferentially perceive (sensing or intuitive), take in (visual or verbal), organise (inductive or deductive) and process (active or reflective) information and in addition how they progress to understanding (sequential or global). Each student will have characteristic strengths and weaknesses in learning styles that can readily be assessed by an instrument such as the Felder-Soloman ILS questionnaire, itself derived from the Felder-Silverman model. In this respect, tertiary science education has been generally criticised for its biased appeal to certain learning styles and large neglect of others (Felder, 1993). Specifically, science education mainly addresses: the intuitive learning dimension by presenting concepts and interpretations rather than beginning with facts and observations (the sensing learning dimension); the verbal learning dimension by traditionally delivering content orally in lectures and in structured written notes rather than providing visual learning clues in the form of pictures, diagrams, flow charts, time lines, films and demonstrations (the visual dimension); the deductive dimension by espousing principles and applications rather than presenting individual cases and inviting inference (the inductive dimension); and the sequential dimension by presenting course content linearly and often in a modular fashion rather than holistically and relationally (the global dimension) (see Felder, 1993).

The primary aim of this study was therefore to examine student attitudes to concept maps introduced as a learning resource (see Beattie & James, 1997) in large class undergraduate pharmacology lectures in relation to preferred learning style and to subsequently evaluate their facility for 'teaching to all types'. In addition, the relationship between student receptivity to concept maps and student approaches to learning was also of interest.

METHODS

Preparation and use of concept maps

Concept maps were prepared by the author according to the general principles outlined by Buzan & Buzan (2000) on the subject of renal physiology and pharmacology and provided as handouts to MPharm and BSc Pharmacology undergraduates during Stage 2 large class renal pharmacology lectures. In class reference to concept maps was integrated with more traditional content delivery.

Influence of preferred learning styles

Preferred learning style was anonymously assessed with the use of the 44-item Felder-Soloman ILS questionnaire based on the Felder-Silverman learning dimension model (Felder & Silverman, 1988). This model was developed within the context of engineering science and has been favourably evaluated by Multimedia Educational Resource for Learning and Online Teaching (MERLOT). In addition, students indicated on the questionnaire whether they considered lecturer-pre-prepared concept maps to be useful to their learning and were also able to add comments in an open format feature.

Influence of learning approach

In a preliminary study, learning approach was anonymously assessed with the use of the 30 item RASI by Duff *et al*. (1997). This instrument scores for three different learning approaches: deep, strategic and surface (Duff *et al.*, 1997). In addition, students indicated on the inventory whether they considered lecturer-pre-prepared concept maps to be useful to their learning.

Statistical analysis

Data are presented as mean ± standard deviation unless otherwise stated. Tests of a single proportion were based on the Normal distribution while non-parametric techniques were used in the analysis of qualitative categorical data including tests of association using the 2*2 contingency table (Fisher's exact test) and a multicomparison of medians from related samples (Friedman test) (Sprent, 1993; Carvounis, 2000; Petrie & Sabin, 2000).

RESULTS

Influence of preferred learning styles

In a sample of 89 Stage 2 MPharm and BSc Pharmacology students, there was approximately the same number of active and reflective learners while preferred sensing, visual and sequential learners outnumbered intuitive, verbal and global learners, respectively (Figure 1). A statistically significant majority (63.0 ± 5.0 %) reported pre-prepared concept maps to be useful to their learning ($P < 0.02$, test of single proportion different from 0.5).

There was no statistically significant association between the self-reported usefulness of concept maps and any of the investigated preferred learning style dimensions, i.e. sensing vs intuitive, visual vs verbal, active vs reflective, sequential vs global identified by the Felder-Soloman ILS questionnaire (Tables 1-4). However, after performing an analysis examining an association based on the strengths of preference within particular learning dimensions, it was determined that moderate/strong verbal learners were approximately 5-fold less likely to report concept maps useful than mild verbal learners ($P < 0.05$, Fisher's exact test) (Table 5). No such statistically significant associations were found when strength of preference was analysed within the other learning dimensions.

Influence of learning approach

Consistent with the preceding study examining the influence of preferred learning styles, a comparable majority of students (60.0 ± 8.0 %, n=40) indicated that they found concept maps useful. However, in this small-scale study investigating learning approach, statistical significance was not attained ($P > 0.05$, test of single proportion different from 0.5, n=40). The median RASI scores for deep, strategic and surface learning approach were 2.60, 2.65

and 2.60, respectively (P> 0.05, Friedman test, n=40). Similarly, there was no statistically significant difference between median RASI scores within sample populations reporting concept maps to be useful or otherwise (P> 0.05, Friedman test, n=24 (useful), n=16 (not useful)).

