Prior Knowledge and Its Relevance to Student Achievement in Introduction to Psychology

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Educational psychologists find that prior knowledge influences new learning. We examined whether course achievement for introductory psychology students is facilitated or impaired by their prior knowledge of psychology. We administered a pretest exam to 422 students early in the semester and gathered subsequent exam scores and other measures of student achievement. Students generally performed poorly on the pretest, as expected, but regressions revealed that pretest scores were uniquely positive, significant predictors of student achievement with other influences on achievement (e.g., homework, attendance) controlled. Further analyses suggested that prior knowledge is a significant resource that faculty can enlist in their instruction.

The influence of prior knowledge on behavior is familiar to psychologists. In studies of the confirmation bias, concept development, mental sets, preattentive processing, selective perception, prejudice, and learning and skill acquisition, researchers have shown how preexisting knowledge and expectations can significantly bias how people respond to new events. The influence of prior knowledge on learning is also a concern for educators. Students are likely to be influenced by preexisting assumptions and beliefs when introduced to new information, especially in courses like psychology in which the topics are so readily related to everyday life. In this study, we examined students' prior knowledge of psychological topics in an Introduction to Psychology course and the relevance of prior knowledge to their subsequent course performance.

Research in cognitive psychology has shown that individuals with greater preexisting knowledge about a topic generally understand and remember more than those with more limited prior knowledge (Chi & Ceci, 1987; Glaser, 1984; Schneider & Pressley, 1997). Indeed, constructivist theory argues that all new learning builds on prior understanding (see Committee on Developments in the Science of Learning, National Research Council, 1999; McCormick & Pressley, 1997). Research reviews in educational psychology have concluded that prior knowledge within a specific domain benefits students' learning and achievement (Alexander & Judy, 1988; Dochy, Segers, & Buehl, 1999). This conclusion has been confirmed in studies of a variety of academic content domains, including physics and mathematics (Hudson & Rottmann, 1981), writing ability and text processing (McCutcheon, 1986), economics (Dochy, 1992), and computer programming (Klahr & Carver, 1988), with students ranging from elementary grades to graduate school.

At times, however, prior knowledge can make it difficult to understand or learn new information (Alexander & Judy, 1988; Committee on Developments in the Science of Learning, National Research Council, 1999; Dochy et al., 1999). Difficulty is especially likely if preexisting information is inaccurate or incomplete, such as when students generalize inappropriately from everyday experiences or from what they learn in the popular media (Chinn & Brewer, 1993; Perkins & Simmons, 1988). Although interference from prior misconceptions is most often observed with young children, mistaken assumptions and prior beliefs can also undermine college students' learning of physics (Clement, 1982), biology (Fisher, Wandersee, & Moody, 2000; Wandersee, 1986), and other topics (Guzzetti, Snyder, Glass, & Gamas, 1993). Remarkably, prior beliefs may be highly resistant to change, even in the context of formal coursework (Fisher et al., 2000).

Undergraduate students in an Introduction to Psychology course arrive on the first day of class with considerable prior knowledge of psychological concepts. Prior knowledge of psychology derives from many sources, including formal coursework in secondary school and informal lessons from folk theories, the media, and everyday experience. These prior beliefs may facilitate student learning of psychological concepts, but prior knowledge can also impair students' understanding. For example, discussions in the popular media of brain development, hemispheric specialization, psychological disorders (e.g., depression, "multiple personality"), and hereditary influences on development are often good reflections of the state of scientific knowledge, but they are also usually incomplete and can exaggerate, obscure, or misrepresent current knowledge (Thompson & Nelson, 2001). Folk theories of interpersonal attraction inaccurately teach that "opposites attract" but also instruct, consistent with social psychological research, that "birds of a feather flock together." Consequently, prior understanding may facilitate students' comprehension of these topics but may simultaneously impede clear and accurate understanding.

Although research psychologists carefully assess prior knowledge in experimental investigations, using a pretest–posttest design to assess (and sometimes control for) previous understanding, it is rare for psychology class instructors to do so. Yet there are several reasons why assessments of prior knowledge, conducted through a pretest at the beginning of the academic term, can be useful to instructors and students in an Introduction to Psychology course. First, a sensitive pretest permits the instructor to evaluate the depth of preexisting

knowledge of course concepts, and the instructor can then adjust instruction to build on shared understanding or correct mistaken ideas. Second, by incorporating pretest questions into subsequent exams (in a pretest–posttest fashion), instructors can evaluate the extent to which course experience enhances student understanding. Third, by using individual differences in pretest results to predict course performance, an instructor can understand whether student achievement is influenced by preexisting differences in student knowledge and understanding. If the association is strong, the instructor may strive to assess sources of prior understanding and enlist these in the introduction of new information. Each of these goals concerns the value of pretesting to refining instruction or conducting outcome assessments of student learning.

