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Reflective Blogs in Clinical Education to Promote Critical Thinking in Dental Hygiene Students

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Abstract: One challenge facing dental hygiene, as well as dental, education is to identify clinical teaching strategies promoting critical thinking and clinical reasoning. These skills are crucial elements in the practice of dental hygiene. A two-group design (intervention, n=28, and control, n=30) assessed first-year dental hygiene students using pre- and post-Health Science Reasoning Test (HSRT) scores to evaluate the effect of reflective blogging on critical thinking skills. A reflective blog rubric, based on Mezirow's levels of reflection, determined if reflective blogging increased the level of reflection for dental hygiene students. The results suggest within this nonprobability sample that reflective blogging did not produce a significant change in students' HSRT scores (p>0.05). However, analyses of reflective blog rubric scores demonstrated statistically significant improvements (p<0.05) in students' levels of reflection. Furthermore, data analysis revealed a correlation (p<0.05) between HSRT subscale scores and the element of reflection scores for the intervention group. This study addressed needs of the dental and dental hygiene education community by examining the use of blogs, an emerging technology, as a tool for reflecting on clinical experiences and, in turn, for promoting critical thinking.

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The American Dental Education Association (ADEA), American Dental Hygienists' Association (ADHA), American Dental Association (ADA), and Commission on Dental Accreditation (CODA) have identified critical thinking as a desired attribute for the dentist and dental hygienist.[1-7] Dental professionals employ clinical reasoning or critical thinking when implementing the process of care to provide comprehensive oral health services for patients. Critical thinking is an essential quality for dental professionals in providing evidence-based care. However, questions remain about how to measure and facilitate the development of critical thinking. The dental literature offers few clearly developed theories of critical thinking and clinical reasoning. Because of this, research from education, nursing, and philosophical professions provided the conceptual framework for this study.

Background

Critical Thinking and Reflection

The American Philosophical Association (APA) consensus statement divides critical thinking into cognitive skills and affective dispositions related to the prevailing tendencies to think critically.[8-10] Interpretation, analysis, evaluation, inference, explanation, and self-regulation are core cognitive skills associated with critical thinking.[9] Consummate dispositions of a critical thinker are to be inquisitive, systematic, judicious, analytical, truth-seeking, open-minded, and confident in reasoning.[8,9]

Critical thinking is a fundamental attribute of the health care provider.[11-15] A review of the literature shows critical thinking and clinical reasoning to be phenomena requiring similar cognitive dispositions.[10,15-18] In addition, educators in the health care professions studied the influence of educational strat-

egies on critical thinking. Their findings demonstrate that clinical reasoning is the application of critical thinking to the clinical environment.[19-22]

Research indicates that writing about one's educational experience is an effective strategy to promote reflective learning leading to the development of critical thinking.[14,15,23-26] Indeed, when proposing methods of stimulating critical thinking and lifelong learning in dental students, the ADEA Commission on Change and Innovation in Dental Education identified written reflection as an effective tool for teaching in clinical education.[20]

Application of Boyd and Fales's 1985 definition of reflection to clinical education suggests that reflection results in the student using critical thinking/clinical reasoning to provide optimal care.[16] This process begins with students' self-assessing their clinical experiences and requires a shift from the current concept of *knowing* how to provide care to the new concept of actually *providing* care or, as the saying goes, "the knowing to the doing" of providing patient care.

Additionally, overwhelming evidence indicates that reflective learning practices should be included in clinical education paradigms.[17,20,23,27-29] Previous research on reflection has provided the following four guiding principles: 1) students should be encouraged to reflect using writing and oral preclinical conferences;[15] 2) educators should provide specific instructions on reflection and connecting clinical and classroom knowledge;[15] 3) methods promoting clinical and didactic learning may differ;[30] and 4) guiding questions have provided an effective focus and resulted in improved reflection.[28,31,32]

Educational theorists provide models for assessing the quality of student reflection.[31,33,34] Additionally, philosophical and educational experts have developed instruments to quantify the disposition and skills associated with critical thinking.[8]

Measurements for Critical Thinking and Reflection

Insight Assessment administers a number of critical thinking measurement tools including the California Critical Thinking Skills Test (CCTST), California Critical Thinking Disposition Test (CCTDT), and Health Science Reasoning Test (HSRT). All derive their construct validity from the APA definition and measure disposition or skills associated with critical thinking. Additionally, the HSRT measures classic inductive and deductive reasoning skills. Prior to the 2006 development of the HSRT, two studies conducted by dental hygiene educators concluded that dental hygiene students' CCTST scores ($p<0.05$) had predictive validity for competence and clinical reasoning, while the CCTDT scores did not.[18] Additionally, the CCTST was found to be a more reliable predictor ($p<0.05$) of student performance on the National Board Dental Hygiene Examination (NBDHE) than the CCTDT.[10] Because the HSRT and CCTST have similar content and construct validity and the HSRT has test items specific to the health science discipline, the HSRT is proposed as a critical thinking measurement tool to evaluate educational strategies designed to promote clinical reasoning.[9,10,18,35]

