Kentucky Journal of Excellence in College Teaching and Learning

Volume 10 Article 7

January 2013

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Kentucky Journal of Excellence in College Teaching and Learning
Volume 10, November 2012

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ABSTRACT

Student performance remediation is an ongoing issue in higher education due to the need for student retention. However, remediation is costly. For example, it is estimated the total annual cost of remedial courses across all types of higher education in 1998 was between one and two billion dollars. In the current financial environment, these additional costs will likely come under increased scrutiny. This study employed empirical research methods on undergraduate participants in order to explore the effect of student self-remediated learning as evidenced by pre- and posttest scores, and to provide research-based recommendations for educators charged with course delivery or management of remediation programs. Specifically, a repeated-measures analysis of variance was conducted in order to explore the extent to which exam scores could be predicted based on student term as well as course section. The results of the analysis did not indicate that either measures of student term or course section were significantly associated with exam scores. Observed power was found to be very low with regard to these effects, indicating a low probability that significant effects would be found even if they do exist in the larger population. Thus, student self-remediation without instructor involvement provided a larger increase between pre- and posttest scores than student self-remediation with instructor involvement.

Keywords: Undergraduate, students, self-remediation, learning, retention

Introduction and Literature Review

Remediation may be defined as "a class or activity intended to meet the needs of students who initially do not have the skills, experience or orientation necessary to perform at a level that the institutions or instructors recognize as 'regular' for those students" (Grubb, 1999, p. 174). Levin and Calcagno state that "a remediation crisis has surely become one of the most controversial issues in higher education in recent times" (2007, p. 1).

Most higher education remediation focuses upon a wide scale: institutions identify academically underprepared students by administering placement tests in basic skills (math, reading, and writing) or by noting deficiencies on high school transcripts based on course graces or completion.

Students then are either required or encouraged to enroll in developmental courses. These courses have been a prominent feature in community colleges since these institutions first appeared in postsecondary education over one hundred years ago (Cohen & Brawer, 2003). Yet this type of remediation carries with it significant costs.

The direct costs of providing the remedial instruction along with the duplication of effort for higher educational institutions to repeat instruction provided on the high school level are significant. It is estimated the total annual cost of remedial courses across all types of higher education in 1998 was between one and two billion dollars (Breneman & Haarlow, 1998). This figure becomes even more prominent when it is taken consideration that remediation at two-year colleges are typically taught by lower-paid adjunct faculty teaching large class sizes (Bettinger & Long, 2007).

Yet remediation for students in individual courses who do not possess the necessary knowledge or skills to be successful is also appropriate. The student population in higher education is much more diverse than in previous years (Levin & Calcagno, 2007). Many are older students, who have become displaced workers due to the economy, may have performed satisfactorily in their previous higher education or high school studies yet have older "rusty skills."

Other students may have poor study habits or learning disabilities, and even immigrant populations who may possess the underlying academic skills for college level work but have difficulty with the English language. These diverse students may lack the requisite knowledge or skills to be successful in a course.

Although many courses typically have prerequisite courses designed to ensure that students possess the necessary knowledge and skills to be successful in a higher-level course, not all students take these prerequisite courses. Courses transferred from a previous institution may lack the required content or rigor, and this could affect a student's success in the new institution.

In addition, many schools are under pressure from external entities such as state legislatures to provide "seamless transition" from another institution and may accept a close that is similar yet not identical to that prerequisite course. In other instances, prerequisite courses are waived as compensation for work experience.

If a student needs remediation for a course, providing that remediation may take a variety of approaches. Levin and Calcagno (Levin & Calcagno, 2007, p. 5) note that "if there is any consensus among educators concerning remediation, it is that so-called drill-and-skill approaches are falling out of favor." Such an approach is based upon the presentation of concepts, operations, or classification schemes followed by the repetitive practice to master them, and often combined with learning laboratories. This style of pedagogy has many drawbacks, including the fact that students--particularly those who need remediation--have serious attitudinal obstacles to learning in this way.

