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Understanding Pedagogical Approaches on Student Learning Styles

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Abstract

The purpose of the study was to evaluate the effect of experiential learning approaches using various pedagogies that have been incorporated in dental education on students' learning styles. Harvard School of Dental Medicine (HSDM) has recently redesigned the predoctoral curriculum to reinforce team-based discussion and to promote self-directed learning and it was necessary to investigate whether the change in pedagogical approach to teaching had any influence on how students learn. Kolb's Learning Style Inventory Survey (KLSI version 3.1) was administered to three classes (Group 1: New curriculum; medical science foundation year, Group 2: new curriculum; dental science foundation year, and Group 3: Old curriculum) at HSDM. Group 1 and 2 experienced the newly redesigned curriculum which emphasizes case-based collaborative learning and flipped classroom, and Group 3 used the old curriculum with lecture-based learning and problem-based learning tutorial cases. The learning styles of students in the previous and new dental curricula were compared. The results showed that the interactive pedagogical approaches could affect students' individual learning style and enhance a reflective learning style in adult learners. Course redesign on the educational experience of students should consider applying multiple teaching strategies in the curriculum to accommodate varying learning styles and address the learning needs of students in a collaborative learning environment.

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Introduction

Dental and medical curricula are transforming to address the emerging needs of self-directed and self-reflective learning, long-term knowledge retention, and clinical applications [1]. Traditionally, dental education places an emphasis on content and skills transfer. However, this lecturer-centered teaching strategy has been revealed to diminish creativity, curiosity, and learning motivation [2]. Broader issues in dental education, such as the integration of basic science and clinical dentistry, knowledge retention and application, critical thinking skills, and utilization of technology to create a student-centered pedagogy, need further development and refinement.

In the past few decades, educational studies on learning styles have emerged in healthcare professional education [3-6]. Beyond the dynamic learning processes, students come from diversified cultural backgrounds with varying previous training and experience [7]. Students may, therefore, develop different preferences to perceive, process, retain and recall the information or skills they are trying to learn [8]. Different learning styles should be considered as individual preferences, rather than one being superior to another [6]. Misalliances between teaching and learning styles may adversely impact learning efficiency [4]. In this regard, educators are encouraged to appreciate various learning styles and employ multiple teaching modalities to accommodate students' needs in learning.

Multiple scales and classifications of learning styles have been used in higher education [9,10]. Kolb's Experiential Learning Theory (ELT), proposed by David Kolb, is one of the most recognized classical theories for adult learning [11]. According to the ELT, learning is a process of organizing and internalizing knowledge and experiences by thinking and reflecting [11,12]. The ELT defines learning processes with perceiving and processing continua [12] (Figure 1). On the perceiving continuum, a learner perceives experiences either through Concrete Experience (CE; feeling) or Abstract Conceptualization (AC; thinking) [12]. On the processing continuum, a learner internalizes experiences either through Reflective Observation (RO; watching) or Active Experimentation (AE; doing) [12]. With these two continua as vertical and horizontal axes, learning styles can be divided into four quadrants based on a learner's natural inclination: Diverging (CE/RO), Assimilating (AC/RO), Accommodating (CE/AE), and Converging (AC/AE) [12].

People with a Diverging learning style view actual scenarios from various aspects and tend to observe rather than taking action, and those with an Assimilating learning style understand a wide range of information by putting it into a concise, logical format. Learners with an Accommodating style learn primarily from hands-on experiences and may rely on others for information rather than technical analysis. People with a Converging learning style actively tackle technical problems and make decisions based on available information and logical analysis. Beyond these four primary learning styles, learning is also a dynamic process and individuals with a predominant learning mode may also utilize different learning modes (i.e., CE, AC, RO, and AE) based on the circumstances [11].

Experiential learning using various pedagogies has been incorporated in dental education recently. Interactive pedagogical approaches can foster active learning and critical thinking, and enhance students' performance [13]. To fully engage our learners with all learning styles, faculty should consider applying multiple teaching strategies to meet learners' needs whether the pedagogical approach has affected their individual learning style. Harvard School of Dental Medicine (HSDM) has recently redesigned the predoctoral curriculum to reinforce team-based discussion and promote self-directed learning. The pedagogical approaches were meant to encourage students to learn through increased peer-to-peer interactions and team learning in a collaborative learning environment. Though learning styles may not be the sole contributing factor for successful implementation of a new curriculum, it was useful to evaluate whether the change in pedagogical approach to teaching influenced how students learn. In addition, the association between students' learning preferences and their performance in the Objective Structured Clinical Examination (OSCE) was explored.

