

# Learning Management Systems and Student Performance

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## Abstract

*In today's technology driven societies, academic institutions, especially at the tertiary level, are incorporating Information and Communication Technologies (ICTs), utilizing learning management systems (LMS) and adopting blended learning approaches to improve student performance and enhance student learning. Currently a good deal of research is conducted to assess the effectiveness of such techniques and technologies on student learning and performance. A great deal of this research deals with LMS's, e-learning platforms, such as Blackboard, but not much is being conducted on LMS's provided by publishing companies, like McGraw Hill Education, whose course management systems are available for a range of courses and being used throughout the world. This paper examines the effectiveness of McGraw Hill Education's Connect on improving student grades in a pre-calculus course at a university in a Gulf Cooperation Council (GCC) country. Using simple and multiple linear regression analysis to investigate whether there was a relationship between the Connect online assignments' grades and the total course grade of students in the course, and two independent sample t-tests to compare the grades between two pre-calculus courses (one taught using the Connect component, and the other taught in the traditional format) results show that using Connect has positive impact on student grades.*

Keywords: learning management systems, online learning, technology, teaching, McGraw Hill Education Connect, EFL/ESL learners

## 1. Introduction

Improving student performance, enhancing student learning, and getting students to be active in the learning process continue to be leading priorities in education. To help achieve such goals in today's technology driven societies, academic institutions, especially at the tertiary level, are incorporating Information and Communication Technologies (ICTs), and faculty are busy experimenting with such technology to enhance their traditional methods of teaching. Online learning management systems (LMS) have been shown to have the potential to help support such efforts.

ICTs have been changing the organization of information and how that information is being

delivered, creating innovative, transformative learning and resourceful classrooms [1] [2]. With diverse e-learning activities and "programs located at different points of the e-learning spectrum ranging from non or trivial online presence to fully online provision", an "abundance of literature on the use, application, and benefits of learning through Information and Communication Technologies (ICT) in almost all stages of education" [62] and a great deal of research is being produced. Courses which have web/internet-based activities are no longer a novelty in higher education [23]. It is predicted that by 2020 higher education will be adopting "teleconferencing and distance learning to leverage expert resources" where "learning activities will move to individualized, just-in-time learning approaches" and where "hybrid" classes will "combine online learning components with less-frequent on-campus, in-person class meetings" [4].

Dominating the academic scenes in higher education are the online learning management systems (LMS). Currently a good deal of research is being conducted to assess the effectiveness of using LMS's on enhancing student learning and performance. A great deal of this research concentrates on using LMS's such as Blackboard, Desire2Learn, and Moodle. However, publishing companies, such as Pearson and McGraw Hill Education, are also providing online learning/course management systems that are becoming part of the academic scene in higher education. Their various adaptive and course management systems are available for a range of courses and being used in blended learning contexts as complementary or supportive techniques to the conventional in-class, face-to face instruction methods. McGraw Hill Education's leading course management system, Connect, is being used extensively in higher education institutions around the world, including the Gulf Cooperation Council (GCC) countries in the Middle East (such as the institution in which this study is conducted). According to an article published on their website [41], Connect is currently being used by more than 5 million students and professors, with about 680 course titles and over 71 disciplines across the curriculum.

Based on research conducted by various institutions in the US, in collaboration with McGraw Hill Education, they assert that Connect has been shown to have positive impact on all aspects of the

teaching and learning process, of importance here are student performance, pass rates, average exam scores, final course grades [58][22]. However, besides these studies conducted in collaboration with McGraw Hill Education, not much research has been conducted on the use of this learning management system. This study examines the effectiveness of this web based tool on course grades in an undergraduate pre-calculus course at a university in one of the GCC countries.

## 2. Background Information

LMS's have been referred to as "learning platforms", "distributed learning systems", "course management systems", "content management systems", "portals", and "instructional management systems", and "combine a range of course or subject management and pedagogical tools to provide a means of designing, building and delivering online learning environments" [15]. Also known as virtual learning environments, LMS's incorporate interactive technology in the classroom [29] [17] and offer different levels of interaction and potential to create active learning contexts [62].