Moreover, studies have concluded that the Mezirow et al. model as incorporated with the works of Boud, Keogh, and Walker was an effective method for measuring reflection.[26,30,33,36,37] Mezirow et al. identified three levels of reflectors (nonreflectors, reflectors, and critical reflectors) according to the person's ability to transform old and current knowledge into future knowledge.[33] Boud et al. identified attending to feelings, association, integration, validation, appropriation, and outcome of reflection as elements of the reflective process.[31] First, in this process, when the student incorporates these elements of reflection with the core cognitive attributes of critical thinking (interpretation, analysis, evaluation, explanation, and inference), the student must first interpret and explain current knowledge.[8,31] Second, the student utilizes current knowledge in order to associate, integrate, and validate that knowledge into new knowledge. This process requires analysis, evaluation, and inference of previous knowledge to appropriation of gained or new knowledge. This three-step process demonstrates an outcome of reflection.

Reflection and Blogging

Baker reviewed seminal works on reflection and critical thinking by Boyd and Fales, Ennis, Maslow, and Schön suggesting that journaling using various media is an effective strategy to promote reflection.[16,23,34,38,39] Historically, journaling has utilized a written paper format, but facilitating journaling for today's student requires an understanding of who the learners are: a new type of learner. NetGen learners born in the 1980s and 1990s are experiential, engaged, and constantly connected to media, with a strong need for immediacy.[40] Based on the educational expectations of today's learners and criteria for reflective journaling, the Web 2.0 interface of the

web-log is more relevant than traditional journaling methods.

By definition, a blog (a portmanteau of "web" and "log") is "an online, chronological collection of personal commentary and links."[41] Educators in various health care professions have implemented blogs and reported specific benefits and suggestions for student success when blogging.[42-46] Benefits include digital date stamping, electronic portability, spell-check capabilities, and instant publishing, all of which encourage students to write as well as share their thoughts with others. Suggestions have included making blog participation a low-stakes grading item to encourage creativity and true reflection.[26,30,43]

This study utilized a blog as a reflective learning tool to facilitate development of critical thinking and clinical reasoning skills in dental hygiene students. Blogging appeals to contemporary learners and offers the potential for reflection and subsequent critical thinking corresponding to journaling.

Materials and Methods

This primarily quantitative, quasiexperimental study utilized a two-group, pretest-posttest design. Administration of a pretest HSRT to an intervention and control group was followed by implementation of the independent variable, blogging, in the intervention group. Then, the posttest HSRT was administered to both groups to determine if blogging had an impact on the dependent variables: critical thinking and levels of reflection. For the intervention group, a posttest rubric was used to assess levels of reflection evidenced in student blogs. This integrated design allowed for empirical testing of the intervention while also providing the opportunity for learning new insights about students' blogging.

Participants

Bachelor of Science in Dental Hygiene (B.S.D.H.) degree-seeking students in their first year of professional study at the University of Texas Health Science Center at Houston, Dental Branch, School of Dental Hygiene (UTDB) (n=28) and Baylor College of Dentistry, Caruth School of Dental Hygiene (BCD) (n=30) volunteered to participate in the intervention and control groups, respectively. These cohorts were homogeneous convenience samples chosen because students were enrolled in university-based dental hygiene programs with similar admissions criteria, prerequisites, and curricula. In addition, both programs are regulated by the State of Texas Higher Education Coordinating Board and Southern Association of Colleges and Schools.

Subsequent to IRB approval, the study was implemented at the UTDB and BCD facilities. A strict protocol was followed regarding confidentiality and ethical rights of participants. Investigator e-mail and face-to-face contact recruitment methods resulted in 100 percent participation.

Data Collection

HSRT. Quantitative data were collected from HSRT pretests and posttests administered to the UTDB and BCD cohorts at the beginning and end of the ten-week study period during which all participants provided eight weeks of patient care. Test administrators were calibrated by using a standardized script provided by Insight Assessment HSRT test manual recommendations.[35] All participants' pretest and posttest composite and subscale HSRT scores were obtained through analysis by Insight Assessment.

Reported content and construct validity identify how well the HSRT measures critical thinking skills based on the 1990 APA definition of critical thinking and theoretically should have similar correlations to the criterion as the CCTST.[35] Criterion validity for the HSRT continues to emerge as the HSRT is being administered and will be updated by Insight Assessment as available.[35] HSRT subscale content requires application of classic reasoning skills to contexts more appropriate to health care professionals.[35] Analysis, inference, evaluation, deductive reasoning, and inductive reasoning subscale scores range from a KR-20 of .77 to .84 with an average KR-20 of .81.[35] These data document overall internal consistency.