Methods

The current study protocol was approved by the Harvard Medical School and Harvard School of Dental Medicine Institutional Review Board (number: IRB15-3864).

The reorganization of the HSDM curriculum was implemented in August 2015 and one of the major changes in this curriculum was the incorporation of a Case-Based Collaborative Learning (CBCL) pedagogical approach [13]. The CBCL method incorporated multiple teaching methodologies in classroom activities, including flipped classroom, problem-based learning, case-based learning, team-based learning, and peer-to-peer learning, to create a dynamic and interactive learning environment.

Kolb's Learning Style Inventory Survey (KLSI version 3.1) was administered to the three classes at HSDM. The learning styles between the previous and new dental curricula were compared. Among these three classes, two used the new curriculum, which emphasizes case-based collaborative learning, including Group 1 in the medical science foundation year and Group 2 in the dental science foundation year. Group 3, on the other hand, used the old curriculum which mixed lecture-based learning and problem-based learning tutorial cases. The data from the three groups were collected and analyzed to correlate pedagogical approach to students' learning styles and student performance in OSCE for comparison.

Univariate analysis was first performed to describe the students' characteristics for each class, including gender and undergraduate major distribution, average Objective Structured Comprehensive Examination (OSCE) score, overall and science Grade Point Averages (GPA), Dental Admission Test (DAT), and Physics Aptitude Test (PAT). The distribution of learning style preferences for each group and the average OSCE score for each learning style preference were assessed.

The Fisher's exact test was used to examine the distribution of learning style preference by group, gender, and undergraduate major. Lastly, the difference in OSCE score with the dental curricula and learning style preferences was assessed using linear regression. The crude and adjusted average OSCE score difference was reported with the corresponding 95% confidence intervals (95% CI). In the full model, gender, undergraduate major, and type of dental curriculum were adjusted for. All statistical analyses were performed using Stata/MP 16.1 (StataCorp, College Station, TX), and alpha was set at 0.05 to determine statistical significance.

Results

Among the three selected groups, 78 students completed the Kolb's Learning Style Inventory Survey (KLSI version 3.1)

(participation rate=75.7%). Most students had science as their undergraduate major (87.7%). Except for Group 3, there were more female students who participated in the study. All three groups were similar in their average OSCE and admission data including the GPA, science GPA, DAT and PAT scores.

Distribution of learning preferences among groups was statistically different (Table 2). Group 1 (new curriculum; medical foundation year) consisted of mainly 57.1% Converging, followed by 20% Assimilating, 11.4% Accommodating and 11.4% Diverging. Majority of Group 2 (new curriculum; dental foundation year) were Assimilating (50%), followed by an equal distribution of Converging and Diverging (21.9%), and only 6.3% were Accommodating. Similar to Group 1, Group 3 (old curriculum) mainly consisted of Converging (45.5%), followed by Assimilating (36.4%), and 18.2% Accommodating (Figure 2). Comparing students in their medical science foundation year (first year of dental school) to dental science foundation year (second year of dental school), the learning style preference shifted from Converging to Assimilating. Students trained using the CBCL pedagogy exhibited significantly higher Diverging learning style than students in the model of a traditional lecture format.

More than a third of the dental students in the cohort preferred learning by thinking over feeling in the perception continuum (Figure 3). In the processing continuum, the distribution of preferences between doing and watching was statistically significant among the groups. While Group 1 and Group 3 preferred doing over watching, most of the students in Group 2 preferred watching over doing in their dental foundation year.

Based on our analysis, students that used either the old or the new dental curriculum exhibited comparable academic performance (Table 3). No statistically significant differences were identified between learning styles and OSCE performance, even after adjusting for students' gender, undergraduate major, and the dental curriculum (Figure 4). Additionally, no differences were found in OSCE scores comparing students' preference of learning styles.