According to Vázquez-Cano and García [62] a "full-fledged LMS addresses three major requirements: first, it is a completely realized, networked digital environment that includes interactive interfaces for both teachers and students. Second, a LMS provides the content of the curriculum and assessments for teaching and learning in digital form. Third, a LMS includes special tools for managing classroom activity" (p. 63). They explain that "A robust LMS should be able to... centralize and automate administration, use self-service and self-guided services, assemble and deliver learning content rapidly, consolidate training initiatives on a Web-based platform, support portability and standards, personalize content, and enable knowledge reuse" (p.63).

The use of LMS are currently dominating the academic scene in higher education institutions [14] and blended learning approaches are the platforms where interaction and communication are being facilitated by such technology driven resources. Blended learning, with its different models [28] and domains [13], like 'hybrid' approaches to learning [5] [10], such as 'flipping' or 'wrapping' [12] [26] [37], is fairly new, which may account for why there is little consensus about its definition in higher education [59]. Definitions range from viewing it as an integration of online approaches and technologies with some face-to-face interaction [29], to describing it as being a formal education program where learning is done online with some student control on factors such as time and pace, but students still attend the brick- and-mortar school structure [59]. Whatever the definition, it is seemingly taking the

lead with "battles over the efficacy of residential learning versus online learning" disappearing, and there is a "quiet adoption of blended learning," with its "attraction of mixed delivery mechanisms" being implemented, "often without transcribing and virtually without announcement" [2]. As things stand right now, the future of academia will see technology being driven by pedagogy in a comprehensive and sophisticated blended learning environment [23].

## 3. Impact on learning outcomes

The pervasive use of digital technologies and online courses has led researchers to question the impact of on-line learning technology on student's educational engagement and learning outcomes. Research conducted has presented somewhat mixed findings. However, while some research conducted showed no significant difference between online and traditional learning [18] [6] [39], a great deal of studies support the effectiveness of using online learning [43] [44] [47] [63], presenting empirical evidence that shows that there is significant positive impact of online, blended and hybrid courses on learning outcomes.

Such positive impact has been attributed to the fact that they not only accommodate pedagogical requirements, disciplines, and course levels, but also student needs [31]. They have positive effects on student interaction, motivation, skills, performance, and achievement [3] [1] [13]. They have been described as being fair in their assessment practices [21] and reported as aiding in helping students become responsible learners who can utilize the knowledge they gained in a variety of contexts [24] [32]. Positive effects on students' academic outcomes and increased student engagement and ownership of learning have been reported, and teachers have also reported that it enables them to be more effective in being able to meet student needs and make fundamental shifts toward higher-value responsibilities [13]. In sum the studies report that such blended learning contexts increase student motivation, ownership of learning, and improve academic outcomes.

According to the McGraw Hill Education Regional Manager (personal communication), their learning/course management system Connect is currently being used across the Gulf Cooperation Countries (GCC) in many of their higher education institutes, as is the case in the university where this study was conducted. Connect has been incorporated in a number of courses in this university, in the hopes of improving the process of learning and teaching of different subjects. It provides support for courses ranging from the Humanities to the Sciences, from courses such as English to Business, Economics, Engineering, to Mathematics.

#### 4. Purpose of the study

There two main goals of this study are:

1. To investigate whether there was a relationship between the Connect online assignments' (homework and quizzes) grades and the total course grade (the accumulative/overall grade the student receives at the end of the semester) for the pre-calculus course taught in the Fall semester.
2. To compare the students' total course grades from the Fall semester with those of the Spring pre-calculus course.

#### 4. Research Methodology

The focus of this paper is on the use of Connect in the field of Mathematics and Statistics, to investigate the effectiveness of Connect on student grades. The research setting is a pre-calculus course at a university in a Gulf Cooperation Council (GCC) country. Authors in this paper work in this university and have been using Connect in teaching their courses.