Reflective blog rubric. Only the intervention group students (UTDB) were provided with the following: a syllabus including criteria for blog postings to earn a pass/fail grade, encouragement via e-mails every ten days, and information about potential benefits from reflective blogging. After all UTDB students joined the blog and blogged once to verify technical competence, weekly guiding questions derived from the ADPIED model of providing dental hygiene care were e-mailed to each student.[6,28,32,47] The model ADPIED—an acronym for Assessment, Diagnosis, Planning, Implementation, Evaluation, and Documentation—is recognized as the Dental Hygiene Process of Care.[5,6,47] The dental hygienist

collects and evaluates data, information, and evidence related to assessment findings and develops a dental hygiene care plan. The dental hygienist utilizes reasoning to complete the final phases of ADPIED: identifying consequences, implications, and evaluation of the proposed care plan and, finally, documenting a chronological history of comprehensive patient care.[6,10,17,18,27,47,48]

Based on the principal investigator (AOW)'s previous blog experience with students, Livejournal was chosen as the blog platform for this study. Advantages of Livejournal included that participants had access to a personal journal, were able to start a discussion thread, and/or could add comments to a continuous blog thread. In addition, all postings were date stamped and archived. A disadvantage of Livejournal was that, in order to maintain blog privacy, the blog sign-up process required approval of the principal investigator for each participant to access the blog.

The reflection rubric utilizing Mezirow et al.'s levels of reflection (see Figure 1) provided composite and individual element of reflection scores on participant blogs scored twice, once within two weeks after onset (pre) and once at the end (post) of this study.[31,33,37] Content validity was established by having the rubric evaluated by a panel of experts who have studied reflection and are familiar with Mezirow et al.'s and Boud et al.'s models of reflection.[31,33] Statistical analyses of blogs from previous students using Cronbach's alpha established intrarater reliability of the investigator-designed reflection rubric (α=0.86).

To reduce bias and provide for blinded review of blogging posts, colleagues of the principal investigator were asked to keep blog participation records and download blog posts at the end of the study to assist the investigator in gathering qualitative data related to student reflection. Post rubric scoring of initial postings was difficult due to students' using the blog to discuss personal clinical issues. In order to gather data regarding true reflection, the principal investigator provided her colleagues with a list of key words ("I think," "thinking," "decided," "I don't know," "I'm confused," and "I feel") utilized by Boyd to identify reflection in student interview transcripts in previous critical thinking research.[17,27] Subsequently, post rubric scores were obtained from downloaded participants' blogs posted within the final two weeks of the study containing these key words.

Study data were entered in a Microsoft Excel spreadsheet, coded with a unique nine-digit identifier to deidentify respondents, and statistically analyzed using the SAS/STAT Version 9.1 program. Demographic data described participant characteristics. All study data were stored in a secure location or in a file on a password-protected computer.

Results

One hundred percent of participants in both intervention (UTDB) (N=28) and control groups (BCD) (N=30) were administered HSRT pretests and posttests; 89 percent (n=25) of intervention (UTDB) participants completed reflective blogging in the spring and summer terms of 2008, and 11 percent (n=3) completed blogging for the summer semester only. Demographic data were gathered for comparison only, and a frequency distribution of gender, age, highest level of education, grade point average, and ethnicity suggested the intervention and control groups were homogeneous samples.

A two-group, two-time, repeated measures between group ANOVA indicated there was no statistically significant difference between HSRT scores for the intervention (UTDB) and control (BCD) groups as measured by HSRT composite scores (F=0.08, p=0.782) and all five HSRT subscale scores: analysis (F=1.07, p=0.305), inference (F=0.45, p=0.506), evaluation (F=0, p=0.990), inductive reasoning (F=0.14, p=0.707), and deductive reasoning (F=0.49, p=0.489) (see Table 1). However, further investigation using ANOVA data analysis showed a statistically significant improvement (p=0.017) in HSRT composite scores and in two of the five HSRT subscale scores—analysis (p=0.010) and deductive reasoning (p=0.008)—within each group.

Level of Reflection and Blogging

A within group ANOVA of the intervention (UTDB) group's pre and post reflection rubric scores demonstrated a statistically significant improvement in mean composite scores (F=5.51, p=0.027), as well as in four of six elements of reflection scores: integration (F=8.54, p=0.007), validation (F=4.81, p=0.038), appropriation (F=8.89, p=0.007), and outcome of reflection (F=6.83, p=0.015) (see Table 2). Two elements of reflection, attending to feelings (F=1.56, p=0.224) and association (F=2.82, p=0.106), did not show a statistically significant improvement (see Table 2).

Further within group analysis of pre and post rubric scores of blogging participants in the intervention group (UTDB) (N=25) determined that 40