This may be because this same style was used in previous courses for which the student was not successful and may have even contributed to their initial difficulties. In addition, this type of remediation is abstract and isolated in its nature, preventing students from seeing its usefulness in real-world situations and from applying the skills that are learned to later academic or vocational coursework.

Levin and Koski used previous literature on remediation in higher education and adult learning to identity ingredients to be central for designing successful interventions for underprepared students in higher education (1998). These include:

- **Connectiveness**. Emphasizing the links among different subjects and experiences and how they can contribute to learning (rather than seeing each subject and learning experience as an isolated and independent event).
- **High Standards**. Setting high standards and expectations that all students will meet if they make adequate efforts and are given appropriate resources to support their learning.
- **Independence**. Encouraging students to do independent investigation

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within the material to develop their own ideas, applications, and understandings.

- **Inquiry**. Developing students' inquiry and research skills to help them learn about other subjects and areas about for which they have an interest.
- **Motivation**. Building on the interests and goals of the students and providing a reward system.
- **Multiple Approaches**. Using collaboration, teamwork, technology, tutoring, and independent investigation as suited to student needs.
- **Problem Solving**. Viewing learning less as an academic memorization task and more as a way of determining what needs to be learned and how (and then implementing the "how").
- **Substance**. Building skills within a real-world context instead of an abstract approach.
- **Supportive Context**. Recognizing that learning is a social activity that thrives on healthy social interaction, encouragement, and support.

A growing number of studies are examining student remediation in individual courses or entities as opposed to broader-based remediation. For example, a study by White, Ross and Grippe looked at how and if the use of an online remediation system requiring reflective review of performance and self-assessment influenced fourth-year medical students' performances on seven objective structured clinical examination (OSCE) stations at the University of Michigan Medical School. Students who failed the exam participated in remediation that included self-assessment and review, plus faculty guidance for failures that were greater than one standard error of measurement of the distribution.

The results showed that there was a statistically significant change in students' performance between first and second attempts and statistically significant improvements in self-assessment between first and second attempts. However, no significant changes were found between self-assessed and faculty-guided remediation (White, Ross, & Gruppen, 2009).

Student remediation is often linked to self-assessment. Self-assessment refers to the involvement of learners in making judgments about their own learning, particularly about their achievements and the outcomes of their learning. Self-assessment is formative in that it contributes to the learning process and may help students to direct their energies to areas for improvement (Boud & Falchikov, Quantitative studies of student self-assessment in higher education: A critical analysis of findings, 1989). It is considered as one form of alternative assessment that allows students to make judgments on their own learning as well as reflect upon their learning (Carlson, 2001).

The ability to assess one's own work is seen as a necessary "real world" skill that workers today should possess. Engaging in self-assessment may develop reflective practice and can foster deep learning in general (Boud, Assessment and the promotion of academic values, 1990). Self-assessment gives students more responsibility for their own learning and may decrease the time-investment professors would otherwise need to make in more frequent assessment (Dochy & Moerkerke, 1997). Anderson says that self-assessments also guides students in making decisions about what they know and what they need to learn, which influences what tasks they will complete next (Anderson, 1998).

Methodology and Results

A repeated-measures analysis of variance was conducted in order to explore the extent to which exam scores could be predicted based on student term as well as section. Initially, a series of descriptive statistics were developed in order to ensure the normality of the dependent measures included in this study as well as the absence of extreme outliers. Following the results of these analyses, the results of the repeated-measures ANOVA will be presented, which will include a description of tests conducted relating to the assumptions of this statistical test, as well as the results of the multivariate tests and the between-subjects factors included in this analysis.

Descriptive Statistics. Initially, a series of descriptive statistics were conducted in order to ensure that the assumptions of analysis of variance relating to the normality of the dependent measures and the absence of extreme outliers were not violated.

Figure 1 serves to illustrate any outliers with regard to pretest grades (N = 110) as well as final grades (N = 110). As indicated in the figure, several cases were identified, which consisted of grades that were approximately two standard deviations below the mean. These extreme outliers based on the definition of scores that are three standard deviations above or below the mean. This suggests that no potentially problematic outliers are present in the data for the purposes of the analysis of variance (ANOVA).