Pretests can also benefit students more directly, especially when students understand that pretests are not measures of aptitude but rather of prior knowledge. A pretest previews ideas and concepts that students will encounter during the term, and pretests can also mobilize relevant prior knowledge about psychology. Moreover, when the pretest is similar in format to subsequent exams, it acquaints students with the instructor's testing approach and style before they take tests that will contribute to the course grade. Students in our course have commented positively about their pretest experience for both of these reasons.

In this study, we administered a pretest on the second day of class in a large-enrollment Introduction to Psychology course. Throughout the semester, we subsequently included questions from the pretest in unit exams to assess improvements in student learning as a result of instruction. Although we expected significant gains in student understanding throughout the semester, we also anticipated that pretest scores would significantly and positively predict subsequent student performance on course exams. We based this expectation on several prior studies that have found significant correlations between pretest scores and course or exam grades in Introduction to Psychology, although none controlled for the influence of other variables that could also affect course performance (Carstens & Beck, 1986; Federici & Schuerger, 1976; Griggs & Jackson, 1988). The positive relation between pretest scores and course performance has not been consistent, however, perhaps because the diverse sources of prior knowledge of psychology can provide misleading as well as accurate understanding of psychological concepts. Thus it was also possible that pretest performance would have a negligible relation to subsequent student achievement in this course, as some have reported (Griggs & Jackson, 1988). Moreover, we were interested in determining whether pretest scores would be significantly predictive of overall course performance when we included other relevant predictors of student performance, including year in school, intended major, recitation performance, and other course activities.

Method

Participants

Students were 422 undergraduates enrolled in two sections of an Introduction to Psychology course at a large midwestern state university (*n*s ranged from 376 to 422 for specific analyses owing to attendance and enrollment fluctuations). The same instructor taught each section in an identical manner. Students from each section also participated together in weekly recitation sections. Consistent with typical enrollments for an introductory course in psychology, 40% of the students were men and 60% were women; 77% were first-year students, 15% were sophomores, and 4% each were juniors or seniors; 11% listed their intended major as psychology, with the remaining students undeclared (33%) or with intended majors in other fields. Most students were residents of the state and reflected the state's predominantly White, middle income population.

Measures

The pretest consisted of a 25-item, five-alternative multiple-choice test. We limited the length of the pretest to 25 items (half the length of the standard course exams) to provide an appropriate assessment of prior knowledge without overwhelming students with a long exam on the second day of class. To create pretest questions, we surveyed psychology faculty members to identify the central concepts, issues, or ideas that they believed students in an introductory psychology course should know and sought to include the range of topics typically included in an introductory course. The pretest included questions about history and theories, research methods, brain and behavior, hereditary influences, states of consciousness, motivation and emotion, sensation and perception, classical and operant conditioning, memory, thinking and reasoning, developmental psychology, social psychology, psychological disorders, and personality theory and therapy. We selected topics for which formal or informal sources of prior knowledge in the popular media, folk theories, or everyday experience might be influential (e.g., interpersonal attraction, reinforcement, hemispheric specialization, sleep and dreaming). One question, for example, asked students to identify which of a series of folk sayings is confirmed by psychological research on interpersonal attraction, and the options included "familiarity breeds contempt," "opposites attract," "absence makes the heart grow fonder," "birds of a feather flock together," and "beauty is only in the eye of the beholder."

Procedure

Our Introduction to Psychology course is a fairly conventional large-enrollment introductory course. Students meet twice weekly for a 75-min large-enrollment lecture section in a large auditorium, and once weekly in a 50-min small-enrollment recitation section led by a graduate teaching assistant. The lecture section consists of the presentation of new information through lecture with presentation software, discussions, and videos. The recitation section emphasizes demonstrations, informal experiments, discussions, and preparation for exams and other class assignments. Although there was no effort to record attendance at the lectures, teaching assistants consistently monitored student recitation attendance and the completion of weekly homework assignments and awarded points based on attendance and home-

work that contributed to the overall course grade. Cumulative attendance and homework scores were thus dual indicators of the contribution of recitation to course achievement, along with student performance on a 25-item end-of-semester multiple-choice cumulative recitation exam.