Elements of Reflective Process	Beginning 1	Nonreflector 2	Reflector 3	Critical Reflector 4
Attending to feelings; sharing personal experience	Blog has no reference to personal clinical experiences.	Blog conveys a single personal feeling about one's clinical experiences using the ADPIED model of dental hygiene care.	Blog conveys some personal feelings about one's clinical experience using the ADPIED model of dental hygiene care but does not relate them to personal learning.	Blog always conveys personal feelings as the student reflects on clinical experiences using the ADPIED model of care and relates them to future personal learning.
Association: relating the old and the new; making way for the new	Blog is only descriptive and does not provide evidence of linking prior knowledge of the ADPIED model of dental hygiene care with new clinical experiences.	Blog provides little evidence of linking prior knowledge of the ADPIED model of dental hygiene care with new clinical experiences.	Blog provides evidence of considering whether prior knowledge of the ADPIED model of dental hygiene care is consistent with new clinical experiences.	Blog provides evidence of reassessing and modifying prior knowledge of the ADPIED model of dental hygiene care, feelings, and attitudes to accommodate new and future clinical experiences.
Integration: relating old and new; emerging originality	Blog entries make no reference to issues raised through readings, clinic, and/or class activities.	Blog entries make a brief reference to issues raised through readings, clinic, and/or class activities.	Blog entries demonstrate awareness of the key issues raised through readings, clinic, and/or class activities.	Blog entries demonstrate comprehension of key issues raised through readings, clinic, and/or class activities.
Validation: self-assessing new and old knowledge	Blogs are superficial and do not provide evidence of self-assessment.	Blogs demonstrate student self-assessing clinical experience based on the ADPIED model of dental hygiene care.	Blogs demonstrate student self-assessing the clinical experience based on the ADPIED model of dental hygiene care and occasionally relating knowledge gained in clinical experience to prior knowledge and beliefs.	Blogs demonstrate student self-assessing the clinical experience based on the ADPIED model of dental hygiene care and consistently relating knowledge gained in clinical experience to prior knowledge and beliefs.
Appropriation: inference of learning	Blog does not demonstrate that student is comprehending the ADPIED model of dental hygiene care or making inferences on clinical experiences.	Blog demonstrates student has some basic comprehension of clinical experience using the ADPIED model of dental hygiene care but does not relate clinical experiences to prior knowledge or experiences.	Blog demonstrates student comprehends clinical experiences using the ADPIED model of dental hygiene care and makes inferences related to prior knowledge and experiences.	Blog demonstrates student is able to make inferences and synthesize clinical experiences using the ADPIED model of dental hygiene care, prior knowledge, and experiences.
Outcome of reflection	Does not reflect on own work at all, and no examples are provided.	Reflects on own work and improvements in knowledge, feelings, and attitudes on occasion, but does not consistently provide examples.	Demonstrates an ability to reflect on own work and change knowledge, feelings and attitudes by providing examples of new actions most of the time.	Demonstrates an ability to reflect on own work and apply new knowledge, feelings, and attitudes by always providing examples of committing to new actions.

Figure 1. Reflective blog rubric

Table 1. Summary of HSRT ANOVA between intervention (UTDB) and control groups (BCD) in study

			Intervention	Control	df	F Value	*p*
Composite	Pre	M	18.11	18.03			
		D	4.50	4.30			
	Post	M	19.05	19.47			
		D	4.66	4.49			
	Between groups				,56	0.08	0.782
	Within groups				,56	6.08	0.017*
Analysis	Pre	M	3.43	3.90			
		D	1.23	1.27			
	Post	M	4.11	4.20			
		D	0.99	1.24			
	Between groups				,56	1.07	0.305
	Within groups				,56	7.16	0.010*
Inference	Pre	M	3.07	3.07			
		D	1.39	1.08			
	Post	M	3.25	3.50			
		D	1.40	1.25			
	Between groups				,56	0.45	0.506
	Within groups				,56	2.59	0.116
Evaluation	Pre	M	4.36	4.00			
		D	1.34	1.64			
	Post	M	4.29	3.93			
		D	1.46	1.44			
	Between groups				,56	0.00	0.990
	Within groups				,56	0.13	0.725
Inductive Reasoning	Pre	M	6.64	6.37			
		SD	1.75	1.88			
	Post	M	6.75	6.67			
		D	4.58	1.94			
	Between groups				,56	0.14	0.707
	Within groups				,56	0.64	0.428
Deductive Reasoning	Pre	M	5.07	5.37			
		D	2.24	2.09			
	Post	M	5.96	5.90			
		D	2.20	2.35			
	Between groups				,56	0.49	0.489
	Within groups				,56	7.63	0.008*

*$p<0.05$

percent (n=10) demonstrated improvement in their reflections (see Table 3). Data from three of twenty-eight intervention group (UTDB) participants were excluded from this analysis because they only participated in the final weeks of this study. Therefore, there were no pre and post rubric scores to compare for these participants. Within group analysis of post rubric scores (N=25) indicated that 44 percent (n=11) of blogging participants (UTDB) demonstrated elements of reflector, 36 percent (n=9) of beginning reflectors, 16 percent (n=4) of nonreflectors, and 4 percent (n=1) of critical reflectors, based on Mezirow et al.'s model of reflection[33] (see Table 4).

Table 3 also demonstrates the distribution of rubric scores for blogging participants in the intervention group (UTDB) related to level of reflection. Participant rubric scores improved for 40 percent (n=10) of the participants; of these ten participants, 70 percent (n=7) had score increases placing them in a higher level of reflection, and 30 percent (n=3) had score increases within the same level of reflection. Results also showed that 56 percent (n=14) of the

Table 2. ANOVA summary of reflection rubric scores in the intervention group (UTDB)

