

THE WORTHINESS AND EFFECTIVENESS OF MATHEMATICS REMEDIAL COURSES: A Case Study

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ABSTRACT

This study presents a formative model that assesses the worthiness and effectiveness of remedial math courses at a private university in Lebanon. The mathematics remedial courses were evaluated along three strategic features; enrollment, retention, and student academic achievement. The formative model was empirically validated, and findings report that those who had higher than one remedial math course were more inclined not to enroll than enroll. The finding also suggest, those who had one remedial course had higher attrition than retention rates. Finally, achievement in remedial courses appeared to reflect parallel and similar results with the first regular mathematics courses and students' cumulative GPA. The results are significant to the extent that mathematics remedial courses maybe a hindrance to the strategic development of the university and they may be hinderance evidence to subsistent intellectual and academic development. This study is illuminative given few studies have emerged to understand non-regular programs in their universities. The formative model presented in this study could be generalizable to studying the effectiveness and worthiness of courses/programs in higher education.

INTRODUCTION

A large number of North American colleges and universities offer remedial programs, as reported by the National Center for Educational Statistics (NCES, 1996), almost 100% of all community colleges offer remedial courses and 78% of all four year higher education institutions. This picture replicates itself in other parts of the world; particularly in Lebanon, where a robust growth of newly established American-based universities seeking American accreditation and quality assurance has demanded for greater accountable measures in the design, development and assessment of remedial programs by international and American accreditation bodies. As Bers (1985) suggested that there is a substantial demand and need for remedial program evaluation studies in higher education focusing on sound research methods. Thus, this study will focus on a formative evaluation of mathematics remedial programs and will assess the effectiveness and success of the math remedial courses in the enrollment, retention, and subsequent performance of students who took these courses. The significance of this study is that it is the first in its kind in the Middle East and in Lebanon, in the hope that other studies replicate the approach and method that they become penetrative and better available for accreditation agencies and general public, and a standard for formative evaluations of programs. A "remedial program to be judged effective, it ought to help some students succeed who otherwise would most likely fail their college-level coursework" (Zhai & Skerl, 2001, p 3) with the knowledge that mathematics preparation are the most important high school curricular experience to predict college success (Adelman, 1999).

Many students complain that they are required to take the same secondary school mathematics in the university- mathematics- remedial program. However, higher

education policy makers and academic administrators contend that mathematics serve as gatekeeper subjects, and they tend to "sieve" unprepared students out of some careers as in the sciences and engineering (Stage & Kloosterman, 1995; Kull, 1999). Academic administrators also suggest that remedial courses play a role in preparing students for material they do poorly or they have missed (Ottley, 1968). The opposing argument between academic administrators and faculty on one hand, parents and students on the other, suggest that an assessment of the worthiness, and effectiveness of the remedial programs in higher education in terms of what are they accomplishing in preparing students for the regular academic program. The assumptions and rationale for most remedial courses comes from the perspective presented by Hoyt & Sorensen (2001) who explore that high school students are rather under-prepared, face low levels of academic preparation, are generously overrated in high school, and not to par with the academic rigor expected at college. In addition, evaluation of remedial programs may also answer questions to the strategic development of higher education in that remedial should not be an obstacle to retention or lack of enrollment. If prospective students are expected to take more remedial courses than is expected, they are more likely to choose another university to enroll which offers less remedial courses. A formative evaluation model would then help answer concerns made by parents and academic faculty and outline for policy-makers measures of effectiveness for remedial programs.

Research has shown mixed results concerning the effectiveness of mathematics remedial programs. Richardson, Fisk, et. al. (1983) argue that remediation does not advance students into college academic programs, and students who have a number of remedial courses to take, are discouraged to continue or drop-out all together. Those who complete a long list of remedial courses tend to be more motivated students and succeed in the regular program of study.

