Hidden Learning: Measuring Student Learning in the Marketing Capstone

Chip E. Miller, Andrew Bryant and Andrew Norman

Purpose of the Study: To seek an understanding of the role that course-embedded repeat-testing can play in the assessment of learning for marketing students.

Method/Design and Sample: A repeat-measure design—pretest/posttest—was employed across 132 marketing students in a senior capstone course at a Midwest university. Mediation analysis was used to analyze the data for direct and indirect effects. Relationships hypothesizing the effects of prior achievement on learning of marketing concepts were based on the Elaboration Likelihood model (Petty & Cacioppo, 1986).

Results: The relationship between students' prior achievement in marketing courses and measures of their learning are inconsistently mediated by their initial test scores. The direct relationship between prior achievement and student learning can be cancelled out due to indirect effects on the measure of learning. Comparing initial test and final test scores may result in suppressed measures of learning for top students. Higher levels of previous achievement have an exponentially increasing direct effect on learning.

Value to Marketing Educators: Our results provide cautionary insight for marketing educators who assess learning via the pretest-posttest method. Final exam scores and final grades should not be relied upon as indicators of learning resulting from the course itself. We strongly recommend that efforts to assess learning in marketing capstone courses via pretest-posttest methods employ our mediating model to properly account for the effects of prior knowledge on course learning.

Keywords: Repeated Test, Pretest-posttest, Mediation Model, Suppression Effect, Marketing Capstone

Chip E. Miller, Drake University, 2507 University Avenue, Des Moines, IA 50311. Tel: 515-271-2992, Email: chip.miller@drake.edu. **Andrew Bryant**, Drake University, 2507 University Avenue, Des Moines, IA 50311. Tel: 515-271-1894, Email: andrew.bryant@drake.edu. **Andrew Norman** (corresponding author), Drake University, 2507 University Avenue, Des Moines, IA 50311. Tel: 515-271-2758, Email: andrew.norman@drake.edu.

It is a centerpiece of higher education that major courses of study seek to enhance student learning in their subject. However, attempts to determine the degree to which information is retained by students during their course of study reveal challenges with respect to the documentation of learning. This study provides insight on the measurement of learning in undergraduate marketing capstone courses.

Assurance of Learning (AoL) has been a major component of business education for many years (Martell, 2007; Pringle & Mitri, 2007). The Association for the Advancement of Collegiate Schools of Business (AACSB) incorporated AoL assessment into their accreditation affirmation and reaffirmation standards in 2003 (Ewell, 2003). Hence the mission of business schools to produce graduates who display proficiency in their field of study became more formalized. A key element of said standards was the requirement that schools use the data from AoL to evaluate and revise curriculum.

The AACSB mandates that accredited schools employ direct measures of student learning in their AoL plans, including cases, projects and internally developed exams (2007)—the tool under consideration in this research. The current study followed Borin, Metcalf, and Tietje (2008), who note that course-embedded assessment measures are a viable means of assessing AoL as an indicator of student learning. Ammons and Mills (2005) further state that this method has many benefits. Evans (2010) argued that direct measures such as course-embedded examinations for assessment purposes help faculty to improve course and program design. The content of pretest-posttest design, i.e. repeated measurements of student knowledge both before and after a course, incorporates ideas from Hopkins and Duke (2004), in that the department members determined key learning outcomes to be assessed rather than using an external test as the measure.

Toward more accurate assessment of AoL standards, the primary purpose of this research is to seek an understanding of the role that course-embedded repeat-testing can play in the assessment of learning for marketing students. While a comprehensive fulfillment of that purpose is beyond the scope of this work, we examine more focused questions. Of specific interest is, can degree of learning for a capstone course be accurately assessed by focusing on the difference between pretest and posttest scores? Recognizing a difference between learning and knowledge, what effect does a student's prior knowledge have on their degree of learning? More to the point, do high-performing students display the same gains in learning over the course of study as lower-performing students?

LITERATURE REVIEW

We focus here on assessment of learning in a marketing capstone course for various reasons. Choi, Tong and Kelley (2010), Dudley and Marlow (2005) as well as LaFleur, Babin and Lopez (2009) all state that assessment of learning must take place at the department level, especially so that meaningful and continuous improvement can take place. Like most undergraduate college programs, many marketing programs require a capstone course wherein this assessment can be conducted. While there is a great deal of variance across capstone courses with respect to their definition, design and purpose, one survey finds that almost all can be described as "an academic culmination that draws on other courses" (Johnson & Halabi, 2011, p. 267). Thus, across marketing capstone courses, a common expectation of students entering the class is some degree of knowledge of concepts taught across marketing courses that comprise the major curriculum. Evans (2010, p.188) relates that a marketing knowledge base is an important element in determining student knowledge and proficiency in their field and that "analysis should involve the knowledge...students acquire."

