Developing students' clinical reasoning skills: correlates of perceived relevance of two teaching and learning approaches

T. C. Postma* and J. G. White

Department of Dental Management Sciences, University of Pretoria, Pretoria, South Africa

*Correspondence

Thomas Cornè Postma

Department of Dental Management Sciences University of Pretoria, Bophelo Road, Gezina, Pretoria 0001, South Africa

Tel: +27 12 3192553

Fax: +27 12 3192146

e-mail: corne.postma@up.ac.za

Abstract

Introduction: "Relevance" is a key concept in adult learning. Hence this study sought to examine students' perceptions of relevance of the teaching and learning in relation to different instructional designs employed in a Comprehensive Patient Care (CPC) course that aims to develop integrated clinical reasoning skills.

Methods: Third to fifth year students (2009-2011) were asked to anonymously rate the relevance of the CPC instructional design (RELID) they participated in by means of visual analogue scales at the School of Dentistry, University of Pretoria. They were also asked to rate their perceptions of the alignment between teaching and learning and outcomes (ATLO), assessments' contribution to learning (ACL), course organisation (CO) and lecturer competence (LC). RELID served as the outcome measure in stepwise linear regression analyses. ATLO, ACL, CO, LC and the instructional design (case-based learning (CBL)=1 and discipline-orientated lecture-

based teaching (DOLBT)=0) served as the co-variables for each of the years of study.

Results: The analysis showed positive correlations between RELID and ATLO and between RELID and ACL for all the years of study. RELID was associated with LC in year three and four and CO was associated with RELID in year four and five. CBL outperformed DOLBT in terms of perceived relevance of the teaching and learning.

Conclusion: The results suggest that there are correlations between RELID and indicators of constructive alignment, LC and CO. The teacher's philosophy appears to have a distinct influence on students' perceptions of the relevance of teaching and learning.

Keywords: relevance; authenticity; clinical reasoning; teaching philosophy; lecturer competence; constructive alignment.

Introduction

Relevance is central to adult learning (1). The establishment of relevance in the learning process has the potential to raise the intrinsic motivation of students. Increased intrinsic motivation, in turn, stimulates self-regulated learning (2).

Ultimately, learners themselves decide whether learning is relevant or not (1, 2). Hence, the attitude, competence (3) and teaching philosophy of the teacher may have a distinct influence on students' experience of relevance in the teaching and learning process (1).

Teacher-centred approaches to teaching and learning (Fig. 1) are often the only methods of instruction some faculty members are acquainted with, given their own undergraduate learning experiences [4, 5]. Moreover, teacher-centred approaches are often preferred because it requires less institutional resources than student-centred approaches [4]. The disadvantage of teacher-centred approaches is that it does not give students autonomy in their learning and as a result render the learner dependent on what the teacher has to offer. Such approaches are generally

regarded as a form of ‘knowledge transmission’, resulting in ‘information gathering’ by the students, which in turn, may contribute to rote and passive learning (Fig. 1) [4, 5].

