

## Articles

# Students' Preferred Teaching Techniques for Biochemistry in Biomedicine and Medicine Courses

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The aim of this study was to investigate the students' preferred teaching techniques, such as traditional blackboard, power-point, or slide-projection, for biochemistry discipline in biomedicine and medicine courses from São Paulo State University, UNESP, Botucatu, São Paulo, Brazil. Preferences for specific topic and teaching techniques were determined from questionnaires on a Likert scale from 1 to 5 (strongly disagree; disagree; neither agree, nor disagree; agree; strongly agree) distributed at the end of biochemistry discipline to 180 biomedical students (30 students/year) and 540 medical students (90 students/year), during the years 2000–2005. Despite of the different number of hours applied to the course topics for the two groups of students, the majority of undergraduates from biomedicine and medicine preferred metabolic topics. Although the perception of a medical student is expected to be different than that of a biomedical student, as the aims of the two programs are different, 92.4% of students from each course agreed or strongly agreed with the biochemistry topics, and 92.1% thought highly on this subject. The majority of students, a number of 139 undergraduates from biomedicine and 419 from medicine course, preferred traditional blackboard teaching than slide-projection, or power-point class. In conclusion, it is imperative that the health courses reflect on sophisticated technology and data presentation with high density of information in biochemistry discipline. The traditional classes with blackboard presentation were most favored by students from biomedicine and medicine courses. The use of students' preferred teaching techniques might turn biochemistry more easily understood for biomedical and medical students.

*Keywords:* Biochemistry, teaching techniques, healthy courses.

Biochemistry is an important area of knowledge in the basic cycle of health courses, such as biomedicine and medicine. In most curricula, it is taught in the first year of the courses [1, 2], with an average number of 120–240 h [3–5]. According to the specificity of each course, it should comprehend theoretical and practical knowledge related to cellular basis of physiological and pathological processes to human body functioning [6, 7]. These issues are of particular importance in multiple aspects to allow for a deeper understanding of health-diseases processes and diagnosis [8].

Systems biology, metabolic engineering, and other recent developments in biochemistry suggest that health professionals also require a detailed familiarity with the compounds and metabolic pathways of intermediary metabolism and biochemical control [9, 10], which should be considered one of the reasons why large number of students fail to develop the true potential and lose the enthusiasm and motivation for the subject.

The teaching of biochemistry has specific features, since it involves an overload of ever-changing information

and implicates an extensive list of terminology, such as names of enzymes and metabolic pathways. It is evident that these specific contents understanding needs a high level of abstract thinking from undergraduates, and has lead to search new teaching techniques, such as problem-based learning (PBL) [11–13], multimedia power-point [14], use of web for dialogues [15], computer-assisted lecture [14, 16], commercially available computer program [17], and lectures who use the “one-minute paper” (OMP) [18]. Information regarding the modes of teaching/learning that are most favored by students indicated that PBL method was acceptable in motivating to clarify biochemical concepts [19], and that satisfaction among students in the presence of computing and information technology was high [1]. However, PBL has been criticized from a number of points of view, especially because the knowledge acquisition of students in PBL system does not differ from students in others teaching techniques [12]. The use of computer and web for dialogues do not hinder the educational process, and students favored more contact with their teachers [20]. Students' opinions of OMP are generally favorable. However, although OMP could be overcome by varying the teaching method, its frequent use might make the teaching/learning monotonous [18]. Therefore, despite the new

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methodological approaches, the modes of teaching/learning to make biochemistry more interesting and more easily understood were not presently identified.

The aim of this study was to investigate the undergraduates' preferred teaching techniques, traditional blackboard, power point, or slide projection, for biochemistry discipline in biomedicine and medicine courses.

#### METHODOLOGY

The present study analyzed the Biochemistry discipline in biomedicine and medicine undergraduate courses at Institute of Biological Sciences and School of Medicine, São Paulo State University, UNESP, Botucatu, São Paulo, Brazil. In these curricula, biochemistry is taught from the Department of Chemistry and Biochemistry, in the first year of courses, with a number of 120 h in one semester for biomedicine and with 150 h, divided into two semesters for medicine course. Each biochemistry topic has theoretical class, and a number of hours reserved to practical activities, which are taught in a specific laboratory for clinical analysis.