Many schools of business employ standardized tests such as the Major Field Test in Business in their assessment protocol. One study found that 46 percent of deans surveyed used such tests (Martell, 2007). The tests themselves save time (i.e. they are created elsewhere), are easy to administer and provide comparable data. Furthermore, previous research (Bycio & Allen, 2007; Contreras, Badua, Chen, & Adrian, 2011) notes that business GPA, overall GPA and student motivation were significantly correlated with better scores on the Major Field Test in Business.

However, a core weakness in this commonly used standardized test is that exam performance may not be correlated with material learned in actual courses or GPA in general (Bagamery, Lasik, & Nixon, 2005; Mirchandani, Lynch, & Hamilton, 2001). Additionally, in a quest to identify a common body of knowledge for marketing majors, LaFleur et al. (2009, p. 133) found that, "No study enumerates concepts and skills required of marketing majors in general or of all business students exiting a basic marketing course." Consequently, evaluations of student marketing knowledge are often generated internally.

For a capstone course designed to both review and apply such concepts on a higher level, a standardized pretest-posttest is a commonly employed measure to assess both the knowledge level of students upon entering as well as the degree of learning that takes place throughout the course. There are valid reasons for this. So far as the nature of exam material, other research (Meuter, Chapman, Toy, Wright, & McGowan, 2009) suggests designing the capstone final to both review material covered in previous marketing courses (both required and elective) and challenge students to apply their learning through numerous application and analysis questions.

Employing a pretest at the onset of a capstone course provides a baseline toward assessing prior knowledge. This is critical as final exam scores and grades for a capstone course, while often used as proxies for student learning, are not direct evidence of such. A student coming into a course with sparse prior knowledge of the material may work hard, learn a great deal and earn average grades. Conversely, a student with much greater knowledge entering the same course may learn little, perform very well and receive a high grade. Neuman (1989) further notes that high-GPA students entering a course with less knowledge learned more than students with more knowledge. This approach of measuring prior knowledge is not without controversy. Lord (1956) and Cronbach and Furby (1970) represent the opinion that the difference between pretest and posttest scores are not useful. They argue that history and maturation may be responsible for the rise in post-test scores over pre-test scores. Further, Hausknecht, Trevor and Farr (2002) note the increase in scores seen when retesting using the same instrument. On the other hand, Zimmerman, Williams and Zumbo (1993), Zimmerman and Williams (1998), and Thomas and Zumbo (2012) argue strongly in favor of the use of the change in scores from pretest to posttest. Their conclusions suggest that comparing pretest and posttest scores is a fair representation of increases in student learning between exams. This study will follow the preponderance of literature suggesting that measuring change scores is appropriate and valuable.

Further support of the importance for pretesting in a capstone course is provided by Bacon and Stewart (2006) who find that most knowledge gained in a consumer behavior course is lost within two years. This does not bode well for capstone assessment tests, as much knowledge can be lost in the two years between taking any marketing course and a capstone course. It follows that knowledge gained from other marketing courses taken less than two years prior to the marketing capstone is also at some risk of being diminished. Thus, faculty cannot assume that students enter the capstone course with an established knowledge of given marketing concepts.

Combining the pretest with a posttest measure at the end of the course enables the professor to determine whether knowledge of the assessed marketing concepts actually increased based on learning from the capstone course itself. Repeat-testing methods also facilitate retention of learned concepts. Prior research (Cepeda, Vul, Rohrer, Wixted, & Pashler, 2008) critically note that a delayed review is a better approach to enhance knowledge long-term retention. They further suggest that compressing learning into short periods gives misleadingly high levels of mastery due to the immediacy of the evaluation measure. In addition to delayed testing, test frequency has also been studied in depth. A common finding is that repeat-testing results in superior learning and retention of material (Bacon & Stewart, 2006; Cepeda et al. 2008; Kling, McCorkle, Miller, & Reardon, 2005).

Repeat-testing was also shown to be superior to repeat-studying in a variety of contexts (Butler, 2010).

HYPOTHESIS DEVELOPMENT

While, "Pretests are necessary to establish prior knowledge, and posttests are requisite to measure learning" (Delucchi, 2014, p. 232), it is important to understand how the two measures should be used. Because the difference between pretest and posttest scores—i.e., change in scores—is used as a measure of learning, it is noteworthy that students with higher pretest scores have less room for improvement in the posttest. This artifact has the potential to mask the measurement of learning for top students, even when learning takes place.

This nuance of repeated testing should not be an issue with a group of students with a relatively homogeneous subject knowledge base, such as an introductory marketing class where students are first introduced to marketing concepts. But in a capstone course, students must review and apply what they know (Meuter et al., 2009). As a result, it is likely that students entering the capstone class will possess varying degrees of knowledge. Specifically, high prior achievement by students in prior marketing courses are expected to result in higher levels of marketing knowledge at the onset of the capstone course. It follows that students with more marketing knowledge should score higher on a pretest than those with relatively less marketing knowledge.