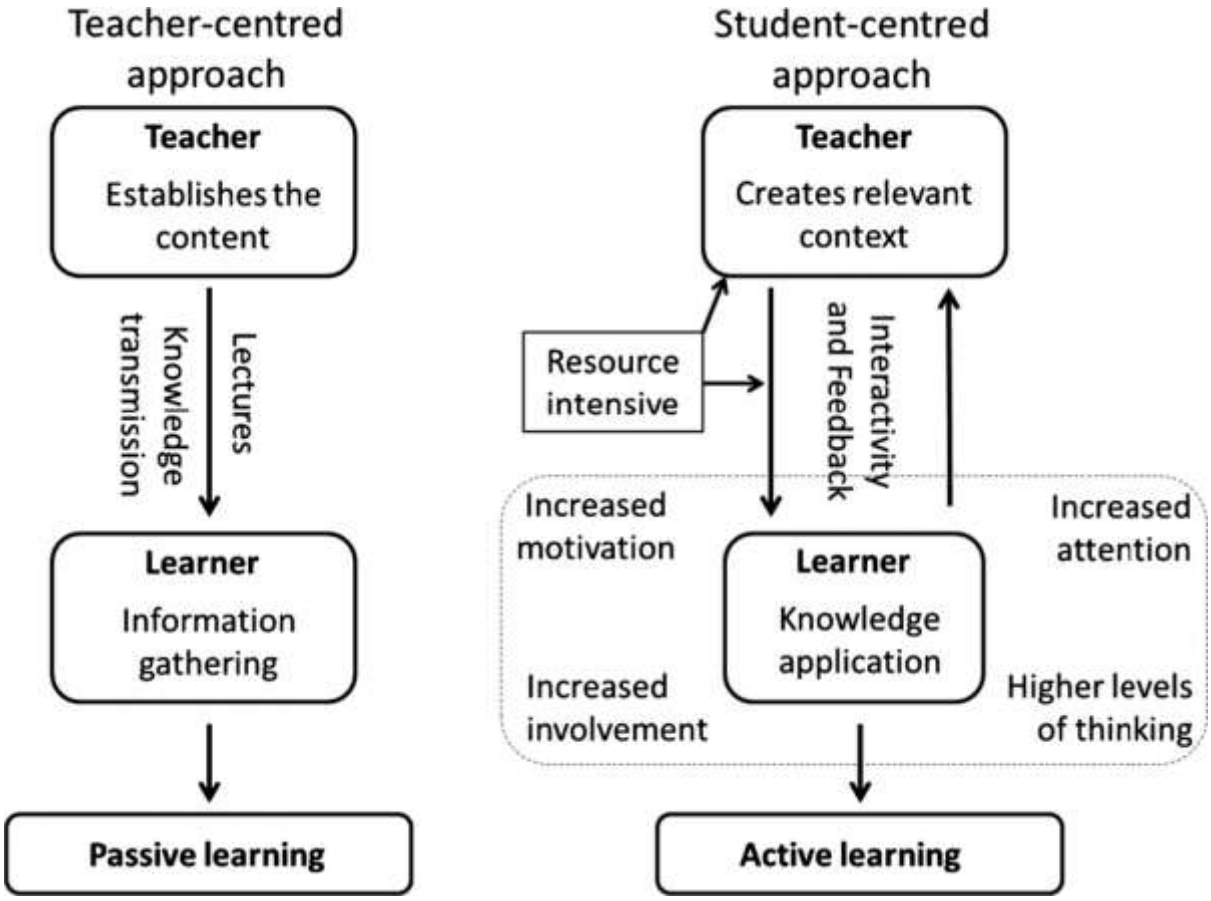


Figure 1. A teacher-centred approach vs. a student-centred approach [5].

The use of teacher-centred approaches limits the teacher's ability to establish an instructional design with a relevant context in which the student can learn [5]. Student-centred approaches (Fig. 1), however, allow for the opportunity to create a relevant context that is conducive to active learning [5]. A relevant context can be created by constructively aligning course outcomes, with the teaching, learning and assessment in the instructional design [6]. The aim of the relevant context is to increase students’ motivation, attention and involvement as well as to evoke higher order reasoning skills through knowledge application [5]. It is indeed suggested that

student-centred approaches are more likely than teacher-centred approaches to induce active learning among students [5].

To date there are no known studies that examine the relationship between students' perceptions of relevance of teaching and learning and different teaching and learning approaches employed in dental education. Ashton suggests that such relationships are indeed worthwhile to explore in order to obtain clarity about the dynamics of perceived relevance as part of learning [1].

Aim

The aim of this study was consequently to explore associations between students' perceptions of relevance of different teaching and learning approaches students were exposed to in a Comprehensive Patient Care (CPC) course.

It was expected that students' perceptions of the relevance of teaching and learning would be enhanced when outcomes, teaching, learning and assessment are constructively aligned during the development of clinical reasoning skills.