To simplify qualitative analysis, individual responses to the RASI were categorically ranked according to ‘preferred’ learning approach (deep vs non-deep approach, i.e. strategic or surface approach) (see Table 6), based on their highest RASI score. Two individuals with equally ranked scores were excluded. Using this analysis, 60.6±7.9 % of students scored highest for a non-deep learning approach (P>0.05, test for single proportion different from 0.67, n=38). On inspection of these data, it was apparent that 73.3±11.4 % of students with their highest score corresponding to a deep learning approach reported concept maps to be useful (n=15) compared with 47.8±10.4 % of students with a preferred non-deep learning approach (n=23). However, a statistically significant association between this simplified interpretation of the RASI and the reported usefulness of concept maps was not attained (P= 0.18, Fisher’s exact test, n= 38) (see Table 6).

DISCUSSION

Pre-prepared concept maps introduced as a teaching/learning activity in large classes were self-reported to be useful to learning by a significant majority of Stage 2 MPharm and BSc Pharmacology undergraduates with only approximately 37 % reporting otherwise. Interestingly, this in fact echoes the result of a previous study addressing science student attitudes to the adoption of concept mapping where approximately 30 % reported that this technique was 'not helpful in any way' (Santhanam *et al.*, 1998). Furthermore, in the present study, self-reported usefulness was essentially independent of the dichotomous learning style dimensions of the Felder-Silverman model as assessed by the Felder-Soloman ILS questionnaire, with the important exception of a minority moderate/strong verbal learning style. This notwithstanding, pre-prepared concept maps appealed broadly to a variety of preferred learning styles, especially when considered as an adjunct to more structured disseminated lecture notes where, according to written student feedback, concept maps were anticipated to be good revision aids even amongst those students ostensibly not reporting concept maps useful (see Figure 2). The availability and perhaps even more significantly the timing of provision of such traditional structured learning content may therefore be a key factor in motivating in particular moderate/strong verbal learners to use and benefit from concept maps and possibly expand their learning dimensions (see Santhanam *et al.*, 1998). Indeed, poor student motivation, a non-cognitive aspect of student performance, has been recently identified as a key factor in delimiting the favourable impact of concept mapping on factual recall in medical education (Farrand *et al.*, 2002).

Furthermore, although statistical significance was not attained in a pilot study examining the influence of learning approach, the preliminary data apparently point to an association between the self-reported usefulness of concept maps and this aspect of learning as assessed by Duff's 30 item RASI (Duff *et al.*, 1997). Indeed, it appeared that students with a preference (highest RASI score) for non-deep learning were approximately 1.5 times less likely than a deep learner to report concept maps as useful. Non-deep learning in this context refers both to a reliance on memorising, a reluctance to construct meaning or appreciate relatedness and coping concerns typical of a surface approach and an overarching need to achieve and excel underpinned by an expeditious strategic approach (Biggs, 1999b). These preliminary data therefore outline a case for discrimination against concept maps arising from a non-deep learning approach, which if significant could blunt the appeal of concept maps in diverse classes. Conversely, support exists for the notion that there is some discernment for concept maps amongst deep learners, which could reflect the value of concept maps as a support for deep learning. In this regard, it is noteworthy that an acknowledgement that concept maps acted as an aid to learning was uniquely reported by concept map enthusiasts. While such findings remain to be consolidated by a large-scale study, there is already support for the notion that concept maps encourage a deep level of information processing (Farrand *et al.*, 2002). Furthermore, in an analysis of science student views on concept mapping reported by Santhanam *et al*. (1998), up to approximately 33 % agreed that the technique 'encouraged thinking more deeply' while up to approximately 50 % agreed that it 'helped in understanding relationships between concepts'. Hence, the use of pre-prepared concept maps in large classes appears to be pedagogically valuable in that it accommodates a majority of learning styles while possibly assisting deep learning, which should favour wider student engagement and higher quality learning. Their introduction in large class biomedical teaching may therefore go some way to addressing those cognitive learning styles often neglected by traditional science instruction (sensing, visual, inductive, active and global learning dimensions) and thereby facilitate 'teaching to all types' (Felder, 1993; Hart, 2000).