Neuman (1989) shows a negative correlation between pretest scores and change scores—higher pretest scores correlate with lower change scores. For this reason, we argue that higher pretest scores are expected to tap into a ceiling effect in pretest-posttest measures of learning. In other words, there is relatively less opportunity for those who score high on initial tests to show an increase in learning by the end of the course. As a result, this could lower the change in learning by the individual that is measured by the change in test scores.

However, high pretest scores in a marketing capstone course may indicate a propensity to put forth high effort in marketing classes in general. By high effort, we mean overall high levels of both motivation and ability (Petty & Cacioppo, 1986). Bycio and Allen (2007) predicted that motivation to do well on the Major Field Achievement Test in Business (MFT-B) would have a measurable effect on performance, although to a lesser extent than student overall test-taking ability and subject knowledge. Terry, Mills and Sollosy (2008) demonstrate as well that motivation and ability have a significant effect on test outcome and that high previous levels of both resulted in higher achievement on the MFT-B. Ketcham, Nigro and Roberto (2018) cite similar outcomes for passion (i.e. motivation). It follows that high achievers in prior marketing courses are likely to display similarly high levels of effort in a capstone course. This should result in higher levels of learning as a result of exposure the capstone course content.

As a result, the effect of prior achievement in marketing courses can simultaneously have both positive and negative effects on the measurements of learning. Consequently, a direct pretest-posttest measure (i.e. how much the student's score increases or decreases) may not reliably reflect student learning. In this case, the baseline pretest measure may act in a way that suppresses the measurement of learning. To accurately understand how prior achievement influences the measurement of learning, we propose the use of a mediation model to help isolate the direct and indirect effects. That is, the direct effects associated with high prior achievement in marketing courses, such as a greater motivation and ability, may be partially cancelled out by high initial test scores.

This type of relationship qualifies as mediation, where "the independent variable causes the mediator which then causes the outcome" (Shadish & Sweeney, 1991, p. 883). However, the specific type of mediation exhibited with the suppressor effect is known as inconsistent mediation, defined by relationships "where at least one mediated effect has a different sign than other mediated or direct effects in a model" (MacKinnon, Fairchild, & Fritz, 2007, p. 602).

An example of inconsistent mediation, or a suppressor effect in a mediation model, was initially given by McFatter (1979) and discussed by MacKinnon, Krull, and Lockwood (2000). In this hypothetical example the relationship between worker intelligence, boredom, and errors made on an assembly line task is discussed. Specifically, "The more intelligent workers would make fewer errors [but] the more intelligent workers would exhibit higher levels of boredom and boredom would be positively associated with number of errors" (MacKinnon et al., 2000, p. 175). In other words, boredom acts as an inconsistent mediator in the process because the direct (i.e. fewer errors due to intelligence) and indirect (i.e. more errors due to boredom) effects have opposite signs cancelling each other out. Such a relationship could cause "the erroneous conclusion that mediation was not present in this situation" (MacKinnon, et al., 2000, p. 175). Specifically, intelligence is linked to the outcome variable of interest, however it cannot be measured without considering potential mediating factors.

This logic can be applied to our marketing capstone situation. While learning may occur in a marketing capstone course, the effects may be muted by the pretest baseline measure. As such, we need to account for potential inconsistent mediation effects of the first test. In other words, we hypothesize that the relationship between prior achievement in the subject matter and the level of learning in the course is inconsistently mediated by the student's current marketing knowledge. Specifically:

Hypothesis 1a: The indirect effects associated with prior achievement in the subject matter are negatively related to the measure of learning in the course.

Hypothesis 1b: The direct effects associated with prior achievement are positively related to the measure of learning in the course.

While we are proposing an inconsistent mediated relationship, these relationships are not necessarily linear. Those with high motivation and high ability may be able to increasingly leverage class material and learn more than those with less motivation and ability. This anticipation of a non-linear effect has been labeled the Matthew Effect (Walberg & Tsai, 1983). In essence, those individuals who start out with greater resources for learning or a greater desire to learn will exhibit greater gains in knowledge than those with a paucity of either or both (Cook & Campbell, 1979). A large body of research has studied this phenomenon in elementary and secondary education, showing that "them as has, gits". The literature also supports the idea that more exposure to subject matter has a positive effect on learning regardless of native ability and motivation. The mechanism whereby this occurs is posited to be the greater number of links in memory that accumulate through exposure and interest (Simon, 1979). As a result, we expect the propensity to achieve high outcomes in marketing courses will have an increasingly positive direct effect on learning.

Hypothesis 2: Prior achievement in the subject matter is associated with an increasing positive relationship with learning.

