

# Problem-Based Learning at the Harvard School of Dental Medicine: Self-Assessment of Performance in Postdoctoral Training

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*Abstract:* Problem-based learning (PBL) was implemented into the dental curriculum at the Harvard School of Dental Medicine (HSDM) in 1994 with an expectation that this pedagogy would enhance students' critical thinking and communication skills as well as general professional competencies. Previous studies have described several aspects of the outcome of PBL curricula at the predoctoral level. However, there is no information available on the perceptions and performance of PBL graduates during their postdoctoral training in dentistry. The purpose of this study was to evaluate the effect of PBL methodology on the performance of HSDM graduates during their postdoctoral training in comparison with their non-HSDM (traditional) co-residents. Surveys containing traditional knowledge-based criteria, preclinical and clinical criteria, and PBL criteria were sent to HSDM graduates from the classes of 2002 through 2004 who were in postgraduate training programs. The HSDM and traditional graduates were asked to evaluate and compare their performance in selected areas with those of their co-residents from either a PBL curriculum or a traditional curriculum. The directors of each program were also asked to assess HSDM graduates relative to other graduates in the program based on the same aspects. Overall, HSDM graduates rated themselves more highly than non-HSDM graduates on all competencies. No significant difference between HSDM and non-HSDM responses was found in general dental knowledge, specialty specific knowledge, preclinical skills, clinical skills, communication with staff, and patient education, whereas significant differences ( $p < 0.05$ ) were found for communication with patients, critical thinking, independent learning, performance in small group settings, self-assessment, and teamwork. The data obtained from the program directors revealed corresponding results. The HSDM graduates' capacity for independent learning was rated as "excellent" by 65.31 percent of the directors and 80.95 percent of the HSDM graduates themselves. These findings suggest that the performance of HSDM graduates during their postdoctoral training met expectations and were similar to non-HSDM graduates for traditional residency program competencies. However, the PBL training appears to provide HSDM graduates with enhanced abilities in independent learning, communication, and cooperation skills.

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Problem-based learning (PBL) began in the McMaster University medical program in 1965 with a goal of improving students' ability to apply knowledge in clinical contexts, increase retention of information, and develop lifelong learning habits.<sup>1</sup> Many health profession schools have adopted various forms of PBL methods, including Harvard University where a PBL-integrated New Pathway program (NP) was introduced into the medical school in 1985.<sup>2</sup>

Numerous studies have compared the effects of PBL and a traditional curriculum on the satisfaction in learning environment, perception, and performance of both faculties and students.<sup>3</sup> The data revealed both pros and cons of PBL methods. However, the conclusion drawn from these studies

indicated positive effects<sup>4-9</sup> or, otherwise, neutral effects of the PBL method.<sup>10-13</sup>

PBL was first implemented in dental classes at the Harvard School of Dental Medicine (HSDM) in fall 1994. The HSDM predoctoral curriculum has transitioned from a traditional curriculum to a PBL-hybrid curriculum in both preclinical and clinical education, with an expectation that this pedagogy would enhance the students' critical and interdisciplinary thinking and communication skills as well as their general professional competencies.<sup>4,14</sup>

Previously published studies have reported several aspects of the effects of PBL methodology on the competencies of HSDM students. These studies demonstrated that PBL has been effective at increas-

ing National Board Dental Examination (NBDE) Part I scores, graduation rates, and percentage of graduates entering postgraduate education programs, as well as decreasing attrition rates.<sup>4</sup> However, the implementation of PBL at HSDM has not universally increased student productivity in research.<sup>11</sup>

Several studies in medical education have shown the positive effect of PBL on the performance of graduates during their practice or residency training. A randomized controlled trial study conducted at Harvard Medical School showed that residents who graduated from the PBL-integrated New Pathway program rated their preparation to practice humanistic medicine higher than did traditional students and expressed more confidence in their ability to manage patients with psychosocial problems. A study by Antepohl et al. showed that PBL graduates tended to pursue a higher education and they were satisfied with their undergraduate education and preparation for communication with patients, collaboration with other health professionals, and development of critical thinking as well as scientific attitudes.<sup>3</sup> Results from several studies carried out in other institutes also indicated superior performance of the graduates from PBL medical programs in professional practice or postdoctoral training especially in the areas of self-directed, lifelong learning, communication with patients,<sup>15</sup> cooperation skill, problem-solving skill, and ability to work independently.<sup>16</sup> Despite the differences between characteristics of PBL and non-PBL graduates, a recent study showed that there were no differences with respect to the main occupation (clinician or others), practice location (urban or rural), or employment sector (public or private) after graduation between medical student graduates from traditional and nontraditional curricula.<sup>17</sup>

It has been accepted that resident evaluation is more reliable if the assessments are based on impressions derived from multiple sources of information, for example, direct observation interactions as well as from more than one evaluator. Supervisors' evaluation of residents' performance has been included in several medical education studies<sup>15,18,19</sup> and has been shown to be valuable in resident performance evaluation.<sup>19,20</sup> However, the investigators were not able to identify any articles in the dental literature that reported the use of multiple evaluators in a PBL outcome study.

