Medical Students' Learning Processes: A Comparative and Longitudinal Study

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Recent studies of students' learning approaches have suggested that they vary according to each student's personality and the characteristics of the student's teaching, learning, and testing environments.[1,2] Comparisons of students in traditional and problem-based learning (PBL) environments[3–6] indicated that, overall, students in traditional curricula reported adopting a learning approach referred to in the literature as the "surface" approach.[3] In other words, they relied on rote learning, they were predominantly motivated by the desire to complete a course or the fear of failure, and the learning outcome was at best a superficial understanding.[1,3] On the other hand, students in PBL curricula reported adopting an approach referred to in the literature as the "deep" approach.[3] With this approach, students were more involved in meaningful learning and in reaching understanding, and were motivated by an interest in the subject matter or its vocational relevance.[1,3] Cross-sectional studies of students at different years of training revealed that, upon entering medical school, students in both types of curricula did not differ in their learning approaches: low in surface learning and high in deep learning.[3–4] However, in the first, second, and third years of training, students in the PBL curricula revealed either a stable or a significant increase in their use of a deep learning approach while maintaining a low surface approach, and students in the traditional curricula reported a drop in deep learning while maintaining low surface learning.[3–5] Although these studies suggest that students' learning approaches vary according to their learning environments, it is difficult to derive from the results those aspects of the programs that might have affected the observed differences in as well as the evolution of students' learning approaches. This is in great part due to substantial differences in the curriculum organization, teaching methods, and assessment techniques of traditional and PBL curricula. The purpose of this study was to investigate and compare the learning processes of students in parallel-track traditional and problem-based learning (PBL) curricula and to trace how the two groups evolved longitudinally during the curriculum years.

Since 1995, the University of Geneva Faculty of Medicine has offered an integrated problem-based curriculum that spans the second through the fifth year of the six-year curriculum. The first year and the sixth year, an elective year, remain unchanged. Because of the school's open admission policy and the resulting large and variable number of students at matriculation time, the first-year program has not been changed. Overall, in the traditional program, the first three years consist mainly of large-group lectures and practical laboratories in various basic medical science disciplines, culminating at the end of each year with several comprehensive objective examinations. In the new program, after the first traditional year, the new second- and third-year program starts with a unit introducing students to aspects of the learning and testing approaches of the new program. This introductory unit is followed by 11 integrated problem-based *system* units (i.e., circulation, respiration . . .) and four *synthesis* units. In the system units, students study in tutorial groups of six to eight students. The groups work up seven to eight problems illustrating the system theme and designed to lead them toward learning objectives integrating different medical sciences disciplines. In addition to the tutorials, a two-hour selected practical laboratory or lecture is scheduled each week to illustrate the biomedical concepts and mechanisms encountered in the problems. The synthesis unit, placed at the end of two or three systems units, is designed to help students revise and integrate the learning objectives of the systems units. Running parallel to these units is the Clinical Practice Skills program, which introduces students to various basic clinical skills (e.g., history taking, physical examination) and to primary care and community-based experiences. The student-evaluation system consists of two examinations per year. Each exam is composed of written multiple-choice and short-answer questions as well as laboratory and standardized-patient–based practical examinations. A more detailed description of the new curriculum and its evaluation system is provided in a separate report.[7]

The fourth- and fifth-year program starts with a 12-week integration unit. In this unit, students work with problems designed to help them to bridge the gap between biomedical and clinical knowledge, and to move from the process of problem analysis accentuated in the second and third years toward the process of problem solving, accentuated in the clerkship year. All clerkships are designed to provide students with multiple exposures to clinical practice and reasoning through patient encounters and tutorial activities. Emphasis is also on integrating topics of diagnostic radiology, clinical pathology, legal medicine, and ethics within each clerkship, and time for self-directed learning is included. The evaluation system consists primarily of a written case-based examination at the end of the integration unit, practical and/or oral examinations at the end of each clerkship, and comprehensive written and oral examinations at the end of all the clerkship rotations.

