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## Textbook Use and Learning: a North American perspective

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Eight hundred and ninety students at 35 US institutions of higher education participated in a comprehensive study of textbook use and its relation to ratings of textbook quality and helpfulness, a student self-report of learning, student self-report of their deep approach to learning, student perceptions of instructors, and a measure of quiz performance. Intercorrelations between key measures revealed surprising relationships about the influence of these variables on self-reported learning and quiz performance. An analysis of textbook differences revealed some significant differences between the books in terms of quality and helpfulness as well as self-reported learning, but not on quiz performance. The authors identified significant predictors of self-reported learning (deep approach and student perceptions of instructor) and quiz performance (grade point average and textbook helpfulness). These results highlight the complexity of examining student learning and suggest some important variables and problems for future research especially the need for a valid, reliable, measure of learning.

How can instructors optimise student learning in the college classroom? A key step towards answering this question involves gaining a thorough knowledge of how students, teachers, and textbooks interact to impact learning. How do students interact with the textbook? What are key student characteristics that predict their learning? The current research was designed to address these questions. Students commonly use the textbook as an aid in studying for exams, but many students do not read the textbook to the extent that they should (Gurung & Martin, 2011). In a comprehensive study conducted in the United States, we assessed how student attitudes (about their textbook, about learning, about study strategies, and about their instructor) are related to student performance (measured with a self-report of deep learning and an actual quiz).

### **Major Correlates of Learning: a theoretical framework**

Hutchins (2007) saw 'the role of theory in the scholarship of teaching and learning as the elephant in the room' (p. 1). Researchers are trying to understand how students learn best and there exists a need to situate all the myriad studies of pedagogical research in a common context (Gurung & Schwartz, 2010). Bernstein et al. (2010) and Chew et al. (2010) provide comprehensive pictures of what is known about the processes surrounding teaching and learning and provide general models that guided our selection of variables.

Any examination of how students learn necessitates a focus on at least three major components: student behaviours (e.g., study techniques), instructor behaviours (how learning is

facilitated), and the means by which content is transferred (textbooks and technology). Each component has multiple strategies available for use. For example, there are many ways students study, for example metacognitive strategies, quizzing, note-taking (rewriting), highlighting, and the use of flashcards and mnemonics (Gurung & McCann, 2012). Empirical tests of study techniques are equivocal at best. Some researchers suggest that the type of study technique that a student uses has a beneficial effect on exam performance (e.g., Bol, Warkentin, Nunnery, & O'Connell, 1999; Hattie, 2009). Other researchers suggest that there is no one style that is useful for everyone, and that a repertoire of techniques is best (Gurung, 2005; Hadwin & Winne, 1996).

There are also many ways the instructor can influence learning. For example, instructor characteristics (ideal/master teacher factors), course format (amount of lecture, discussion, group work), how much writing is involved, and whether study guides are provided, may all influence student learning (Fink, 2003; Gurung & Schwartz, 2009; Gurung & Vespia, 2007). In addition, there are suggestions of effective ways to teach. Bain (2004) culled a set of characteristics identifying the 'best' college teachers. Similarly, Buskist (2004) has earmarked a set of features held by 'master teachers', such as passion, organisation, and inspiration. However, few efforts directly address instructor variables as they impact student performance. The modality by which knowledge is transmitted is also very important, and the primary sources of content delivery tend to be the instructor and the textbook, both of which are highly variable. For example, textbooks vary in length, writing style, number of pedagogical aids used, applied or research focus, tone, and comprehensiveness (Bord, Jeske, & Gurung, 2007). However, detailed studies connecting textbook quality to student performance are not readily available.

### **The Importance of the Textbook**

Textbook research can be separated into two broad major categories: content and pedagogical aids. Research has examined the content of textbooks, particularly looking for similarity of core concepts (Griggs, Bujak-Johnson, & Proctor, 2004), and suggests that introductory and even upper level textbooks may have similar chapters or topics, but vary considerably in terms of coverage, terms used, and citations (Christopher, Griggs, & Hagans, 2000; Griggs & Marek, 2001).