Variable	Pre Mean (std dev)	Post Mean (std dev)	DF	F Value	*p*
Reflection composite	2.9 (0.8)	3.3 (0.8)	1,24	5.51	0.027*
Attending to feelings	3.2 (0.9)	3.6 (0.7)	1,24	1.56	0.224
Association	3.0 (1.0)	3.4 (0.8)	1,24	2.82	0.106
Integration	2.6 (1.0)	3.4 (0.9)	1,24	8.54	0.007*
Validation	2.7 (0.9)	3.2 (1.0)	1,24	4.81	0.038*
Appropriation	2.8 (0.9)	3.3 (0.7)	1,24	8.89	0.007*
Outcome of reflection	2.6 (0.9)	3.1 (1.0)	1,24	6.83	0.015*

*$p<.05$

Table 3. Distribution of student reflection rubric scores in the intervention group (UTDB)

Changes		Scores		
Score changes	Changes within level of reflection	Pre-Reflection	Post-Reflection	Difference
4.0% (*n*=1) No change		3.000	3.000	0
56% (*n*=14) Decreased scores	86% (*n*=12) Decreased to different level of reflection	3.333	1.333	-2.000
		3.333	1.333	-2.000
		3.500	1.666	-1.834
		2.666	1.166	-1.500
		3.000	1.666	-1.334
		3.000	1.666	-1.334
		2.333	1.333	-1.000
		2.833	1.833	-1.000
		3.333	2.500	-0.833
		4.000	3.333	-0.667
		3.166	2.666	-0.500
		4.000	3.666	-0.334
	14.0% (*n*=2) Decreased within same level of reflection	3.166	3.000	-1.660
		1.166	1.333	-0.327
40% (*n*=10) Increased scores	30.0% (*n*=3) Improved within same level of reflection	3.500	3.666	0.166
		3.166	3.500	0.334
		3.333	3.833	0.500
	70.0% (*n*=7) Improved to different level of reflection	3.833	4.000	0.167
		1.833	2.666	0.833
		2.666	3.500	0.834
		2.666	3.666	1.000
		1.333	2.500	1.167
		2.000	3.500	1.500
		1.166	3.166	2.000

Table 4. Post rubric scores categorizing student levels of reflection in the intervention group (UTDB)

	Students (*N*=25)			
Post-Composite Rubric Scores	Beginners	Nonreflectors	Reflectors	Critical Reflectors
1.166–1.833	36% (*n*=9)			
2.50–2.666		16% (*n*=4)		
3.0–3.83			44% (*n*=11)	
4.0				4% (n=1)

participants had score decreases. Of these fourteen participants, 14 percent (n=2) had score decreases but remained within the same level of reflection, and 86 percent (n=12) had score decreases from one level to another level of reflection. Four percent (n=1) did not demonstrate a change in score.

HSRT Relationship with Level of Reflection

Pearson's correlation coefficient within group analysis indicated pretest and posttest HSRT subscales scores for analysis, evaluation, inductive reasoning, and deductive reasoning correlated with pre and post composite attending to feelings, association, integration, validation, appropriation, and outcome of reflection rubric scores for UTDB participants. There were no correlations between pretest and posttest HSRT subscale scores for inference and any of the pre or post reflective blog rubric scores. Of a possible 168 correlations, 20.23 percent (n=34) were significant (p<0.05) positive correlations (see Tables 5 and 6). Therefore, study results identified statistically significant correlations (p<0.05) between pretest and posttest HSRT subscale scores and pre and post composite and element of reflection rubric scores of these intervention group participants (UTDB).

Discussion

This study addressed needs of the dental and dental hygiene education community by examining the use of an emerging technology, blogs, for dental hygiene students to reflect on clinical experiences and, in turn, to promote critical thinking.

Critical Thinking and Blogging

Between the groups, no statistically significant difference in critical thinking was found in the intervention group participants (UTDB) exposed to reflective blogging as compared to the students in the control group (BCD), who did not blog. However, significant improvements within each group in the overall sample were noted in 1) critical thinking HSRT composite scores and the subscale scores, 2) analysis, and 3) deductive reasoning. Improvements in composite HSRT scores for both the intervention (UTDB) and control (BCD) cohorts suggest that educational methodologies implemented in the UTDB and BCD dental hygiene curricula as well as clinical patient experiences contributed to the overall critical thinking skills of participants. Additionally, the curricula for both programs included case studies, self-assessment, and face-to-face clinical conferences said in the literature to be methods to promote critical thinking. [21,49,50] Improvement in the core critical thinking skills of analysis and deductive reasoning for both the intervention (UTDB) and control (BCD) groups suggested that these dental hygiene students were synthesizing knowledge gained in didactic coursework and translating this knowledge to the clinical environment, thereby applying critical thinking skills to patient care and honing their clinical reasoning.[19-21]

Currently, there is a paucity of research in dental and allied dental education on critical thinking. Further research on critical thinking skills of students in the dental profession as well as licensed oral health care providers is needed to clarify the relationship between critical thinking and practices related to oral health. Studies to identify those characteristics that make a dental professional a critical thinker exhibiting clinical reasoning skills necessary to provide competent comprehensive oral health care would benefit the entire dental profession. Examination of best practices in andragogy to promote critical thinking and clinical reasoning could assist all dental academicians in teaching students to be critical thinkers and lifelong learners.[51] Critical thinking research specific to each profession within the dental education community would be valuable to those individuals charged with developing program curriculum, as an admissions tool for student selection, and for assessment of program outcomes.