Early studies found that mathematics remedial did not improve college mathematical abilities through regular college course work or that it did not fulfill the objective it tended to achieve in subjects as English (Lawson, 1959; Ottley, 1968). For instance, a National Study of Developmental Education in the US (Boylan, Bonham, et. al., 1992) found that dropout rates in remedial courses were highest in mathematics, and the National Center for Educational Statistics study corroborated these results to suggest that 74% successfully completed mathematics remedial courses. Saxon & Boylan (2001) conducted a meta-analysis of research and evaluative findings from over 100 studies, which examined the impact of remediation on the GPAs. They found that those who went through the remedial program in mathematics had higher GPAs than those who recommended but did not take the remedial courses. According to Adelman (1995), the mathematical grounding of many remedial college students is so deficient that a high failure rate exists *even* in the remedial classes. In the same study, those who completed the remedial courses had slightly higher and non-significant core curricular English courses compared to those who did not go through the remedial program. Johnson & Kuennen (2004) have shown that remedial courses taken before subject-curriculum, had students perform better on the latter courses than those who took the courses concurrently with remedial ones.

Empirical evidence in the US suggest that remedial, placement preparation and college support programs in colleges show some success in degree attainment (Cabrera & La Nasa, 2001; McCabe 2000 cited in Brothen & Wambach, 2004). Students in remedial programs are more likely to persist in college than those who were not required to take

courses (Bettinger & Long, 2005). Schoenecker, Bollman, et al., (1998) comparison of those who completed remedial courses with those who do not, found that those students who completed the recommended remedial courses, were less apt to continue with the program of study. Even those who do enroll in calculus courses, without the remedial courses, 40% fail these courses (Wieschenberg, 1994). Richardson, Fisk et. al. (1983) argue that students who do enroll in regular courses without the remedial prerequisites often force faculty to water-down the curriculum so as to accommodate low achievers. Current research has drawn the pros and cons of remedial programs, but still the question of policy and effective remedial programs is stipulated rather than answered rigorously or empirically.

The authors are not aware of one study that evaluates “pre-university programs” in the Middle East. Even in the US research about the effectiveness of remedial education programs has typically been sporadic, under funded, and inconclusive (Bers, 1985). For instance, a study of 116 two- and four- year colleges and universities revealed that only a small percentage conducted any systematic evaluation of their remedial education programs (Weissman, Bulakowski, et. al., 1997). Research literature as that presented by Roueche and Snow (1977) cited in Bers (1985) reviewed programs of 139 public community colleges and 134 universities found that these universities related the success of remedial programs to student completion of the program i.e., retention. In addition, they found that student success was a function of faculty and staff involvement and caring for students to persist in programs. More recently, Zhai & Skerl (2001) conducted a comprehensive study on the effectiveness of remedial at a four-year institute in the US and found that remedial courses were effective in that they increase the success in regular courses and subsequently in the retention, and high graduation rates. There is currently questionable practice as to what makes the best remedial program. Keeping in mind there is no empirical and formative based evaluation studies that provide models to identify and examine the success of remedial programs in other parts of the world.

With this in mind, this evaluative/research, paper suggests a basic model and approach to evaluating remedial programs in Lebanese universities and elsewhere. The implied model has three basic components established along strategic principles and issues that address the effectiveness of remedial programs and whether they are achieving their purpose in helping students advance in higher education, the model has three basic components, these are: 1) increased *enrollment*; 2) *retention* and 3) *better performance in subsequent mathematics courses and overall academic progress*. The three modules can formally upraise, remedial programs at colleges and universities. As modules have theoretically substantiated (see above literature review), become guiding nodes that can critically examine the effectiveness of remedial programs.

Research Questions

A number of research questions will be answered through this study. Question to what extent do mathematics remedial courses taken, hinder students from enrolling at the university? Second, to what extent those assigned in remedial courses enroll at the university, remain or dropout all together i.e, those that take more than one or more remedial course are they more apt to stay or leave the university? Third, are remedial

courses effective in preparing students for their required college-level mathematics course? Fourth, do the mathematics remedial courses reflect generally a better overall academic performance i.e., grade point average (GPA)? Particularly, those who go through remedial courses do they have an overall better performance in degree courses than similar students who do not?

