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WEB PAPER

Influence of study approaches on academic outcomes during pre-clinical medical education

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Abstract

Background: Different approaches to study lead to differing academic outcomes. Deep and strategic approaches have been linked to academic success while surface approaches lead to poorer understandings.

Aims: This study sought to characterize how the approaches to study used by medical students impacted their academic success as measured by three outcomes: cumulative grades at the end of the first year, cumulative grades at the end of the second year, and performance on a medical licensing examination.

Methods: The approaches and study skills inventory for students was administered to medical students to determine their predominant study approach (deep, strategic, superficial) at the beginning of their first year, end of first year, and end of second year. Each group's mean performance on each outcome measure was compared by ANOVA to find significant differences.

Results: For all three outcome measures, strategic approaches to study were associated with high performance while surface approaches with a poor one. Deep approaches were most popular at all times and were largely associated with adequate performance.

Conclusions: Deep approaches to study are sufficient for success in the current paradigm of medical education but strategic ones may offer a selective advantage to those who use them. Surface approaches to study must be discouraged by instructors through deliberate course design.

Introduction

Students' approaches to study can have a beneficial or detrimental effect on their performance on exams and later recall of class material. However, the number of variables in a classroom environment makes it difficult to find simple cause-and-effect relationships between study practices and educational outcomes. To generate a model of student learning that was drawn directly from actual classroom experience, the phenomenographic method of qualitative research was created (Marton & Säljö 1976a,b) to describe how students arrived at different levels of understanding within the context of a course. Interviews with students showed that their approaches to study fell into two distinct categories: deep or surface. Students using a deep approach worked to internalize coursework and make it personally meaningful. In contrast, students using a surface approach saw learning as an activity that required exact replication of course information to meet external demands. A third approach to learning, the strategic approach, was later identified (Ramsden 1979) to describe students who used either deep or surface approaches in response to their perception of how they would be assessed. Students using a strategic approach treat assessments as the final goal of studying rather than either generating a personal understanding or verbatim knowledge of the classroom data. As described in a review, students using a deep approach show superior performance compared to students using a

Practice points

- During their pre-clinical years, medical students preferentially adopt deep learning approaches, followed by strategic and surface approaches.
- Students adopting strategic approaches generally had greater success than peers in coursework and on board examinations.
- Students adopting surface approaches generally struggled in comparison to peers.

surface one and this finding has been consistently replicated in a variety of contexts (Case & Marshall 2009).

Surface approaches are used when the learning is seen as something outside of the learner and are often undertaken when students feel overwhelmed by class demands. Ramsden (2003) demonstrated that students can be pushed to adopt a surface approach by course design, with perceptions of excessive workload and poor feedback leading to surface approaches. The ASSIST (approaches and study skills inventory for students) instrument was designed to quantitatively assess student approaches to study and categorize them as either deep, strategic, or surface (Entwistle 1997). It does not measure personality characteristics so much as it measures subject responses regarding their approach to learning and studying within a specific educational context. The ASSIST has

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been singled out (Coffield et al. 2004) as particularly useful in higher education research because of its foundation within actual classroom experience in higher education and its congruence with psychological theory related to adult learners. Questions in the ASSIST and the various sub-categories are listed in Table 1.

The few phenomenographic studies examining how medical students learn are primarily from the United Kingdom and Australia where medical education largely takes place in an undergraduate curriculum (Newble & Jaeger 1983; Newble & Gordon 1985; Newble & Entwistle 1986; Onion & Slade 1995;

Stiernborg & Bandaranayake 1996; McManus et al. 1998; Martin et al. 2000; Smith and Mathias 2007). Regarding medical education specifically, some authors (Pandey & Zimitat 2007; Smith & Mathias 2007) have demonstrated that medical students preferentially adopt a deep approach in undergraduate medical anatomy courses and have reaffirmed that students who do adopt a deep approach have better outcomes than students who adopt a surface approach. Smith and Mathias (2010) showed that medical students who adopt a deep approach generally think holistically when learning, applying their knowledge across a broad range of available

Table 1. Statements in the ASSIST inventory grouped according to approach (Entwistle 1997).

<i>Deep approach</i>	
Seeking meaning	4. I usually set out to understand for myself the meaning of what we have to learn. 17. When I'm reading an article or book, I try to find out for myself exactly what the author means. 30. When I am reading I stop from time to time to reflect on what I am trying to learn from it. 43. Before tackling a problem or assignment, I first try to work out what lies behind it.
Relating ideas	11. I try to relate ideas I come across to those in other topics or other courses whenever possible. 21. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together. 33. Ideas in course books or articles often set me off on long chains of thought on my own. 46. I like to play around with ideas of my own even if they don't get me very far.
Use of evidence	9. I look at the evidence carefully and try to reach my own conclusions about what I'm studying. 23. Often I find myself questioning things I hear in lectures or read in books. 36. When I read, I examine the details carefully to see how they fit in with what's being said.
Interest in ideas	49. It's important for me to be able to follow the argument, or to see the reason behind things. 13. Regularly I find myself thinking about ideas from lectures when I'm doing other things. 26. I find that studying academic topics can be quite exciting at times. 39. Some of the ideas I come across in the course I find really gripping. 52. I sometimes get "hooked" on academic topics and feel I would like to keep studying them.
<i>Strategic approach</i>	
Organized studying	1. I manage to find conditions for studying which allow me to get on with my work easily. 14. I think I'm quite systematic and organized when it comes to revising for exams. 27. I'm good at following up some of the reading suggested by lecturers or tutors. 40. I usually plan out my week's work in advance, either on paper or in my head.
Time management	5. I organize my study time carefully to make the best use of it. 18. I'm pretty good at getting down to work whenever I need to. 31. I work steadily through the term or semester, rather than leave it all until the last minute. 44. I generally make good use of my time during the day.
Alertness to assessment demands	2. When working on an assignment, I'm keeping in mind how best to impress the marker. 15. I look carefully at tutors' comments on course work to see how to get higher marks next time. 28. I keep in mind who is going to mark an assignment and what they're likely to be looking for. 41. I keep an eye open for what lecturers seem to think is important and concentrate on that.
Achieving	10. It's important to me to feel that I'm doing as well as I really can on the courses here. 24. I feel that I'm getting on well, and this helps me put more effort into the work. 37. I put a lot of effort into studying because I'm determined to do well. 50. I don't find it at all difficult to motivate myself.
Monitoring effectiveness	7. I go over the work I've done carefully to check the reasoning and that it makes sense. 20. I think about what I want to get out of this course to keep my studying well focused. 34. Before starting work on an assignment or exam question, I think first how best to tackle it. 47. When I have finished a piece of work, I check it through to see if it really meets requirements.
<i>Surface approach</i>	
Lack of purpose	3. Often I find myself wondering whether the work I am doing here is really worthwhile. 16. There's not much of the work here that I find interesting or relevant. 29. When I look back, I sometimes wonder why I ever decided to come here. 42. I'm not really interested in this course, but I have to take it for other reasons.
Unrelated memorizing	6. I find I have to concentrate on just memorizing a good deal of what I have to learn. 19. Much of what I'm studying makes little sense. 32. I'm not really sure what's important in lectures, so I try to get down all I can. 45. I often have trouble in making sense of the things I have to remember.
Syllabus-boundedness	12. I tend to read very little beyond what is actually required to pass. 25. I concentrate on learning just those bits of information I have to know to pass. 38. I gear my studying closely to just what seems to be required for assignments and exams. 51. I like to be told precisely what to do in essays or other assignments.
Fear of failure	8. Often I feel I'm drowning in the sheer amount of material we're having to cope with. 22. I often worry about whether I'll ever be able to cope with the work properly. 35. I often seem to panic if I get behind with my work. 48. Often I lie awake worrying about work I think I won't be able to do.