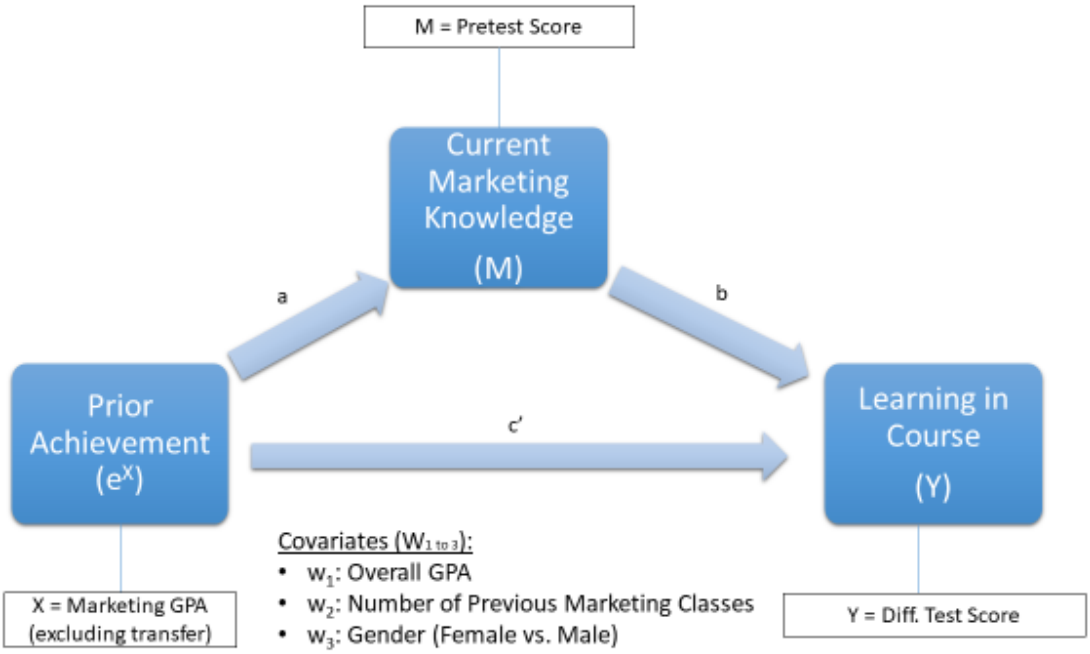
Taking these hypotheses together, we get the following model (see Figure 1):

$$(1)\quad \hat{M} = i_1 + ae^{X} + d_{1a}W_1 + d_{2a}W_2 + d_{3a}W_3 + e_1$$

$$(2)\quad \hat{Y} = i_2 + bM + c'e^{X} + d_{1b}W_1 + d_{2b}W_2 + d_{3b}W_3 + e_2$$

In this model, Y is the dependent variable, M is the mediating variable, X is the independent variable, and W are the covariates used as controls. We selected an exponential function (e^x) to reflect our hypothesis of an increasing relationship between prior achievement and the measurement of learning.

Figure 1 – Mediation Model



These hypothesized relationships are visually displayed in Figure 1 and are expected to exist even after controlling for variables shown in the model (W's). According to path a, we expect the prior achievement of a student (measured by marketing GPA) to be associated with a higher current level of marketing knowledge upon entering the capstone (measured by a pretest). In turn, this measurement of current knowledge will be associated with a lower measurement of learning in the course (path b). Thus, by modeling both path a and path b, we are accounting for the indirect relationship between prior achievement and learning measured through change scores. At the same time, we expect a direct and positive (path c') association to exist between prior achievement and learning in the course.

METHODOLOGY

To test our hypotheses, students were evaluated on their marketing knowledge at the beginning and the end of a three credit Marketing Management senior capstone course at a Midwest university in the United States in pretest-posttest fashion. To develop this test, the marketing faculty created a comprehensive list of concepts introduced in the marketing principles course and taught throughout other courses comprising the marketing curriculum—concepts they expected students to be familiar with upon entering the capstone course. This test not only served as a core assessment tool for the capstone course, but as a component in assessing proficiency in marketing.

The exam consists of 120 multiple-choice questions with scores recorded as percentage points (i.e. 100 points possible). Students entering the capstone course took the exam on the first day of the semester with scores recorded as SCORE1. At the end of the semester, students completed the same exam with scores recorded as SCORE2. The same exam was used at the beginning and the end of the semester in an effort to enhance internal validity. The initial exams were not returned, nor were the students informed that they would be given the same exam at the end of the semester. This pretest-posttest process was administered across Marketing Management courses taught during four different semesters over a four-year period.

This pretest-posttest method allowed for the calculation of a change score as the difference between SCORE1 versus SCORE2. This score, designated CHANGE, was used as our measure of learning in the course and is the dependent variable in our study. Our use of change in scores as the dependent variable is reflective of our interest in student learning via the course, not the actual level of student knowledge (i.e., SCORE2). While our selection of a dependent variable is driven by our outcome of interest, some have criticized the use of change in scores as an unreliable measure (Lord, 1956). However, Rogosa (1988) found this critique to be based on an improbable assumption and change scores can be reliable measures of true change.