Figure 1. Box Plot to Test for Outliers

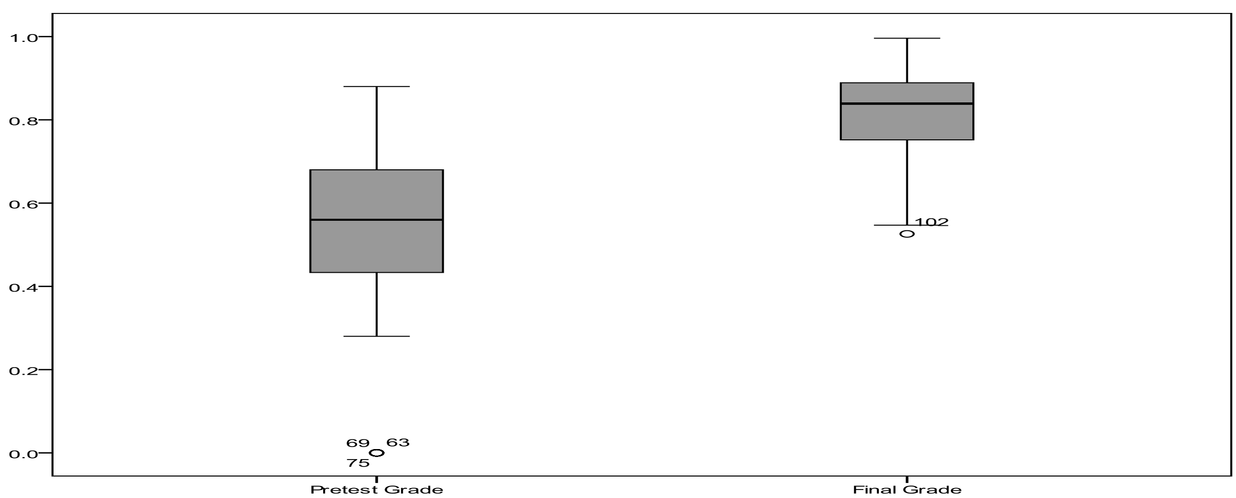

Figure 2 presents the distribution of pretest grades. While a fairly substantial number of very low grades were indicated on the basis of this figure, no extreme departures from normality were indicated on the basis of this plot. The distribution of final grades is summarized by the histogram in Figure 3. This figure serves to indicate that negative skewness is present with regard to the distribution of this measure, while no extreme departures from normality were indicated.

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Figure 2. Pretest Grade Distribution