A second category of research has examined the effectiveness of textbook pedagogical aids (Gurung & Daniel, 2005; Nevid & Lampmann, 2003) and how students use them (Clump, Bauer, & Bradley, 2004; Sappington, Kinsey, & Munsayac, 2002; Sikorski et al., 2002). A number of studies have assessed how often pedagogical aids are used and if they are helpful (Gurung, 2003, 2004; Marek, Griggs, & Christopher, 1999; Weiten, Deguara, Rehmke, & Sewell, 1999; Weiten, Guadagno, & Beck, 1996). The use of pedagogical aids and their perceived helpfulness does not always relate to student performance on exams. For example, Gurung (2003) reported that the use of some pedagogical aids was not related to performance and use of some features, such as key terms, was negatively correlated with exam scores. Clearly factors beyond the textbook are important as well.

### **A Focus on Deep Learning**

Our primary research goal was to systematically measure the different factors that influence student learning by comparing these factors to actual student performance (in addition to student perceptions about performance). We reviewed the literature to identify key variables and then included them in this study to assess and account for correlations between factors and the consequent relationship to learning. Some of our measures have seen limited use in this context. For example, we measure the extent to which students take a deep approach to learning: 'Deep learning is learning that takes root in our apparatus of understanding, in the embedded meanings that define us and that we use to define the world' (Tagg, 2003, p. 70). Students adopting a deep approach set out to understand what they have read or heard for themselves, which makes it more likely they will grasp the authors' meaning and learn the material better (Entwistle, 2009). When students are using deep level processing they focus on substance and the underlying meaning of the information, making a personal commitment to understanding, and reflecting on relationships between different pieces of information presented. Students strive to apply what they are learning

to their everyday lives and integrate and synthesise information with their prior learning, essentially moving up Bloom's (revised) hierarchy of learning (Anderson & Krathwohl, 2001). Students who use such an approach learn more, as measured by grades earned (Biggs, 2003; Ramsden, 2003). Deep learning is associated with an enjoyable learning experience while the surface approach tends to be less satisfying (Tagg, 2003). However, although the approach to learning concepts has been studied for some time (Marton & Saljo, 1997) and figures prominently in international studies (e.g., Entwistle, 2009), it does not figure prominently in North American studies in psychology.

### **Measuring Learning**

The study of student learning is a complex task involving many different components. In reviewing the extant literature related to pedagogy and student learning, there are two important concerns that remain to be addressed. Most importantly, many relevant studies primarily use self-reported learning as the sole outcome measure. Cognitive and educational psychologists have established that student perceptions of their own learning are not good indicators of actual learning (Hacker, Dunlosky, & Graesser, 2010). Kennedy, Lawton, and Plumlee (2002) pointedly observed that students cannot accurately assess their performance because they do not know what they do not know. Likewise, Wesp and Miele (2008) examined the predictive validity of student perceptions of exam performance. Not surprisingly, they found student ratings of performance to be inaccurate predictors of actual performance. In this study we assessed both student perceptions of their own learning as well as their performance on multiple-choice questions in relation to their utilisation of their textbook and its varied features. The latter parallels the major form of assessment of learning in introductory psychology courses.

Second, most studies are conducted with students from one institution (e.g., Lammers & Smith, 2008), or one course (Chase & Houmanfar, 2009), or one textbook (e.g., Gurung, 2005). Correspondingly, there is limited internal and external validity. Some recent meta-analyses have combined studies to provide a broader picture of student learning (Entwistle, 2009; Hattie, 2009), but no research addresses the interaction between the many different components simultaneously and with a diverse sample. Some researchers have examined parts of the puzzle, however. For instance, Lammers and Smith (2008) examined faculty and student perspectives on factors influencing learning, and although using data from only one institution, they reported that students and faculty placed the greatest importance on instructor variables.

In contrast, in this study, we assessed students from across the United States at community colleges, colleges, and universities, using a variety of different textbooks. In short, we essentially took a fine-tuned look at students' attitudes towards learning and their use of and perceptions of their textbook, in an effort to begin understanding the complex dynamics of teaching and learning in the classroom. Our three explicit research questions were: (1) do textbooks vary in helpfulness?; (2) does student learning vary with the textbook that they use?; and (3) what factors best predict student learning measured objectively and by self-report?