Materials and methods

Institutional context

The School of Dentistry, University of Pretoria, South Africa is a discipline-based dental school, which requires adjunctive interventions to ensure integration across disciplines. For the past few decades the School has been exploring the use of a subject called CPC to facilitate integrated clinical reasoning [7-10]. Before 2009, students received lectures in the various undergraduate dental disciplines from the

third to the fifth year of study, complemented by lecture-based teaching in CPC (DB-LBT1) in the fourth year of study [11]. Integrated clinical teaching and learning (CTL) subsequently took place in years four and five [11]. In 2009, the School implemented interactive case-based learning (CBL) in CPC in the pre-clinical year of study (year three) [10-12]. The purpose of CBL was to scaffold the transition from the pre-clinical year to CTL. The CBL included simulation exercises to develop communication [13, 14], patient administration, diagnostic and treatment planning skills [9-12]. CBL continued in the fourth and fifth years of study through portfolio exercises alongside CTL. Table 1 shows the exposure of the 2009–2011 cohorts to CBL.

CBL was implemented based on the following beliefs: (i) to develop clinical reasoning skills, an outcomes-based approach will be more relevant than a content-based approach [4, 12]; (ii) outcomes, teaching and learning and assessment should be constructively aligned to obtain the maximum educational benefit [6, 12] and (iii) part-whole scaffolding methods should be employed, not only to manage the cognitive load of the inexperienced learners [10-12, 15], but also to maintain relevance in the teaching and learning process [12, 15].

Ethical clearance

The University of Pretoria provided ethical clearance for the study (Protocol153 /2009).

Data collection

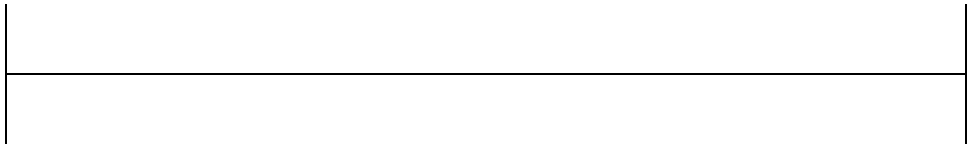
Third, fourth and fifth year students (2009–2011) rated the following characteristics of their teaching and learning experience anonymously on paper-based visual

Table 1 Students' perceptions of the RELID, ATLO, ACL, CO and LC

Year of study	Year	CBTL in year 3	RELID			ATLO			ACL			CO			LC		
			n	X	Sd	n	X	Sd	n	X	Sd	n	X	Sd	n	X	Sd
3	2009	Yes=1	43	88.12	14.08	43	86.56	14.50	43	84.34	14.18	43	86.27	16.22	43	89.05	14.48
3	2010	Yes=1	55	93.13	8.03	55	87.07	18.44	55	84.31	18.68	55	87.75	12.30	55	90.08	12.64
3	2011	Yes=1	56	91.32	9.20	56	91.37	9.89	56	87.92	12.10	56	91.04	9.93	55	89.59	10.59
4	2009	No=0	51	66.74	19.05	51	54.89	24.41	51	60.61	22.90	51	76.24	17.50	51	73.88	25.41
4	2010	Yes=1	46	80.47	16.33	46	82.27	19.76	46	74.65	19.18	46	75.11	19.18	46	82.85	17.25
4	2011	Yes=1	53	86.14	13.42	52	82.47	15.09	52	81.50	14.98	53	85.53	16.36	53	84.13	17.22
5	2009	No=0	45	66.19	17.95	45	57.08	24.19	45	51.83	21.24	45	62.82	20.68	44	70.29	22.79
5	2010	No=0	50	60.99	19.51	50	59.83	20.29	50	50.60	23.72	50	62.19	20.95	50	70.46	18.61
5	2011	Yes=1	43	86.83	12.71	43	82.42	14.37	43	77.66	18.27	43	84.56	15.29	43	86.03	14.33

Relevance of the instructional design (RELID)

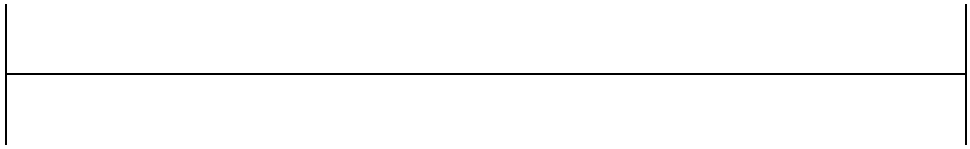
Do you think the content of the Comprehensive Patient Care course is relevant to what a dentist does on a daily basis?