contexts within the course, and prize the opportunity to dissect in the anatomy lab and work in a hands-on manner. In the United States, there have been few studies of how student approaches to study impact their academic achievement apart from a study that took place during a veterinary anatomy course (Ward & Walker 2008) and another on the learning approaches of first year medical students and their influence on outcomes in a gross anatomy course (Ward 2011). Although the first study had a relatively small number of participants, students who used a deep approach once again showed significantly better course grades and recall after 1 year than students using a surface approach. The second study showed that students utilizing strategic approaches to study were more likely to succeed while students using surface ones tended to struggle. To confirm these findings and expand upon them, this study examines the approaches to study adopted by a cohort of students in their first year of an American medical school and how these approaches may influence their academic success. For the purpose of this study, academic success is defined by three measures. First, their overall percentage scores gathered from every class during the first year, their first year overall grade point average (GPA). Next, the second-year GPA is similar to the first but includes all course work taken during the first 2 years prior to beginning their clinical rotations. The third measure is the students' performance on their first licensure exam, the COMLEX step 1 board exam, taken at the end of the second year of medical school.

The purpose of this study is to: (1) profile the approaches to study that students use at the beginning of the first year of medical school, the end of the first year, and at the end of the second year, (2) determine the percentage of students who maintain a consistent approach to study during the first year as well as those who change study approaches during the same period, (3) determine the percentage of students who maintain a consistent approach to study during the second year as well as those who change study approaches during the same period, (4) correlate academic outcomes (cumulative GPA at the end of the first year, cumulative GPA at the end of the second year, and performance on the COMLEX step 1 board exam at the end of their second year) with their approaches to study at the beginning of the first year, the end of the first year, and the end of the second year, and (5) correlate student performance with consistency or change in approach to study during the first and second years. This study is the first to examine the approaches to study in a population of American medical students in conjunction with their performance on board exams and cumulative GPA. This will allow educators to find ways to identify students who may struggle and also key times to intervene so that they can develop effective study approaches.

Setting and participants

The participants in this study were all medical students at the West Virginia School of Osteopathic Medicine (WVSOM) and had earned undergraduate degrees prior to matriculating to medical school. Please note that in the United States, osteopathic physicians are granted the same practice rights as MD

physicians and their medical coursework is very similar. One notable difference is an increased emphasis on the musculo-skeletal system as part of their coursework in manipulative medicine. Students were recruited by email and were reminded of the study with an announcement between class periods. A total of 497 students in the graduating classes of 2009, 2010, and 2011 were invited to participate during their first year of medical school and the response rate from each class was 83.8%, 83.5%, and 88.5%, respectively.

Overall, 49.7% of the participants were female and 50.3% male; 17.5% were enrolled in the problem-based learning (PBL) track while 82.5% in the traditional systems-based learning (SBL) track. The SBL students had a more traditional lecture and lab-based learning environment while the PBL students worked in small groups to define specific learning issues as they worked through a clinical case presentation. The ratio of study participants was not significantly different from the overall school population (50.1% female and 18% PBL).

Methods

Approval to conduct this study was granted in August 2005 by the WVSOM Institutional Review Board and data gathering took place from the fall of 2005 until the fall of 2009. I recruited participants from the student population at the beginning of their first year in late August and asked them to complete a consent form and the ASSIST (Table 1) three times:

- (1) at the beginning of the first year, prior to start of classes;
- (2) at the end of the first year in May, 2 weeks before the end of classes; and
- (3) at the end of the second year in May, after coursework was over but prior to the COMLEX exam.

ASSIST results were calculated using a variety of related sub-measures to characterize the predominant study approach into three categories: deep, strategic, and surface. Students with scores that were ambivalent (e.g., equal deep, and strategic scores) were excluded from subsequent analysis.

In the next portion of the study, I compared the responses of those participants who completed the ASSIST at both the beginning and end of the first year to find the proportion of students who were consistent in their overall approach to study (consistently deep, consistently strategic, and consistently surface) and the proportion of students who changed their approach (change to deep, change to strategic, and change to surface) during the first year. I repeated this procedure with the responses of the participants who completed the ASSIST at both the end of the first and second years to find the proportion of participants who were consistent in their approach and the proportion that changed their approach during the second year of medical school.

Three different outcomes were then correlated with the approaches to study employed by each group:

- (1) cumulative GPA at the end of the first year (percentage score on a scale of 0–100 reflecting all first-year coursework);

- (2) cumulative GPA at the end of the second year (percentage score on a scale of 0–100 reflecting all second-year coursework); and
- (3) first-attempt scores on the COMLEX medical board exam (normalized around a mean of 500 with scores below 400 considered failing).

Apart from gross anatomy and histology where some free-response questions were administered, all the outcomes are the result of student marks on multiple choice question examinations. Throughout all portions of this study, I used *f*-tests to assess the variability of each group prior to comparison of the mean grades of students in each category. When more than one group mean was compared, I employed one-way ANOVA followed by a Bonferroni post-test to find any significant differences between groups. Significance was determined by $p < 0.05$ or less.