Independent Variable

As a measure of prior achievement in marketing classes, each student's grade point average in previous marketing classes was recorded (MKTG_GPA). This measure was selected to ensure a temporal ordering required for any mediation modeling. That is, student grades from prior classes were given before the initial test, so there should be no confounding effects. In addition, GPA in previous marketing courses is a more objective and reliable measure compared with the alternative of a self-evaluation through a questionnaire designed to gauge prior achievement.

Control Variables

To ensure MKTG_GPA is a measure of prior achievement in marketing classes and not just the overall scholastic ability of the student, a control variable of the student's total grade point average (GPA) was included in the model. In addition, SCORE1 could potentially be a function of the breadth of marketing knowledge instead of achievement in previous classes. To account for this possibility, the total number of marketing courses taken by the student (MKTG_CLASS) was used as a control variable in the model.

Finally, as previous studies have shown gender differences in learning can exist (Philbin, Meier, Huffman, & Boverie, 1995; Tempelaar, van der Loeff, Gijselaers, & Nijhuis, 2011), we included a dummy variable corresponding to gender (FEMALE: where the value of "1" corresponds to a female student and the value of "0" corresponds male students) to account for other potentially spurious correlations.

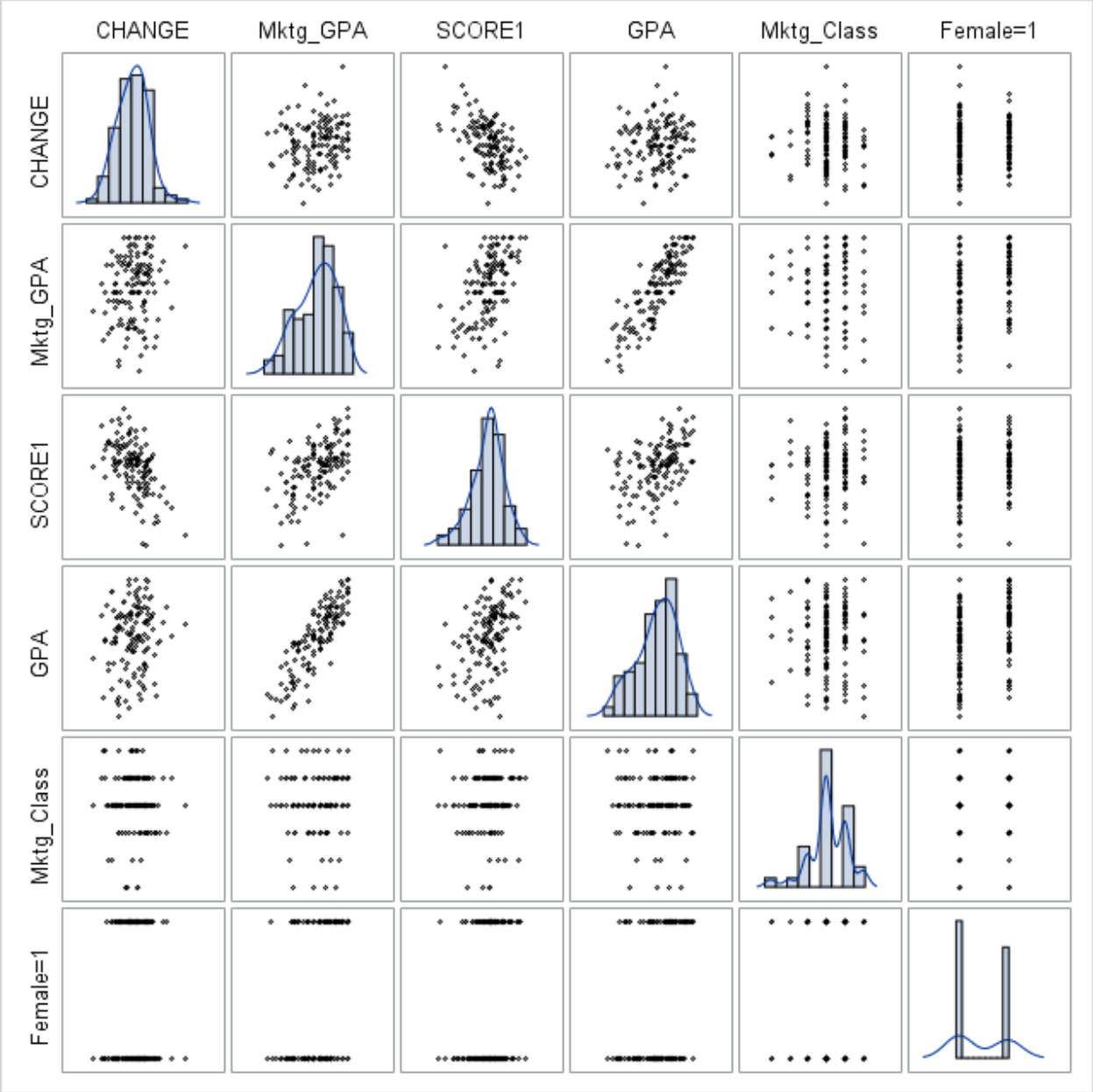
RESULTS AND DISCUSSION

We begin our analysis with descriptive statistics. A total of 132 observations were used in building the model. A correlation matrix and descriptive statistics are shown in Table 1 and the bivariate relationships are shown in a scatterplot in Figure 2. While there are three marketing prerequisite courses for Marketing Management, the sample's mean COURSES score was greater than six (Table 1), indicating many of the students were exposed to a broad range of marketing concepts.