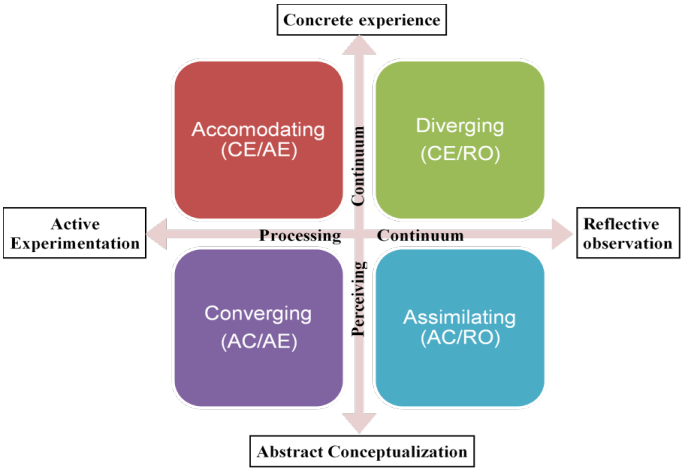

Figure 1: Classification of learning styles based on Kolb's experiential learning theory (Adapted from Dalal A. ALQahtani and Sara M. Al-Gahtani with permission from Journal of Dental Education. Copyright © 2014 John Wiley & Sons, Inc.).

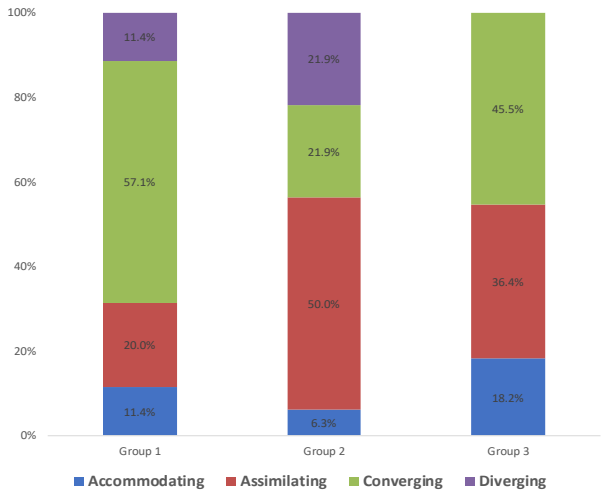

Figure 2: Learning style preference distribution per group
*Fisher's exact test indicated a significant difference in the distribution of learning style preference among groups.

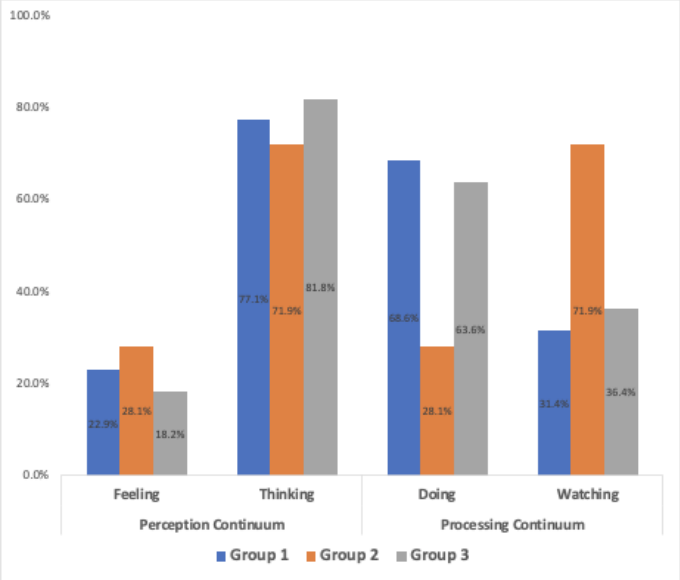

Figure 3: Preference of inner cognitive process by each continuum
*Fisher's exact test indicated a significant difference in the distribution of processing continuum among groups.

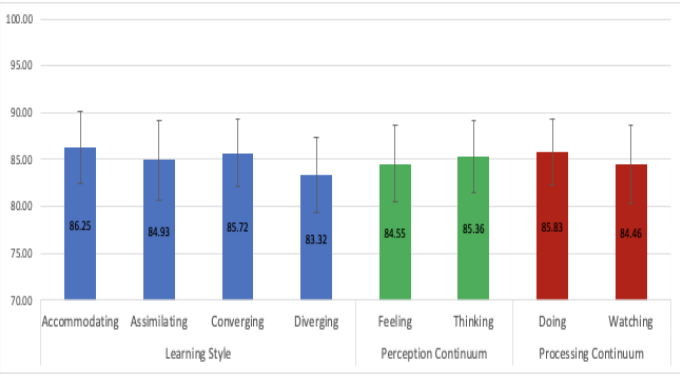

Figure 4: Average OSCE scores by learning styles.