### **Method**

#### *Participants*

Eight hundred and ninety students from 35 schools (higher education institutions) participated in this study (78% women). All classes were taught by faculty, not teaching assistants. Schools varied in size and geographical location. No clear majority of type of school emerged and participants represented most schools in the US Carnegie classification system (four-year public college, four-year private college, two-year college). The average age was 20.66 years ( $SD = 5.59$ ). The majority (62%) were first-year students. The remaining students were second-year students (sophomores: 26%), third-year students (juniors: 7%), and fourth-year students (seniors: 5%). Of those reporting a grade point average ( $N = 587$ ), the average GPA was 3.26 ( $SD = 0.50$ ) on a 4.00 scale.

### Materials

Participants completed a 95-item questionnaire designed to capture various aspects of student learning behaviour. We modified existing scales to measure textbook quality and attitude towards learning. We also included measures of instructor ratings and study strategies. A complete copy of the 95-item questionnaire is available upon request.

*Textbook assessment.* We used a modified version of the Textbook Assessment and Usage Scale (TAUS; Gurung & Martin, 2011), utilising questions designed to assess the main components of a textbook (study aids, figures, visual appeal, boxed information, tables, research studies, writing, examples, and photographs). Students first rated their textbook on the quality of each of the items (with regard to placement, relevance, and clarity). Students responded on a Likert-type scale from 1 (*poor*) to 9 (*excellent*). Next, students indicated the extent to which each component of the textbook helped them to understand the material. Students responded on a Likert-type scale from 1 (*not helpful at all*) to 9 (*very helpful*). We created two total scores, summing items for quality (3 items) and helpfulness (9 items). Both scales showed high reliability (Cronbach's  $\alpha = .95$  for text quality and Cronbach's  $\alpha = .93$  for text helpfulness).

*Student attitude towards learning.* We used items from the Approaches and Study Skills Inventory for Students (ASSIST; Tait, Entwistle, & McCune, 1997). The original scale measured three different approaches to studying and learning: deep approach, strategic approach, and surface apathetic approach. In order to limit the total length of the survey but still provide a sense of student attitude to learning, we used 8 items measuring the deep approach (e.g., 'Often I find myself questioning things I hear in A lecture') from an original set of 16 items. We created a summated composite score to measure deep learning (Cronbach's  $\alpha = .86$ ).

We also included a number of items to assess various other aspects of instruction, studying, and learning (e.g., perceptions of instructor's PowerPoint quality, online quiz-taking behaviour) that are not included in this study.

*Student performance.* We measured performance or learning in two ways. Students indicated how much they were learning in the class (self-reported learning). All students also took an 11-item quiz that covered general concepts from classical and operant conditioning (quiz performance). Although we would have preferred to use a more comprehensive exam we had to keep the survey to a minimum given how we collecting data (i.e., from a national sample and not from our own classes). Items were modified from test banks and had previously been used repeatedly in the authors' classes, and consequently had undergone considerable fine-tuning. Nevertheless, on reviewing student responses to the quiz in this study, we determined that the multiple-choice options for one item were ambiguous, and hence that item was excluded from further analysis. We created a total quiz score from the remaining 10 items (Cronbach's  $\alpha = .85$ ).

*Instructor ratings.* We asked students to indicate how each of 20 different characteristics described their instructor (e.g., communicates well, uses relevant examples). Students responded on a Likert-type scale from 1 (*strongly disagree*) to 9 (*strongly agree*). We used items from previous research on teacher characteristics (Bain, 2004; Gurung & Vespia, 2007; Keeley, Smith, & Buskist, 2006). We summed responses on all 20 items to create a total score (Cronbach's  $\alpha = .96$ ).

*Study time.* We asked students to report the amount of time spent on each of 11 study behaviours, modifying a measure from earlier research (Gurung, Weidert, & Jeske, 2010) and created a total score from 9 of the above items (responses to two items – take notes from book and make up examples – were lost due to a survey software error). The scale showed moderate reliability (Cronbach's  $\alpha = .76$ ).