Table 1 – Correlations and Descriptive Statistics

Correlation Matrix	Change Score	Marketing GPA	SCORE1	Overall GPA	Gender: Female = 1 Male = 0	Number of Marketing Classes
Change Score	1.000	0.170	-0.501	0.137	0.034	-0.058
Marketing GPA	0.170	1.000	0.497	0.854	0.021	0.325
SCORE1	-0.501	0.497	1.000	0.455	0.058	0.162
Overall GPA	0.137	0.854	0.455	1.000	-0.007	0.331
Number of Marketing Classes	0.034	0.021	0.058	-0.007	1.000	0.057
Female = 1 (Male = 0)	-0.058	0.325	0.162	0.331	0.057	1.000
Mean	15.563	3.089	59.975	3.157	0.447	6.121
Standard Dev	8.086	0.595	8.735	0.482	0.499	1.034
Range	[-6.0, 43.0]	(1.6, 4.0]	(33, 80]	(2.0, 4.0]	[0, 1]	[3, 8]
N	132	132	132	132	132	132

Figure 2 – Scatter Plot Panel



An initial examination of these results are directionally consistent with the idea of indirect effects hypothesized in H1a. Examining the bivariate relationships between CHANGE, MKTG_GPA, and SCORE1, we see MKTG_GPA has a positive correlation with SCORE1 ($\rho = 0.497$, $p < 0.01$), which in turn has a negative correlation with CHANGE ($\rho = -0.501$, $p < 0.01$). A visual examination of these distributions (Figure 2) leads to a similar conclusion.

Mediation Analysis

To formally test our hypotheses, we use a technique developed by Hayes and Preacher (2010) to measure and test both direct and indirect effects. The MEDCURVE macro for SAS in version 9.4 was used, which allows for nonlinear relationships between variables unlike the traditional Sobel test (Hayes & Preacher, 2010). As such we are able to model both equations (1) and (2) as well as measure the indirect effect of prior achievement (MKTG_GPA) on our measure of learning (CHANGE) through the pretest (SCORE1).

Table 2 – Model Parameter Estimates

Parameters	**Model:** Change Score	**Model:** Score1
constant	50.28 ***	42.76 ***
e^{MKTG_GPA}	0.32 ***	0.23 **
Score1	-0.73 ***	n/a
control vars		
Overall GPA	1.20	3.18
Number of Marketing Classes	-0.43	0.25
Female (vs. Male)	-0.79	-0.38
R-square	0.51	0.25

*** p < 0.01, ** p < 0.05, * p < 0.10

Using this process, we fit our data to the proposed model. The parameter estimates are shown in Table 2. In support of the mediation model, we find MKTG_GPA has a significant positive relationship with SCORE1 ($A_{e\text{^}MKTG\_GPA}$ = 0.23, t = 2.61, p = 0.01) which in turn has a negative significant relationship with CHANGE (B_{M_Score1} = -0.73, t = -10.92, p < 0.01). However, these results only show the individual paths are significant. Of true interest in this study is the combination of these two paths.

To measure the effect of MKTG_GPA on CHANGE through its effect on SCORE1, we calculate what Hayes and Preacher refer to as instantaneous indirect effects—a term used as a reference to the partial first derivative of a function (2010). Instantaneous indirect effects are a measure designed to quantify the often-skewed (with a nonzero kurtosis) relationship between the independent variable and dependent variable through only the mediating variable (Hayes & Preacher 2010). It is generally inaccurate to assume a normal distribution in this situation, so instead we use a bootstrapping technique with 5000 resamples of the original sample. This technique is used to eliminate the assumption that the shape of the sampling distribution potentially makes the results more accurate compared with traditional approaches (Mackinnon, Fairchild & Fritz, 2007). These instantaneous indirect effects are shown in Table 3.

Table 3 – Indirect Effects of GPA on Change Score

GPA	**Instantaeous Indirect Effect**	**95 % Confidence***	
		Lower	**Upper**
1.5	-0.736	-1.397	-0.068
2.0	-1.214	-2.271	-0.096
2.5	-2.001	-3.809	-0.199
3.0	-3.300	-6.282	-0.339
3.5	-5.440	-10.331	-0.577
4.0	-8.969	-17.010	-1.097
*note: bias corrected bootstrapping (5,000 samples)			

The nonlinear effects are conditioned on specific values of MKTG_GPA. These values were calculated at half-point increments across the samples range shown in Table 1. At each value, a 95% confidence interval was constructed. At no point does this confidence interval contain the value of zero. Therefore, this consistently negative instantaneous indirect effect supports the hypothesis (H1a) that the indirect effects of prior achievement in the subject matter are negatively related to the learning in the course when measured through change scores.