Qualitative Results of Reflection and Blogging

Qualitative analysis of student blogs in the intervention group (UTDB) determined that 48 percent of blog participants demonstrated desirable reflective characteristics based upon Mezirow et al.'s levels of reflection.[33] Study findings identified the following intervention group (UTDB) participants' levels of reflection: 4 percent critical reflectors, who reflected at a level validating their reflections, identified outcomes of reflection, and continuously reflected on the experience and themselves; 44 percent reflectors, who were able to identify feelings, associate experience with knowledge, and integrate knowledge into their learning; and 16 percent nonreflectors, who just reported it and described it.[36,37] However, 36 percent of the participants did not exhibit characteristics

within Mezirow et al.'s level of reflection and therefore were identified as beginners.[33] These findings are consistent with Chirema and Wong et al. who discovered several levels of reflectors among students who are not novice learners.[36,37]

Additionally, within-group qualitative examination of intervention (UTDB) participant blogs revealed an improvement in 40 percent of reflective blog rubric scores after eight weeks of blogging. These results are consistent with research findings

Table 5. HSRT pretest and rubric scores correlation statistics in the intervention group (UTDB)

	Analysis	Inference	Evaluation	Inductive	Deductive
Pre: reflection	0.51074* 0.0091* 25	0.24448 0.2389 25	-0.01033 0.9609 25	0.10958 0.6021 25	0.30262 0.1415 25
Post: reflection	0.33325 0.0831 28	0.13577 0.4909 28	0.59658* 0.0008* 28	0.62960* 0.0003* 28	0.35245 0.0658 28
Pre: attending to feelings	0.28755 0.1634 25	0.29434 0.1532 25	-0.07723 0.7137 25	-0.01100 0.9584 25	0.11599 0.5808 25
Post: attending to feelings	-0.14131 0.4732 28	-0.05416 0.7843 28	0.46313* 0.0131* 28	0.43638* 0.0203* 28	0.21311 0.2762 28
Pre: association	0.50235* 0.0105* 25	0.22729 0.2745 25	0.01641 0.9380 25	0.11651 0.5792 25	0.42169* 0.0358* 25
Post: association	0.25916 0.1830 28	0.07831 0.6920 28	0.58244* 0.0011* 28	0.58619* 0.0010* 28	0.26005 0.1814 28
Pre: integration	0.49959* 0.0110* 25	0.09589 0.6484 25	-0.07206 0.7321 25	0.05256 0.8029 25	0.23913 0.2496 25
Post: integration	0.18877 0.3360 28	0.12567 0.5240 28	0.43780* 0.0198* 28	0.50169* 0.0065* 28	0.22257 0.2550 28
Pre: validation	0.41037* 0.0416* 25	0.17683 0.3978 25	-0.04674 0.8244 25	0.12161 0.5625 25	0.26127 0.2071 25
Post: validation	0.25706 0.1867 28	0.18490 0.3462 28	0.41523 0.0280 28	0.51174* 0.0054* 28	0.33541 0.0810 28
Pre: appropriation	0.48026* 0.0151* 25	0.22942 0.2700 25	-0.01486 0.9438 25	0.08575 0.6836 25	0.25638 0.2161 25
Post: appropriation	0.18627 0.3426 28	-0.06557 0.7403 28	0.28024 0.1486 28	0.35499 0.0638 28	0.18140 0.3556 28
Pre: outcome of reflection	0.35067 0.0857 25	0.19118 0.3600 25	0.04459 0.8324 25	0.14292 0.4956 25	0.22040 0.2898 25
Post: outcome of reflection	0.50836* 0.0057* 28	-0.00207 0.9917 28	0.43908* 0.0194* 28	0.49088* 0.0080* 28	0.28517 0.1413 28

Cell order is:
Pearson correlation coefficient
p value; *$p<0.05$
Number of observations

related to the positive impact of reflection on clinical education.[15,17,27,28,30,36,52,53] Blog participants (UTDB) demonstrated reflective blog rubric score increases in four of the six elements of reflection: integration, validation, appropriation, and outcome of reflection.

A possible explanation for an increase in integration (relating old knowledge to new knowledge) scores may be that dental hygiene students are linking didactic learning with clinical experiences. For example, one student reported: "I used the Cavitron and my

Table 6. HSRT posttest and rubric score correlation statistics in the intervention group (UTDB)