Results

Demographic considerations and ASSIST results

Using one-way ANOVA, I found no significant differences between deep, strategic, and surface scores of participants in the SBL and PBL programs although the PBL students did tend to have consistently higher scores on deep measures. However, at each time point, SBL students had significantly higher scores on one surface sub-measure than their PBL peers, *syllabus-boundedness*, at the beginning of the first year ($t = 4.27$, $p < 0.05$) the end of the first year ($t = 4.71$, $p < 0.05$), and the end of the second year ($t = 4.86$, $p < 0.05$).

With one exception, I did not find any significant differences in deep, strategic, and surface scores based on sex. One sub-measure of surface learning, *fear of failure*, was higher in female participants at the beginning of the first year ($t = 7.16$, $p < 0.05$) and end of the first year ($t = 7.09$, $p < 0.05$), but no significant difference between the groups existed at the end of the second year.

Study approaches and cumulative GPA at the end of the first year of medical school

Of the students in the graduating classes of 2009, 2010, and 2011, 425/497 (85.5%) completed the ASSIST at the beginning of the first year. Participants' preferred approaches to learning at the beginning of the first year were: 217/425 (51.1% of subjects) deep, 175 (41.2%) strategic, and 28 (6.6%) surface. At this time, five (1.1%) students were classified as ambivalent, without a distinct preference for any single approach, and were excluded from subsequent analysis.

Of the students who completed the first year, 352/453 (77.7%) completed the ASSIST at the end of the first year. Participants' preferred approaches to study at the end of the first year were: 188/352 (53.4%) deep, 118 (33.5%) strategic, and 34 (9.7%) surface. At this time, 12 (3.4%) students were classified as ambivalent and excluded from subsequent analysis.

The mean GPAs of students who identified themselves as preferring deep, strategic, and surface approaches at the

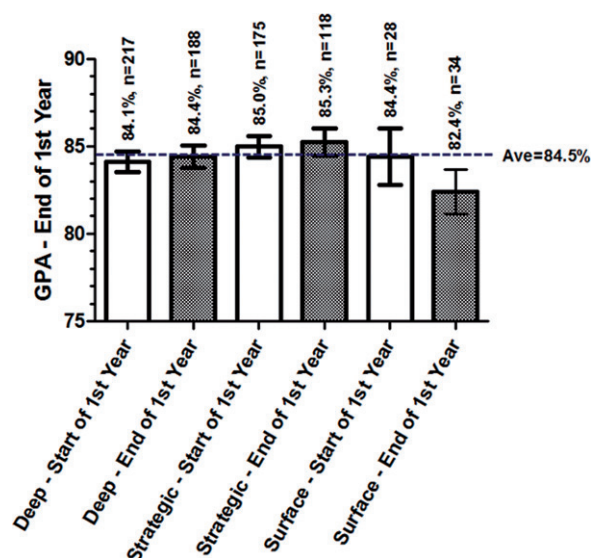


Figure 1. First-year GPA and ASSIST results from beginning and end of first year.

beginning of the first year were 84.1%, 85.0%, and 84.4%, respectively. The mean GPAs of students who identified themselves as preferring deep, strategic, and surface approaches at the end of the first year were 84.4%, 85.3%, and 82.4%, respectively. These data are shown in Figure 1. Students with a preference for strategic approaches at the end of the first year had significantly higher scores than their peers who used surface measures at the same time ($t = 3.47$, $p < 0.05$).

Changes to study approaches and cumulative GPA at the end of the first year of medical school

Of the students who successfully finished the first year, 299/453 (66.0%) students completed the ASSIST at both times, enabling comparison of their approaches to study before and after the first year. A total of 209/299 participants (68.9%) maintained a consistent approach to study. Of these, 117/299 (39.1%) were consistently deep, 81 (27.1%) consistently strategic, and only 8 (2.7%) consistently surface during the first year. In contrast, 93 (31.1%) changed their preferred approach: 48 (16.0%) changed to a deep approach, 23 (7.7%) to strategic, and 22 (7.4%) to a surface approach during the first year.

The mean GPAs of students who identified themselves as utilizing consistently deep, consistently strategic, and consistently surface approaches during this time were 84.4%, 85.8%, and 83.7%, respectively. The mean GPAs of students who identified themselves as changing to use a deep, strategic, or surface approach during the first year were 84.4%, 84.3%, and 82.2%, respectively. These data are shown in Figure 2. Students who maintained a consistently strategic approach to study during the first year had a significantly higher mean GPA than students who changed to adopt a surface approach during the same period ($t = 3.49$, $p < 0.05$).

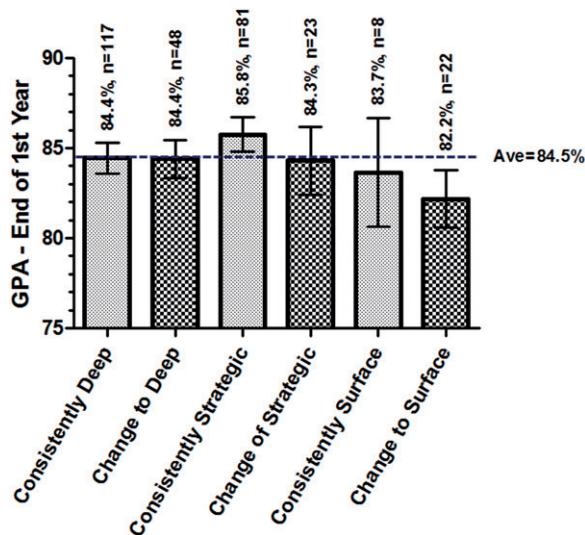


Figure 2. First-year GPA and changes in ASSIST results during first year.

Study approaches and cumulative GPA at the end of the second year of medical school

Due to student attrition during the second year, the numerical data in this section will vary slightly from those presented in the previous section. Of the students who successfully finished the second year, 417/453 (92.1%) completed the ASSIST at the beginning of the first year. Participants' preferred approaches to learning at the beginning of the first year were: 213/417 (51.1% of subjects) deep, 172 (41.2%) strategic, and 27 (6.5%) surface. At this time, five (1.2%) students were classified as ambivalent, without a distinct preference for any single approach, and were excluded from subsequent analysis.