After accounting for the mediating effects of SCORE1, we examine the relationship between MKTG_GPA and learning as measured by CHANGE. Table 2 shows a direct positive significant relationship ($C'_{e\text{^}MKTG\_GPA}$ = 0.32, t = 4.78, p < 0.01). This supports the hypothesis (H1b) that the direct effects of prior achievement are positively related to the measure of learning in the course.

Taken together (H1a and H1b) suggest a relationship described as inconsistent mediation. That is, there is evidence of a relationship between prior achievement and learning in the course. However, when observing learning as measured by change in test scores this effect is suppressed due to the negative relationship between initial test scores and the overall change in test scores. To assess the level of suppression, a multiple regression model was fit to the data to mirror our model (Figure 1). The only exception is that the mediating relationship was excluded from this model. Our results do not show a significant model fit (R^2 = 0.04, d.f. = 4, F = 1.47, p = 0.22) nor was a significant relationship found between MKTG_GPA and CHANGE ($C_{e\text{^}MKTG\_GPA}$ = 0.15, t = 1.71, p = 0.09). In other words, if the effect of initial scores are not taken into consideration, no evidence of a relationship between prior achievement and learning in the course is found.

Increasing Effects of Prior Achievement

In order to test Hypothesis 2, we use the same process described above to fit a model with linear effects against which to test the previously discussed exponential model. That is, instead of using an exponentiation of student MKTG_GPA as the independent variable, an untransformed measure is used as the independent variable. By contrasting the exponential model, discussed above, with a linear model we are testing the hypothesized increasing effects of prior student achievement against a constant linear effect.

The results of this model are similar to the results of an exponential fit. The relationship between MKTG_GPA and CHANGE is shown to be inconsistently mediated by SCORE 1. As both the linear and exponential models show a significant mediating relationship, we examine the overall model fits. These results show that an exponential transformation of MKTG_GPA does not increase the model of M (SCORE1). In fact, both model fit measures are the same (R^2 = 0.25). Therefore, our model results fail to support the claim that prior achievement is exponentially related to the level of current marketing knowledge.

Examining the overall model fit, we find some support (H2) that prior achievement is exponentially related to the measure of learning in the course. As both models contain the same number of independent and control variables, we can directly compare their R-square values. The exponential independent variable model fits the data slightly better (R^2 = 0.51) than the model where MKTG_GPA is treated as a linear effect (R^2 = 0.49).

Robustness Check

Hake (1998, 2002) has argued that measuring pretest-posttest change scores is appropriate for measuring learning at both the individual student and classroom level, however he recommends one modification: scaling the change score by the total possible change. Accordingly, in this situation Hake (2002) argues that learning should be measured by the following expression:

(SCORE2 – SCORE1) / (100 – SCORE1)

Examining the effect of using this measurement of learning without explicitly accounting for the mediating relationships, we find a significant model fit (R^2 = 0.23, d.f. = 4, F = 9.31, p < 0.01) and a significant relationship between prior achievement and learning ($C_{e\text{^}MKTG\_GPA}$ = 0.01, t = 3.65, p < 0.01). Consequently, using this measure of learning could ameliorate the need for a mediation model. That is, if this scaling of the change score by the complementary value of the pretest score accounts for the indirect effects of prior achievement, then evaluating learning through a mediation process becomes unnecessary.

To examine this possibility, the mediation analysis was conducted using the scaled measure of learning (described above) as the dependent variable, as opposed to the difference in test scores. However, even with this new measure of learning, we still find a mediation analysis enhances our understanding of the data. Specifically, SCORE1 is still significant and negatively related to this new measure of learning (B_{M_Score1} = -0.01, t = -4.93, p < 0.01), i.e. there is value in explicitly accounting for the initial pretest score. Additionally, prior achievement is still significant and positively related to both SCORE1 ($A_{e\text{^}MKTG\_GPA}$ = 0.23, t = 2.61, p = 0.01) and this new measure of learning ($C'_{e\text{^}MKTG\_GPA}$ = 0.01, t = 4.98, p < 0.01). Comparing these R-square values (R^2 = 0.35) to that of a linear model (R^2 = 0.31), we also find evidence for an increasing effect of prior achievement. So, even with this alternative measure of learning, we find our understanding of learning is enhanced when we allow the initial pretest score to be a mediating value between prior achievement and our measurement of learning.

In other words, even after using a measure designed to compensate for higher initial pretest scores, we still find evidence that prior achievement is directly and increasingly related to greater learning scores. These direct measures are attenuated by the indirect effects where higher prior achievement is associated with higher initial pretest scores which are then associated with a lower measurement of learning in the class.