METHODOLOGY

Several cohort data from within subgroups were groups obtained from the student enrollment database from a private's university's Administrative Computer Centre in Lebanon. Data obtained for students for both those who enrolled and the none-enrollees to the university. The type of data accrued was related to the number of remedial students take at the university. A maximum of three remedial math courses could be taken before enrollment in regular programs. Data pertaining to those who did not enroll included their entrance exam scores, and the type and number of mathematics remedial courses that were required. The basic design, crossed the number of remedial courses with a number of variables that helped answer the research questions. In the first analysis for instance, we compared those enrollees with those non-enrollees, to determine whether those who choose to enroll at the university had higher or lower number of mathematics remedial courses than those who did not. Second, we wanted to find out whether the number of remedial courses taken by students was related to student retention variable i.e., attrition and retainment. Third, to determine the effectiveness of the mathematics remedial courses on subsequent courses and general academic performance. Student enrollees were fit into cohort groups for those who took zero remedial, one remedial, two remedial, and three remedial courses were crossed with their performance on the first mathematics course and cumulative GPA. Lastly based on the average grades on the mathematics remedial course, three cohort groups of remedial students were classified as low achievers, middle achievers and high achievers as to cross these levels with their GPA and the first mathematics course grades in that order.

Sample

All students accepted who either enrolled or did not enroll to the university were selected for the study. The sample size came to 8587 who applied then enrolled or did not enroll. Those rejected were not included in the data set. The data was accrued from 2000/2001 to 2005/2006 academic years. Substantive reorganisation and restructuring of the data was performed to establish a multifarious cohort and subgroups. Graduate students applying to the university were not included in the sample data.

RESULTS

The first analysis determined whether placement in the number of remedial courses had an effect in determining the level of non-enrollment into the university. A count was calculated for the number of students in remedial courses, and crossed with enrollment status (whether they enrolled, or did not enroll at the university).

Table 1 reports the percentages of the non-enrollee and enrollee classifications. The results indicated a significant difference between non-enrollees and enrollees ($\chi^2(3, 8587)$

= 106.86, $p < .0001$). Surprisingly, those who had one remedial math course had a significant and high number of none enrollees than those who matriculated or enrolled. This differences appears for those who took one remedial course with a percentage of 22.4% (none enrollees) compared to 4.55% (matriculated). In the second analysis, we reclassified the number of remedial courses into those who took one or more mathematics remedial courses with those who took zero remedial courses and crossed it with enrollment status (enrolled/not enrolled). A significant Chi-square was found ($\chi^2(1, 8587) = 35.23, p < 0.001$), for those who were not required to take mathematics remedial courses enrolled at a higher percentage 59.9%, compared to 52.1% who did not enroll. However, those who had one or more math remedial course to take had a higher probability of not enrolling at the university compared to those who enrolled (40.1%). Thus, a conclusion that math remedial courses at general and minimal level, do provide some sort of barrier to student enrollment at the university.

Table 1 Frequencies and percentages for enrollees and non-enrollees in none remedial and mathematics remedial courses

		Number of Remedial Courses				
		0	1	2	3	
<i>Did not Enroll</i>	Number	898	387	364	76	1725
	Row %	52.1%	22.4%	21.1%	4.4%	100.0%
	Column %	17.9%	18.7%	27.7%	38.8%	20.1%
	Percent of the Total	10.5%	4.5%	4.2%	.9%	20.1%
Enrolled	Number	4113	1678	951	120	6862
	Row %	59.9%	4.5%	13.9%	1.7%	100.0%
	Column %	82.1%	81.3%	72.3%	61.2%	79.9%
	Percent of the Total	47.9%	19.5%	11.1%	1.4%	79.9%