Of the students who successfully finished the second year, 345/453 (76.2%) completed the ASSIST at the end of the first year. Participants' preferred approaches to study at the end of the first year were: 184/345 (53.3%) deep, 115 (33.3%) strategic, and 34 (9.9%) surface. At this time, 12 (3.5%) students were classified as ambivalent and excluded from subsequent analysis.

Of the students who successfully finished the second year, 172/453 (38.0%) completed the ASSIST at the end of the second year. Participants' preferred approaches to study at the end of the second year were: 91/172 (52.9%) deep, 56/172 (32.6%) strategic, and 16 (9.3%) surface. At this time, nine (5.2%) students were classified as ambivalent and excluded from subsequent analysis. These data are presented in Figure 3.

The mean second-year GPAs of students who identified themselves as preferring deep, strategic, and surface approaches at the beginning of the first year were 85.3%, 86.1%, and 85.4%, respectively. The mean GPAs of students who identified themselves as preferring deep, strategic, and surface approaches at the end of the first year were 85.6%, 86.6%, and 83.6%, respectively. The mean GPAs of students who identified themselves as preferring deep, strategic, and surface approaches at the end of the second year were 85.4%, 87.0%, and 84.9%, respectively. These data are shown

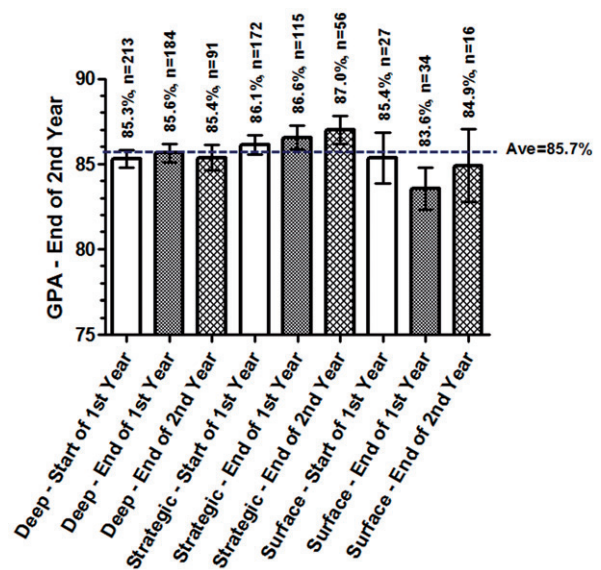


Figure 3. Second-year GPA and ASSIST results from beginning of first year to end of second year.

in Figure 3. Students with a preference for strategic approaches at the end of the second year had significantly higher scores than their peers who used surface measures at the same time ($t = 4.11$, $p < 0.05$).

Changes to study approaches and cumulative GPA at the end of the second year of medical school

Of the students who successfully finished the second year, 294/453 (64.9%) students completed the ASSIST at the beginning and end of the first year while 119/453 (26.3%) completed the ASSIST at the end of the first and second years. This enables us to compare how their approaches to study changed during both the first and second years.

Of the participants in this section of the study, during the first year, a total of 201/294 (68.4%) maintained a consistent approach to study, 114/294 (38.8%) participants were consistently deep, 79 (26.9%) consistently strategic, and only 8 (2.7%) consistently surface; 93/294 participants (31.6%) changed their preferred approach during the first year – 48 (16.3%) changed to a deep approach, 23 (7.8%) to strategic, and 22 (7.5%) to a surface approach.

Of the students who completed the ASSIST at both the end of the first and second years, a total of 85/119 (71.4%) maintained a consistent approach to study: 51/119 (42.9%) participants were consistently deep, 28 (23.5%) consistently strategic, and only 6 (5.0%) consistently surface. During the second year, 34/119 (28.6%) changed their preferred approach: 8 (6.7%) changed to a deep approach, 19 (16.0%) to strategic, and 7 (5.9%) to a surface approach.

The mean second-year GPA of students who identified themselves as utilizing consistently deep, consistently strategic, and consistently surface approaches during the first year were 85.8%, 87.0%, and 84.1%, respectively. The mean second-year GPA of students who identified themselves as changing to use a deep, strategic, or surface approach during the first year were 85.6%, 85.4%, and 83.4%, respectively. These data are shown

in Figure 4. Students who had a consistently strategic approach during the first year had a significantly higher second-year mean GPA than students who changed to adopt a surface approach during the same time ($t=3.93$, $p < 0.05$).

The mean second-year GPA of students who identified themselves as utilizing consistently deep, consistently strategic, and consistently surface approaches during the second year were 85.6%, 87.6%, 84.8%, respectively. The mean second-year GPA of students who identified themselves as changing to use a deep, strategic, or surface approach during the second year were 83.7%, 86.4%, 84.6%, respectively. These data are shown in Figure 5. None of the inter-group comparisons reached the $p < 0.05$ level of significance.

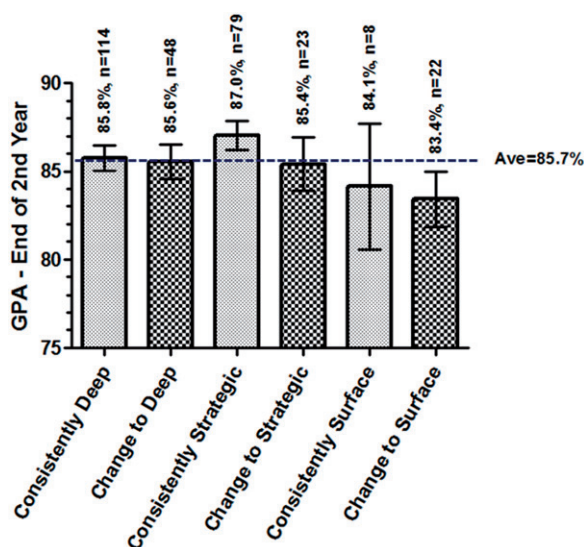


Figure 4. Second-year GPA and changes in ASSIST results during first year.