The majority of students in the university, and therefore those taking the pre-calculus course, could be characterized as English as a Foreign Language (EFL) or English as a Second Language (ESL) learners. Students who enroll in this course are freshman level students who have not been able to satisfy the Mathematics placement test required by the university and are therefore obliged to register for the pre-calculus course in order to reach competence in basic Mathematics. Once they successfully complete the pre-calculus course, they can then take credit-bearing university mathematics courses. These students have no experience using learning management systems before taking this course.

For this study two pre-calculus courses were examined, one conducted in the Spring semester of 2012, the other offered in the Fall semester of 2012. The pre-calculus course offered in the Spring was taught in the traditional format, with no on-line component. The pre-calculus course offered in the Fall semester of 2012 was conducted in a blended context in which Connect was used for the online assignments (homework and quizzes) which were allotted 10% of the overall grade of the course (see further details below). These two courses/and or semesters will be referred to as 'Fall' and 'Spring' course/semester, and the Connect online assignments will be referred to as 'homework' and 'quizzes' from here on end. The pre-calculus course in both semesters was taught by the same instructor who is one of the authors in this study. The number of students enrolled in both Spring and the Fall pre-calculus courses were the same with difference in the ratio of males to females. 30 students (11 males and 19 females) were enrolled in the Spring pre-calculus

course, and 30 students (6 males and 24 females) were enrolled in the Fall pre-calculus course.

#### 5.1 Instruments

In order to use Connect, the university contacted the McGraw-Hill Education regional representative and set up accounts for its instructors. The instructors and students are provided with the necessary instructions and training that involve creating the course, activating accounts, and navigating through the website. Upon completing registration they are provided with user names and passwords which enable a secure login. They can access Connect via computers or any other portable devices, such as tablets or smartphones. Students can also access various educational resources made available by the instructor, including eBooks, PowerPoint presentations, prerecorded instructor lectures, and additional resources. The process is relatively simple. One of the drawbacks encountered when using Connect is that it is only compatible with specific books, those provided by McGraw Hill Education, and instructors are not able to use books of their choice. So in order to use the books available by the publishing company, instructors need to make sure that the books available on Connect satisfy the learning objectives and outcomes of the course they are teaching.

LMS's offer tools that are quite productive in learning, like file sharing, discussion forums, lesson plans, syllabus, chat, and management of assignments, among others. Connect, as a web-based study program, includes an eBook with quizzes and practice problems on every chapter, and interactive learning tools like audios and videos. Using Connect, instructors are able to create various assignments and projects and follow the students' progress through each assignment, and in the overall course. They have full control on things such as assignment material, including the content, topics, particular problems, number of maximum attempts to complete an assignment and their due dates. The assignments could be selected from chapter templates or by selecting specific questions from the question bank. If the whole chapter template is selected, then all the material in the book needs to be covered, without skipping any topics, or students may not be able to answer the questions that were not covered. All the questions need to be reviewed in an assignment to ensure that the chapter questions are appropriate and aligned with the material covered.

Other options are afforded such as creating one's own questions (but that of course is time consuming), and being able to utilize and modify the same assignments every semester, allowing instructors to save the time and effort of having to continually create new assignments. Another benefit provided by Connect is the grading system. Connect grades the assignment, with the instructor having the

discretion to define the number of points per question. Depending on the structure of the question, partial credit can be granted for the correct sections of each answer. The grades can also be exported to Microsoft Excel.

As explained above, the study used the learning and assessment tool Connect for the online assignments (comprised of homework assignments and quizzes), which were allotted 10% (5% for homework assignments and 5% for quizzes) of the total/overall course grade, as seen in Table 1.

**Table 1.** Grade weights and tentative schedule

	% Grade	Dates and time	Location
<b>Homework</b>	5%	Every 2 weeks	Online
<b>Quizzes</b>	5%	TBA week in advance	Online
<b>Exam 1</b>	20%	TBA 2 weeks in advance	In Class
<b>Exam 2</b>	20%	TBA 2 weeks in advance	In Class
<b>Exam 3</b>	20%	TBA 2 weeks in advance	In Class
<b>Final Exam</b>	30%	TBA by administration	In Class

Only 10% of the grade was allocated to the online assignments so there would be minimal effect on students' overall grade. In total, there were 10 homework assignments and 5 quizzes (see samples of the questions for these assignments and quizzes on Appendix 1) that were assigned to students using Connect. Homework assignments were given every 2 weeks, with each assignment due every fortnight (2 weeks). Each homework assignment had a minimum of 50 questions that students were required to answer.