Given that student attitudes to pre-prepared concept maps in any given large class will probably not be influenced by preferred learning styles (this study), unless moderate/strong verbal learners form a significant faction, the major sources of dissatisfaction with concept maps are likely to be rooted in non-deep learning approaches, poor motivation and in addition fixed student notions of traditional teaching/previous student experience and unfamiliarity with novel teaching/learning activities. A straightforward lack of interest in course content is also known to be a factor in the non-adoption of memory strategies (Krapp, 1999). Of course, alternatively, students could be encouraged to construct their own concept maps in the interests of fostering a more self-directed teaching/learning activity that would also benefit study skills relating to learning particular content (Biggs, 1999c). This approach has the additional benefit of promoting a better student sense of inclusion and ownership, which cultivates a positive attitude to learning and might be expected to raise student metacognitive skills (Taber, 1994). However, studies by Farrand et al. (2002) and Santhanam *et al*. (1998) have recently highlighted important workload and contextual motivation problems surrounding the student adoption of self-directed concept mapping. In addition, there is a wider problem that, while students may come to appreciate the value of concept mapping or indeed any other teacher- or self-directed flexible learning device, their perceived relevance to successfully completing the course may be undermined by the overall institutional teaching and in particular assessment contexts (Ramsden *et al.*, 1986; Santhanam *et al*., 1998).

CONCLUSIONS

Student attitudes to pre-prepared concept maps introduced in large lectures were not significantly influenced by dichotomous learning style dimension with the specific exception of a minority preferred moderate/strong verbalising learning style that may have an absolute requirement for more traditional lecture content. Given the evident popularity of pre-prepared concept maps and their broad appeal to a variety of learning styles often largely unaddressed in traditional science education, concept maps may therefore offer flexible teaching/learning opportunities in large class biomedical science teaching that may promote deeper student engagement and learning by ‘teaching to all types’.

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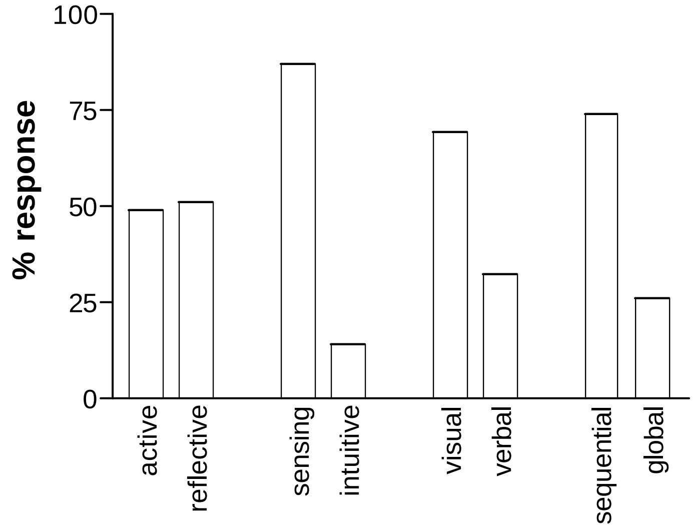
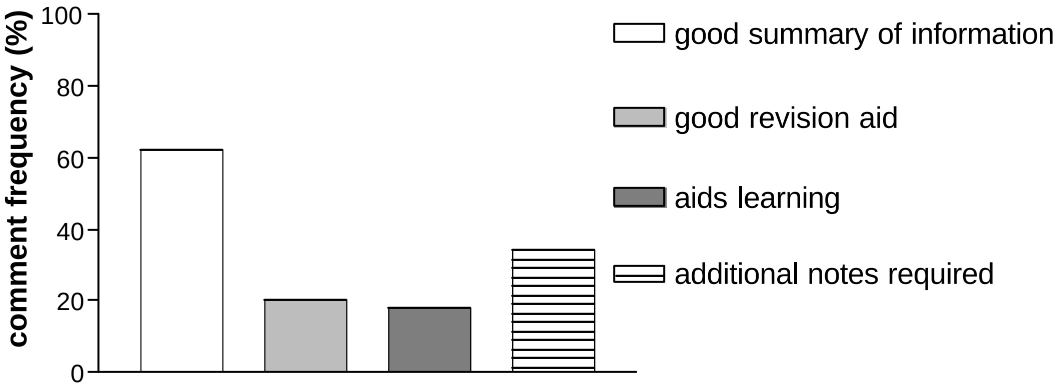


Figure 1. Percentage composition of Stage 2 BSc Pharmacology and MPharm undergraduates by preferred learning style according to the Felder-Soloman ILS questionnaire. N=89.