In the third analysis, we controlled for only those who matriculated, using the number of mathematics remedial courses, those who took zero, one, two, and three remedial courses with a attrition/retention variable. We were interested to find if there was a relation between the number of math remedial courses required and whether it had a direct link with attrition or retention. Table 2 presents the percentages of those who took mathematics remedial courses crossed by the retention variable. The analysis showed that those students who took three remedial courses had lower attrition rate of the total (0.2%) compared to those who were retained (1.5%) with a significant $\chi^2(3, 6862) = 21.03, p < 0.0001$. Generally, this relation appeared across the various number of mathematics remedial courses taken. In the fourth analysis to this study and in line with Grubb (1998) and Boylan, Bonham et. al. (1994), to examine the dropout percentages of those enrolled in remedial courses. We created a cohort group of those who had taken zero mathematics remedial courses in one group and one or more mathematics remedial course in another. We then crossed this newly constructed variable with the retention/attrition variable; a significant and high relation appeared ($\chi^2(2, 2749) = 14.29, p < 0.001$). Generally, those who had to take one or more remedial course, the attrition rate was at 47.5% compared to those who were retained 39.6%. However, an inverse

relation appeared when comparing those who were not required to take mathematics remedial courses with those who were required. The attrition was at 52.5% compared to a retained 60.4%. Mostly students who finished the first remedial were prone to dropout than to be retained.

Table 2: Frequencies and percentages for the leavers and retained in none remedial and mathematics remedial courses

		Number of Math Remedial Courses				
		0	1	2	3	
Attrition	Number	662	345	142	17	1166
	Row %	56.8%	29.6%	12.2%	1.5%	100.0%
	Column %	16.1%	20.6%	14.9%	14.2%	17.0%
	Percent of the Total	9.6%	5.0%	2.1%	0.2%	17.0%
Retained	Number	3451	1333	809	103	5696
	Row %	60.6%	23.4%	14.2%	1.8%	100.0%
	Column %	83.9%	79.4%	85.1%	85.8%	83.0%
	Percent of the Total	50.3%	19.4%	11.8%	1.5%	83.0%

The fifth analysis determined the impact of remedial math courses on student performance in their first mathematics course and cumulative GPA. The design crossed the number of mathematics remedial course (i.e., zero and one or more remedial courses) by the first math course in the regular program and cumulative GPA for the enrollee cohort group. A significant difference was found between those who did not take remedial course, and those who took one or more on the first math courses ($t(df=4917)=9.17, p<0.0001$). A t-value test conducted to study the same effects of the number of remedial course on cumulative GPA. The difference ($t(df=6447)=25.25, p<0.00001$) on the cumulative GPA for those who took zero remedial courses was higher than those who took one or more. The means are reported on Table 3. A significant and high positive correlation appeared for the average remedial grade and first math course at ($r=0.85, p<0.0001$). In general, the results show that those who have not taken a remedial courses have had a higher cumulative GPA, however, those who had one or more mathematics remedial course had a higher average than those who had zero or no mathematics remedial courses to take.

Table 3: Means on the first math course and cumulative GPA by those who took zero remedial courses and those who took more than one remedial course

	Zero Remedial Courses			More than One Remedial Courses		
	N	Mean	SD	N	Mean	SD
First Math Course	2241	2.31	1.23	2678	1.98	1.22
Cumulative GPA	3825	2.70	0.64	2624	2.30	0.6

The sixth analysis investigated whether zero, one, two, or three mathematics remedial courses had any direct affect on their performance in the first math course and their cumulative GPA. Table 4 reports these results. We created four cohort groups those who enrolled into zero, one, two, and three remedial courses, then ran a one way ANOVA to see if any differences existed between the four groups. A high significant difference was found ($F(3,4915)=65.28, p<0.0001$) on the first math course. A Scheffe' post-hoc analysis between the four groups showed differences among all combinatorial groups. The highest was for those who took three remedial courses, followed by those who took zero, two and lastly one remedial courses. On the GPA, a significant difference was found ($F(3,6445)=212.83, p<0.0001$), the Scheffe' post-hoc analyses reports a no significant difference between those who took one and two, one and three, and two and three remedial courses. However, a significant difference appeared between those who took zero remedial courses with those who took one, two, and three respectively. The results in general indicate that the more mathematics remedial courses students take, impacts negatively first math course performance that students take in the regular programs. However, those who took zero remedial courses had higher cumulative GPA than those who took one, two, or three remedial courses. The higher the number of remedial courses students take, the lower the cumulative GPA.