The goal of this study was to extend the information on the outcomes of PBL education by examining the performance of HSDM graduates during their postdoctoral training. The study was

designed to test the hypothesis that HSDM graduates perform well during their postdoctoral training, especially in the areas considered to be enhanced by PBL curricula including critical thinking, teamwork, communication skills, and self-directed learning. To test this hypothesis, two types of data were collected and analyzed: 1) comparison of competency self-assessments completed by HSDM graduates and graduates of other schools, and 2) comparison of self-assessments completed by HSDM graduates and graduate program directors' ratings of the competency of residents from HSDM. In addition, graduates' future plans were collected to determine whether HSDM and non-HSDM graduates had different preferences for their future careers.

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## Methods

A questionnaire was distributed in January 2005 to eighty-four HSDM graduates from the classes of 2002, 2003, and 2004 who were in postgraduate training across the United States. These graduates represented 82.36 percent of the total population who graduated from HSDM during those three years. A co-resident of each of these eighty-four HSDM graduates who went to a non-HSDM, non-PBL, lecture-based school was also asked to fill out the questionnaire and served as the control group. In addition, the program directors (fifty-eight directors) of each HSDM graduate's postgraduate program were asked to complete a questionnaire comparing HSDM graduates to other residents who were graduates of traditional dental education programs that did not employ PBL.

A questionnaire was created and approved by the Harvard Medical School Office for Research Subject Protection. The questionnaire was a modification of a questionnaire created for a previous study by Santos-Gomez et al.<sup>15</sup> and also was based on a questionnaire developed for the ACGME Outcomes Project by the Accreditation Council for Graduate Medical Education (ACGME). The questionnaire asked HSDM graduates to rate themselves in comparison with other residents (co-residents) in their advanced graduate programs who had graduated from non-PBL, lecture-based dental schools other than HSDM on twelve selected competencies on a four-point scale, which consisted of excellent, good, fair, and poor. These twelve competencies were organized into three categories. The first category includes competencies expected to be enhanced by

PBL including communication with patients and staff, critical thinking, independent learning, performance in small group settings, patient education, self-assessment, and teamwork. The second category includes competencies known to be equal between PBL and non-HSDM students including general dental knowledge and knowledge that is specific for a specialty area; and the final category includes competencies that are speculated to be strengths of a traditional curriculum including preclinical and clinical skills. The competencies were placed in a random order in the questionnaire to control bias.

The HSDM graduates were asked to randomly give the questionnaire to one co-resident in the program who had been trained in a non-HSDM dental school. Each co-resident was asked to assess himself or herself on the twelve competencies. The director of each program was also asked to assess HSDM graduate(s) in the program on the selected competencies. The questionnaire included an overall evaluation in which the directors were asked to rate the HSDM graduates comprehensively, considering all aspects of performance, using a scale that consisted of superior, satisfactory, marginal, and unsatisfactory.

The questionnaire completed by the HSDM and non-HSDM graduates also included a question on the graduates' future career plans with the response options being full-time clinical instructor, full-time researcher, part-time clinical instructor, part-time researcher, and private practitioner. The graduates were allowed to select more than one option that is in their plan. To prevent misinterpretation, definitions of the competencies were enclosed with the questionnaire. Follow-up letters were sent to the HSDM graduates who did not respond one month after the first letters were sent.

Differences between the responses provided by HSDM and non-HSDM residents were analyzed

with the Mann-Whitney test with significance set at  $p < 0.05$ . The responses by HSDM-trained residents and their directors were paired and analyzed with the Wilcoxon signed ranks test to determine the degree of correspondence and to investigate the direction of any differences that were identified from analysis of the responses.

## Results

Of the subjects who were sent the questionnaires, responses were available for forty-two respondents from HSDM, thirty-eight from non-HSDM, and fifty-one from program directors (response rates are shown in Table 1). Figure 1 shows the distribution of the respondents by the type of residency program. More than 45 percent of the respondents were in orthodontic advanced graduate programs, and about 24 percent of the respondents were in periodontal programs. The others were in prosthodontics, endodontics, pediatric dentistry, oral surgery, or General Practice Residency/Advanced Education in General Dentistry (GPR/AEGD) programs. However, since there was only one AEGD resident who graduated from HSDM responding to the questionnaire and there was no matched non-HSDM resident, those data were excluded. Results of the graduates' self-assessments are shown in Table 2, which displays the percentages of the total number of responses in the four rating categories: excellent, good, fair, poor. The "non-applicable" responses were not included. The competencies expected to be enhanced by PBL are marked with asterisks in Table 2 and are highlighted in subsequent tables.