### Procedure

We reached students by contacting faculty members at institutions across the United States. To generate as random a sample as possible, we first sent faculty on two US-based teaching of

psychology listserves (PSYCHTEACHER and TIPS) an invitation to participate in our survey. Additionally, we asked textbook publishers (e.g., McGraw-Hill, Prentice Hall) for email addresses of faculty who adopted books, and we invited those faculty to participate as well.

We instructed faculty volunteers to distribute our survey participation request to students in their introductory psychology classes after they had covered the relevant section or chapter on learning in class (and the material had been tested in an exam, though we did not have a means to verify this). Faculty consenting to take part sent their students an email with the following message: 'You are invited to participate in a comprehensive, nationwide study that assesses how students study, how instructors facilitate student learning, and how textbooks and associated technology mediate the process of student learning in the introductory psychology course'.

Students deciding to participate clicked on a link to our survey provided in the email. The first page of the survey had a standard consent form. All student responses were confidential and the data was anonymous. Students who wanted to take part in the prize draw provided their names using a separate survey so that at no point were names and data linked. Faculty forwarding the survey also completed a brief survey that provided us with details of the textbook used by their students. We could not measure how many students the email was sent to and correspondingly do not have a return rate measure. Student participants had a chance to win one of three iPod Nanos. Instructors had a chance to win one of three \$100 American Express gift cards.

## Results

Our primary goal was to compare the relative contributions of factors such as the textbook, and student attitudes to learning, on learning and performance, to provide a detailed picture of student learning behaviour. To that end, we first provide descriptive statistics reporting a variety of behaviours, then test for student perceptual differences between textbooks regarding quality and helpfulness, and finally we examine the relationship between student self-reported learning and student scores on our quiz. Table 1 shows mean values and standard deviations for the major variables.

Table 1. Description of main measurement scales.

Scale label	Mean	SD	Score range	Cronbach's $\alpha$
Instructor rating	46.95	8.05	6-54	0.96
Textbook quality	34.52	8.18	5-45	0.95
Textbook helpfulness	19.15	5.74	3-27	0.93
Study time	25.64	9.78	0-60	0.76
Deep approach	46.73	12.52	8-72	0.85
Self-reported learning	7.13	1.77	1-9	–
Quiz learning	4.93	3.17	0-10	0.85

### *Factors Associated with Learning and Performance*

To examine the factors that associated with greater self-reported learning and quiz performance we conducted correlational analyses between the two main outcome variables, self-reported learning and quiz performance, and the main categories of interest (textbook quality, textbook helpfulness, instructor rating, study time, and deep approach to learning score). Table 2 shows the results.

### *Are All Textbooks Created Equal?*

Students reported using 13 different textbooks. In comparing student ratings by textbook, we selected only those textbooks for which we had at least 25 respondents ( $n = 595$ ). Seven textbooks fit this criteria (with percentage of sample in parentheses): Book A (20%), Book B (14%), Book C (13%), Book D (13%), Book E (5%), Book F (5%), and Book G (3%). We conducted a multivariate analysis of variance (MANOVA) with hierarchical adjustment for non-orthogonality focused on

textbook quality and helpfulness. Although we would have liked to control for grade point average (GPA), 403 students did not provide GPA, and including this control would have reduced the sample size for this analysis (this is likely due to the inclusion of first semester college students enrolled in introductory psychology who have not yet established a college GPA).

Table 2. Intercorrelation matrix of key measures.

Measure	1	2	3	4	5	6	7
1. Textbook quality							
2. Textbook helpfulness	.72**						
3. Instructor rating	.35**	.30**					
4. Study time	.09*	.14**	-.02				
5. Deep approach	.25**	.22**	.28**	.24**			
6. Quiz performance	.05	-.06	.02	-.03	.07		
7. Self-reported learning	.24**	.25**	.51**	.05	.34**	.06	–

Note. \* < .05, \*\* < .01.

We found a significant multivariate test for textbook ratings using Wilks' lambda,  $F(12, 1174) = 3.46$ ,  $p < .05$ . Tests of between-participants effects showed both the quality of textbooks,  $F(6, 595) = 6.00$ ,  $p < .001$ , partial  $\eta^2 = .06$ , and the helpfulness of textbooks,  $F(6, 595) = 4.50$ ,  $p < .001$ , partial  $\eta^2 = .04$ , were significantly different across books; a posthoc Games-Howell statistic showed the effect was solely due to one book. Ratings of quality from users of Book D were significantly lower than the ratings of quality from users of all books except Book A. Ratings of helpfulness from users of Book D were significantly lower than the ratings of users of Books B, E, and G. Additional differences are shown in Table 3.