Table 1: Characteristics of students by group.

Characteristics	Overall Frequency(n)/ mean	Percent/ SD[a]	Group 1		Group 2		Group 3	
			Frequency(n)/ Mean	Percent/SD[a]	Frequency(n)/ Mean	Percent/SD[a]	Frequency(n)/ Mean	Percent/SD[a]
Overall	**78**	**100.0%**	**35**	**44.9%**	**32**	**41.0%**	**11**	**14.1%**
Gender								
Female	45	57.7%	21	46.7%	21	46.7%	3	6.7%
Male	33	42.3%	14	42.4%	11	33.3%	8	24.2%
Undergraduate major								
Science	70	89.7%	33	47.1%	30	42.9%	7	10.0%
Not science	8	10.3%	2	25.5%	2	25.0%	4	50.0%
OSCE[b]	85.16	3.88	84.97	3.62	85.43	4.34	84.98	3.57
GPA[c]	3.85	0.14	3.87	0.10	3.84	0.17	3.88	0.12
Science GPA	3.85	0.16	3.87	0.10	3.81	0.21	3.86	0.15
DAT[d] score	23.22	1.77	23.41	2.00	23.16	1.61	22.80	1.48
PAT[e] score	21.53	2.09	22.06	1.98	20.91	2.20	21.70	1.64

[a] Standard Deviation, [b] Objective structured clinical examination, [c] Grade Point Average, [d] Dental Admission Test, [e] Physical Abilities Test.

Table 2: Learning Style preference by students' characteristics by group.

Variable	Accommodating	Assimilating	Converging	Diverging	*p*-value
	N (%)	N (%)	N (%)	N (%)	
Class					
Group 1	4 (11.4)	7 (20.0)	20 (57.1)	4 (11.4)	0.021*
Group 2	2 (6.3)	16 (50.0)	7 (21.9)	7 (21.9)	
Group 3	2 (18.2)	4 (36.4)	5 (45.5)	0 (0.0)	
Sex					
Female	7 (15.6)	14 (31.1)	18 (40.0)	6 (13.3)	0.355
Male	1 (3.0)	13 (39.4)	14 (42.4)	5 (15.2)	
Undergraduate Major					
Science	5 (7.1)	25 (35.7)	29 (41.4)	11 (15.7)	0.091
Non-Science	3 (37.5)	2 (25.0)	3 (37.5)	0 (0.0)	

***p*-value:** calculated using Fisher's exact test, *Significant at alpha=0.05.

Table 3: Linear Regression Analysis of the Objective structured clinical examination (OSCE) for dental students, comparing the average score with the learning style preference, their perception continuum, and their processing continuum.

Variable	Crude difference in OSCE score	95% Confidence Interval	Adjusted difference in OSCE score[a]	95% Confidence Interval
Dental Curriculum				
Old Curriculum	Ref	Ref	Ref	Ref
New Curriculum	1.09	(-0.60, 2.78)	1.08	(-0.73, 2.89)
Learning Style Preference				
Accommodating	Ref	Ref	Ref	Ref
Assimilating	-1.32	(-4.42, 1.78)	-0.86	(-4.21, 2.48)
Converging	-0.53	(-3.57, 2.51)	-0.11	(-3.37, 3.14)
Diverging	-2.93	(-6.51, 0.64)	-2.52	(-6.40, 1.37)
Perception Continuum				
Feeling	Ref	Ref	Ref	Ref
Thinking	0.80	(-1.24, 2.85)	1.07	(-1.02, 3.16)
Processing Continuum				

Doing	Ref	Ref	Ref	Ref
Watching	-1.36	(-3.10, 0.37)	-1.22	(-3.02, 0.57)

[a] Adjusted for gender, undergraduate major, dental curriculum.

Discussion

One of the goals of our recent medical and dental curricula redesign was to provide students with a core clinical foundation that is integrated across the basic, social, population, and clinical sciences. The incorporation of CBCL pedagogies provided an interactive classroom environment and helped foster a self-directed and self-reflective learning experience. Notably, the millennial generation's unique features have been acknowledged as a drive for the curricular reform of health professions [14]. With varying literature sources, generational boundaries of the millennial generation were set from 1978 to 1984, with the end proposed to be 1990 to 2001 [14]. The millennial generation was described to be optimistic, intelligent, goal-oriented, ambitious, interested in learning, multitaskers, respectful of cultural differences, collaborative, desiring flexibility, needy for feedback, and anticipatory of immediate response [14,15]. Learning is a complex and dynamic process, and individuals may utilize different learning styles to obtain or internalize knowledge based on the circumstances. The current study aimed to explore the effect of pedagogical changes on learning styles of adult learners at HSDM and did not intend to categorize students simply based on their predominant learning preference.