Not relevant at all — Highly relevant

Alignment of teaching and learning with the course outcomes (ATLO)

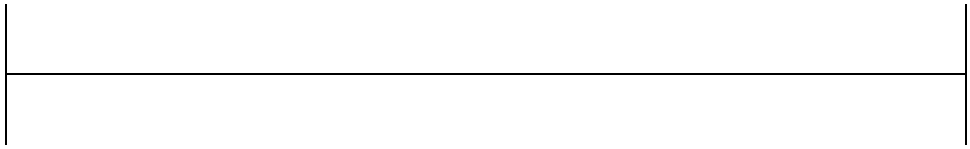
Do you think the discipline-based training you received in your third year of study provided you with a good basis to diagnose and plan treatment comprehensively for a real patient?



Not at all — Definitely

Assessments' contribution to the learning (ACL)

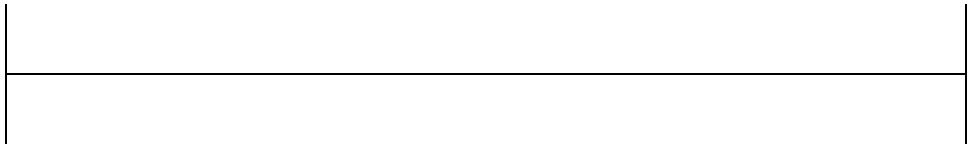
Did assessment opportunities contribute to your learning of outcomes?



Not at all — Definitely

Course organisation (CO)

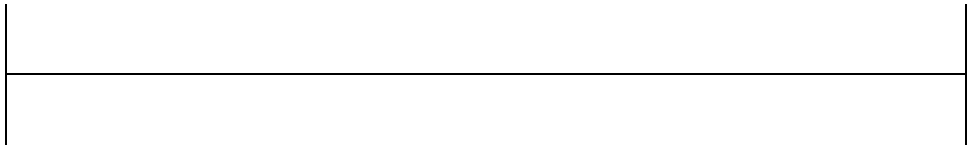
Was the Comprehensive Patient Care course well organised?



Poorly organised — Very well organised

Lecturer competence (LC)

Were the lecturers competent to present the course material?



Not competent at all — Competent

Figure 2. Visual analogue scales were used to measure RELID, ATLO, ACL, CO and TC. ack questionnaire

analogue scales (Fig. 2) at the end of each of the academic years:

- The relevance of the CPC instructional design (RELID);
- The alignment of the teaching and learning with the outcomes (ATLO) [6];
- Assessments' contribution to learning (ACL) [6];
- Course organisation (CO) [3] and

- Teacher competence (TC) [3].

It is pertinent to note that the phrase ‘discipline-based’ was replaced with ‘case-based’ for the second visual analogue scale (ATLO, Fig. 1) for those who participated in CBL.

The visual analogue scales were 127 mm long and only the endpoints were defined as indicated in Fig. 2. Students marked their perceptions with an ‘X’ on the continuum. The distance from the lower endpoint was measured by means of a standard ruler by an administrative member of staff. Values obtained were divided by 0.7874 to provide a value on a 100-point scale.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics for Windows Version 23.0 (IBM Corp. Released 2015. Armonk, NY, USA: IBM Corp).

The responses to the different questions displayed in Fig. 2 were cross-correlated using the Pearson correlation test, stratified per year of study and according students’ participation in DB-LBT or CBL.

The pooled data for each year of study was treated with stepwise linear regression. The numerical value obtained for the students’ perception of RELID (Fig. 1) served as the outcome measure. The remaining variables (ATLO, ACL, CO, TC) (Fig. 1) were entered as co-variables into the regression analyses together with the applicable instructional design (DB-LBT=0 or CBL=1) (Table 1).

In order to monitor the potential effects of multicollinearity among variables, the variance inflation factor (VIF) was calculated for each variable entered into the stepwise regression model [16].

Cohen's f^2 was employed to calculate effect sizes [17].

Results

Table 1 contains the detail feedback scores for each of the cohorts. The students who participated in the CBL generally provided more positive feedback in comparison to cohorts who received DOLBT.