For these online assignments, students received immediate feedback upon answering. If their answer was correct, Connect "locks in" the answer and students move to the next question. If the answer is wrong the students have the option of entering a new answer, the second answer is taken as final. In answering the questions, students are allowed to use all the Connect helping tools, at their disposal. These numerous tools (see Appendix 2) are available to offer students help as they complete their assignments.

For each online quiz students were given a time limit (20 minutes) with a maximum of 5 questions. For these questions, Connect helping tools are disabled, which eliminates the possibility of cheating until the quizzes were submitted. To further reduce the possibility of cheating, each quiz was created

using the process of pooling, with random questions assigned to each student.

The course grading scale used is a standard grading scale used in the university, see Table 2.

**Table 2.** Grading scale

Percent	95 & above	90-94	86-89	83-85	80-82	77-79	73-76	69-72	63-68	62 & below
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D	F

## 7. Analysis

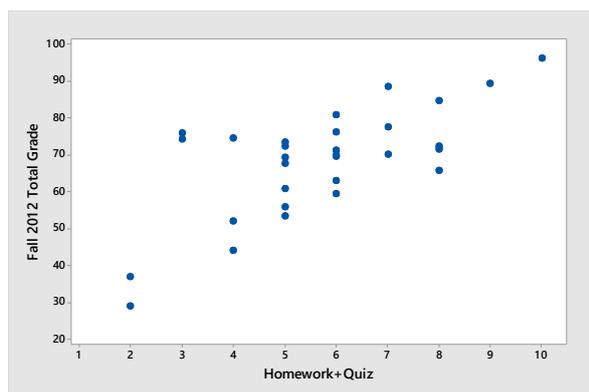
The first goal of the data analysis of this study investigated whether there was a relationship between the Connect online assignments grades and the total course grade for the pre-calculus course taught in the Fall semester. To test if such a relationship existed a scatter plot of the grades was created and linear correlation analysis was conducted. We used simple and multiple linear regression analysis to predict the total grade in the course based on the online assignments and the quizzes in two different ways. The first, in the multiple regression, we predicted the total course grade based on 2 individual grades, the homework assignments and the individual grade of quizzes. The second, in the simple linear regression analyses, we predict the total course grade based on the total grade achieved in the homework assignments and the quizzes together.

For the second goal of the analyses, we wanted to see if there was significant difference between the average of total grades in the Fall and the average of total grades in the Spring semester. We used two independent sample t-tests to compare the grades between the two courses taught in the Spring and the Fall.

## 8. Results

For the first goal of the study, the first undertaking was to look for graphical representation of the data to see if there is any familiar pattern that data could form. The scatter plot of online assignment grades and the total course grades for the Fall semester pre-calculus course, as seen in Figure 1, reveals pattern of positive linear correlation.

**Figure 1.** Scatter plot of online assignment grades vs. course grades



By conducting linear Pearson correlation tests, it was determined that there was significant positive linear correlation between online assignments and course grades, see Table 3.

Table 3. Pearson correlations for online assignments for fall 2012

Variable	Pearson Correlation Coefficient r	P value
Total Grade and Homework Assignments	0.539	P-value = 0.002
Total Grade and quizzes	0.761	P-value < 0.001
Total Grade and Homework Assignments +Quiz	0.696	P-value < 0.001

The  $r(30)=.539$ ,  $p=.002$  indicates strong positive linear correlation between Connect online grades and total course grades (i.e. as the Connect online assignments grade increases, the total course grade will increase). The  $r(30)=.761$ ,  $p<0.001$  indicates strong positive linear correlation between Connect assignment quiz grades and total course grades (i.e. as the Connect assignment quiz grade increases the total course grade increases). The  $r(30)=.696$ ,  $p<0.001$  indicates strong positive linear correlation between Connect homework assignments and the total course grades (i.e. as the homework assignment grades increase the total course grades increase).