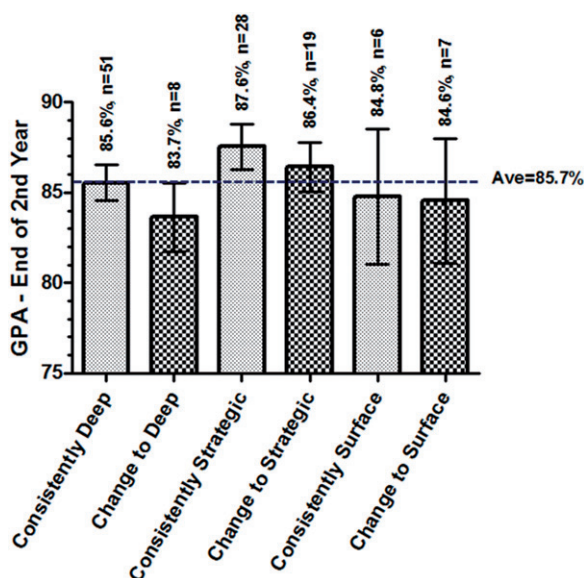


Figure 5. Second-year GPA and changes in ASSIST results during second year.

Study approaches and COMLEX step 1 board exam performance

As mentioned previously, data presented in this section are similar to those presented in the previous one but the numbers vary slightly due to student attrition and variation in students scheduling the board exam. Of the students who made their first attempt taking the COMLEX exam at the end of the second year, 412/471 (87.5%) completed the ASSIST at the beginning of the first year. Participants' preferred approaches to learning at the beginning of the first year were: 210/412 (50.9% of subjects) deep, 170 (41.3%) strategic, and 27 (6.6%) surface. At this time, five (1.2%) students were classified as ambivalent, without a distinct preference for any single approach, and were excluded from subsequent analysis.

Of the students who made their first attempt taking the osteopathic medical board exam at the end of the second year, 341/471 (72.4%) completed the ASSIST at the end of the first year. Participants' preferred approaches to study at the end of the first year were: 181/341 (53.1%) deep, 114 (33.4%) strategic, and 34 (10.0%) surface. At this time, 12 (3.5%) students were classified as ambivalent and excluded from subsequent analysis.

Of the students who made their first attempt taking the osteopathic medical board exam at the end of the second year, 172/471 (36.5%) completed the ASSIST at the end of the second year. Participants' preferred approaches to study at the end of the second year were: 91/172 (52.9%) deep, 56/172 (32.6%) strategic, and 16 (9.3%) surface. At this time, nine (5.2%) students were classified as ambivalent and excluded from subsequent analysis. These data are shown in Figure 6.

The mean COMLEX exam performance of students who expressed preference deep, strategic and surface approaches to learning at the beginning of the first year, the end of the first year, and the end of the second year were compared. The mean COMLEX score of the classes of 2009, 2010, and 2011

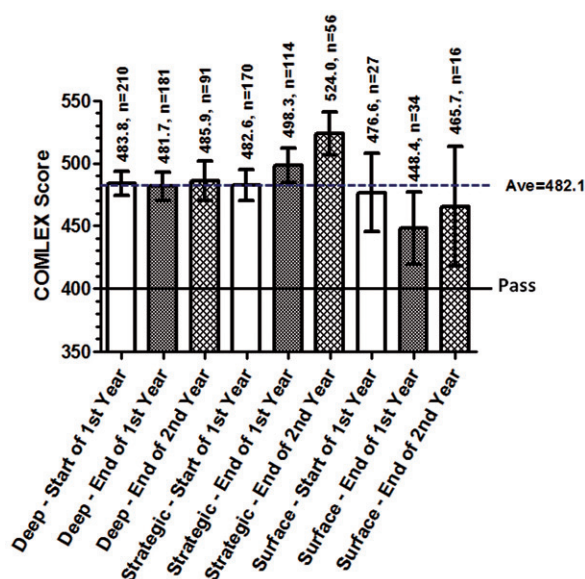


Figure 6. Board exam performance and ASSIST results from beginning of first year to end of second year.

was 482.1 and the minimum passing score for COMLEX step 1 was 400.

The mean COMLEX score of students who identified themselves as preferring deep, strategic, and surface approaches at the beginning of the first year were 483.8, 482.6, and 476.6, respectively. The mean COMLEX score of students who identified themselves as preferring deep, strategic, and surface approaches at the end of the first year were 481.7, 498.3, and 448.4, respectively. The mean COMLEX score of students who identified themselves as preferring deep, strategic, and surface approaches at the end of the second year were 485.9, 524.0, and 465.7, respectively. These data are shown in Figure 6. Students with a preference for strategic approaches at the end of the first year had significantly higher scores than their peers who used surface measures at the same time ($t=3.36$, $p<0.05$) and students with a preference for strategic approaches to learning at the end of the second year had significantly higher scores than the mean COMLEX step 1 score ($t=3.87$, $p<0.01$).

Changes to study approaches and COMLEX step 1 board exam performance

Of the students who made their first attempt taking the osteopathic medical board exam at the end of the second year, 290/471 (61.6%) students completed the ASSIST at both the beginning and end of the first year while 119/471 (25.3%) completed the ASSIST at both the end of the first and second years. This enables us to compare how their approaches to study changed during the first and second years.

Of the participants in this section of the study, a total of 199/290 (68.6%) maintained a consistent approach to study during the first year: 112/290 (38.6%) participants were consistently deep, 79 (27.2%) consistently strategic, and only 8 (2.8%) consistently surface. During the same period, 91/290 (31.4%) changed their preferred approach: 47 (16.2%) changed to a deep approach, 22 (7.6%) to strategic, and 22 (7.6%) to a surface approach.

Of the students who completed the ASSIST at the end of the first and second years, a total of 85/119 (71.4%) maintained a consistent approach to study: 51/119 (42.9%) participants were consistently deep, 28 (23.5%) consistently strategic, and only 6 (5.0%) consistently surface. In contrast, 34 (28.6%) changed their preferred approach during the second year: 8 (6.7%) changed to a deep approach, 19 (16.0%) to strategic, and 7 (5.9%) to a surface approach.

The mean COMLEX step 1 score of the classes of 2009, 2010, and 2011 was 482.1 and 400 was the designated passing score. The mean COMLEX performance of students who identified themselves as utilizing consistently deep, consistently strategic, and consistently surface approaches during the first year were 490.6, 505.7, and 455.6, respectively. The mean COMLEX performance of students who identified themselves as changing to use a deep, strategic, or surface approach during the first year were 478.9, 473.9, and 445.8, respectively. These data are shown in Figure 7.