Table 3. Ratings of textbook helpfulness.

Textbook	M	SD
A	18.44 <sub>b</sub>	6.76
B	19.87 <sub>a</sub>	5.13
C	19.41	5.20
D	17.37 <sub>ac</sub>	5.26
E	21.44 <sub>bc</sub>	5.42
F	20.15	6.01
G	21.44 <sub>c</sub>	4.71

Note. Means sharing the same subscript are significantly different.

#### *Does Student Performance Vary By Textbook?*

We conducted a second MANOVA with hierarchical adjustment for non-orthogonality, focused on self-reported learning and quiz performance. We also found a significant multivariate test for performance using Wilks' lambda,  $F(12, 1252) = 3.57$ ,  $p < .001$ , partial  $\eta^2 = .33$ . Tests of between-participants effects showed that self-reported learning,  $F(6, 595) = 5.20$ ,  $p < .001$ , partial  $\eta^2 = .05$ , was significantly different across books. A posthoc Games-Howell statistic showed users of Book F reported learning significantly more than the reports of users of all books except Books E and G. The MANOVA predicting quiz performance was not significant.

#### *What Best Predicts Learning?*

We next conducted analyses predicting our two main measures of learning: 1) self-reported learning (how much the students said they learned in class), and 2) quiz score. We conducted two multiple regression analyses. In each regression we entered all major factors in as a block: student

factors that could influence the outcome (grade point average, amount of time studied, and deep approach to learning), instructor ratings, and textbook factors (quality and perceived helpfulness). Only about half the students provided GPA, which limited the sample size, but given the importance of GPA in predicting learning and as a proxy for general college ability, we kept this variable in the equation.

The predictor variables accounted for 32% of the variance in self-reported learning,  $F(6, 404) = 30.93, p < .001$ . Two variables were significant predictors: the students' attitude towards learning (i.e., the extent to which they held a deep approach),  $\beta = .02, SE \beta = .01, B = .14, p < .01$ , and the ratings of the instructor,  $\beta = .10, SE \beta = .01, B = .46, p < .001$ .

The predictor variables accounted for 12% of the variance in quiz scores,  $F(6, 404) = 9.22, p < .001$ . Again, two variables were significant predictors: the students' grade point average,  $\beta = 1.41, SE \beta = .22, B = .30, p < .001$ , and the ratings of helpfulness of the textbook,  $\beta = -.07, SE \beta = .03, B = -.17, p < .05$ .

## Discussion

The question of how can instructors optimise learning is both complex and vitally important to answer. Our study uniquely contributes to the existing literature by students completing an actual quiz (in addition to answering perception questions about instructor and textbook) and by conducting a major study spanning 35 academic institutions. Our results help us take a large step towards answering this question of optimising student learning, but there are also areas that need additional work. To systematically begin to answer this complex question, this section addresses three present concerns: (1) do textbooks vary in helpfulness; (2) to what extent might a student quiz score vary in relation to the textbook used; and (3) cumulatively, what factors best predict student self-reporting learning as well as actual quiz performance? *Relationships between Key Measures*

The key measures included in the study are presented in Table 1, and the resulting intercorrelation matrix is reported in Table 2. Students who rate the quality of a textbook as high also rate textbook helpfulness highly. In addition, student ratings of the instructor are also significantly and positively correlated with both the textbook quality and helpfulness subscales. These findings may indicate that there may be just one dimension underlying these subscales (e.g., overall satisfaction).