Overall, HSDM graduates rated themselves more highly than non-HSDM graduates on all competencies. For the eight items expected to be enhanced by PBL, the differences between HSDM and non-HSDM graduates' responses were statistically significant for six of these competencies.

HSDM graduates rated themselves the highest for the competency "independent learning"; 80.95 percent self-assessed their skill level as "excellent" for this item. In contrast, 29.73 percent of the non-HSDM believed they were excellent in independent learning. The highest rating for the non-HSDM graduates was "ability in communication with staff"; 51.35 percent self-assessed their skill level as "excellent" for this item.

Table 3 compares the self-assessment ratings for all forty-one HSDM and thirty-eight non-HSDM

**Table 1. Survey response and return rates**

	Number of Questionnaires		
	HSDM	Non-HSDM	Director
Sent	84	84	84
Responded*	42	38	51
Returned**	6	6	5
% of Response	57%	43%	67%

\*Subjects who answered and sent back the questionnaire.

\*\*Unopened questionnaires that were returned either because of an address change or because the graduates were no longer in the program.

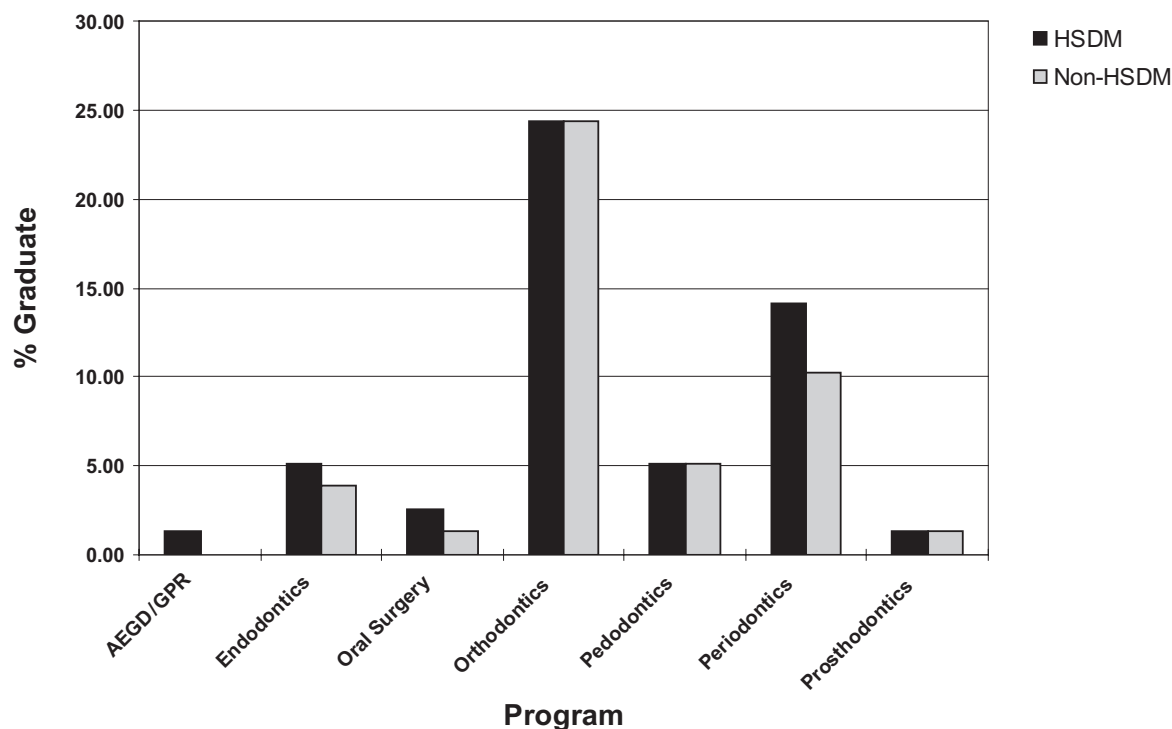


Figure 1. Program distribution of the HSDM and non-HSDM respondents (n=80), shown in percentage of graduates

residents combined without regard to type of post-graduate program. The statistical analysis displayed in Table 3 showed that there was no significant difference found for general dental knowledge, knowledge specific for specialty, preclinical skills, clinical skills, communication with staff, and patient education. However, there was a significant difference ( $p < 0.05$ ) comparing HSDM and non-HSDM ratings in communication with patients, critical thinking, independent learning, performance in small group settings, self-assessment, and teamwork.

