

Study Skills and Academic Performance among Second-Year Medical Students in Problem-Based Learning

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Abstract

Purpose: This research study highlights the relationship between study aid use and exam performance of second year medical students. It also discusses how students used study aids in preparing for PBL exams and whether students who used others' study aids performed as well as students who created their own.

Methods: A questionnaire was distributed to second-year medical students after completion of their exam. The data from the questionnaire were linked to students' examination scores and other academic indicators.

Results: The study habits were more similar than different when compared by exam performance. A majority of students used study aids as a memory aid or for review, but students who performed in the top third of the class were less likely to use them at all. Pre-existing differences related to academic achievement and study strategies were found when students at the top, middle and bottom of exam performance were compared.

Conclusions: A better understanding of the differences in study habits and study aid use in relation to examination performance can help in providing future students with appropriate academic support and advising.

Students have always shared various study materials, but computers and networks have now made it easier than ever. We might think this is a good thing, right? But not necessarily.

In February of 2004, one of our faculty members noticed that her PBL students were sharing study materials at a higher rate than in previous years. She also noticed that the students had a lower level of performance on the problem-based learning (PBL) exams as compared to previous students. She wondered if there might be some relationship between a perceived increase in students' sharing study aids and performance on the exam.

We looked for published research on the use of study aids and exam performance. Two studies by Gurung^{1,2} that looked at undergraduates' use of textbook aids, such as summary sections, found that use of such aids did not relate to exam performance. A further search led us to theories about time-on-task and concept mapping.

Time-on-task is defined by Levin and Nolan as a measure of students' time spent actively engaged in learning.³ In 1988, Jere Brophy demonstrated that increased time spent on learning activities yields increased learning, provided that the teacher was competent and that the learning

activities were effectively designed and implemented.⁴

Another theory that guided us was concept mapping. Concept mapping is a technique in which the learner links new knowledge to a framework of relevant concepts that the learner already knows. Ausubel⁵ maintained that this linking of new with existing knowledge was a key factor in successful learning and that it was the difference between meaningful learning and rote learning. Many researchers have studied the benefits of concept mapping and have determined some tangible outcomes: an improved ability to form conceptual relationships, improved clarity of reasoning and focus on key ideas, and an easier grasp of difficult or new concepts.^{3,6-9}

Students who create their own study aids are spending time making them, whereas those who use others' study aids are not. It may also be that the process of creating study aids helps the learner gain more meaningful knowledge through the process of synthesizing disparate pieces of information into new knowledge, as has been shown with notetaking. The related literature on notetaking and performance, as noted in the ERIC Digest on notetaking,¹⁰ indicates a positive relationship between notetaking and retention. We wondered if students who used study aids made by others rather than making their own

might be missing out on the benefits of time-on-task and concept mapping.

Three questions guided this exploratory study: (a) To what extent did students use study aids? (b) How did students use study aids to prepare for an exam? and (c) To what extent did study habits and study aid use relate to exam performance?

Methods

The context of our research was the MSU College of Human Medicine's second-year PBL curriculum. The subjects were second-year medical students who had just completed their final examination in Metabolism, Endocrine and Reproductive (MER) content. The instrument we used was a written questionnaire that we created for this study. The questionnaire asked students about the following topics: (1) the information sources they used to study for their PBL exam in terms of time and usefulness, (2) attendance at lectures, (3) use of study aids that they created in terms of usefulness and how they were best used; (4) similar questions about students' use of study aids made by others; and (5) students' overall opinion about the efficacy of study aids.

The survey included the following definition of "study aids" in order to provide a context for the questions. "Study aids are sets of organized, summarized information on a particular topic that help students learn by facilitating memorization and synthesis through organization and by reducing the amount of information to be learned." Descriptions of specific types of study aids were provided: summaries of notes, concept maps, flash cards, practice test questions, and tables and charts. This study was approved by the university Internal Review Board.

For analysis purposes, the sample was divided into thirds, based on the percentage total score for the content examination. This approach allowed for comparison of the use of study aids by the top, middle and bottom thirds of the class. Based on the distribution of final examination scores, the bottom third of the class had 29 students, the middle third 38 students and the top third 29 students.