Based on the data presented, the authors came up with two models which could be used to predict the total course grade in similar contexts, not included here, but is in the appendix section (see Appendix 3) for those interested in testing these models.

For the second goal of the study, the aim was to compare the students' total course grades from the Fall semester with those of the Spring pre-calculus course. To do this the average of the Fall course

grade (68.1) was compared with the class in the Spring which achieved an average of 60.4. An independent two variable T-Test was performed. Students taking the course in the Fall had better grades for the course ( $M=68.1$ ,  $SD=14.8$ ) than the students taking the Spring course,  $t(55)=1.77$ ,  $p=.041$ . This indicates significant difference between the averages of the two classes at the five percent level of significance. The course taken in the Fall, where the online Connect was used, had a significantly higher average than the course taken in Spring, which was taught in a traditional manner with no online component. This result seems to indicate that the use of the online component, Connect, improved students' total course grades.

### 9. Discussion

The results in this study indicate that the students' grades improved when using Connect, supporting the claims that open learning ecosystems improve students' pass rates, elevate their grades [41] and improve in their learning by outperforming their colleagues studying in traditionally taught courses [11] [57]. However, factors such as availability and easy access to the information at anytime, anywhere may account for this apparent improvement, as has been seen in previous studies [44]. Students in this study had the many Connect help tools provided as they did their homework and quizzes, which the students in the traditional format class did not. These help tools were excellent guides to the information that was needed to understand how to solve the problems and answer the questions they were given and this information was available whenever they needed it. They received immediate feedback, as to whether their answers were correct or not. They were given a range of tools to look at from resource icons that they can just click on and were referred to relevant readings that will help them answer the questions, to unlimited access (of course the instructor can set a limit on the number of times students can check their work and their answers, if they chose to) of hints that provide suggestions, to practice questions to being able to directly send a question to the instructor.

In contrast, students doing the assignments in the traditional class setting, without online support, were disadvantaged in many ways. For one, there was a time lag between submitting an assignment and receiving the graded assignment. During such a waiting period there is always a chance that students lose the immediacy of the assignment and do not learn from the feedback when they eventually receive it. No matter how much faculty want to help their students in a traditional setting, the amount of feedback they can provide and the time they can allocate to each question and or student is also limited.

Being able to study at their leisure and their own pace meant that learning extended beyond the classroom. . This means more student engagement with the coursework assigned which in turn means students have the time to think and reflect on what has been presented and learned, leading to better understanding [55] deeper approaches to learning [51], and therefore better outcomes [16]. The students who were availed the opportunity to work on Connect also learned many new skills, not only those that dealt with the technology, but with self-regulated learning [50].

Though the results are positive, generalizations cannot be made from the results of this study due to the limited number of students and courses examined. Examining Connect in courses from different disciplines and with larger sample sizes would help to gain a better picture of the effectiveness of Connect. This would also allow for the models developed by the authors to be tested in a variety of contexts. Having the complete course online using Connect, and not just limiting it to the 10% of homework assignments and quizzes may certainly reflect better results. Other factors that may have impacted students' performance, such as mathematical backgrounds that were not examined. The correlation established between online assessments and the total course grades does not guarantee cause-and-effect relationship between variables [61]. Further research may seek to address factors such as motivation and students' perceptions of online learning for ESL/EFL learners.

## 10. Conclusion

The popularity and effectiveness of on-line learning is anticipated to increase in the future with the adoption of newer technology additions, such as game mechanics, that aim at increasing 'task engagement' and 'decreasing attrition' [20] [34] [35]. Education is being shifted to accommodate for more communication and information access with innovative pedagogies that enable and support the acquisition of knowledge in today's knowledge based societies and lend themselves to developing new skills for lifelong learning motivated by new career paths and working hours [27] [48] [53] [54].