Table 4 shows responses from the graduate program directors who were asked to evaluate HSDM graduates' performance in their program. The directors' highest rating was in the category of independent learning, where 65.31 percent of the HSDM graduates were evaluated to be excellent. The statistical analysis shown in Table 5 shows no significant difference ( $p > 0.05$ ) between the directors' evaluations and HSDM graduates' self-assessments in twenty-seven instances where responses were available from both director and resident. However, there were seven competencies where the directors rated HSDM graduates less favorably than the

HSDM graduates' self-assessment, and there were five competencies where the directors rated HSDM graduates more favorably than the HSDM graduates' self-assessment. However, none of these differences between residency director and HSDM graduates' ratings were significantly different.

The program directors' evaluation of the HSDM graduates' overall performance showed that 53.33 percent were rated as superior, 37.78 percent were rated as satisfactory, 6.67 percent were rated as marginal, and 2.22 percent were rated as unsatisfactory.

Residents' future career plans are shown in Figure 2. Most of the HSDM and non-HSDM residents planned to pursue their careers either as full-time private practitioners (57.58 percent of all non-HSDM and 26.83 percent of all HSDM respondents) or as part-time private practitioners who also worked as part-time clinical instructors in dental schools (33.33 percent of all non-HSDM and 43.90 percent of all HSDM respondents). Interestingly, 70.73 percent of the HSDM graduates expected to be involved in the academic field, either full-time or part-time, whereas 45.75 percent of non-HSDM respondents planned to work in academia.

**Table 2. Results of self-assessment of HSDM and non-HSDM graduates in each postgraduate program**

Program (n=HSDM/non-HSDM)	% of HSDM Graduates				% of Non-HSDM Graduates				
<b>ORTHODONTICS (n=19/19)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	10.53	42.11	47.37	0.00	15.79	31.58	52.63	0.93
Knowledge specific for specialty	5.26	0.00	42.11	52.63	0.00	10.53	47.37	42.11	0.54
Communication with patients*	0.00	5.26	10.53	84.21	0.00	5.56	44.44	50.00	0.18
Communication with staff*	0.00	5.56	33.33	61.11	0.00	5.26	52.63	42.11	0.54
Independent learning*	0.00	0.00	10.53	89.47	0.00	10.53	52.63	36.84	0.00
Teamwork*	0.00	5.26	21.05	73.68	0.00	5.56	61.11	33.33	0.10
Patient education*	0.00	5.26	47.37	47.37	0.00	5.56	61.11	33.33	0.71
Preclinical skills	0.00	11.11	61.11	27.78	0.00	22.22	50.00	27.78	0.71
Clinical skills	0.00	5.26	47.37	47.37	0.00	10.53	52.63	36.84	0.51
Critical thinking*	0.00	5.26	15.79	78.95	0.00	5.26	57.89	36.84	0.03
Performance in small group settings*	0.00	0.00	26.32	73.68	0.00	11.11	38.89	50.00	0.11
Self-assessment*	0.00	0.00	36.84	63.16	0.00	11.76	58.82	29.41	0.08
<b>PERIODONTICS (n=11/9)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	0.00	63.64	36.36	0.00	11.11	66.67	22.22	0.46
Knowledge specific for specialty	0.00	36.36	18.18	45.45	0.00	33.33	55.56	11.11	0.46
Communication with patients*	0.00	0.00	18.18	81.82	0.00	11.11	44.44	44.44	0.15
Communication with staff*	0.00	0.00	9.09	90.91	0.00	11.11	22.22	66.67	0.37
Independent learning*	0.00	0.00	9.09	90.91	0.00	11.11	66.67	22.22	0.01
Teamwork*	0.00	0.00	27.27	72.73	0.00	11.11	44.44	44.44	0.26
Patient education*	0.00	0.00	36.36	63.64	0.00	22.22	33.33	44.44	0.33
Preclinical skills	0.00	27.27	36.36	36.36	0.00	22.22	55.56	22.22	0.82
Clinical skills	0.00	0.00	60.00	40.00	0.00	11.11	44.44	44.44	0.82
Critical thinking*	0.00	0.00	36.36	63.64	0.00	11.11	66.67	22.22	0.10
Performance in small group settings*	0.00	0.00	18.18	81.82	0.00	22.22	44.44	33.33	0.05
Self-assessment*	0.00	0.00	27.27	72.73	0.00	11.11	77.78	11.11	0.01
<b>ENDODONTICS (n=4/4)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	0.00	75.00	25.00	0.00	0.00	75.00	25.00	1.00
Knowledge specific for specialty	0.00	50.00	25.00	25.00	0.00	25.00	50.00	25.00	0.69
Communication with patients*	0.00	0.00	50.00	50.00	0.00	0.00	75.00	25.00	0.69
Communication with staff*	0.00	0.00	50.00	50.00	0.00	0.00	50.00	50.00	1.00
Independent learning*	0.00	0.00	50.00	50.00	0.00	25.00	25.00	50.00	0.89
Teamwork*	0.00	25.00	25.00	50.00	0.00	25.00	50.00	25.00	0.69
Patient education*	0.00	25.00	25.00	50.00	0.00	0.00	75.00	25.00	0.89
Preclinical skills	25.00	25.00	25.00	25.00	0.00	0.00	75.00	25.00	0.49
Clinical skills	0.00	50.00	0.00	50.00	0.00	0.00	75.00	25.00	0.89
Critical thinking*	0.00	0.00	50.00	50.00	0.00	25.00	50.00	25.00	0.49
Performance in small group settings*	0.00	0.00	75.00	25.00	0.00	25.00	50.00	25.00	0.69
Self-assessment*	0.00	25.00	50.00	25.00	0.00	0.00	75.00	25.00	0.69