The biochemistry subjects in these courses are divided into structural and metabolic topics [21, 22]. The structural aspects included amino acids, peptides, proteins structures, membranes and transport, enzymes, vitamins, thermodynamics, carbohydrate structure, lipid structure, and inborn metabolic errors. The metabolic topics involved carbohydrate, lipid, and amino acid metabolisms, as well as the integration of the metabolic pathways (Table I).

For each course, the subjects were taught by a same biochemistry professor, during all analyzed period (years 2000–2005). As teaching techniques the teachers used slide presentation, power-point multimedia, and traditional blackboard. All methodological techniques were taught during several sequential classes having the same number of total hours for structural and metabolic topics.

Preferences for specific topic and teaching techniques were determined from questionnaires applied to students on a Likert scale from 1 to 5 (strongly disagree; disagree; neither agree, nor disagree; agree; strongly agree) [23] (Table II). Data relative to subject objectives, evaluation methodology, and contents were analyzed both qualitatively and quantitatively.

All 720 students from biomedicine (30 students/year) and medicine (90 students/year) courses, São Paulo State University, UNESP, were asked to respond a questionnaire distributed at the end of biochemical discipline, during the years 2000–2005. Therefore, 180 questionnaires from biomedicine and 540 from medicine students were analyzed. Students were surveyed to determine the impressions on the discipline, and asked on the preferred biochemistry contents and teaching techniques. They were also asked to respond questions as showed in Table II, having the opportunity to offer any additional comment for improving the discipline.

#### RESULTS

Table I shows the structural and metabolic topics of biochemistry that have been taught for biomedicine and medicine courses, the numbers of hours/class for these topics. Despite of the different number of hours presently applied to the course topics for the two groups of students (Table I), 151 undergraduates from biomedicine and 455 from medicine course preferred metabolic topics, while only 25 students from biomedicine and 80 students from medicine courses preferred structural topics (Table II).

TABLE I

*Biochemistry topics taught and number of hours/class for these topics, in biomedicine and medicine courses of São Paulo State University, UNESP, Botucatu, São Paulo, Brazil*

Biochemistry topics	Hours	
	Biomedicine course	Medicine course
Structural topics	60	75
Amino acids	4	4
Peptides and proteins	4	5
Proteins structures	4	8
Lipid structure	4	6
Membranes and transport	4	4
Enzymes	8	8
Vitamins	8	8
Thermodynamics and ATP	4	8
Carbohydrate structure	4	6
Inborn metabolic errors	8	8
Insulin, glucagons, epinephrine actions, and diabetes	8	10
Metabolic topics	60	75
Carbohydrate metabolism: anaerobic and aerobic glycolysis, citric acid cycle; gluconeogenesis, glycogen synthesis, and mobilization	16	18
Electron transport chain and oxidative phosphorylation	4	8
Lipid metabolism: Lipolysis, fatty acid oxidation, lipid synthesis	12	14
Lipid transport, cholesterol, and atherosclerosis	4	10
Amino acid metabolism: amino acid oxidation and nitrogen excretion	16	16
Integration and regulation of metabolism	8	9

The subject topics included in biochemistry discipline were considered adequate, and the majority of students recognized the biochemical importance for their courses. One-hundred sixty-six students from biomedicine and 499 from medicine course agreed or strongly agreed with the biochemistry topics, and 166 biomedical students and 498 medical students thought highly on this subject. One-hundred forty-five students from biomedicine and 435 students from medicine course considered that there was coherence between theoretical objectives and laboratory practices. A number of 139 undergraduates from biomedicine and 419 from medicine course preferred traditional face-to-face explanation using blackboard-teaching methods, than slide-projection, or power-point class (Table II).

#### DISCUSSION

Analysis of objectives and course contents in the teaching plans showed a homogenizing tendency in biochemistry topics and number of hours, with most curricula for health courses [2, 3, 24–26]. The designing of learning objectives involved three different aspects: the cognitive aspect, which encompasses knowledge, ideas, and mental skills; the psychomotor aspect, which is associated with the actions and procedures; and the affective-aspects whose concern in the learning of atti-