Table 4: Grade point average means of remedial courses crossed with the first math and cumulative GPA

	Zero Remedial	One Remedial	Two Remedial	Three Remedial
	Mean(SD) N			
First Math Course	2.31(1.23) N=2241	1.79(1.31) N=1610	2.22(1.02) N=948	2.64(0.97) N=4919
Cumulative GPA	2.70(0.64) N=3825	2.30(0.63) N=1560	2.29(0.54) N=938	2.27(0.49) N=120

Table 5: Means and F-Ratio of the average grade level crossed by the first math and cumulative GPA

	First Math Course	Cumulative GPA
	Mean (SD) N	
Low Achievers	0.95 (1.0) N=1130	2.08(0.60) N=1080
Middle Achievers	2.4 (0.56) N=947	2.34 (0.51) N=941
High Achievers	3.29 (0.55) N=601	2.66 (0.53) 597
	F(df)	
	1988.89 (2,2675)**	219.15 (2, 2615)

A high correlation between the average remedial grade and the first math course appeared, where a significant correlation between average remedial grade and cumulative GPA, indicate that a relation may exist between the course content of the math remedial

courses and the first math course. It may also say that remedial courses have little effects on other courses in the regular program and that remedial math course have merely “short-term returns” rather than lengthened affects on the intellectual development of the typical college student. So, in order to determine what may be already prevalent in our data but not evident was to investigate the levels of achievement on these remedial courses on the first mathematics course and cumulative GPA. We created three cohort groups, those who received grades less than a C (low achievers), a group who received a grade between C and B (middle achievers), and a third group who received a B and above (high achievers) on the average of the remedial course(s). A separate one-way ANOVA was run on the first math course and on the cumulative GPA. Table 5, reports the means and the F-ratios. A Scheffe’ post-hoc analysis produced a significant difference between all combinatorial groups with higher mean ratings for those who were high achievers on the mathematics remedial courses followed by the middle achievers and lastly the low achievers. The higher achieving students had the highest first math course and cumulative GPA average. Conversely, those who received lower grades on the remedial courses had the lowest grades on first math and cumulative GPA respectively.

DISCUSSION

In our review of the literature, we found few studies that examine the effectiveness of remedial programs. Particularly, we found not one study that assessed remedial courses in relation to enrollment into a program. In this paper we proposed a model to assess the effectiveness of remedial programs. We also examined this model in a sequential and modular approach in establishing an applicable, appropriate and concurrent formative evaluation model for the assessment of remedial program. The model conceptualized in this paper follows a three-module approach discussed in the introduction section (*enrollment, retention, and performance in subsequent subject matter courses and overall academic progress*). The model was coursed at a private university in Lebanon, in the hope that such model becomes recognizable and easily applicable for programs along the lines of institutional self-assessment studies.

One of the major finding of this study presented the relation between the number of math remedial courses students where placed in, and whether they enroll or do not. Particularly, those who had three remedial courses were less apt to enroll at the university than enroll. Thus, it would be advantageous for future studies to understand whether remedial courses act as obstacle or an opportunity to enroll and continue in regular programs. The results also show that number of remedial courses has a direct relation with students remaining or leaving a university i.e., retention. Particularly those who had one remedial math course were more inclined to dropout than stay enrolled. In a large US study by Boylan, Bonham, et. al. (1992) they found that dropout rates in remedial courses were highest in math which created problems and difficulty in interpreting the dropout rates in regular programs. Grubb’s (1998), data from the City University of New York (CUNY) system indicated the attrition rate was close to 40% in remedial courses. The National Center of Educational Statistics in review of community colleges in the US pointed to a 74% retention rates in remedial math. Grubb (1998) pointed out that high dropout rate in remedial courses was one of the major problems in evaluating the effectiveness of remediation; however, this limitation is a point worth of study in that we

found that remedial courses had a direct relation between students attrition and retention. Perhaps, these students found that their first remedial was so challenging that they could not foresee themselves making it through regular program in college and decided to dropout rather than go through a rigorous academic work.