Bivariate analyses

Moderately strong correlations were found between most of the variables in the third fourth and fifth-year bivariate analyses (Table 2) with a few exceptions. In the fourth year DOLBT grouping, perceptions of ATLO and perceptions of ASCL did not correlate with perceptions of CO. The fourth-year DOLBT students' perceptions of LC also did not correlate with perceptions regarding ATLO, but correlated weakly with perceptions of ACL. In the fourth year CBL grouping, a relatively strong correlation was found between perceptions of CO and perceptions of LC (Table 2). In the fifth year DOLBT grouping, a weak correlation was found between perceptions of CO and the ATLO, while no significant correlation could be found between the same variables in the CBL grouping. Strong correlations were noted between perceptions of ATLO and ACL as well as between CO and LC in the fifth year CBL grouping (Table 2).

Multivariate analyses

The third year analysis (Table 3) showed a positive correlation between students' perceptions RELID (outcome measure) and perceptions of ATLO, ACL and LC (Adjusted R^2: 48%, Cohen's f^2: 0.92). The fourth year analysis (Table 3) displayed the same correlations as in the third year analysis in addition to positive correlations with CBL and CO (Adjusted R^2: 52%, Cohen's f^2: 0.92). The fifth year analysis (Table 3) rendered the same results as the fourth year analysis, except for LC that displayed an insignificant association with RELID (Adjusted R^2: 58%, Cohen's f^2: 0.92).

Table 2 Bivariate correlations between RELID, ATLO, ACL, CO and LC

	ATLO	**ACL**	**CO**	**LC**
Year 3: CBL				
N	153	153	153	152
RELID	0.61**	0.62**	0.57**	0.60**
ATLO		0.68**	0.65**	0.65**
ACL			0.60**	0.60**
CO				0.69**
Year 4: DOLBT				
N	53	53	53	53
RELID	0.49**	0.31*	0.31*	0.38**
ATLO		0.55**	ns	ns
ACL			ns	0.27*
CO				0.41**
Year 4: CBL				
N	97	97	97	97
RELID	0.51**	0.62**	0.66**	0.56**
ATLO		0.50**	0.51**	0.49**
ACL			0.58**	0.46**
CO				0.72**
Year 5: DOLBT				
N	95	95	95	95
RELID	0.56**	0.47**	0.51**	0.40**
ATLO		0.59**	0.34**	0.31**
ACL			0.27**	0.35**
CO				0.63**
Year 5: CBL				
N	43	43	43	43
RELID	0.63**	0.68**	0.33*	0.35*
ATLO		0.86**	ns	0.32*
ACL			0.38*	0.43**
CO				0.84**

ns: not significant; * P<0.05; **P<0.01

Table 3 Multivariate correlations of RELID with ATLO, ACL, CO and LC

	Coefficient	SE	P	VIF
Third year of study				
ATLO	0.14 (0.02-0.27)	0.06	<0.05	2.38
ACL	0.14 (0.04-0.32)	0.06	0.001	2.05
CO	1.10 (-0.46-0.24)	0.07	0.18	2.29
LC	0.23 (0.10-0.37)	0.07	<0.05	2.30
Adjusted R^2: 48%, Cohen's f^2: 0.92				
Fourth year of study				
CBL=1; DOLBT=0	5.85 (0.72-11.00)	2.60	<0.05	1.40
ATLO	0.23 (0.09-0.36)	0.07	0.001	2.40
ACL	0.15 (0.01-0.29)	0.07	<0.05	2.02
CO	0.18 (0.03-0.33)	0.08	<0.05	1.68
LC	0.14 (0.01-0.27)	0.07	<0.05	1.64
Adjusted R^2: 52%, Cohen's f^2: 1.08				
Fifth year of study				
CBL=1; DOLBT=0	6.74 (0.92-12.57)	2.95	<0.05	1.49
ATLO	0.28 (0.13-0.43)	0.08	<0.001	2.33
ACL	0.15 (0.01-0.29)	0.07	<0.05	2.28
CO	0.27 (0.15-0.40)	0.07	<0.001	1.58
LC	Dropped from the regression model		ns*	2.42**
Adjusted R^2: 58%, Cohen's f^2: 1.38				

VIF: Variance Inflation Factor
*ns: not significant
** VIF of co-variable before dropped from the regression model

Discussion

This is the first known study in dental education that compares dental students' perceptions of the relevance of diverging teaching and learning philosophies. The teaching and learning philosophies under scrutiny are illustrated in (Figure 2).