A finding of particular interest involves the degree of deep approach that students take to their own learning. A student's deep approach score was significantly positively correlated with all key measures (textbook quality, textbook helpfulness, instructor ratings, study techniques, and self-reported) except for quiz performance. In fact, none of the key measures was significantly correlated with the student's score on the content quiz. This may indicate a disconnect between what introductory psychology students think they are learning, and what their quiz performance indicates. However, this lack of a correlation could also be because the quiz scores did not 'count' for students; that is, there was limited motivation to take the quiz seriously even though they had a chance to win merchandise (but there was no course grade involved). The moderate to low quiz score average suggests this may have been the case and that students were just guessing. Furthermore, students did not take the quiz at the exact same time of the semester or right after they studied the learning material. It is possible that many of the students had some time elapse since their last exam or since they studied the learning chapter, which could also account for the low scores and the lack of quiz score as a significant predictor. For this reason, and given that all other indicators suggest that a deep learning approach is related to the measures that educators would think drive quiz performance, we cannot make too much of the finding that those patterns are not present here.

On a broader level, students who are studying deeply and think they are learning (self-reported learning) may become frustrated when the quiz results do not match the investment of time and energy. In these cases, preparation in adequate study skills and an enhanced sensitivity to metacognition (e.g., Hattie, 2009) may help students be more realistic in their self-assessment. Given that self-reported learning is moderately correlated with instructor rating ( $r = .51$ ), the disconnect between student self-assessment and quiz performance could have implications for how introductory psychology instructors are evaluated at the end of the semester, though again we

caution against making too much of the disconnect until a stronger objective measure of learning is used.

#### *Does the Textbook Make a Difference?*

A typical lament of instructors of introductory psychology is that all introductory psychology textbooks seem essentially the same. When textbooks are reviewed superficially, this could be a plausible conclusion: introductory psychology textbooks tend to have high production qualities, cover the same general topics, and often share a similar organisation. However, when textbooks are systematically examined, there is actually just a very small core of terms that are common across multiple textbooks (e.g., Griggs, Bujak-Johnson, & Proctor, 2004; Landrum, 1993). One issue to address in the future is whether differences across textbooks relate to factors associated with student performance.

With one exception, students in this large sample tended to rate their textbook's quality and helpfulness towards the top of the scale. All of the highly rated textbooks were representative of the market: generally high production quality with colour photos and charts, boxes, and replete with italics, bold words, concept checks and the like. Posthoc analyses following a MANOVA indicated that the lowest rated textbook for both quality and helpfulness was a black-and-white text without all of the typical bells and whistles. Additionally, both self-reported learning and quiz performance were subjected to similar MANOVA and posthoc analyses, and the results indicate that students using a different textbook (i.e., Book F) had higher self-reported learning scores. However, this same textbook was not rated the highest on textbook helpfulness and this analysis cannot make a causal link between textbook quality and learning. Regardless of ratings, however, learning as assessed by quiz performance did not differ across these groups. Thus, a complicated picture emerges – although textbooks are clearly different from one another based on systematic study (e.g., Griggs et al., 2004; Landrum, 1993), instructors who hold to the notion that textbooks are alike may be correct in the context of student learning (measured via quiz scores). A key question for future research would be to determine those variables, if any, that would lead to enhanced learning as evidenced by student quiz scores.

Together, these results raise the question: are students in the introductory class the best group to discriminate between textbooks with respect to impact on learning? They have little experience with alternative textbooks and may base their judgements on aspects of the text that have little true learning impact (e.g., pedagogical aids; Gurung, 2003, 2004). Students may have an overall positive impression of a course but not very adept at discriminating the impact of various components. Of course, this also implies a study such as this can only support very limited and tentative conclusions until additional research is conducted and the findings replicated.

#### *Predicting Learning*

Two separate multiple regression analyses (self-reported learning, quiz learning) were conducted to answer the question 'what predicts learning?' When predicting students self-reported learning scores, 32% of the variance is explained by student scores on two variables: their attitude towards learning (i.e., a deep approach) and their instructor ratings. Students who take a deep approach towards learning also report higher self-reported learning scores, and this level of metacognitive awareness makes sense – students who study deeply also report that they are learning a great deal. A student's deep approach score was significantly positively correlated with all key measures (textbook quality, textbook helpfulness, instructor ratings, study techniques, and self-reported learning). In addition, students who take a deep approach towards learning report learning more despite quiz scores similar to those who do not use this approach. This finding can be explained by students confusing effort with mastery, the quiz used, or a combination of these and other variables. Based on earlier analyses (see Table 1), self-report of learning is linked to many other key variables. Indeed, students at all GPA levels tend to overestimate their performance in general psychology. At present, more research is needed to determine which factors, if any, contribute to content mastery and the motivation to use more efficient strategies.