With the practical constraints of program implementation and in order to provide the new PBL program to all students as soon as possible, the school made two decisions. The first was that the new second- and third-year program would be offered in parallel with the traditional one, with the goal of admitting within four years (1995 to 1999) all the students into the new program. The second decision was to bring students in the two tracks back together in the new fourth- and fifth-year program, starting with the integration unit. The temporary coexistence in the second and third years of the traditional and the integrated problem-based curricula offers an opportunity to study the effects of the two learning environments on students' learning processes. In addition, it provides a chance to determine how these learning processes evolve longitudinally across the curricula, and to evaluate whether the new PBL program fosters the intended learning behaviors. In Geneva's integrated, PBL environment, the emphasis of the tutorial sessions is to familiarize the students with the processes of problem analysis and problem resolution, and to bring them to elaborate, organize, and synthesize their prior and newly acquired knowledge. It was thus anticipated that within this environment the students would at least maintain or improve their deep and elaborative learning processes. In order to derive a baseline for comparison, the learning processes of entering second-year students were also obtained from two other medical schools using PBL.

Method

To derive a detailed profile of students' learning behaviors, the Inventory of Learning Processes[8] (ILP), a self-report instrument, was used. The instrument provides an unambiguous description of learning behaviors considered conducive to learning and fostered within a PBL environment. It has documented validity and reliabil-

ity,[2,8] and is practical to administer and score. The ILP consists of 48 true–false items divided into four scales: Deep Processing (17 items), describing the extent to which information studied is critically evaluated, conceptually organized, compared and contrasted; Methodical Study (16 items), describing a systematic, careful study method; Fact Retention (6 items), characterizing students' propensity to retain detailed, factual information; and Elaborative Processing (9 items), portraying the study habit of encoding information by restating and reorganizing it so as to relate it to one's own experiences or prior knowledge. For this study, minor adaptations of the ILP items were made to make them more relevant to the PBL environment. For example, items that referred to a learning behavior within "a course" were modified, when appropriate, to refer to a "learning unit" or "tutorial." Finally, the French- and Dutch-translated versions of the instrument were both reviewed by two independent judges for accuracy.

To study the effects of Geneva's PBL and traditional curricula on students' learning behaviors, the ILP was first administered to students in both tracks ($n = 30$ and $n = 109$, respectively) within the first few days of the second-year program. To establish a baseline for comparisons, the instrument was also administered, at the beginning of the second year, to PBL students at the University of Maastricht ($n = 143$) and at the University of Sherbrooke ($n = 134$). Comparisons of group differences in mean percentage scores on the ILP subscales were analyzed by two-tailed unpaired Student t tests.

To follow students longitudinally, the ILP were re-administered to Geneva's PBL students at the beginning of their third year ($n = 24$), and in the fourth year upon their completion of the PBL integration unit and before starting the clerkships ($n = 21$). For those students in the traditional curriculum, because their curriculum did not change until the integration unit, the ILP was readministered to them upon their completion of the integration unit ($n = 101$). Because of the small number of students in the first PBL class, additional data were obtained for a second class of students. The ILP was administered to these students at the beginning of their second year ($n = 43$) and third year ($n = 33$). The drop-off in the number of students from the second to the third and fourth years was in great part due to those students who did not get promoted academically. Comparisons of group differences in mean percentage scores on the ILP subscales were analyzed by two-tailed paired Student t tests.

Results

The alpha coefficient reliability indexes obtained for the Geneva, Sherbrooke, and Maastricht students were, respectively, .79, .63, and .70 for the Deep Processing scale; .75, .63, and .56 for the Methodical Study scale; .63, .46, and .67 for the Fact Retention scale; and .74, .48, and .66 for the Elaborative Processing scale.

Comparisons between Geneva's PBL students and the traditional second-year students upon their entering the second-year program revealed no significant difference on any of the ILP subscales. The data were thus combined for subsequent analyses. These findings were expected and consistent with the fact that both groups of students came from a traditional first year.

Comparisons between second-year students from Maastricht and Sherbrooke indicated no significant difference in the students' learning processes between the two PBL schools. When these students were compared with those from Geneva, no significant difference was found except on the deep processing scale. The Geneva students had the lowest mean percentage score and were significantly different from the Sherbrooke students ($t = -2.64$; $p = .01$). Overall, regardless of the type of curricula, students were found to adopt similar behaviors in methodical study, fact retention, and elaborative processing. Furthermore, they were found to score highest on the elaborative processing scale (80–84%) and lowest on the methodical study scale (44%–55%). While most students reported adopting the learning behaviors of encoding and of learning new information by restating and reorganizing it so as to relate it to their prior knowledge and experiences, few reported adopting systematic, careful study techniques. Few students reported having regular weekly review periods, completing all the needed readings, attempting to integrate information from different sources, preparing a set of probable questions and answers when studying for an exam, or participating in frequent group studying. The one significant difference between the traditional students and the PBL students was that more PBL students reported using deep information processing and organizational processes.