Interactive CBL can be defined as a student-centred approach (Figure 2) (17) whereby the outcomes, teaching, learning and assessment are constructively aligned (13) to create a relevant context for the student to actively learn in (6-9). The aim of the relevant context is to increase students' motivation, attention and involvement as well as to evoke higher order reasoning skills through knowledge application (17). For this purpose context-rich case studies were developed and functionalised as CBL in the preclinical year of study in CPC (6-9). Students used these case studies to practice their communication, patient administration, diagnostic and treatment planning skills before the transfer to CTL (7-9). Case studies allow for the creation of a context whereby the sourcing and interpretation of clinical knowledge can be simulated (7-9). Due to the inductive nature of these complex activities, the inexperienced students need support to manage their cognitive load and to eliminate misconceptions through timely feedback (7, 14). This interaction inevitably creates an information exchange between the students and the teachers as well as between the students themselves. Such interactivity is crucial to facilitate active learning (17).

The interactive CBL were preferred in place of the conventional content-based didactic teacher-centred approach (Figure 2) (12) employed during DOLBT in the School, including CPC before 2009. Such teacher-centred approaches are often preferred because it requires less institutional resources than student-centred approaches (12). Teacher-centred approaches are also often the only methods of instruction some faculty members are acquainted with given their own undergraduate learning experiences (12, 17). The disadvantage of teacher-centred approaches is that it does not give students autonomy in their learning and as a result render the learner dependent on what the lecturer has to offer. This may result in so-called "information gathering", contributing to rote and passive learning (Figure 2) (12, 17). The use of such methods surely limits the teacher's ability to establish a relevant context in which the student can learn. The results of this study

provide empirical evidence that CBL may indeed be more appropriate to enhance students' perceptions of teaching and learning compared to teacher-centred teaching.

The multivariate analysis (Table 3) also suggests that a link may exist between students' perceptions of RELID and perceptions of ATLO (diagnosis and treatment planning) as well as between RELID and ACL. These findings relate to the philosophy of constructive alignment (13). Biggs made a very strong case for the need for alignment between outcomes, teaching, learning and assessment to improve learning (13), which could be further enhanced if teachers provide conceptual guidance on what is required during assessment (18). Teacher-centred approaches are certainly not adequate to create a relevant context for students to develop higher order skills such as diagnosis and treatment planning. Ultimately, learning can only be improved when students perceive the content to be meaningful (1,2), and when they engage in active learning as part of their own being (1). It was this realisation that led to the functionalisation of CBL as the teaching philosophy in CPC.

The way in which a teacher functionalises a curriculum may however impact on students' perceptions of the teacher (3). Literature indeed suggests that faculty competence and attitude may have a distinct impact on the quality of learning (3). The findings that perceptions of LC were independently associated with perceptions of RELID during the third and fourth year analyses may indicate the importance of the teacher's philosophy and ability to create a relevant context during the students' transfer from the preclinical to the clinical environment. The fact that the perceptions of LC could not be associated with perceptions of RELID in the fifth year (Table 2) suggests that the final year students may have become less dependent on the inputs of their teachers to create a relevant context to learn in. In the fifth year students are by and large engaged in CTL in an authentic environment, which is an organisational feature in the curriculum. CTL are rarely dependent on a single teacher.

In the current study perceptions of CO were independently associated with perceptions of the RELID in the fourth and fifth years of study but not in the third year of study (Table 2). This may be due to the fact that the CO in the fourth and fifth years of study mainly includes CTL, with limited classroom intervention. The third

year course mainly comprised of “authentic” simulation. Simulation only imitates the way knowledge are interpreted and applied in a real world setting which may influence the way in which students interpret relevance (19). Obviously large class interactive CBL are more chaotic compared to highly organised CTL, which may have influenced these results.