<b>PEDODONTICS (n=4/4)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	0.00	75.00	25.00	0.00	0.00	75.00	25.00	1.00
Knowledge specific for specialty	0.00	0.00	0.00	100.00	0.00	0.00	75.00	25.00	0.11
Communication with patients*	0.00	0.00	25.00	75.00	0.00	0.00	50.00	50.00	0.69
Communication with staff*	0.00	0.00	25.00	75.00	0.00	0.00	25.00	75.00	1.00
Independent learning*	0.00	0.00	25.00	75.00	0.00	0.00	75.00	25.00	0.34
Teamwork*	0.00	0.00	0.00	100.00	0.00	0.00	25.00	75.00	0.69
Patient education*	0.00	25.00	25.00	50.00	0.00	0.00	33.33	66.67	0.89
Preclinical skills	0.00	0.00	50.00	50.00	0.00	0.00	100.00	0.00	0.34
Clinical skills	0.00	0.00	50.00	50.00	0.00	0.00	75.00	25.00	0.69
Critical thinking*	0.00	0.00	50.00	50.00	0.00	0.00	50.00	50.00	1.00
Performance in small group settings*	0.00	0.00	50.00	50.00	0.00	0.00	75.00	25.00	0.69
Self-assessment*	0.00	0.00	75.00	25.00	0.00	0.00	75.00	25.00	1.00
<b>PROSTHODONTICS (n=1/1)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
Knowledge specific for specialty	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
Communication with patients*	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	1.00
Communication with staff*	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	1.00
Independent learning*	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
Teamwork*	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	1.00
Patient education*	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	1.00
Preclinical skills	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
Clinical skills	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
Critical thinking*	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	1.00
Performance in small group settings*	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	1.00
Self-assessment*	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	1.00
<b>ORAL SURGERY (n=2/1)</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Excellent</b>	<b>p-value</b>
General dental knowledge	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Knowledge specific for specialty	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Communication with patients*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Communication with staff*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Independent learning*	0.00	0.00	50.00	50.00	0.00	0.00	100.00	0.00	0.67
Teamwork*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Patient education*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Preclinical skills	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.67
Clinical skills	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.67
Critical thinking*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Performance in small group settings*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67
Self-assessment*	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.67

\*Competencies expected to be enhanced by PBL.

## Discussion

PBL has been implemented in the predoctoral curriculum at HSDM for twelve years. Earlier studies conducted at HSDM demonstrated the benefits of this system. Our study was interested in the performance of HSDM graduates during their postdoctoral training, to examine if these students retained characteristics expected of a PBL student.

This study focused on the competencies relevant to professional practice, which could be categorized into three groups: the competencies expected to be enhanced by PBL, the competencies known to be equal between PBL and non-HSDM students, and the competencies speculated to be stronger in traditional curricula. The results from self-assessment showed that HSDM graduates rated themselves more highly than non-HSDM graduates on all competencies. This implies a higher confidence in their abilities. Statisti-

**Table 3. Comparison of self-assessment by all HSDM (n=41) and all non-HSDM (n=38) residents**

	% of HSDM graduates				% of non-HSDM graduates				p-value
	Poor	Fair	Good	Excellent	Poor	Fair	Good	Excellent	
Independent learning*	0.00	0.00	19.51	80.49	0.00	10.81	59.46	29.73	0.00
Communication with patients*	0.00	2.44	19.51	78.05	0.00	8.33	44.44	47.22	0.01
Teamwork*	0.00	4.88	21.95	73.17	0.00	11.11	47.22	41.67	0.02
Communication with staff	0.00	2.50	27.50	70.00	0.00	5.41	43.24	51.35	0.15
Performance in small group settings*	0.00	0.00	31.71	68.29	0.00	11.11	47.22	41.67	0.01
Critical thinking*	0.00	2.44	29.27	68.29	0.00	8.11	56.76	35.14	0.00
Self-assessment*	0.00	2.44	41.46	56.10	0.00	8.57	65.71	25.71	0.01
Patient education	0.00	7.32	39.02	53.66	0.00	11.43	48.57	40.00	0.25
Knowledge specific for specialty	2.44	14.63	31.71	51.22	0.00	13.51	54.05	32.43	0.27
Clinical skills	0.00	7.50	50.00	42.50	0.00	8.11	54.05	37.84	0.86
General dental knowledge	0.00	4.88	56.10	39.02	0.00	10.81	48.65	40.54	0.85
Preclinical skills	2.50	15.00	52.50	30.00	0.00	16.67	58.33	25.00	0.82

\*Items where the differences between HSDM and non-HSDM graduates' responses were statistically significant. Results of self-assessment of HSDM (n=41) and non-HSDM (n=38) graduates on selected competencies sorted by the percentage of "excellent" results of HSDM graduates. The competencies expected to be enhanced by PBL are screened.