The longitudinal follow-up of Geneva's PBL students indicated that there was no significant change in the students' learning behaviors from the second year to the third year, a result that was later confirmed with a second PBL class. The results further suggested that the students maintained relatively stable behaviors in methodical study, fact retention, and elaborative processing from the second year to the fourth year. However, they were found to improve significantly from the first year to the fourth year on the deep processing scale ($t = -3.06$; $p = .008$), and this improvement was most marked from the third year to the fourth year ($t = -4.10$; $p = .001$). Specifically, more students in their fourth year reported being able to organize their information, to handle questions requiring critical evaluation, to do well on short-answer exams, to formulate a good guess when they do not know the answer, and to easily plan work when confronted with a complex task.

For the students in the traditional curriculum, it was found that while they maintained stable behaviors in the deep processing, fact retention, and elaborative processing scales, there was a significant drop in their methodical study scale ($t = 2.49$, $p = .02$). Specifically, in the fourth year fewer students reported doing weekly and periodical reviews of the class materials, preparing overviews of the materials studied, making an effort to get all the details, and preparing probable questions and answers when studying for an exam (see Table 1).

Discussion

Results of the present study showed that regardless of the learning environment, second-year medical students reported adopting similar learning behaviors on three of the four learning-process scales. Overall, the students reported that they studied material by encoding information by restating and reorganizing it so as to relate it to their own prior knowledge or experiences. They also reported, but only to a moderate extent, having the ability to retain detailed and factual information, and, to a much lesser extent, adopting systematic, careful study techniques.

However, it was found that those students who had had a traditional first-year of medical school education adopted significantly fewer deep information processing habits and organizational processes than did those who had had a PBL first year. Nevertheless, after being introduced to a PBL environment, these students did improve significantly on their deep processing while maintaining their strategies of methodical study, fact retention, and elaborative processing. In contrast, those students who continued in the traditional program did not show improvement in their deep processing abilities, and their methodical study habits declined. The results further suggested that all these learning processes developed slowly and were acquired with repeated exercises over a long period, in this case, two years. This is further confirmed by the findings that in the fourth year, after 12 weeks in the PBL integration unit, the traditional students did not alter or improve their deep processing learning habits. These findings seem to imply that the emphasis in the PBL environment on the processes of analyzing, organizing, structuring, and integrating knowledge during the tutorial sessions do help students to maintain high levels of elabora-

TABLE 1. Comparisons by Years of Training* of Mean Percentage Scores on the Inventory of Learning Processed (ILP) Subscales Achieved by Students in Problem-based Learning (PBL) and Traditional Classes at the University of Geneva, 1995–1997

	PBL Class						Traditional Class		
ILP Scale	Year 1 (n = 30)	Year 2 (n = 24)	Year 3 (n = 21)	p (Year 1–Year 2)	p (Year 1–Year 3)	p (Year 2–Year 3)	Year 1 (n = 109)	Year 3 (n = 101)	p
Deep processing (17 items)	67.8	66.5	78.1	n.s.	.008	.001	67.7	68.3	n.s.
Methodical study (16 items)	54.3	53.2	52.5	n.s.	n.s.	n.s.	51.5	41.3	.02
Fact retention (6 items)	59.6	67.6	63.3	n.s.	n.s.	n.s.	68.8	66.6	n.s.
Elaborative processing (9 items)	83.2	77.1	82.5	n.s.	n.s.	n.s.	78.5	74.8	n.s.

*Year 1 of training: 1995; year 2, 1996; year 3, 1997.

tive processing while increasing their ability in deep processing. Overall, with the findings suggesting that methodical study did not contribute to students' success in college and that "the most successful college students were deep, elaborative, fact retainers,"[2] so it would be beneficial to have a curriculum that fostered these abilities.

This is the first longitudinal study that was followed, over a period of three years, the development of students' learning processes. The lack of existing direct and valid measures of learning processes, and hence the use in this study of self-reporting, do not lend less credence to the results, since they were confirmed and validated by previous findings.[1–6] In addition, with the goals of evaluating the curriculum and determining its impact on students, the perceptions and assessments of students of their own learning are important and useful both to the curriculum planners and to the students in charting their progress. With the preliminary results based on a relatively small number of students, a similar follow-up study is presently planned with the next two classes, where all the students will be in the new program. Meanwhile, discussions have already been started to determine how to assist students in acquiring earlier deep and elaborative learning competencies so they can fully profit from the PBL learning environment.

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