	Analysis	Inference	Evaluation	Inductive	Deductive
Pre: reflection	0.25833 0.2125 25	0.30215 0.1421 25	-0.09060 0.6667 25	0.05028 0.8114 25	0.43851* 0.0283* 25
Post: reflection	0.30936 0.1092 28	0.09980 0.6134 28	0.43492* 0.0207* 28	0.37774* 0.0475* 28	0.46632* 0.0124* 28
Pre: attending to feelings	0.23163 0.2652 25	0.19789 0.3430 25	-0.24082 0.2462 25	-0.17592 0.4003 25	0.32651 0.1112 25
Post: attending to feelings	0.22058 0.2593 28	0.04923 0.8035 28	0.51341* 0.0052* 28	0.41179* 0.0295* 28	0.39374* 0.0382* 28
Pre: association	0.39671* 0.0496* 25	0.26541 0.1998 25	-0.10061 0.6323 25	0.02262 0.9145 25	0.52678* 0.0068* 25
Post: association	0.28318 0.1442 28	0.01690 0.9320 28	0.45930* 0.0139* 28	0.49641* 0.0072* 28	0.35264 0.0657 28
Pre: integration	0.27454 0.1841 25	0.28726 0.1638 25	-0.14021 0.5038 25	-0.00202 0.9923 25	0.32722 0.1103 25
Post: integration	0.20148 0.3039 28	0.04340 0.8264 28	0.47648* 0.0104* 28	0.37335* 0.0504* 28	0.35716 0.0621 28
Pre: validation	0.14717 0.4827 25	0.20898 0.3161 25	-0.05910 0.7790 25	0.06047 0.7740 25	0.37923 0.0615 25
Post: validation	0.21391 0.2744 28	0.05435 0.7836 28	0.33562 0.0808 28	0.24182 0.2151 28	0.43569* 0.0205* 28
Pre: appropriation	0.09180 0.6625 25	0.31118 0.1300 25	0.00666 0.9748 25	0.16345 0.4350 25	0.36229 0.0751 25
Post: appropriation	0.11327 0.5660 28	-0.00985 0.9603 28	0.35668 0.0624 28	0.28913 0.1356 28	0.30943 0.1091 28
Pre: outcome of reflection	0.18360 0.3797 25	0.18265 0.3822 25	-0.01997 0.9245 25	0.02421 0.9085 25	0.34904 0.0872 25
Post: outcome of reflection	0.31888 0.0981 28	0.19303 0.3251 28	0.37671* 0.0482* 28	0.33717 0.0793 28	0.43828* 0.0197* 28

Cell order is:
Pearson correlation coefficient
p value; *$p<0.05$
Number of observations

files (which I loved) and really felt like I'm pulling together everything I've learned and really getting the hang of everything and using all my instruments."

Anecdotally, the principal investigator has heard those experiences described as "aha" moments when one of the myriad of facts dental hygiene students must learn is synthesized in the clinical experience of providing patient care.[54] Indeed these "aha" moments were exciting for students to share with their peers in blogs. One student reported: "In quad three there were no probe depths greater than 4 so I also treatment planned her for an adult prophy. Surprisingly enough, when my instructor came to check my findings, I was right! It was really rewarding to realize that you are finally 'getting the idea' and implementing it correctly." Another student commented: "This is the first SRP patient I saw and I was really surprised how well the tissue responded! It was pink and firm against the tooth! When I asked the patient if he noticed the difference, he said all he noticed were the new spaces between his lower anteriors. Before the cleaning, they had been filled with calculus!"

Self-assessment is introduced in the UTDB dental hygiene preclinic course. Validation element scores of these dental hygiene students may have increased because participants found validation (self-assessing new and old knowledge) a familiar concept and had the opportunity to apply and discuss it. Increases in students' scores for the reflective element of appropriation (inference of learning) may have been related to the fact that students were given guiding questions based on the ADPIED model of the dental hygiene process of care and had spent three clinical seminars discussing this model. The blogs written by students demonstrated their ability to apply knowledge of the ADPIED model to their clinical learning experiences. Finally, increases in outcome of reflection scores indicate that these student participants are willing to apply knowledge, feelings, and attitudes learned in clinical sessions to ensure success in future professional practice.

Attending to feelings did not show a score increase and might relate, in this sample, to the predominantly female gender of dental hygiene students, who are perhaps more comfortable than men with sharing feelings.[30,55,56] These results suggest that female students might have been skilled in sharing personal experiences and therefore did not demonstrate a measurable change. Indeed, a literature review of thirty-eight sources by Ruth-Sahd identified an affective component to reflection.[30] Additionally, Belencky et al. and Gilligan have argued that sharing personal feelings and being intuitive are qualities more associated with women's ways of learning.[55,56]

Additionally, the association element of the reflection scores of participants did not improve. The novelty of providing patient care and the time involved in proving competency demonstrations may have limited participants in the opportunity to follow a patient through an entire ADPIED sequence during this study. As a result, students were unable to provide consistent evidence in their blogs of assessing and modifying old knowledge, feelings, and attitudes to allow for new and future learning experiences.

Within the intervention group (UTDB), 40 percent of the participants showed a distinct improvement in their levels of reflection, while 56 percent did not. Plausible explanations for this phenomenon might include students' preference for traditional passive educational methods that do not require student involvement. Indeed, anecdotal evidence from student comments suggested that novice clinicians might find reflective learning different and difficult.[30] All UTDB participants were informed of the importance of reflective blogging; however, there may have been a perception that blogging manifested the principal investigator's personal agenda.[30] Potentially, dental hygiene students are driven by grades; thus, the low-stakes blog may have influenced these students' compliance with reflective blogging. The principal investigator tried to be cognizant of the drive for grades by leading discussions at several class meetings during the study on the importance of reflection in learning and critical thinking as recommended by the literature.[43,46,57] Because the only stipulation for blogging per the course syllabi was a required number of blogs, according to blog date stamping some students posted all required blogs in one day or even one hour. These postings did not provide the principal investigator opportunities to evaluate those students' blogs over the eight-week study, nor did they provide students with an opportunity for reflection over time.