The third and more important finding as to whether math remedial courses generally improve student performance on the mathematics subjects and others alike. This particular proposition drawn from Yoram, Siadat, et. al. (2000) that remedial courses benefits outweigh the costs and improve academic performance, general skills, employment, academic and life goals. But, if remedial programs are to place some sort of barrier to student enrollment they only provide improvement in mathematics courses, which suggests that the locus of benefits are extremely localized and thus only serve students, in the short run, as in their first mathematics courses that they take in college. This particular finding corroborates that of Boylan, Bonham, et. al. (1992), which surveyed students from 150 colleges in the US and found that those who passed their math remedial courses were to benefit and perform at an acceptable level in their first college-level course. The findings in this study showed that students who took two or more mathematics remedial courses performed better on their first math, than those who took one or none at all. Particularly, those who took three remedial courses were to benefit the most as they scored higher than those students who had zero remedial courses. However, on the cumulative GPA students who took three remedial courses had the lowest cumulative GPA, followed by those who took, two, one, and zero, in order. Thus, this particular finding is significant in that the level of academic achievement among those who enroll with out remedial courses appears to be the highest. Even if those students so poorly prepared register in remedial programs have done little to the overall student performance. As Weissman, Bulakowski, et. al. (1997) indicated that the purpose of remedial courses is to gain skills necessary to complete in regular programs in college- our results showed that the more remedial courses students take the lower the cumulative GPA. These results also corroborated with Weissman, Silk, et. al. (1997), who found that the average GPA for the remedial students was not as high as that of college-ready students. This is significant because these courses show that they may be not doing what they set out to do and thus fail to be effective in providing extensive and comprehensive academic preparation for entering college students in a private university in Lebanon.

In our final analysis, we attempted to investigate whether success in courses was related to the more logical and evident factor as educational achievement. By establishing three groups; low, middle and high achievers, it was found that those low achievers on remedial courses performed poorly in the first course in the regular program and on their cumulative GPA. Similarly, those who were high achievers in remedial courses were the high achievers in the first mathematics course and on their cumulative GPA. This finding corroborates to that of Weissman, Bulakowski et. al. (1997), who found those students who performed well above the average grade in remedial courses did not perform to par with those who did not take remedial. Remedial students do tend to do poorer than those who do not go through such programs and those who do not perform higher than those who did not go through remedial courses. These findings are substantial and informative in that those students who are high achievers tend to perform well anyway, irrespective if

they take remedial courses or not. It could be concluded that mathematics remedial courses, have little effectiveness in promoting academic success.

In conclusion the results of this study indicate that students with more mathematics remedial courses place little barriers to enrolling students to a University. For instance, those who were assigned three mathematics remedial courses had a higher probability of not enrolling than attending the university. Those who had one remedial course were more inclined to dropout than stay at the university. In terms of effectiveness, those who enrolled and were not required to take remedial courses performed higher than those who had one or more remedial courses on their first math course. However, analyzing those who took one or more remedial course, we found that those who took three remedial courses garnered higher grades than those who did not take remedial courses in their beginning mathematics course. This result can't be generalized to how students did in other courses in their regular program. In fact, those who did not take remedial were prone to have a higher grade point average than those who did. These findings are substantial and informative in that those students who are high achievers tend to perform well anyway, irrespective if they take remedial courses or not. It could be concluded that mathematics remedial courses are ineffective in promoting academic success further needs call for the need to examine the palpability of remedial programs locally and internationally.

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