(a)



(b)

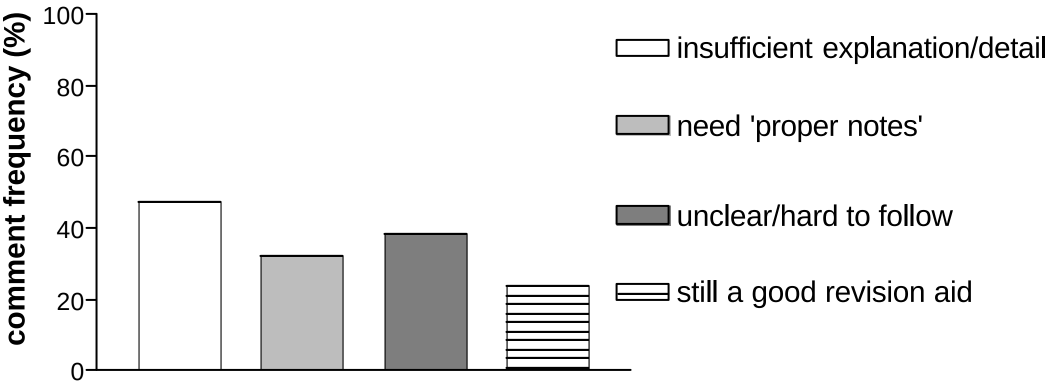


Figure 2. Content analysis of open format written feedback from Stage 2 BSc Pharmacology and MPharm undergraduates: (a) ‘concept maps useful’ group (N=56); (b) ‘concept maps not useful’ group (N=33).

Table 1. 2*2 contingency table relating preference for visual and verbal learning style dimensions (Felder-Silverman model) to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates. P> 0.05

	Concept maps useful?			
	Yes	No		*Totals*
Dimension				
Visual	42 (69 %)	19 (31 %)		*61*
Verbal	14 (50 %)	14 (50 %)		*28*
Totals	*56*	*33*		*89*

Table 2. 2*2 contingency table relating preference for sequential and global learning style dimensions (Felder-Silverman model) to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates. P> 0.05

	Concept maps useful?			
	Yes	No		*Totals*
Dimension				
Sequential	40 (61 %)	26 (39 %)		*66*
Global	16 (73 %)	7 (27 %)		*22*
Totals	*56*	*33*		*89*

Table 3. 2*2 contingency table relating preference for active and reflective learning style dimensions (Felder-Silverman model) to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates. P> 0.05

	Concept maps useful?			
	Yes	No		*Totals*
Dimension				
Sensing	46 (60 %)	31 (40 %)		*77*
Intuitive	10 (83 %)	2 (17 %)		*12*
Totals	*56*	*33*		*89*

Table 4. 2*2 contingency table relating preference for sensing and intuitive learning style dimensions (Felder-Silverman model) to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates. P> 0.05

	Concept maps useful?			
	Yes	No		*Totals*
Dimension				
Active	25 (57 %)	19 (43 %)		*44*
Reflective	31 (69 %)	14 (31 %)		*45*
Totals	*56*	*33*		*89*

Table 5. 2*2 contingency table showing strength of preference for verbal learning style (Felder-Silverman model) related to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates. P< 0.05 for association between rows and columns (Fisher's exact test)

	Concept maps useful?			
	Yes	No		*Totals*
Dimension strength				
Mild	13 (65 %)	7 (35 %)		*20*
Moderate/Strong	1 (13 %)	7 (87 %)		*8*
Totals	*14*	*14*		*28*

Table 6. 2*2 contingency table showing simplified interpretation of highest RASI score related to self-reported usefulness of concept maps in Stage 2 BSc Pharmacology and MPharm undergraduates.

	Concept maps useful?			
	Yes	No		*Totals*
Learning approach				
Deep	11 (73 %)	4 (27 %)		*15*
Non-deep	11 (48 %)	12 (52 %)		*23*
Totals	*22*	*16*		*38*