The mean COMLEX performance of students who identified themselves as utilizing consistently deep, consistently strategic, and consistently surface approaches during the

second year were 485.1, 529.2, and 498.8, respectively. The mean COMLEX performance of students who identified themselves as changing to use a deep, strategic, or surface approach during the second year were 435.9, 524.3, and 445.9, respectively. These data are shown in Figure 8.

Students who maintained a consistently strategic approach during the first year had consistently higher COMLEX scores than students who changed to adopt a surface approach during the same period of time ($t=3.26$, $p<0.05$). Students who maintained a consistently strategic approach to study during the second year had significantly higher scores on the COMLEX step 1 board exam than the average COMLEX score ($t=3.20$, $p<0.05$).

In addition to the comparisons listed above, it is important to note that participants who consistently used a surface

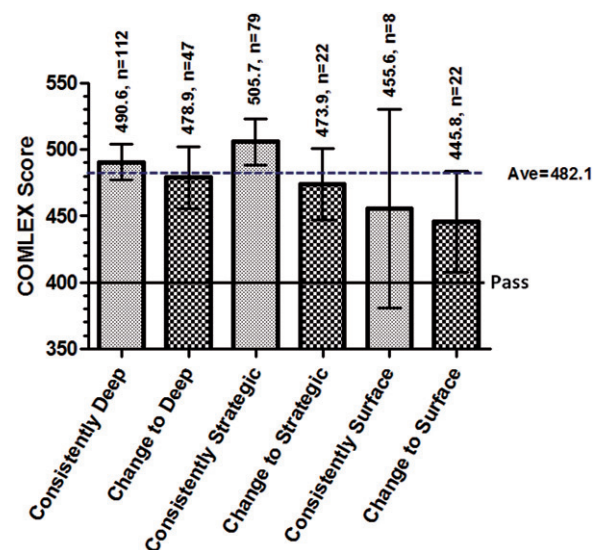


Figure 7. Board exam performance and changes in ASSIST results during the first year.

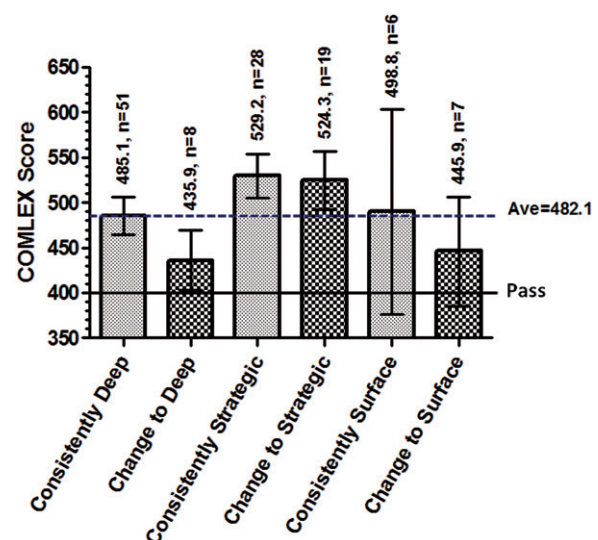


Figure 8. Board exam performance and changes in ASSIST results during the second year.

approach during the first year, consistently used a surface approach during the second year, or changed to a surface approach during the second year were more likely to fail COMLEX step 1 since the 95% confidence intervals for these groups dipped below 400, the passing level for the board exam.

Conclusions

- (1) The approaches to study used by students during their first year of medical school had a definite association with their cumulative GPA at the end of that year. The grades of “naïve” students who expressed a preference for deep, strategic, or surface approaches to learning at the beginning of the first year did not vary from each other. However, by the end of the first year, the students who had a preference for strategic approaches to learning had higher grades than those using a surface approach. Students who maintained a strategic approach (strategic at start and finish of first year) had higher grades than average while students who changed to adopt a surface approach during the first year had lower grades than average (Figures 1 and 2). The use of strategic approaches to study are associated with academic success in medical school, deep approaches are beneficial and surface approaches are clearly associated with poorer performance during the first year.
- (2) The approaches to study used by students during the first and second years of medical school had a definite association with their cumulative GPA at the end of the second year. These results parallel those seen in the first year. Strategic approaches to study at either the end of the first or second year were associated with improved grades while the use of surface approaches was associated with poorer performance. Interestingly, students using surface approaches at the end of the first year had lower second-year GPA, dipping below the class average, than those using surface approaches at the end of the second year. Consistent use of strategic

approaches once again was associated with academic success while changing to a surface approach during the first year led to a second-year GPA below the class average.

- (3) The approaches to study used by students during the first and second years of medical school also had strong associations with their success rates when first taking COMLEX medical board exam. These results parallel those seen with the second-year GPA but are even more pronounced. Strategic approaches to study at either the end of the first or second year were associated with improved grades while the use of surface approaches was associated with poorer performance than average. Consistently using a strategic approach during the first and second years seems to have led to better-than-average performance on the COMLEX exam while surface approaches were often associated with poorer-than-average performance and failure.

Discussion

Differing outcomes and approaches to study

During the statistical analysis of data in this study, I analyzed the outcome measures (GPA and COMLEX score) as a range of values alongside the variable measures (approaches to study at any time, stability, or change of study approach) and not as single numerical value. This was done to insure that claims made regarding the differences in group means analyzed by one-way ANOVA would only be presented as significant only if there was a strong evidence that this was the case. However, looking at the first-year average GPA, second-year GPA, and average COMLEX score as a single numerical value instead of a range of values gives a slightly different view of the results. In several instances, the 95% confidence interval associated with one of the group means fell above or below the numerical first-year average GPA (Table 2), second-year mean GPA (Table 3), mean COMLEX step 1 score (Table 4), or the COMLEX step 1 passing score (Table 5). This not only implies

Table 2. Significant differences between specific approaches to study and mean first-year GPA (shown in Figures 1 and 2).

Groups with 95% confidence interval entirely above second-year mean GPA	First-year mean GPA	Groups with 95% confidence interval entirely below second-year mean GPA
Strategic at end of first year 85.3 (84.51, 86.0) Consistently strategic throughout first year 85.8 (84.8, 86.7)	84.5%	Surface at end of first year 82.4 (81.1, 83.7) Change to surface during in first year 82.2 (80.6, 83.8)

Table 3. Significant differences between specific approaches to study and mean second-year GPA (shown in Figures 3–5).