One major difference of note in the new analysis is the new model had a lower R-square value in terms of explanatory power associated with the final score (R^2 = 0.35) compared to the original model (R^2 = 0.51). This difference in model fit values could imply that when explicitly allowing pretest scores to have a negative effect on learning measurement, you would not want to scale the learning measurement value by the complementary value of the pretest score.

Discussion

Overall, our model shows the importance of explicitly accounting for the initial test when learning is attributed to the change between two test scores. Further, while prior achievement in marketing is positively related to learning, these results would be hidden if there is no adjustment for initial scores.

It is interesting to note that there are no significant effect associated with any control variable. Neither overall GPA, gender, nor number of marketing courses (ceteris paribus) were found to have a significant relationship with either the initial test score or the final learning measure. Most surprising is the lack of significance between the number of marketing courses and learning, as a broad background in the subject should be useful in integrating concepts.

CONCLUSIONS AND LIMITATIONS

As mentioned in the introduction, course-embedded examinations are commonly employed as components in AoL plans for business education. We join others in recognizing the role that pretest-posttest designs can play in marketing capstone courses. Our study adds to the literature discussing the nuances of using such a design to measure learning. Further, one of the goals of the capstone is to teach students to integrate their marketing knowledge and enhance their ability to apply what they have learned. The pretest-posttest format could be structured in a manner similar to foreign language proficiency tests. Lower scores would relegate students to courses with a larger review component. In a similar manner, instructors could identify those students who have a weaker grasp of the subject and assign them more or different work during the course. Students with stronger scores on the pretest could be directed toward different learning opportunities such as case analyses or outside consulting projects in an effort to enhance their abilities even further.

It is also possible to use the pretest-posttest method as a substitute for the capstone altogether. Those students who demonstrate mastery of the material could be allowed to take an alternative to the capstone that is more self-directed such as working on undergraduate research with a professor. Less advanced students could be identified and be assigned supplemental work to strengthen their shortcomings. Even if no changes to the capstone are made, the professor can identify areas from previous marketing courses where students seem to be lacking. This helps promote collaboration among the faculty by illuminating those topics that students habitually do less well in, enabling both feeder classes and the capstone to adapt their learning goals and materials to achieve better AoL.

The results of this study provide cautionary insight for the assessment of learning for marketing capstone courses. While final exam scores and final grades may serve as indicators of student knowledge at the point of the assessment, they should not be relied upon as indicators of learning resulting from the course itself. Prior student knowledge must be taken into account when considering final exam scores.

In so doing, it is tempting to use pretest-posttest change scores as a measure of student learning. However, our results show that such scores in isolation can be misleading as high levels of prior knowledge serve to suppress the reflection of student learning exhibited by change scores. Therefore, we strongly recommend that efforts to assess learning in marketing capstone courses via pretest-posttest methods employ our mediating model to properly account for the effects of prior knowledge on course learning.

We recognize certain limitations in generalizing the findings of this research to applications outside the parameters of our study design. While learning can exist in a hierarchy of levels (Bloom, 1956), our research measured learning along a single dimension. This calls for future research to examine this mediation process across multiple learning levels, potentially showing that learning outcomes are only affected in certain dimensions.

Furthermore, including the initial test score as a mediating variable is necessary to explore its suppressor effects on prior achievement. However, by including the initial test score as a predictor of changes in scores, we are making two assumptions. First, that our test instrument is a reliable measure without a regression-to-the-mean bias. And second, that changes associated with score differences are attributable to the classroom and not a separate event (Glymour, Weuve, Berkman, Kawachi, & Robins, 2005). We encourage future research to extend our methodological approaches, such as quantile regression, in order to relax these assumptions.

We also recognize the possibility that there are factors not identified in this research that may affect students' ability to learn in a capstone course. Such factors could prove helpful in explaining pretest-posttest change scores beyond the variables identified in this research. For example, some students may not perform well in courses that are rooted in theory and fundamental principles as are commonly found in lower-division courses. Such students, however, may excel in curriculum that is more applied or based on active learning methods such as case studies and simulations commonly employed in capstone courses. Additionally, factors affecting student motivation should be examined. For example, motivation to achieve in their final or penultimate semester might be diminished by the fact that a slightly lower grade will not affect their GPA, they already have a job, or even spring weather is too nice to ignore. Because motivation to succeed is a factor in performance, this may have a negative impact on the outcome of the capstone. Future studies should consider measuring these potential effects on motivation.

Finally, it is worth noting that these are the results of a single study. As such, further research into the suppressing effects of pretest scores on measurements of learning should be explored further.

Measuring student learning is complicated. While a baseline pretest may be necessary to measure learning, it presents its own methodological challenges. Specifically, relatively high initial scores on a pretest may potentially suppress the measurement of learning. And variables correlating with higher pretest scores, such as effort in the subject, can potentially have their effects on learning in a class masked. In fact, the results of this study show some evidence of an increasing direct effect of prior achievement on

learning. As such, careful consideration needs to take place when attributing variable effects to the measurement of learning in a class.

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