After the pretest, students subsequently completed four unit exams at approximately 1-month intervals throughout the semester. Each noncumulative exam was identical in format to the pretest. Like the pretest, exam questions assessed students' direct recall and comprehension of course concepts and their ability to apply these concepts to new situations and to integrate them in novel ways. Each exam incorporated six or seven questions that had previously appeared on the pretest (for five of the pretest questions, we made minor changes in wording for clarity).

Students also completed a five-page paper in which they applied course concepts to their analysis of one of four books chosen by the instructor (selections were *The Crucible,* Miller, 1953; *Anne Frank: The Diary of a Young Girl,* Frank, 1952/1993; *Dibs in Search of Self,* Axline, 1964; and *Hamlet,* Shakespeare, 1600/1963). Papers were due late in the semester, and the teaching staff graded papers using a 50-point scale, using criteria that included fulfilling content guidelines and writing mechanics. Therefore, student achievement in the course was indexed by four exam scores, the paper score, and the indicators of recitation performance described earlier. The analyses of student course performance thus included scores from four 50-item unit exams (each worth 50 points), the evaluation of a student paper worth 50 points, and scores awarded for attendance and homework assignments in recitation, together with scores on a 25-point recitation exam.

Results

Descriptive Analyses

Table 1 presents means and standard deviations for the pretest, the four exams, the paper assignment, and the recitation exam. Student performance on the exams was highly consistent throughout the semester, with mean scores ranging from 71% to 75% of the total possible points. Students' performance was somewhat higher on the paper assignment and recitation exam (each at 80%). By contrast, the mean of 9.31 on the 25-item pretest was only 37% of the total points possible. The high score for the pretest was 19 (76%), by contrast with the perfect or near-perfect scores that were at the top of the range for the exams and paper assignment. Not surprisingly, therefore, students had some knowledge of psychological concepts on the second day of class, but their understanding was rather limited and incomplete.

Other psychometric properties of the pretest also contrasted with the four exams. Coefficient alpha, an index of the internal consistency of the test items, was .39 for the pretest, by contrast with the high alphas of .79 to .89 of the exams. The lower alpha of the pretest likely derived from its shorter length and the greater heterogeneity of the test items (by comparison with the exams). Taking these factors into account, however, the lower internal consistency of the pretest may also suggest that students' understanding of one topic in psychology was not highly related to their understanding of other topics, which would be consistent with the informal, unsystematic sources of knowledge that probably contributed to pretest performance.

Table 1. Descriptive Statistics for Student Performance Measures in Introduction to Psychology

Measure	Range of Scores	Actual Range	*M*	*SD*
Pretest	0 to 25	3 to 19	9.31	2.79
Exam 1	0 to 50	19 to 49	37.60	5.95
Exam 2	0 to 50	10 to 49	35.58	7.16
Exam 3	0 to 50	15 to 50	35.93	7.78
Exam 4	0 to 50	10 to 49	36.62	7.70
Composite exam score (average across four exams)	0 to 50	18 to 48	36.70	6.14
Paper assignment	0 to 50	17 to 50	40.27	5.16
Recitation exam	0 to 25	8 to 25	20.10	2.76

There was also, as expected, considerable variability in student performance on specific pretest questions, with the proportion of students answering questions correctly ranging from 8% to 66%. The pretest questions that the greatest proportion of students answered correctly concerned the characteristics of rapid eye movement (REM) sleep (66% answered correctly), the nature of schizophrenia (65%), the themes of developmental psychology (65%), and hemispheric specialization (55%). These topics are likely to be featured in news accounts or media feature stories, are relevant to personal interest or experience, and are commonly included in psychology courses in secondary schools (Carstens & Beck, 1986; White, Marcuella, & Oresick, 1979). By contrast, students performed most poorly on pretest questions concerning judgment heuristics (8%), the James–Lange theory of emotion (9%), and sympathetic nervous system (14%), each of which entails more specialized terms or knowledge specific to the field of psychology.

Student performance improved from the pretest to the course exams. The proportion of students who obtained the correct answer on pretest questions averaged 38% (range = 8% to 66%), by contrast with 77% (range = 28% to 91%) of the students who obtained the correct answer on the same questions when they subsequently encountered them on one of the four exams. On only six pretest questions did more than half the students answer correctly. By contrast, for the same questions included in the unit exams, more than half the students answered correctly all but one of these questions. On average, there was a gain of 39% in the proportion of students who answered each question correctly on the exam compared to the pretest. Interestingly, two of the three questions yielding the strongest performance (better than 90% answered correctly) when students responded to these questions subsequently on one of the four unit exams were the same as those eliciting the strongest pretest performance (i.e., REM sleep and schizophrenia), suggesting further the facilitating effects of prior knowledge.