Groups with 95% confidence interval entirely above second-year mean GPA	Second-year mean GPA	Groups with 95% confidence interval entirely below second-year mean GPA
Strategic at end of first year 85.3 (85.9, 87.2) Strategic at end of second year 87.0 (86.2, 87.8) Consistently strategic throughout first year 87.0 (86.2, 87.9) Consistently strategic throughout second year 87.6 (86.3, 88.8)	85.7%	Surface at end of first year 82.6% (82.3, 84.8) Change to surface during first year 83.4 (81.9, 85.0) Change to deep during second year 83.7 (81.7, 85.6)

Table 4. Significant differences between specific approaches to study and mean COMLEX step 1 score (shown in Figures 6–8).

Groups with 95% confidence interval entirely above second-year mean GPA	Mean COMLEX score	Groups with 95% confidence interval entirely below second-year mean GPA
Strategic at end of first year 498.3 (484.4, 512.2)	482.1	Surface at end of first year 448.3 (419.6, 477.2)
Strategic at end of second year 524.0 (507.0, 541.0)		Change to surface during first year 445.8 (407.9, 483.6)
Consistently strategic throughout first year 505.7 (488.1, 523.3)		Change to deep during second year 435.9 (402.6, 469.1)
Consistently strategic throughout second year 529.2 (504.8, 553.6)		
Change to strategic during second year 524.3 (492.1, 556.4)		

Table 5. Specific approaches to study that lead to failure on medical board exams (shown in Figures 7 and 8).

Minimum passing COMLEX score	Groups with 95% confidence interval that includes failing scores on COMLEX
400	Consistently surface throughout first year 455.6 (380.9, 530.4)
	Consistently surface throughout second year 498.8 (376.2, 603.4)
	Change to surface during second year 445.9 (385.4, 506.3)

that students in these groups have a greater likelihood of outperforming or underperforming when compared to their peers, but that they are at definite risk of falling below 400, the pass rate for COMLEX step 1.

The approaches to study that students reported at the beginning of the first year had no association with improved or decreased academic performance on any of the three outcomes that were measured: first-year GPA, second-year GPA, and COMLEX step 1 score. This implies that students' approaches to study are flexible and change to accommodate the demands of the medical school curriculum.

However, the end of the first year of medical school was a key time for predicting academic performance based on approach to study. Students using deep approaches to learning at the end of the second year had roughly average mean scores on all outcomes, which is not surprising since they made up the majority of the participants in the study. The use of surface approaches at the end of the first year was associated with poorer-than-average performance on all three outcome measures, while use of strategic methods was associated with above-average performance. The observation that a significant difference was seen at the end of the first year between strategic and surface approach groups leads to the conclusion that strategic students, who are constantly tailoring their study to the class assessments, experiment until they discover profitable ways to study. Interestingly, this constant reassessment of study method implies that strategic approach users will continue to improve while deep and surface users plateau.

This is indeed what happens and at the end of the second year; strategic approach users perform even better than previously and significantly outperform their deep and surface peers. Students using a strategic approach to study at the end of the second year had the highest mean performance of any group on both second-year GPA and COMLEX step 1

board scores. Interestingly, students using a surface approach at the end of the second year had better scores than those using surface methods at the end of the first year. This may be due to a degree of "fine-tuning" of the surface methods that make them slightly more effective after an additional year of practice. Another possibility is that the second-year curriculum and board exam preparation are more rewarding of surface learning than the first-year curriculum.

During both the first and second years, one interesting observation was that students who were consistent in their choice of any of the three study approaches outperformed, although not always significantly, their peers who changed to adopt that study approach. It would appear that students who maintain a consistent approach to study are able to fine tune that approach and improve, but the deep and strategic approaches have a higher "achievement ceiling" than the surface approach.

Consistently using a strategic approach during the first year was associated with improved performance on all three outcomes, while changing to a surface approach during the first year was associated with poorer-than-average performance on all outcomes. Students who were consistently strategic throughout the second year had a higher mean second-year GPA than average. Interestingly, students who changed to adopt a deep approach during the second year performed significantly worse than average, but a small number of respondents ($n=8$) hampers the power of this observation.

However, one important finding is that despite the small number of students in three groups (consistently surface during the first year, consistently surface during the second year, change to surface methods during the second year), they each had means whose 95% confidence intervals dipped below the passing rate of COMLEX step 1 (Figures 7 and 8). The wide confidence intervals seen in the consistently surface students during the first and second years means that a wide variety of outcomes was seen in some groups but the students who changed to adopt a surface approach during the second year had a reasonably narrow confidence interval, making this group definitely "at risk" for failure on board exams.

Demographic considerations and medical students' approaches to study

The medical students in this study had a definite predilection for using deep approaches to learning, moving from 51.1% at the beginning of the first year to 53.3% at the end of the first

and 52.9% at the end of the second year. This marked preference for a deep approach by medical students is in agreement with other researchers' findings (Newble & Gordon 1985; Smith & Mathias 2007) and suggests that at this stage in their professional development, these students have invested in generating a meaningful understanding of the coursework.

The strategic approach was the next most popular, although its popularity waned from 41.2% to 33.3% and finally 32.6% by the end of the second year. Despite this decrease, students who expressed a preference for strategic approaches at the beginning of the first year had significantly better performance than average at the end of the first and second years. This is not particularly surprising since students who use a strategic approach tailor their studying to their perceptions of how exams will be formatted.

Student participants choosing a surface approach were clearly in the minority but their numbers increased as the first year progressed, moving from 6.5% to 9.9% and 9.3% by the end of the second year. This trend is worrying, since adopting this approach was associated with decidedly poorer outcomes, particularly at the end of the first year. It has been previously demonstrated that the use of surface approaches is correlated with poorer academic achievement and recall of information (Ward & Walker 2008; Ward 2011) and treats learning as an externalized activity rather than a process of meaningful education. It may even be more important for educators to *discourage* surface approaches than for them to encourage deep approaches.

There was no single definite reason for the rate of participation dropping from 87.5% at the beginning of the first year to 72.4% at the end of the first year and finally to 36.5% at the end of the second year. One possible explanation is fatigue at the end of the year coupled with additional demands on student time, such as filling out a large number of course evaluations and preparing to take the high-stakes board examination but the drop in participation must be noted as a limitation of this study. The increase in the number of ambivalent students from 1.2% of respondents at the beginning of the first year to 3.8% at the end of the first year and finally to 5.2% by the end of the second year is curious. While I have been unable to develop a hypothesis to address this finding, it is possible that as students gained experience, their approaches to study might become more blended and less extreme than they were at the beginning of the first year.