The relatively strong effect sizes obtained in the multivariate analyses (Table 3) and the above-mentioned inferences should only be interpreted bearing the sample size, local context, and the quasi-experimental nature of the study design (20) in mind. The quasi experimental design can be regarded as one of the main limitations of the study. The comparison of different cohorts is not always the most appropriate way to investigate differences because different cohorts may experience teaching and learning differently over time (20). Due to ethical considerations comparisons between cohorts remain one of few feasible options for experimental designs (20). Moreover, the relatively strong correlations observed between certain variables (Table 2) may have slightly overinflated some of the reported variances and effects. The VIFs obtained in the multivariate analyses (Table 3) however indicate that these over-inflation effects are within acceptable limits (15). A further limitation of the study is that the effect of the instructional design of the previous years on students’ perceptions could not be controlled for all the cohorts. Longitudinal data was not collected for all the cohorts. Controls of repeated measures would have rendered more accurate assessment of the interrelationships of the variables tested in especially the fourth and fifth years of study.

Despite these limitations, this study provides valuable insight into the association of students’ perceptions of relevance of different instructional designs.

Conclusion

Dental students' perceptions of the relevance of the instructional design appear to be enhanced when outcomes, teaching, learning, and assessment are constructively aligned during the development of diagnostic and treatment planning skills. The teaching philosophy, competence of the teacher and course organisation may have a distinct impact on how students perceive and behave in the learning environment.

It is suggested that students' perceptions of the relevance of various educational strategies be explored more extensively in various contexts and be linked to academic outcomes.

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References

1. Ashton S. Authenticity in adult learning. Int J of Lifelong Education 2010: 29: 3-19.
2. Ryan RM, Deci EL. Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. Am Psychol 2000: 55: 68–78.
3. Elzubeir MA, Rizk DE. Identifying characteristics that students, interns and residents look for in their role models. Med Educ 2001: 35: 272-277.
4. Seeliger JE, Snyman WD. A new approach to undergraduate dental education. JDASA 1996: 51: 746-749.
5. Snyman WD, Ligthelm AJ. The new Pretoria curriculum. SADJ 2000: 55: 642-648.
6. Snyman WD, Kroon J. Vertical and horizontal integration of knowledge and skills − a working model. Eur J Dent Educ 2005: 9: 26-31.
7. Postma TC, White JG. Developing clinical reasoning in the classroom – analysis of the 4C/ID-model. Eur J Dent Educ 2015: 19: 74-80.
8. Postma TC, White JG. Developing integrated clinical reasoning competencies in dental students using scaffolded case-based learning – empirical evidence. Eur J Dent Educ. In Print.
9. Postma TC. Evaluating the impact of adjunctive integrated case-based

dental teaching and learning on clinical reasoning in a discipline-based teaching and learning environment (Phd thesis). Pretoria: University of Pretoria. Pretoria, 2014: 1-346.

10. White JG, Kruger C, Snyman WD. Development and implementation of communication skills in dentistry: an example from South Africa. Eur J Dent Educ 2008:12: 29-34.
11. White JG. Strategy for teaching communication skills in dentistry. SADJ 2010: 65: 260-265.
12. Harden RM, Sowden S, Dunn WR. Educational strategies in curriculum development: the SPICES model. Med Educ 1984: 18: 284-297.
13. Biggs J. Enhancing teaching through constructive alignment. Higher Educ 1996: 32: 347-364.
14. Van Merriënboer JJ, Clark RE, De Croock MB. Blueprints for complex learning: the 4C/ID-model. Education Tech Research and Dev 2002: 50: 39-64.
15 O'Brien RM. Caution regarding rules of thumb for variance inflation factors. Qual Quant 2007: 4: 673-690.
16 Cohen J. Statistical Power Analysis for the Behavioral Sciences (2nd Edition). Hillsdale, NJ: Lawrence Earlbaum Associates, 1988.
17. Steinert Y, Snell LS. Interactive lecturing: strategies for increasing participation in large group presentation. Med Teach 1999: 21: 37-42.
18. Case SM, Swanson DB. Constructing written test questions for basic and clinical sciences 3 ed (revised). Philadelphia: National Board of Medical Examiners, 2002: 1-180.
19. Gulikers JTM, Bastiaens TJ, Martens RL. The surplus value of an authentic learning environment. Comput Hum Behav 2005: 21: 509-521.
20 Eccles M, Grimshaw J, Campbell M, Ramsay C. Research designs for studies evaluating the effectiveness of change and improvement strategies. Qual Saf Health Care 2003: 12: 47-52.