Interrelations Among Student Performance Measures

The intercorrelations among the student performance measures appear in Table 2 ($N > 376$). As expected, individual differences in exam performance were highly intercorrelated (mean $r = .68$), and exam scores were also positively related to scores on the recitation exam (mean $r = .49$) and the paper assignment (mean $r = .39$), even though the latter required somewhat different skills. By comparison, pretest scores were correlated with the other performance measures at a more modest but nevertheless significant level (mean $r = .34$; all correlations $p < .01$).

Predicting Student Course Achievement

Although pretest scores were significantly correlated with subsequent exam performance, it is also important to determine the unique contribution of pretest performance when considering other predictors of student performance. Consequently, the final analyses consisted of hierarchical linear regression models to predict student course achievement. Because of its significance to the overall course grade, the outcome measure we selected was the composite created by the mean of the four unit exam scores. Predictors were included in the following order: (a) two background variables (entered as a block): the student's year in school (1 = first year; 4 = senior) and intended major (0 = nonpsychology; 1 = psychology), (b) pretest score, (c) paper assignment score, and (d) three indexes of recitation performance (entered as a block): score for cumulative attendance, score for homework assignments, and score on the recitation exam. The results appear in Table 3.

The addition of each set of predictors significantly incremented the proportion of variance explained in student overall exam performance. In the final equation, composite exam performance was significantly predicted by pretest scores, the paper assignment score, the recitation exam score, and the cumulative score for recitation homework. The background variables of year in school and intended major were not significant predictors in the final equation. Taken together, the regression accounted for nearly half (49%) of the explained variance in exam performance. Among these predictors, pretest exam performance was the second strongest, predicting 16% of the variance in exam scores.

We created similar regression models to predict each unit exam score based on student year in school and major (Step 1), pretest performance (Step 2), and scores for cumulative recitation attendance and homework prior to that exam (Step 3). We did not include scores for the paper assignment and the recitation exam in these models because these were primarily end-of-semester activities. The findings were consistent across regressions for each of the exams and were similar to the findings for the composite exam score reported in Table 3. In each, 26% to 28% of the explained variance in exam scores was predicted ($p < .01$). Among the significant predictors in the final equation, the pretest score accounted for 11% to 16% of the variance ($p < .01$) and was either the largest or second-largest (to recitation homework scores) in predicting exam scores.

Table 2. Intercorrelations Among Student Performance Measures in Introduction to Psychology

Measure	1	2	3	4	5	6	7	8
1. Pretest	—	.41	.33	.35	.38	.42	.27	.28
2. Exam 1		—	.64	.63	.67	.82	.36	.47
3. Exam 2			—	.69	.71	.87	.36	.50
4. Exam 3				—	.73	.89	.43	.45
5. Exam 4					—	.90	.40	.54
6. Composite exam score						—	.45	.57
7. Paper assignment							—	.31
8. Recitation exam								—

Note. All correlations significant at or beyond $p < .01$, two-tailed.

Table 3. Regression Analyses of Pretest and Other Predictors of Student Overall Exam Performance

Step Variables Entered	ΔR^2	R^2	*df*	ΔF	β (Step 1)	β (Step 2)	β (Step 3)	β (Step 4)
1 Background	.03	.03	2, 360	4.94*				
Year in school					.13*	.10*	.07	.07
Major					.12*	.06	.04	–.01
2 Prior knowledge	.16	.19	1, 359	73.00**				
Pretest						.41**	.33**	.25**
3 Paper assignment	.09	.28	1, 358	45.83**				
Score for paper							.32**	.16**
4 Recitation	.21	.49	3, 355	49.79**				
Cumulative attendance								.03
Cumulative homework score								.22**
Recitation exam score								.39**

Note. All betas are standardized.
*$p < .05$. **$p < .01$.

Discussion

Students in Introduction to Psychology performed rather poorly on the pretest exam, but their performance improved significantly on the same questions that were included on subsequent unit exams, which suggests strengthened student understanding as the result of instruction. Nevertheless, individual differences in pretest performance were positively and significantly associated with every subsequent measure of course achievement. Moreover, the pretest accounted for a unique and significant proportion of variance in composite exam scores (and in unit exams) even when we included other predictors of student course achievement, such as paper and recitation performance, year in school, and intended major.