The study aid questionnaire data were linked to the results of a self-assessment of study skills that students completed during their orientation to medical school. The Learning and Study Skills Inventory¹¹ (LASSI) is a 10-scale self-assessment of awareness about and use of learning and study strategies. The questionnaire focuses on thoughts, behaviors, attitudes and beliefs related to

successful learning that can be altered through educational interventions.

The results of our questionnaire on students' use of study aids were also linked to the students' MCAT scores to determine if examination performance was associated with pre-existing differences in problem-solving skills and knowledge.

Results

A total of 99 students (95%) completed the questionnaire. Three respondents did not include their student number on the questionnaire, so their responses could not be linked to the final examination scores or other data sources. Thus Table 1 summarizes the data for 99 students, and Tables 2 and 3 summarize the data for 96 students.

Information Sources and Study Time - Ninety percent of the top students reported attending all or most of the lectures, compared to 76% of students in the middle third and 80% of students in the bottom third; these differences were not statistically significant. Overall, students reported studying an average of 84 hours (median=60 hours) in preparation for their examination; total study hours were consistent across the bottom, middle and top thirds of the class. Total study time was unrelated to examination performance ($r=-.13$, $p=.35$). The course textbook (mean=36.9 hours) and personal lecture notes (mean=32.8 hours) were the most used information sources for studying. Other information sources used included other textbooks (mean=12.3 hours), notes from classmates (mean=6.8 hours), PBL group meeting notes (mean=1.3 hours) and hand-me-down notes from prior years (mean=0.9 hours). The only information source to vary by examination performance was notes from classmates ($F=3.19$, $p=.05$): the mean for students in the top third of the class was 2.9 hours compared to 9.4 and 9.1 hours for students in the middle and bottom thirds of the class. The hours of use of hand-me-down notes was significantly negatively correlated with examination performance ($r=-.51$, $p=.003$).

Study Aid Use - Students were asked about their use of study aids in preparing for their examination. The most frequently used study aids were charts and tables made by others (80%), self-made summaries of notes (77%), summaries of classmates' notes (63%) and self-made concept maps/graphic overviews (55%). Only 66% of top students used their class note summaries to prepare for the examination compared to 89% of students in the middle third and 84% of students in the bottom third ($\chi^2=5.61$, $p=.061$). The use of charts and tables made by others was

Table 1: Self-Reported Study Aid Use for Examination Preparation

	Study Aids Made by Self		Study Aids Made by Others	
	N	%	N	%
Summaries of Notes	75	77%	62	63%
Concept Map or Other Graphic Overview	54	55%	36	37%
Tables or Charts	48	49%	78	80%
Flash Cards	26	27%	14	15%
Practice Test Questions	12	13%	31	32%

The mean MCAT scores of the top cohort were greater than those of the bottom cohort; these differences were statistically significant for the physical science (F=3.03, p=.05) and biological science

found to vary by examination performance ($\chi^2=10.86$, $p=.004$); 59% of top students reported their use compared to 86% of students in the middle third and 92% of students in the bottom third. Students in the top third of the class also were less likely to use self-made concept maps and other graphic overviews ($\chi^2=6.83$, $p=.033$): 38% for top students compared to 61% of middle students and 72% of bottom students. Similarly, top students were less likely (18%) than middle (43%) and bottom (52%) students to use concept maps made by others ($\chi^2=7.35$, $p=.025$). Three study aids were found to be correlated with examination performance: self-made concept maps

(F=3.43, $p=.04$) scores suggesting preexisting differences in science knowledge and problem solving skills. There were no significant correlations between MCAT scores and the reported study hours for each information source. With regard to study aid use, MCAT Physical Science was negatively associated with the use of flash cards produced by others ($r=-.23$, $p=.03$); both MCAT Physical Science ($r=-.21$, $p=.05$) and MCAT Biological Science ($r=-.26$, $p=.01$) were negatively associated with the use of practice test items made by others. LASSI percentile scores for each cohort, based on examination perfor-

Table 2: Mean MCAT Scores by Examination Performance Cohort

Examination Performance Cohort	MCAT Verbal Reasoning		MCAT Physical Science		MCAT Biological Science	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Bottom Cohort (N=27)	8.7	1.9	8.5	1.4	9.2	1.5
Middle Cohort (N=36)	9.3	1.6	9.1	1.1	9.6	1.3
Top Cohort (N=28)	9.5	1.7	9.4	1.5	10.1	1.1

and graphic overviews ($r=-.27$, $p=.011$), concept maps and graphic overviews made by others ($r=-.23$, $p=.026$), and summary charts and tables made by others ($r=-.31$, $p=.003$).