**Table 4. Program directors' (n=51) evaluation of HSDM graduates' performance in postdoctoral training program**

	% of HSDM Graduates Rated in Each Performance Category			
	Poor	Fair	Good	Excellent
Independent learning	4.08	0.00	30.61	65.31
Communication with patients	2.08	2.08	47.92	47.92
Teamwork	2.13	8.51	34.04	55.32
Communication with staff	2.00	8.00	34.00	56.00
Performance in small group settings	2.04	4.08	38.78	55.10
Critical thinking	2.04	2.04	40.82	55.10
Self-assessment	4.44	4.44	42.22	48.89
Patient education	2.38	0.00	54.76	42.86
Knowledge specific for specialty	4.00	12.00	44.00	40.00
Clinical skills	4.08	12.24	46.94	36.73
General dental knowledge	2.08	4.17	45.83	47.92
Preclinical skills	2.33	16.28	48.84	32.56

Results of the program director evaluation (n=51) of HSDM graduates' performance in postdoctoral training program. The competencies expected to be enhanced by PBL are screened.

cal analysis showed significant differences ( $p < 0.05$ ) between the HSDM and non-HSDM graduate self-ratings for almost all of the competencies expected to be enhanced by the PBL method including ability in communication with patients, critical thinking, independent learning, self-assessment, teamwork, and performance in small group settings. On all of these competencies, HSDM graduates rated themselves one to two scores higher than non-HSDM graduates. In particular, more than 80 percent of HSDM graduates considered themselves to be excellent in conducting

independent learning. These results correspond with previous self-assessment studies, which also showed that the PBL graduates gave themselves higher ratings for these areas, especially in communication and independent learning skills as well as the ability to collaborate with others.<sup>15,21,22</sup> However, a significant difference was not found in communications with staff and patient education, which are expected to be one of the strengths of a PBL curriculum.

The results also showed that HSDM and non-HSDM graduates believed that they performed equally well in general dental knowledge and knowledge specific for their chosen dental specialty. It has been demonstrated in previous studies that the performance of PBL students in these areas is typically equivalent but not superior in comparison to traditionally educated students.<sup>21,22</sup> These results, which are generally consistent with previous research, indicate that the HSDM and non-HSDM students probably did not overestimate or underestimate their level of competency when completing the self-assessment surveys. More importantly, no significant differences were found between HSDM and traditional graduates for preclinical skills or clinical skills. There has been speculation that HSDM graduates' level of competency in procedural skills would be adversely affected by the reduction of laboratory time resulting from implementation of the PBL program at Harvard. The results presented here confirm findings from an-

**Table 5. Statistical comparison of the HSDM graduates' self-assessment and program directors' evaluation (n=27)**

	p value	% of Response		
		Same	Higher	Lower
Independent learning	0.07	59.3	11.1	29.6
Communication with patients	0.22	59.3	14.8	25.9
Teamwork	0.44	63.0	14.8	22.2
Communication with staff	0.93	59.3	22.2	18.5
Performance in small group settings	0.36	51.9	22.2	25.9
Critical thinking	0.24	51.9	18.5	29.6
Self-assessment	0.48	25.9	44.4	29.6
Patient education	0.45	44.4	33.3	22.2
Knowledge specific for specialty	0.05	48.1	11.1	40.7
Clinical skills	0.12	44.4	18.5	37.0
General dental knowledge	0.90	55.6	25.9	18.5
Preclinical skills	0.96	37.0	33.3	29.6