These findings suggest that the knowledge that students bring with them to the first day of class is positively and significantly predictive of their academic achievement in an introductory psychology course. Prior knowledge contributed to course achievement even though, relative to their subsequent achievement, students had relatively little understanding of psychological concepts as reflected in their pretest performance. These findings are consistent with broader literatures in psychology and education documenting the importance of preexisting understanding to new learning and the value of incorporating prior knowledge into instructional strategies. The large sample size of this study contributes to the strength and reliability of these results. Despite the diverse sources of prior knowledge in psychology, it appears that preexisting understanding facilitated, rather than undermined, student achievement in this introductory course.

Although these findings are important, it is noteworthy that the amount of variance explained in student achievement in Introduction to Psychology was nevertheless much lower than the level obtained in other studies of the effects of prior knowledge on later learning, where assessments of preexisting understanding explained 42% to 60% of the variance in follow-up assessments (Dochy, 1992; Tobias, 1994). The more limited contribution of prior knowledge in psychology may be due to the diverse sources of understanding available to students in psychology, which include formal coursework in secondary school, features in the popular media, folk wisdom, personal experience, and many other influences. Student achievement in an Introduction to Psychology course may build on earlier understanding derived from these sources, but it may also be undermined by misunderstanding and confusion as well. Moreover, this study is the only one to assess the influence of prior knowledge in psychology while controlling for other influences on student course achievement.

Fortunately, the findings of this research suggest that prior understanding has a significantly positive association with subsequent learning. The concepts with which students were most familiar on the second day of class were those on which they achieved greatest proficiency subsequently in the course, and the concepts students poorly understood related to specialized ideas in psychology and did not appear to derive from misconceptions from previous experience. Of course, a more systematic assessment of psychological knowledge is needed to confirm the conclusions of this study, but these findings suggest that instructors in introductory courses would be wise to build on students' prior knowledge, rather than seeking to correct or ignore it, as a way of building student understanding of new terms and concepts. Building new instruction on students' prior knowledge is also supported by research in cognitive psychology, especially from constructivist theory, which emphasizes the importance of enlisting prior understanding into the construction of new understanding (Committee on Developments in the Science of Learning, National Research Council, 1999). In an Introduction to Psychology course, therefore, it may often be appropriate to engage students in systematic reflection about what they already understand about a topic that the instructor will discuss. In our teaching, we increasingly begin the discussion of new topics by asking students "What do you know about … ?" and build a lecture around what students have identified as elements of their prior knowledge. On other occasions, we use a news item or campus event to provoke student discussion of issues relevant to the next course topic, asking students to apply what they know of psychology to interpreting the event.

Do the effects of prior knowledge derive primarily from broader differences in student ability or aptitude? Unfortunately, we did not have access to admission test scores (e.g., the ACT or SAT) at the of time this study to use as assessments of general student ability. Prior research has found, as one would expect, that SAT scores correlate significantly with measures of prior knowledge in psychology and with final course grades in introductory courses (Carstens & Beck, 1986; Griggs & Jackson, 1988). However, the amount of explained variance is low to moderate in each case, indicating that although general ability contributes to pretest performance and course achievement, other contributors (specific to developing understanding of psychology) are also influential. One important way of addressing this issue is, in future research, to add a measure of general ability to the regression analyses.

Despite the competencies students displayed at the beginning of the semester, students also improved significantly in their understanding as the semester progressed. This improvement was indicated by the stronger performance on pretest items when they appeared in subsequent unit exams (and, to a lesser extent, by the stronger internal consistency of the unit exams compared with the pretest). This improvement is not surprising after a semester of instruction in psychology, but it documents in ways that seldom occur the specific learning outcomes that can derive from students' participation in an introductory course. In this regard, long-term follow-up assessments would be an additional, important way of evaluating the enduring benefits students derive from their class participation.

Although individual differences in pretest performance were associated positively with subsequent student achievement, it remains for future research to elucidate the determinants of pretest scores. Consistent with the educational literature, this discussion has emphasized prior knowledge derived from the many sources of information about psychology that people encounter in everyday life. However, there are other contributors to pretest performance, including students' test-taking skills (e.g., question-attack abilities), vocabulary and verbal ability, and conscientiousness as well as others. Each of these qualities is likely to affect pretest performance and subsequent achievement on other class requirements, and they constitute a broader array of

personal resources (in addition to prior content knowledge) that students bring to the classroom on the first day. Further understanding of these qualities and their influence on academic achievement is important because it can potentially provide a multidimensional portrayal of the determinants of individual differences in learning in the collegiate classroom and the origins of these differences earlier in a student's life experience.

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Notes

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