Regarding curricular track, while no differences between the deep, strategic, and surface scores were evident at the start of the first year, significant differences in one surface approach sub-measure was noted. SBL students reported higher scores in the surface approach sub-measures of *syllabus-boundedness* at the beginning of the first year ($t=4.27, p < 0.05$), the end of the first year ($t=5.71, p < 0.05$), and the end of the second year ($t=4.86, p < 0.05$) than their PBL peers. Those familiar with the PBL paradigm may not be surprised by these results since the students in a PBL curriculum set their own learning issues and investigate them in a group context. Students who self-select themselves into such a program likely begin with less drive to follow a rigid syllabus than peers who are more interested in following a pre-designed pedagogic scaffold. This study partially reinforces the findings of another

study (Newble & Clarke 1986), although they used a different, but related, assessment, showing that PBL students had lower scores on the *syllabus-boundedness* surface sub-measure when compared to their peers in a more traditional curriculum.

One-way ANOVA showed no significant differences between deep, strategic, and surface scores in ASSIST responses of participants in the SBL and PBL programs although the PBL students did tend to have consistently higher scores on deep measures. No significant differences in deep, strategic, and surface scores were found in ASSIST responses of participants based on sex, with one exception. One sub-measure of surface learning, *fear of failure*, was higher in female participants at the beginning of the first year ($t=4.58, p < 0.05$) and end of the first year ($t=5.39, p < 0.05$) but no significant difference was seen at the end of the second year. This is in agreement with a study (Stiernborg & Bandaranayake 1996) that found that female medical students had significantly higher fear of failure scores than male students and that this discrepancy grew by the end of the first year but does not explain why the male and female groups show no difference by the end of the second year. The fact that this measure was raised at the beginning and end of the first year implies that the discrepancy is pre-existing and exacerbated by the first year of medical school. However, at the end of the second year, there was no significant difference in the fear or failure sub-measure between female students and their male peers. While this is a complex issue, perhaps fostering a culture of high expectations combined with mutual support helped to alleviate the anxiety caused by a fear of failure, particularly in those students who enter medical school already expressing uncertainty regarding their ability to succeed during the first year. Whether the abrupt drop in fear of failure scores during the second year is due to acclimatization to the stresses of medical school or to some other factor is unknown.

Implications for pedagogy and curricular design

It is important to remember the point made by Laurillard (1979) that there is no such thing as a "deep student", "strategic student", or "surface student" since approaches to study are not ingrained personality traits but context-dependent ways in which students respond to their learning environments. While student motivations and approaches to study are definite tendencies that are somewhat fixed, they are flexible enough to change in response to the demands of particular learning environments (Biggs 1987, 1999). In fact, the same group of students can manifest different approaches to study in separate classes, depending upon the course design. By following a single cohort of students in different classrooms during the same period of time, Eley (1992) demonstrated that deep approaches to learning can be encouraged by courses offering cohesion, metacognitive opportunities, and independent learning. Because of this, it is possible for students and educators to discourage surface approaches, as demonstrated elsewhere (Entwistle & Ramsden 1983; Newble and Jaeger 1983). Looking at the variety of learning outcomes manifested by students as they moved from replicative learning to a more abstract and elaborative

understanding, Australian researcher Biggs (1979) demonstrated that a utilizing (surface) motivation led to lower-yield learning than an internalizing (deep) motivation. Approaches to study can be assessed in the context of any curriculum, making them an excellent benchmark for comparing the learning outcomes of various pedagogies such as PBL, lecture, small group activity, team-based learning, SBL, and others. Each of these instructional modalities may have unique features that can be used to promote effective learning by a diverse population of students.

The phenomenographic literature has consistently demonstrated the benefits of a deep approach compared to a surface approach to study in a variety of contexts, but relatively little time has been devoted to assessing the possible merits of a strategic approach (Case & Marshall 2009). Several researchers in the United Kingdom have shown the advantage of strategic (achieving) approaches on medical student performance on course exams (McManus et al. 1998; Smith & Mathias 2010) and on objective structured clinical examinations (Martin et al. 2000), with students using strategic approaches slightly outperforming students using a deep one. Perhaps the strategic method is not only associated with improved course performance but also with a greater sophistication in appraising how to match effort to outcome when confronted with a challenging and dense curriculum. It is worth considering that students using a strategic approach are not necessarily “grubbing for points” but may actually be demonstrating a metacognitive awareness of their learning environment and adjusting their strategies accordingly.

When designing a course to promote a deep approach, effective teaching moves away from a focus on what the instructor does in front of a class and focuses instead on the tasks assigned to the students and the anticipated outcomes of those tasks (Biggs 1999). Educators who have attempted to create curricula that encourage deep approaches to learning have had difficulty in doing so since a major determinant of their approach is perception of the volume of course material and the need to pass the ever-present standard exams (Newble & Jaeger 1983; Case & Marshall 2009). By shifting from traditional examination formats to essays and written reports, one group of researchers (Gordon & Debus 2002) was able to increase the use of deep learning approaches in a cohort of students in a teacher education program over a 3-year period. Using similar methods over a 5-year period, another group (Cope & Staehr 2005) was able to significantly increase deep learning in a class on information systems and found that student perception of the workload was one major determinant of learning approach. In addition to the demands of the material itself, instructors' approaches to teaching directly influence student approaches, with a teacher-focused/information transmission paradigm leading to surface approaches, while instructors who adopt student-focused/conceptual change-based paradigms are able to encourage deep approaches in students (Trigwell et al. 1999). More research is needed before such an approach could be deliberately applied to a medical school curriculum due to the volume of material, relatively short time available, and high-stakes board examinations. These factors strain the resolve of students to maintain deep or strategic approaches to study

and push them toward low-yield surface approaches to study (Biggs 1987).

A worthwhile next step in this process will be to categorize the ways in which students build their study approaches during their pre-clinical education and how they adapt to the rigors of professional education. By describing how students organize specific study methods to produce a deep, strategic, or surface approach to learning, faculty can guide curricular reform to discourage low-yield approaches. Educators can then begin testing curricular designs and assessments that specifically encourage meaningful and high-recall approaches to study and discourage the binge-and-purge, surface study approaches that are prevalent under poorly designed or unnecessarily stressful curricula in some areas of higher education.

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Notes on contributor

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