With the demands of today's technology driven academic contexts, teachers need the tools like LMS's that can help them cope, and achieve the goals set for the 21century learning and teaching. They also need the professional development to be able to utilize these course management systems, among the many other tools required by today's technology driven institutions, which requires a great deal of time, effort and trial and error, as was the case with the authors in this study. The end result of the experience, as the authors of this study have found, is that there is no doubt that harnessing

technology can enhance learning, whether it is inside or outside of the classroom. The key to enhancing learning tools in the classroom is how effectively they are used [49], and to use them in an effective manner requires a great deal of work, time and patience. As seen, "The effective use of digital resources and provision of opportunities for students to be active participants in building their knowledge and developing their skills is beneficial if the engagement with technology is strongly underpinned by sound educational procedure" [52]. Using technology in class holds the potential to empower not only students but instructors in a variety of ways. It ensures consistency, leaving little, if any, room for human bias and or errors. It also has the potential to deepen the connections between teachers and their students since it allows for more student-instructor face to face interactions.

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## 11. Acknowledgements

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## 12. Appendixes

### Appendix 1

#### Sample Questions for Homework and Quizzes

Factor completely:

1.  $64x^6 - y^6$ 
  - a)  $64(x - y)^6$
  - b)  $(8x^3 - y^3)(8x^3 + y^3)$
  - c)  $64(x^3 - y^3)(x^3 + y^3)$
  - d)  $(2x - y)(2x + y)(4x^2 - 2xy + y^2)(4x^2 + 2xy + y^2)$
2.  $9x^3 - 21x^2 + 18x$ 
  - a)  $3x(x^2 - 7x + 6)$
  - b)  $3(x^3 - 7x^2 + 6x)$
  - c)  $3x(x - 6)(x - 1)$
  - d)  $3x(x + 6)(x + 1)$
3. Perform indicated operations and simplify the rational expressions

$$\frac{x^2-1}{3x^2+6} \cdot \frac{4x^3+8x}{x^2-5x-6}$$

- a)  $\frac{4x(x-1)}{3(x-6)}$
- b)  $\frac{4x^5+4x^3-8x}{2x^4-15x^3-18x^2+6x^2-30x-36}$
- c)  $\frac{4x(x+1)}{3(x-6)}$
- d)  $\frac{4x^5+4x^3-8x}{2x^4-33x^3+6x^2-30x-36}$

### Appendix 2

Connect Tools Available to Help Students as They Complete Their Assignments

**eBook-** Students will be able to access their eBook during the assignment by clicking the eBook Links icon that appears with each question. A student who uses this will see relevant readings that may help the student answer that question. This is a good option for practice and homework assignments, or open-book quizzes and tests.

**Hint-** If a student is unsure of how to go about answering a question, the View Hint link will offer a suggestion.

**Allow students to check their work-** When a student clicks the "check my work" link after answering a question, a "check" icon will appear if the answer is correct, or an "x" icon if the answer is incorrect. The actual answer won't be given.

**Allow students to ask the instructor-** Students can ask their instructors questions about the assignment. They will receive a message in their section homepage with the student's question, and an image of the activity in question, for reference. Instructors can respond directly to that student, or to the entire class if the information is relevant to everyone.

**Show special character palette-** This is selected if the course is a foreign language, so that students can answer the questions using the appropriate characters.

**Show the solutions with the answer-** This option appears for certain science, math and engineering questions. On those questions, students will be able to see the solutions. If a question is algorithmic, they can try answering it again with new algorithmic values.

**Guide students to the answer-** This option appears for certain science, math and engineering questions. On those questions, students can follow step-by-step guides to the solutions and can try answering the questions again with new algorithmic values.

**Practice questions-** This option is for available for most science, math and engineering algorithmic questions. It allows your students to practice non-scored versions of the assignment questions, with different values. This is best used on assignments intended for increased exposure to, and understanding of, the concepts (rather than assignments meant to assess understanding).

Note: Instructors can apply a percent deduction for using these tools if they chose to)

(Source: The information above was provide by the McGraw Hill Education Representative, Personal Communication)

### Appendix 3

#### Two Models

##### Model 1:

Course Grades = 33.52 + 0.83 \*(Homework) + 11.48 \*(Quizzes)

##### Model 2:

Course Grades = 37.91 + 5.29 \*(Homework +Quizzes)

The following illustrates the use of these two models.