Previous blogging piloted by the principal investigator provided anecdotal reports from students indicating that when the course director posted and responded on the blog, students were more cooperative knowing they were being "heard" by the course director. The literature has noted that the instructor's involvement has a positive influence on student reflection in addition to the potential for immediate feedback regarding quality and consistency of blogs.[42-46]

In addition, some students forgot about the guiding questions and simply blogged about stress over course requirements and competencies they needed to complete, using the blog as an arena to share negative comments and feelings. While there may be some advantage to this type of atmosphere for student sharing on a blog as they do with MySpace and Facebook, for this study's purpose, the blog was meant to be limited to reflection on clinical learning.

Correlation Between Critical Thinking and Reflection

Correlation analysis between HSRT scores and rubric scores within the intervention group (UTDB) adds to existing data suggesting a relationship between core cognitive skills of critical thinking and elements of reflection.[17,23,24,26,27,29,36,45,52,58] These findings related to blogging activities of dental hygiene students are related to Baker's review of influential works on reflection and critical thinking by Boyd and Fales, Schön, Ennis, and Mazlow.[16,23,34,38,39] Baker suggested that journaling using various media is an effective strategy to promote reflection.[23] The following is an example of how the elements of reflection and critical thinking skills may be related in the clinical reasoning process. The dental hygiene student providing comprehensive patient care might share personal experience (attending to feelings), relate and integrate old and new knowledge (association) to create original knowledge or new thoughts (integration), self-assess these new thoughts (validation), apply them to learning (appropriation), and finally demonstrate the ability to reflect by committing to new actions (outcome of reflection). In reflecting, this same student may synthesize ideas from complex to basic (analysis) and judge the value of data, knowledge, and/or beliefs (evaluation), as well as use inductive and deductive reasoning skills. In this study, there were no correlations with the cognitive skill inference. It is important to note that the results of this study do not imply a causal relationship between critical thinking and reflection.

Blogging, journaling, and reflective writing to promote critical thinking have potential for further research.[29,36,44-46] While this study suggested that blogs may be beneficial as a reflective learning tool to enhance critical thinking, longitudinal studies using randomization are needed to determine if blogging using guiding questions based on the process of care and other significant competencies promotes reflection and critical thinking.

Limitations

Writing in a blog has statistical conclusion validity because a correlation between critical thinking and writing has been demonstrated in previous research studies.[23,26,29,32,36,49,50] Threats to internal validity of this study were minimized by having the principal investigator not participate in the blogging, having all blogs downloaded and deidentified by a colleague, evaluating reflection using key themes, completing two measurements of reflections, and statistically analyzing the reflection rubric.

Potential effects of history and maturation provide a plausible explanation for improved HSRT scores in both groups. Because there is evidence that critical thinking skills will improve with educational strategies like reflection that span the curriculum and are ongoing processes, the eight-week length of this study was the most important limitation.[29,30,34,39,59] Additionally, lack of availability of current national demographic data, nonrandomized sampling methods, and the small sample size preclude generalization of results beyond the study sample.

A longitudinal study with a randomized sample more representative of students in all dental professions would serve to strengthen the value of blogging as a reflective learning tool. Additionally, studying the implementation of blogging across the curriculum utilizing Web 2.0 blogging platforms that are more intuitive and interface in course management software, like Blackboard or Moodle, in a variety of dental/allied dental education settings would allow analysis of more robust data related to reflective abilities and critical thinking skills of students.

Conclusion

In this study, results indicated that blogging did not have a direct impact on participants' critical thinking as measured by the HSRT. However, the participants who blogged demonstrated improvement in their levels of reflection. Furthermore, correlation analysis of participant HSRT subscale scores in analysis, evaluation, inductive reasoning, and deductive reasoning and pre- and post-reflection rubric composite and element of reflection scores in attending to feelings, association, integration, validation, appropriation, and outcome of reflection suggested that, for these study participants, core cognitive skills for critical thinking may be related to elements of reflection.

The results of this study were consistent with research findings suggesting that allied dental and dental education need to continue to explore options for teaching critical thinking. While this study suggests blogs may be beneficial as a reflective learning tool to enhance critical thinking, longitudinal studies using randomization are needed to determine if blogs increase critical thinking. Future students will be confident in their technological abilities, be increasingly perceptive with Web 2.0 technology, and demand the social connectedness of media.[40] On a basic level, the blog can serve as another form of communication between students and faculty. Blogging could be integrated throughout the curriculum as a forum to encourage discourse and discussion on pertinent topics and for educational methodologies such as problem-based learning, clinical rounds, service-learning, and case studies that encourage critical thinking. This sharing of information in a blog may ultimately be a method of providing students as well as practicing dental professionals with opportunities for reflection to enhance critical thinking as well as collegial sharing of knowledge that can, in the end, improve the quality of care.

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