When asked how they used their self-made study aids, students were most likely to use them for course review (63%) and as memory aids (61%) rather than as a primary learning resource (15%). This did not vary by examination performance. Similarly, when students were asked about their use of study aids created by others, most used them for course review (54%) and memory aids (57%) rather than as a primary resource (7%), with no significant differences by examination performance cohort.

Prior Performance - To provide a context for the identified differences in study aid use by examination performance cohort, MCAT scores for each cohort were examined.

mance, are shown in Table 3.

Significant differences among the three cohorts were found for three LASSI scores. The bottom cohort scored lower than the middle and top cohorts in motivation and discipline (F=4.32, $p=.04$). For the measure of concentration and attention, the top cohort had the highest scores and the bottom cohort had the lowest score (F=5.68, $p=.02$). Conversely, students in the top cohort were less likely to have reported the use of support techniques and materials than the other cohorts (F=3.63, $p=.03$). With respect to study strategies, there were significant correlations between LASSI scores and the reported study hours for one information source, notes from PBL group meetings: attitudes and interest ($r=-.40$, $p=.006$), motivation and discipline ($r=-.35$, $p=.02$), concentration and attention ($r=-.30$, $p=.04$), selecting main ideas ($r=-.51$, $p=.001$) and test-taking and preparation strategies ($r=-.44$, $p=.01$). There was only one statistically significant correlation between LASSI scores and the use of specific study aids:

Table 3: Mean LASSI Percentiles by Examination Performance Cohort

LASSI Sub-Scores (reliability) ¹¹	Bottom Cohort		Middle Cohort		Top Cohort	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Strategies Related to Will						
Attitude & Interest (.77)	87.1	13.1	82.5	19.3	89.6	11.8
Motivation & Discipline * (.84)	65.1	25.6	74.8	18.4	73.5	21.1
Anxiety & Worry (.87)	63.4	28.1	65.8	21.9	70.0	21.0
Strategies Related to Self-Regulation						
Time Management (.85)	71.0	25.9	73.5	21.1	65.8	21.9
Concentration & Attention* (.86)	72.8	25.5	78.4	20.2	85.9	15.5
Use of Support Techniques/Materials* (.73)	73.3	20.3	78.1	18.0	63.3	28.5
Self-Testing & Reviewing (.84)	64.6	26.9	71.6	26.9	76.3	22.3
Strategies Related to Skill						
Information Processing & Reasoning (.84)	79.4	17.7	73.4	24.7	75.1	19.2
Selecting Main Ideas (.89)	68.4	20.3	67.2	26.3	79.1	17.9
Test-Taking & Preparation Strategies (.80)	73.3	26.9	72.8	20.4	82.0	16.8

* p< .05

self-made summaries of notes (r=.35, p=001).

study aids made by others were in fact created by other students or were commercially available study materials.

Discussion

Our investigation of study habits revealed few differences among cohorts of students based on examination performance. There were no differences in lecture attendance or amount of time students reported preparing for their examination. The reported use of various information sources also was consistent for all cohorts: the course textbook and lecture notes were the primary learning sources. The differences found were related to notes from other sources: top students were less likely to rely on notes provided by other students, whether from the same class or from prior classes. However, these sources accounted for relatively few study hours and suggest more similarities than differences in the study habits of students across performance groups.

Of particular interest was the use of study aids in addition to the information sources available to students. At least half of the class reported using summary charts and tables and summaries of notes, whether self-made or made by others. In addition, many students reported the use of self-made concept maps or other graphic overviews. Students, regardless of exam performance, reported that they used study aids for course review and as memory aids rather than as a primary learning resource. Therefore it appears that study aids play an important role in students' learning and exam preparation; many students reported the use of study aids. A limitation of our study is that it does not allow us to determine the extent to which the

Also of interest was the relationship between study aid use and examination performance. The literature on time-on-task and concept mapping suggested that there might be a negative association between the examination score and the use of others' study aids. While the use of study aids—both self-made and made by others—was pervasive, our findings suggest that top performing students were less likely to use many of these study aids, instead relying on their primary information sources for exam preparation. Students in the top third spent less time using classmates' notes, were less likely to use study aids for exam preparation, and were most likely to attend lectures than other students. Conversely, students in the bottom third of the class based on examination performance were more likely to use their own and others' study aids and spent more time doing so. Although few statistically significant associations were found between exam performance and study aid use, when identified, the relationship was negative: study aid use was associated with lower examination scores. The possibility of a chicken-and-egg situation emerged. Did the pattern of study aid use among the lowest performing students enable them to reach this level of performance, or does their pattern of study aid use limit their level of achievement?