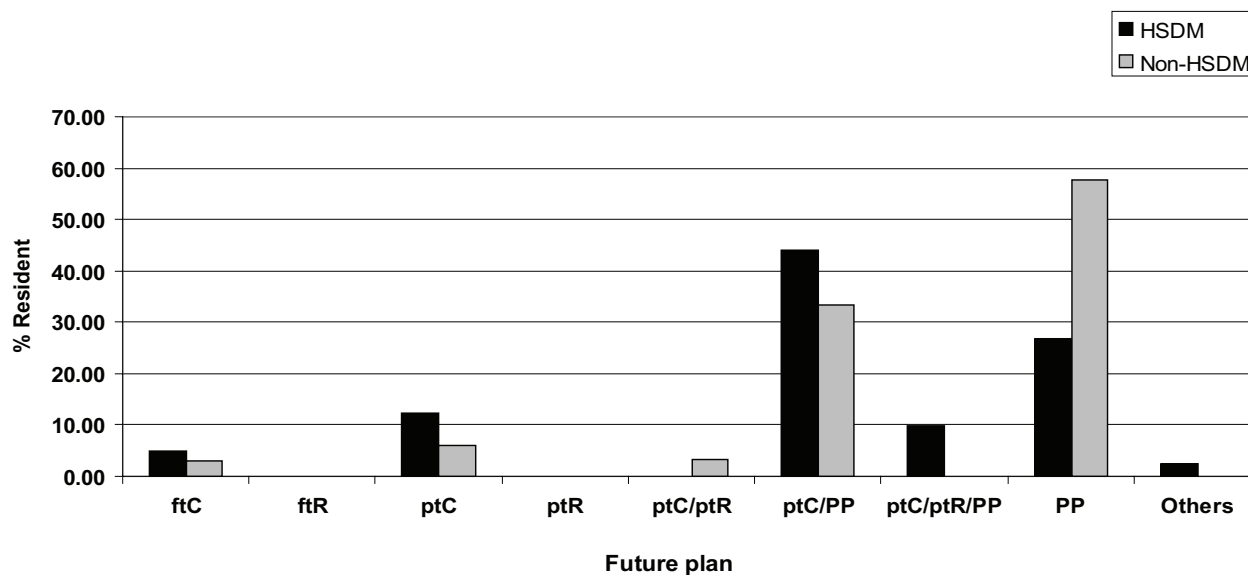
Statistical results of the comparison between the HSDM graduate self-assessment and program director evaluation (n=27): *Same* (the directors and HSDM graduates rated the performance similarly); *Higher* (the directors rated HSDM graduates more highly than the graduates did); *Lower* (the directors rated HSDM graduates less favorably than the graduates did). The competencies expected to be enhanced by PBL are screened.

other as yet unpublished study conducted at HSDM that showed the reduction of laboratory preclinical exercises at HSDM did not affect students' didactic and clinical performance.

The HSDM graduates' self-assessments and the evaluations completed by the program directors were generally similar. Program directors also rated HSDM graduates to be excellent in independent learning. However, the directors gave less favorable ratings compared to the graduates' self-assessments in a few areas. These results are not consistent with several studies that have shown that directors tend to be more lenient evaluators than residents,<sup>23</sup> and poor correlations between director and resident self-evaluations have been reported.<sup>15,18</sup> One explanation that has been proposed is that supervisors' ratings of residents are usually based on an overall impression instead of actual performance, while self-assessment tends to examine performance in discrete areas.<sup>15</sup> However, most of the dental postdoctoral programs have considerably smaller size than medical residency programs. This could result in more stringent evaluations or more similar responses between self- and directors' evaluations, which were found in our study.

In regard to future career plans, there was no statistically significant difference between HSDM and non-HSDM residents, which is consistent with previous findings.<sup>2,17</sup> However, the data suggested that HSDM graduates appear to be more likely





**Figure 2. Residents' future career plans**

*ftC* (full-time clinical instructor); *ftR* (full-time researcher); *ptC* (part-time clinical instructor); *ptR* (part-time researcher); *PP* (private practitioner)

to get involved in academia as part-time clinical instructors.

The findings in our study suggest that some characteristics of the PBL curriculum appear to remain with graduates in their postdoctoral training. However, there may also be some confounding variables. Performance of the graduates might reflect other factors unrelated to the PBL method. For example, the selection procedures of Harvard University that target candidates who have specific characteristics and attributes may preferentially sort students by PBL characteristics prior to exposure to the PBL environment in HSDM. It is also possible that the prestige of Harvard University creates high confidence in its graduates, resulting in higher self-assessment ratings by HSDM graduates. In addition, the majority of the respondents were in orthodontic and periodontal programs. The findings of the study might have represented unique characteristics of the residents in these programs rather than characteristics of the PBL graduates. However, significant differences for certain competencies were found between HSDM and non-HSDM graduates within the same program including orthodontic and periodontal programs.

It is also possible that the positive responses by the HSDM subjects in this study reflect their gratitude to their school or their faculties. Similarly, the directors' responses could be influenced by their relationship with HSDM or by their global impression of Harvard as a high-quality academic institution, which may have produced "halo effect" ratings for residents known to be HSDM graduates.

Despite the positive results, interpretation of the data in the present study was limited by the small sample size as well as the low response rate and the inherent disadvantages of using a questionnaire with a rating scale because respondents may avoid using the extreme ends of a rating scale. It is also possible that responses were subjective or biased. An evaluation of the effectiveness of a PBL curriculum was challenging because it is difficult to recruit subjects from a parallel traditional education track that could serve as better controls. More importantly, the results from self-assessment reflect the subjects' perceptions of their own performance, which may or may not demonstrate their true performance.