The predictive relationship between instructor rating and self-reported learning may be more instructive, and is also intriguing. Although instructor rating did not predict quiz score, it was highly related to perceived learning. As the perception of the quality of instruction increases, so do student self-perceptions of learning, and vice versa. Although, we cannot determine from these data the positive role instructor ratings may have on aspects of content mastery, the literature is quite clear that instructor characteristics are significantly related to student motivation, enthusiasm for the subject, and enjoyment of the course (Buskist, 2004), in addition to perceptions of learning. The role of the instructor is a key variable in research and teaching and learning and deserves much more study.

We used two very different measures of learning in this study: perceived learning, which was self-reported, and quiz scores based on a short multiple-choice assessment. Unlike perceived learning, 12% of the variance is explained by both student GPA and ratings of textbook helpfulness when the criterion variable is the actual quiz score in the multiple regression analysis. The relationship between GPA and quiz scores is straightforward; students who score well on the quiz also tend to be good students who score well in other classes, hence the positive predictive relationship between GPA and quiz scores.

However, the predictive relationship is less intuitive between quiz scores and ratings of textbook helpfulness – a negative beta weight (-.17) emerges. Thus, the less helpful the textbook is rated, the higher the quiz score. Students who rate their textbooks as lower in helpfulness may determine that they need to compensate for the book by placing their efforts into other areas, such as utilising deep learning from lectures or other supplemental materials, such as textbook-linked Web resources. Alternatively, students who are better textbook consumers and able to differentiate good and bad textbooks may be the better students. More research is needed here to disentangle these complex relationships.

Surprisingly, students reporting greater use of metacognitive and other study strategies did not significantly score higher in the quiz. As the measure was self-report, we have no idea if the students actually were engaging in such strategies or, if they were, whether they were doing so in a productive manner. However, it is important to note that the quiz was a relatively short set of questions aimed primarily at the factual level. Thus, a quantitatively high score in the quiz did not allow for the assessment of the qualitatively different outcomes predicted by the use of metacognitive processing (Hattie, 2009). Had the quiz assessed knowledge at a variety of levels, the impact of deeper processing may have been more accurately assessed. Alternatively, students may simply feel that the harder they work (the more the effort), the better they are doing, regardless of actual performance (Zinn et al., 2011).

As evidenced by the finding that only 12% of the variance explained in the regression model was accounted for, it is important to stress the potential complexity of studying factors related to actual learning. In the present study, we used a relatively basic quiz with 10 items addressing core concepts. The testing done on the items by the test bank writers and the authors suggested the quiz would be a valid objective measure of learning. It is likely that differences in when the survey was taken relative to when the material was studied as discussed above, or a lack of incentive (i.e., students were not graded on this quiz) hurt the validity of the measure. Correspondingly, we were unable to differentiate between levels of knowledge, or of nuanced concepts. This might help explain why quiz scores are not significantly correlated with any of the key measures presented in Table 1. The restriction of range might also be due, in part, to the motivational nature of the task. In other words, these quiz scores did not count toward a student's final grade in the course, but were administered as part of a larger research study. Future studies should determine whether embedding the quiz questions in the context of a course where the points count would lead to different outcomes and relationships with the quiz learning scores (Daniel & Poole, 2009). Thus, this study is just a starting point to direct efforts related to student performance.

The present study highlights the complex interrelationships between key measures of interest. In a very large and diverse sample from across North America, students demonstrated a preference for highly produced texts. However, this preference was not associated with quiz scores. Thus, objective measures of textbook content may not have as significant an impact on student mastery of core content as many believe. The relationship between instructor ratings and textbook also argues for further research, as we are unable to determine its direction nor the key components related to the relationship in this study. Lastly, GPA, though not deep learning, was

associated with better quiz performance. This study points to a more complex relationship between pre-existing 'subject' variables that students bring to the learning environment, textbook use, and instructor variables.

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