The initiative to create a dental curriculum to integrate basic science and clinical dentistry throughout the entire four years, offering longitudinal continuity of cross-disciplinary learning, reflected an effort for a curriculum that fosters mentorship for students. In this integrative dental curriculum, multiple pedagogies were utilized to create a dynamic and collaborative learning environment, such as flipped classroom and team-based learning in addition to the mini-lectures. Students should gradually develop essential knowledge in dental medicine, critical thinking skills and an active learning attitude in utilizing their knowledge in patient care.

Changes in pedagogical approaches to teaching and learning started with the incorporation of the flipped classroom educational methodology in dental anatomy [16,17]. HSDM redesigned the predoctoral curriculum in 2015 to incorporate Case-Based Collaborative Learning (CBCL) methods to meet the continuously evolving medical and dental education starting in the first year of the predoctoral program. The CBCL method incorporated into the flipped classroom aimed to reinforce team-based discussion and promote self-directed learning. The educational methodology emphasizes student accountability for their own learning in order to contribute to team discussions and participate in the class. These learning models also encourage students to learn from each other through increased peer-to-peer interactions and team learning in a collaborative learning environment. The role of instructors is changed from deliverer of content to facilitator and guide during educationally purposeful, interactive classroom activities.

Most students majored in basic sciences were admitted to dental schools as an abstract learner, and their learning styles might change over time in the program [18,19]. The HSDM students exhibited Converging learning style in their medical foundation year, and then switched to the Assimilating learning style. On the other hand, dental students in Saudi Arabia preferred an Assimilating style during their early preclinical years, and then they switched to Diverging style during their later clinical years [19]. Interestingly, students trained using CBCL exhibited significantly higher Diverging learning style, suggesting that the CBCL approaches may enhance the reflective learning mode.

The evolution of learning styles within the curriculum has been reported in other health professions [20]. Medical students demonstrated a significant transition in learning from an abstract-reflexive style to an abstract-active one later in the clinical years, [11] which may indicate an adaptation to the curriculum, evolving from a lecture-based, teacher-centered to a problem-based, patient-centered model. According to our data, no correlation was identified between a particular learning style and academic performance, similar to the previous studies [19-21]. More research could be done to demonstrate the impact of learning styles on dental students' learning and their subspecialty interests.

In light of the pedagogical change to the curriculum, a prospective student's learning style was considered an important question to explore as part of the admissions review process. The predictive value of learning styles in this study was questionable as a sole determinant of student performance in the overall student performance in dental school. Even though non-cognitive indicators can be challenging to interpret that are used in the admissions process, these values may provide unique perspectives in helping students achieve academic success in dental school and the dental profession. Responsibilities of Admissions Committee members include recruitment of diverse applicants and the admissions committee should continue to perform a comprehensive review of various factors, including individual's motivation and an active learning attitude in selecting the candidates for admissions.

Faculty development effort was necessary to train the faculty and staff in this curriculum reform, and institutional resources were necessary to implement and sustain this pedagogical approach. The new educational model will continue to explore and offer faculty development opportunities, including program development, curriculum, instruction design, faculty development, student support and management of class dynamic. Continued planning and evaluation of the program is essential, as well as faculty development and training in the current curriculum.

Some major limitations of the current study were identified, including the small size of our population due to the small class size at HSDM, which limits our ability to detect smaller differences in the students' academic performance. The power of our study was 0.70 to detect the difference we observed. In addition, the varying participation rate observed across the groups could potentially contribute to selection bias in the study, especially, the distribution of gender and their undergraduate major. However, the admission scores of participating students across the groups were indistinguishable, and we adjusted for both gender and undergraduate major in our models to estimate the differences in OSCE performance. Admissions selection data and its relationship to outcomes measured in student performance in the dental curriculum that can provide information to improve the current practice and identify future directions are being explored further.

Conclusion

The interactive pedagogical approaches can enhance a reflective learning style, and encourage students to learn through increased peer-to-peer interactions and team learning in a collaborative learning environment. The impact of course redesign on the educational experience of students needs to be continuously refined and measured to support the new educational approach and to acclimate students to the various learning styles.

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