For example, if we have two students who both scored 6 out of possible10 on online homework assignments and quizzes combined: student one had 3 out of 10 for

homework assignments and 3 out of 10 for quizzes (i.e 6 out of 10), while student two had 4 out of 10 on quizzes and 2 out of 10 for homework (i.e.6 out of 10). In both cases the total quiz and homework assignment is 6 out of 10. For those two examples, Model 2 would predict the same total course grade of 69.65 for both students, while model 1 would predict different grades for the two student: student one's total course grade would be 70.45 and for student two, the total course grade would be 81.1.

In Model 1 (see analysis 1 below) we used the individual scores for online homework and online quizzes. The p-value for the homework variable was 0.002 while the p-value for the quiz variable was close to zero (see Figure 4). Therefore Model 1 is significant at one percent level of significance. In Model 2 (see analysis 2 below) we combined online homework and quiz grades as one variable and the p-value for the new variable was close to zero, therefore Model 2 is significant at one percent level of significance.

Both models could be used for predicting the total course grades for students in similar contexts and or courses that use Connect. The models could predict total course grades in similar classes by obtaining the Connect grade and plugging it into the model equations. For example in Model 2: if a student scored 8 out of the possible 10 on the Connect assignments the grade would be,  $Total\ Grade = 37.91 + 5.29 * (8) = 80.23$ . Basically knowing only the Connect grade to be 8 (as in this example) we can predict the total course grade to be 80.23. This could be significant for future classes where we can monitor students' progress in Connect and inform students of potential failure/success in the course. The authors realize that the two models could predict totally different grades and it is left to the reader to decide which model to use.

### 1. Regression Analysis-Fall 2012 Total Grade versus Homework and Quizzes

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	3704.94	1852.47	18.79	0.000
homework	1	16.75	16.75	0.17	0.683
quizzes	1	1854.19	1854.19	18.81	0.000
Error	27	2661.79	98.58		
Lack-of-Fit	10	1653.93	165.39	2.79	0.030
Pure Error	17	1007.86	59.29		
Total	29	6366.73			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
9.92899	58.19%	55.10%	48.04%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	33.52	5.95	5.63	0.000	
homework	0.83	2.02	0.41	0.683	1.76
quizzes	11.48	2.65	4.34	0.000	1.76

Regression Equation

$$\text{Fall 2012 Total Grade} = 33.52 + 0.83 \text{ homework} + 11.48 \text{ quizzes}$$

### 2. Regression Analysis-Fall 2012 Total Grade versus Homework + Quiz

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	3087	3087.35	26.36	0.000
Homework+Quiz	1	3087	3087.35	26.36	0.000
Error	28	3279	117.12		
Lack-of-Fit	7	1668	238.35	3.11	0.021
Pure Error	21	1611	76.71		
Total	29	6367			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
10.8222	48.49%	46.65%	38.19%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	37.91	6.20	6.12	0.000	
Homework+Quiz	5.29	1.03	5.13	0.000	1.00

Regression Equation

$$\text{Fall 2012 Total Grade} = 37.91 + 5.29 \text{ Homework} + \text{Quiz}$$

Fits and Diagnostics for Unusual Observations

	Fall 2012	Std	
Obs	Total Grade	Fit	Resid
28	75.88	53.79	22.09
30	96.00	90.82	5.18

R Large residual

X Unusual X

### 3. Two-Sample T-Test and CI: Spring 2012 Total Grade, Fall 2012 Total Grade

Two-sample T for Spring 2012 Total Grade vs Fall 2012 Total Grade

	N	Mean	StDev	SE Mean
Spring 2012 Total Grade	30	60.4	18.7	3.4
Fall 2012 Total Grade	30	68.1	14.8	2.7

Difference =  $\mu$  (Spring 2012 Total Grade) -  $\mu$  (Fall 2012 Total Grade)

Estimate for difference: -7.71

95% upper bound for difference: -0.41

T-Test of difference = 0 (vs <): T-Value = -1.77 P-Value = 0.041 DF = 55