TABLE II  
Results of the students' evaluations

Statements	Course	SD	D	N	A	SA
I prefer metabolic topics rather than structural topics	BM	15	10	4	74	77
	M	42	38	5	220	235
The subject topics were adequate	BM	0	2	12	53	113
	M	0	0	41	157	342
There was coherence between theoretical objectives and laboratory practice	BM	0	0	35	71	74
	M	0	0	105	213	222
I think highly of this subject	BM	0	2	12	81	85
	M	0	7	35	241	257
The personal participation and study dedication was high	BM	0	0	41	96	43
	M	0	0	123	288	129
The teaching strategies were adequate	BM	1	2	16	87	74
	M	0	6	51	259	224
I prefer teacher explanation and blackboard-classes	BM	0	6	35	50	89
	M	0	17	104	148	271
I prefer power-point or slide-projection classes	BM	124	41	15	0	0
	M	374	122	44	0	0

Responses of 180 biomedical and 540 medical students. Students were asked whether they strongly disagreed (SD); disagreed (D); were neutral (N) or neither agree, nor disagree; agreed (A); strongly agreed (SA) with the statements listed in the table.

tudes and values. Consensus methods such as the Delphi survey technique are being employed to curriculum development, making possible a comprehensive evaluation of the course and proving basis for recognize and select the important concepts, essential for inclusion in a biochemistry discipline, to maintain the integrated curricula, and stimulate the students' motivation [27–29].

Despite of the perception of a medical student is expected to be different than that the biomedical students, as the aims of the two programs are different, Table II showed that 92.4% of students from each course agreed or strongly agreed with the topics included in biochemistry discipline. Similarly, the majority of students from the two courses recognized the biochemical importance for their courses.

The question of which mode of biochemistry teaching is most appreciated by students indicated that they preferred traditional face-to-face explanation using blackboard-teaching methods, than slide-projection or power-point class. It is not evident from the data why the students preferred blackboard rather than power-point classes. A question may be raised as to whether it is because the blackboard is really more effective, or because the power-point tool is unsuccessfully applied by the teachers. Considering that 84% of the undergraduates from each course preferred metabolic topics (Table II), presented with blackboard methodology, the answer to the question is that biomedical and medical students prefer to be taught using traditional blackboard than with power-point class. Furthermore, the teachers had more than 10 years of experience on biochemistry teaching, and the UNESP annually updated the teachers for teaching techniques application.

The traditional blackboard-used class is a presentation manner of metabolic pathways, in which the reactions are showed step-by-step, allowing student to learn the changes in the structure of important metabolic starting compound. The blackboard method allows the presentation and study of problems in which biochemistry compounds can be used through two or more metabolic pathways, thus illustrating how these pathways are inter-

connected. The understanding that all the pathways intermediary metabolism are interconnected provides opportunities to discuss the metabolic control by mechanisms such as signaling, feedback inhibition, location in organelles, regulatory enzymes activities, and coenzyme recycling rates. By requiring the oral presentations association, the class became familiar with each other's topics [14, 30]. After each metabolic pathway presentation in the blackboard, the power point or slide presentation were used, only to show the integrated view of each metabolic pathway. Therefore, the power-point presentation was only used at the end of a metabolic pathway study, to give the students the integrated view of the previously studied reactions in the blackboard. In fact, Feldberg [8] considered allowing for the development of abilities, as well as learning to take place, to be of greater importance than the coverage of histograms with multiple, colored columns.

Judging from our data (Tables I and II) the students appreciation for traditional blackboard teaching method and for metabolic topics were attributed, at least in part, to the density of information in slide presentation, that is, necessary to show metabolic pathways as a dynamic view. The power point has become ever more sophisticated, scattering the students' attention [14].

## CONCLUSIONS

It is imperative that the health courses reflect on sophisticated technology and graphical data presentation with high density of information in biochemistry discipline. The traditional class with blackboard presentation allows understanding the substrate changes due to enzyme actions, catabolism, and the generation of phosphate-bond energy, biosynthesis, and utilization of phosphate bound energy. In this view, the power-point presentation might give a wide perception of the integrated metabolism, as previously studied, step-by-step in the blackboard. By introducing students earlier to the functions of the metabolic pathways, it is possible to present metabolism as a realistic sequence of reactions to phos-

phate bound energy generation and use of this energy source to biosynthesis of structural and metabolic compounds. The traditional classes with blackboard presentation were most favored by students from biomedicine and medicine courses, allowing undergraduates to understand the metabolic topics, which were preferred by the students of these courses. The use of students' preferred teaching techniques might turn biochemistry more easily understood for biomedical and medical students.

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