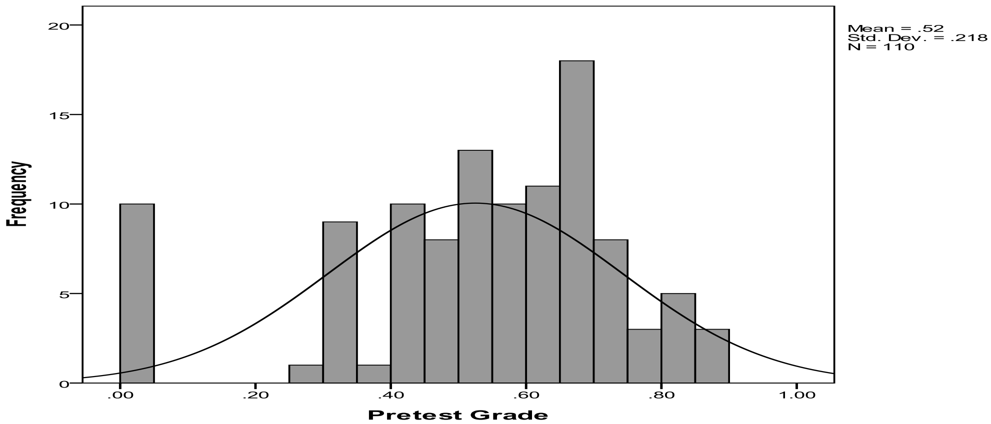
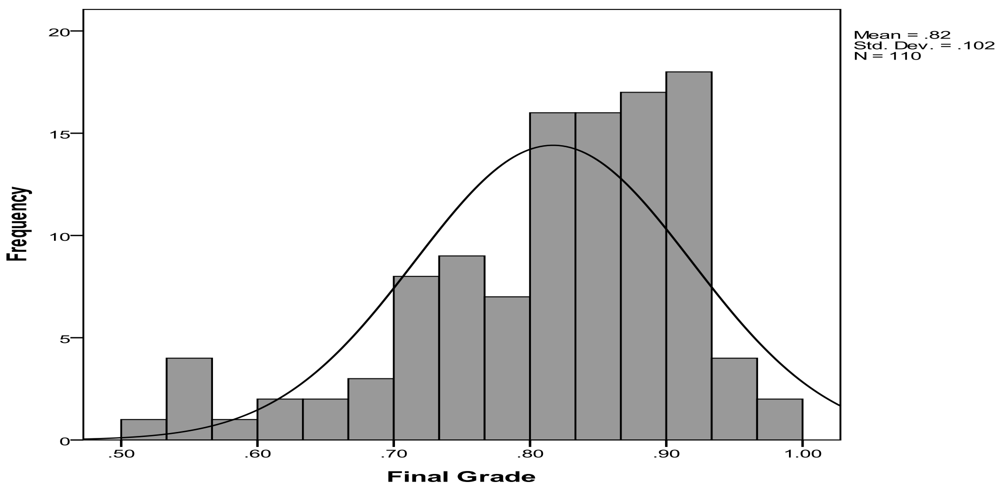


Figure 3. Final Grade Distribution



Finally, Table 1 summarizes descriptive statistics associated with both pretest as well as final grades. First, with regard to pretest grades, the mean grade was found to be .525, with a standard deviation of .218. The ratio of skewness to its standard error was found to be -4.387, which indicates high negative skewness. The ratio of kurtosis to its standard error was found to be 1.602, which does not indicate abnormally high or low kurtosis. Final grade was found to have a mean of .817, with a standard deviation of .102. This measure also had high negative skewness, with the ratio of skewness to its standard error being equal to -4.261. No problematic issues were found with regard to kurtosis, with the ratio of the measure of kurtosis to its standard error found to be 1.337 with regard to final grade. Overall, while some level of non-normality was indicated, no extreme departures from normality were found on the basis of these data. As normalizing these two measures of test scores would serve to bias the difference between scores among respondents, no efforts were taken to normalize these data in preparation for the repeated-measures analysis of variance.

Table 1. Descriptive Statistics for Pretest and Final Grades Analysis of Variance

Measure	*Pretest Grade*	*Final Grade*
N	110	110
Mean	.525	.817
Standard Deviation	.218	.102
Skewness	-1.009	-.980
Standard Error	.230	.230
Skewness / SE	-4.387	-4.261
Kurtosis	.732	.611
Standard Error	.457	.457
Kurtosis / SE	1.602	1.337

A repeated-measures analysis of variance was conducted, which included pretest grades and final grades as the outcome measures, with term and section consisting of the predictors. Descriptive statistics relating to pretest grades and final grades on the basis of term as well as section are summarized in Table 2.

Table 2. Pretest and Final Grades: Descriptive Statistics (ANOVA)

Measure		*N*	*Mean*	*Standard Deviation*
Pretest Grade				
Fall	MC	30	.529	.154
	MR	28	.470	.256
	Total	58	.501	.209
Spring	MC	29	.530	.281
	MR	23	.580	.132
	Total	52	.552	.227
Total	MC	59	.530	.223
	MR	51	.520	.214
	Total	110	.525	.218
Final Grade				
Fall	MC	30	.825	.081
	MR	28	.862	.077
	Total	58	.843	.080
Spring	MC	29	.786	.110
	MR	23	.790	.123
	Total	52	.788	.115
Total	MC	59	.806	.098
	MR	51	.830	.105
	Total	110	.817	.102

This table presents the sample sizes, mean scores, as well as the standard deviation for pretest as well as final grades on the basis of term and section. These measures serve to present an initial picture of differences in exam scores over time, as well as on the basis of the predictor measures included in the repeated-measures analysis of variance. The primary substantial difference found on the basis of these descriptive statistics consist of the comparison between pretest and final grades, with a strong increase in average grades being evident over time. No obvious mean differences in grades were found on the basis of either term or condition.