In reviewing prior academic and study skills information, a number of consistent pre-existing differences were identified. There were differences in MCAT performance that suggested differences in basic science knowledge

and problem-solving skills. In addition, there were differences in self-assessed study skills. According to LASSI scores, top students were least likely to use support techniques, such as study aids; the bottom third of students were more likely to use support techniques and scored lowest on the LASSI scales on which the top students scored highest. The LASSI scales associated with examination performance were measures of motivation, discipline and self-regulation.

That top-performing students were less likely to report the use of support techniques and materials suggests that for many students the pattern of study aid use was in place prior to matriculation to medical school. Research¹² comparing the study habits of high school and college students concluded that study strategies that are effective in high school may not be as effective in college. The findings revealed that (1) high-performing high school students used study aids more often than low-performing high school students, (2) high school students used study aids more often than college students, and (3) high- and low-performing college students used study aids about the same amount. In our study we found that the top students used study aids less often than the lower students. It may be that study aids are more useful in earlier school years than later, and that students who do not change their study habits to accommodate changing learning requirements may perform less well than those who do change. This may explain some of our findings but cannot resolve the question of which came first, study aid use or academic performance.

We found that multiple LASSI scales were negatively associated with the number of hours spent studying from PBL group meeting notes. The pattern of correlations suggests that students who devoted more study time to PBL group notes, which may have been created by a group of students, had lower total exam scores. The lower exam scores may be explained by the theory underlying concept mapping, that students who read others' linking of concepts gain only rote knowledge but not deep understanding, hence have lower exam scores, while those who actively link new concepts with existing knowledge gain meaningful knowledge and have higher exam scores.

The second question we asked was how students use study aids to prepare for an exam. We found that all students spent around 60-80 hours studying for the domain exam and that all students were most likely to use study aids for course review and as a memory aid. This did not vary across examination performance cohorts.

Our third research question asked to what extent study habits and study aid use were related to exam perfor-

mance. Research has shown that study habits are related to exam performance^{12,13} whereas the use of study aids is not.^{1,2} Our findings suggest that the relationship between study aid use and study habits is unclear. That is, we do not know if study habits come from study aid use, or if study aid use comes from study habits. The research by Gurung^{1,2} suggests that the use of certain kinds of study aids was not related to exam performance, but we could find no literature on the relationship of self-made study aids and exam performance. There is evidence, however, that note-taking—a kind of self-made study aid—is related to better retention than non-note-taking.¹⁰

Our findings were counter-intuitive to our theoretical framework. There are several possible explanations:

1. It might be that the top students did not feel the need to create their own study aids because they got what they needed from what was already available: the course text and their lecture notes.
2. Another possible explanation is that top students are synthesizing their notes as they take them, whereas the bottom students may be doing that post hoc.
3. A third explanation may be that the bottom students scored higher on the exam as a result of creating their own study aids, and that without that activity they may have scored even lower. These are all possible explanations that need further research.

We do not know if the use of self-made study aids raises or limits exam performance to its current level. So our exploratory study has raised more questions than it has answered: What is the relationship of study habits and study aid use? Do students in the bottom third use study aids as a means of achieving their current level of success, having learned this through their past experiences? Alternatively, is it the pattern of use of study aids that contributes to their performance in the bottom third of the class? The similarities between students in the bottom and middle third might suggest support for the first option, but other research supports the second.^{1,2}

Conclusions

Although research shows some association between the use of study aids and low performance on exams, our research shows some association between the use of others' study aids and low exam scores, at least enough to warrant further study.

This pilot study into the use of study aids and the relationship between study aid use and examination performance has a number of limitations. These findings are derived from a single cohort of students from one institu-

tion and a single content domain. The extent to which the results are generalizable to other content areas, students or institutions is unknown, and further investigation is required.

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