Even though the present study illustrates the experience of a select group of dental residents who graduated from only one PBL program—the Harvard

School of Dental Medicine—these findings extend the results of earlier studies and hopefully will be informative for dental faculty who desire to implement a PBL curriculum in other schools.

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## REFERENCES

1. Saarinen-Rahiika H, Binkley JM. Problem-based learning in physical therapy: a review of the literature and overview of the McMaster University experience. *Phys Ther* 1998;78(2):195-207; discussion 207-11.
2. Peters AS, Greenberger-Rosovsky R, Crowder C, Block SD, Moore GT. Long-term outcomes of the New Pathway Program at Harvard Medical School: a randomized controlled trial. *Acad Med* 2000;75(5):470-9.
3. Antepohl W, Domeij E, Forsberg P, Ludvigsson J. A follow-up of medical graduates of a problem-based learning curriculum. *Med Educ* 2003;37(2):155-62.
4. Susarla SM, Medina-Martinez N, Howell TH, Karimbux NY. Problem-based learning: effects on standard outcomes. *J Dent Educ* 2003;67(9):1003-10.
5. Baig LA, Asad F. Introducing problem-based learning in a medical school with traditional/conventional curriculum. *J Coll Physicians Surg Pak* 2003;13(7):378-81.
6. Fincham AG, Baehner R, Chai Y, Crowe DL, Fincham C, Iskander M, et al. Problem-based learning at the University of Southern California School of Dentistry. *J Dent Educ* 1997;61(5):417-25.
7. Fincham AG, Shuler CF. The changing face of dental education: the impact of PBL. *J Dent Educ* 2001;65(5):406-21.
8. Fasce E, Calderon M, Braga L, De Orue M, Mayer H, Wagemann H, et al. [Problem-based learning in the teaching of physics to medical students: comparison with traditional teaching]. *Rev Med Chil* 2001;129(9):1031-7.
9. Iputo JE, Kwizera E. Problem-based learning improves the academic performance of medical students in South Africa. *Med Educ* 2005;39(4):388-93.
10. Hsu SC, Ong GH. Evaluation of problem-based learning: a lecturer's perspective. *Ann Acad Med Singapore* 2001;30(5):524-7.
11. Susarla SM, Bergman AV, Howell TH, Karimbux NY. Problem-based learning and research at the Harvard School of Dental Medicine: a ten-year follow-up. *J Dent Educ* 2004;68(1):71-6.
12. Garvey MT, O'Sullivan M, Blake M. Multidisciplinary case-based learning for undergraduate students. *Eur J Dent Educ* 2000;4(4):165-8.
13. Herzig S, Linke RM, Marxen B, Borner U, Antepohl W. Long-term follow up of factual knowledge after a single, randomised problem-based learning course. *BMC Med Educ* 2003;3(3).
14. Howell TH, Matlin K. Damn the torpedoes—innovations for the future: the new curriculum at the Harvard School of Dental Medicine. *J Dent Educ* 1995;59(9):893-8.
15. Santos-Gomez L, Kalishman S, Rezler A, Skipper B, Mennin SP. Residency performance of graduates from a problem-based and a conventional curriculum. *Med Educ* 1990;24(4):366-75.
16. Kelly M, McCartan BE, Schmidt HG. Cognitive learning theory and its application in the dental curriculum. *Eur J Dent Educ* 1999;3(Suppl 1):52-6.
17. Pearson SA, Rolfe I, Ringland C, Kay-Lambkin F. A comparison of practice outcomes of graduates from traditional and non-traditional medical schools in Australia. *Med Educ* 2002;36(10):985-91.
18. Davis JD. Comparison of faculty, peer, self, and nurse assessment of obstetrics and gynecology residents. *Obstet Gynecol* 2002;99(4):647-51.
19. Joshi R, Ling FW, Jaeger J. Assessment of a 360-degree instrument to evaluate residents' competency in interpersonal and communication skills. *Acad Med* 2004;79(5):458-63.
20. Gray J. Global rating scales in residency education. *Acad Med* 1996;71(1 Suppl):S55-63.
21. Schmidt HG, van der Molen HT. Self-reported competency ratings of graduates of a problem-based medical curriculum. *Acad Med* 2001;76(5):466-8.
22. Prince KJ, van Eijs PW, Boshuizen HP, van der Vleuten CP, Scherpbier AJ. General competencies of problem-based learning (PBL) and non-PBL graduates. *Med Educ* 2005;39(4):394-401.
23. Keck JW, Arnold L, Willoughby L, Calkins V. Efficacy of cognitive/noncognitive measures in predicting resident-physician performance. *J Med Educ* 1979;54(10):759-65.