Next, Box's *M* test was conducted, which served to test whether there is homogeneity of covariance matrices of the dependent measures based upon all levels of the between-subjects factors, which consist of term as well as section. This test was found to achieve statistical significance, indicating that this assumption was violated in regard to these data as Box's $M = 39.866$, $F(9, 107313.093) = 4.276$, $p < .001$.

However, this test has been found to be very sensitive and hence very likely to produce significant results (Ntoumanis, 2001; Tabachnick & Fidell, 1989). For this reason, no changes to the methodology were made on the basis of this finding.

In addition, Levene's test of the equality of error variances was also conducted to determine whether the error variance significantly varies on the basis of the predictors included in this analysis. This test was found to be statistically significant for pretest grade, $F(3, 106) = 4.219$, $p < .01$, as well as for final grade, $F(3, 106) = 3.215$, $p < .05$. These significant findings indicate that the assumption of the equality of error variances was violated with regard to this analysis. However, no changes will be made as the analysis of variance is robust in the face of violations of this assumption (SAS Publishing, 2008).

Table 3 summarizes the results of the multivariate tests associated with the repeated-measures analysis of variance. The effects of time (comparing pretest and final grades), as well as the interaction between time and term, section, and the three-way interaction between all three of these measures are summarized in this table.

The effect of time as well as the interaction between time and term was found to be statistically significant. With regard to time, the significant effect was associated with the increase in test scores over time, indicating that a significant increase in test scores is present when comparing pretest with final grades. Next, a significant interaction was indicated between this change over time and term. Specifically, a significantly larger increase in test scores was found among students in the fall term, as compared with students in the spring term. The interaction between time and section, as well as the three-way interaction, was not found to achieve statistical significance.

Table 3. Repeated-Measures ANOVA: Multivariate Tests

Measure	*Value*[a]	*F (df)*	*Partial* η^2	*Power*
Time	2.082	220.661*** (1, 106)	.676	1.000
Time*Term	.929	8.093** (1, 106)	.071	.805
Time*Section	.996	.407 (1, 106)	.004	.097
Time*Term*Section	.969	3.346 (1, 106)	.031	.441

Note. *$p < .05$, **$p < .01$, ***$p < .001$; [a]Hotelling's Trace reported for time, Wilk's Lambda reported for all interaction effects.

However, observed statistical power relating to both of these effects was very low, suggesting that even if a significant effect was present, it would likely not be found.

The effect of the between-subjects effects, consisting of term and section, on grades is summarized in Table 4. As indicated, no significant differences in grades were found on the basis of either term, section, or the interaction between term and section. However, statistical power was found to be low with regard to these effects, indicating the difficulty present in finding any of these effects significant.

Table 4. Repeated-Measures ANOVA: Tests of Between-Subjects Effects

Measure	*F (df)*	*Partial* η^2	*Power*
Term	.000 (1)	.000	.050
Section	.092 (1)	.001	.060
Term*Section	.538 (1)	.005	.112
Intercept	2679.018*** (1)	.962	1.000

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

Conclusion

A repeated-measures analysis of variance was conducted in order to determine whether significant differences in exam grades exist on the basis of either term or section. The results of the analysis did not indicate that either of these measures was significantly associated with exam scores; however, observed power was found to be very low with regard to these effects, indicating a low probability that significant effects would be found even if they do exist in the larger population. The difference between pretest and final grades was found to achieve statistical significance, with students overall having significantly higher final grades as compared with their pretest grades. Additionally, a significantly larger positive increase in pre- and posttest score difference was found among students in the fall term, as compared with students in the spring term. Thus, self-remediation without instructor involvement provided a larger difference between pre- and posttest scores than remediation with instructor involvement.

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