AN EVALUATION OF A REMEDIAL MATHEMATICS PROGRAMME

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REMEDIAL MATHEMATICS PROGRAMME

by

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Abstract

This study investigated whether a remedial mathematics programme offered at Memorial University of Newfoundland improved students' performance in subsequent mathematics courses and/or changed their attitudes toward mathematics. Academic records from 194 remedial and 304 non-remedial students were examined. Results indicated that: a) remediation did not influence students' grades in subsequent mathematics courses; b) students' grade point average in high school as well as their performance in high school mathematics courses were reliable predictors of performance in university-level mathematics courses; c) students in a remedial mathematics programme were less likely than non-remedial students to enrol in more advanced mathematics courses; d) remedial students had lower overall grade point averages in high school and university than non-remedial students; and e) female students in the remedial programme perceived themselves to be less mathematically proficient than their male counterparts.

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I would like to thank Dr. Ross and the members of my committee for their assistance in the completion of my thesis. In addition, this study would not have been possible without the invaluable financial and administrative assistance of Memorial University of Newfoundland. Specifically, I would like to extend a special note of gratitude to Rosemary Gladney for her help in obtaining student records.

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Over the last twenty years, the number of undergraduate students taking remedial mathematics courses has increased dramatically. For example, between 1975 and 1980, enrolment in remedial mathematics courses at post-secondary institutions increased by 72%, whereas total student enrolment increased by only 7% (Coleman & Selby, 1982 as cited in Chang, 1983). Similarly, Kenschaft (1990) noted that, during the 1980s, almost two-thirds of students admitted to the university she investigated failed a mandatory postmatriculation exam and, therefore, were required to take a remedial course in elementary algebra. Researchers also suggest that the growth in remedial programmes may be attributed to the increasing diversity of college and university populations (Cohen, 1984; Cox, 1990; Fischer, 1989; Tomlinson, 1989).

Some of the research examining the impact of remediation programmes at the post secondary level suggests that remedial courses in mathematics are useful. For example, Wepner (1987) conducted a three-year longitudinal investigation to determine whether remedial instruction would enhance students' proficiency in mathematics. In this study, all first-year students were required to take a Basic Skills Placement Test (BSPT). Students were classified as:

a) "remedial" if they had scores lower than 50% on the computation section of the BSPT; b) "developmental" if they had scores lower than 70% on the algebra section and between

50% and 80% on the computation section of the BSPT; or c) "non-remedial/non-developmental" if they attained at least 80% on the computation section and at least 70% on the algebra section of the BSPT. Results indicated that remedial and developmental students who had participated in a remedial mathematics programme performed significantly better on an algebra post-test than non-remedial/non-developmental students. In addition, a greater proportion of remedial and developmental students successfully completed college level mathematics.

Kolzow (1986) also provides evidence which suggests that remedial programmes are effective in improving students' academic performance. Specifically, he investigated the scholastic achievement of randomly selected groups of remedial students enroled in a communications course, a developmental mathematics course and a developmental reading course. Results indicated that grade point average and the duration of one's stay at college were positively correlated with performance in remedial courses. Specifically, about 44% of remedial students scoring an A in developmental mathematics went on to pass higher level mathematics courses, whereas less than 4% of those receiving a D, F, or N (incomplete) evidenced the same level of achievement.

A study conducted by Sparks and Davis (1977) also suggests that remedial programmes enhance academic proficiency. These researchers evaluated the impact of a special studies programme which was designed to improve performance in specific subject areas. All entering students who had scores of 330 or less on either the verbal or quantitative components of the Scholastic Aptitude Test (SAT) were required to take the Comparative Guidance and Placement Test (CGP). Individuals who failed to meet the institutional cut-off score for the CGP tests in language, reading, and/or mathematics were placed in the special studies programme. To successfully complete the mathematics component of this programme, students were required to meet the minimum standard on the CGP and obtain no less than 80% on their homework and examinations.

Sparks and Davis (1977) noted that 70% of students in the special studies programme subsequently enroled in university-level mathematics courses and that their grades were comparable to those earned by other students.

Another investigation found that only 19% of first-year students entering a teacher education programme passed a required examination in mathematics (Lee, Lee, & Davidson, 1985). Remedial instruction in mathematics was provided to enhance students' chances of successfully completing the programme. Results indicated that remediation significantly improved students' mathematical ability.

Lovell and Fletcher (1989) also investigated the effectiveness of remediation. Specifically, they examined how students who had successfully completed remedial mathematics performed in a college level mathematics course. The comparison group consisted of other students in the course who had not taken the remedial programme. Results indicated that remedial students performed as well as their non-remedial counterparts.

Finally, results from a national survey of academic post-secondary institutions suggest that students benefit from remedial education (Chang, 1983). Over 70% of the schools surveyed indicated that a majority of their remedial students successfully completed at least one college-level mathematics course. In addition, as many schools tracked the performance of remedial students over time, the survey found that some of these students had higher retention and/or success rates than their non-remedial counterparts.

It should be noted that not all studies have obtained favourable results for remedial mathematics programmes. For example, Eisenberg (1981) found that only 19% of those enroled in a remedial programme went on to successfully complete a more advanced mathematics course. However, as this study did not provide a control group, it is difficult to ascertain the true effect of remediation.

Cuneo (1985) circumvented this problem by comparing students who had remedial mathematics instruction with students of similar ability who opted to bypass remediation. Results indicated that the grades obtained by the two groups in a pre-calculus course did not significantly differ.

Finally, Head and Lindsey (1984) investigated the effectiveness of a remedial mathematics course. They compared groups of students who had taken remedial mathematics and/or college algebra in five distinct sequences. The sequences were as follows: a) S1 - passed remedial mathematics then took college algebra; b) S2 - failed remedial mathematics then took college algebra; c) S3 - failed college algebra, passed remedial mathematics, then took college algebra again; d) S4 - failed college algebra, passed remedial mathematics, but did not attempt college algebra again; and e) S5 - failed college algebra, then took college algebra again, but did not take remedial mathematics.

The findings in this study were equivocal. Students who had successfully completed remedial mathematics (S1) obtained significantly higher grades in college algebra than unsuccessful remedial students (S2). However, those who failed college algebra then passed remedial mathematics and took college algebra again (S3) did not obtain significantly higher grades than students who failed remedial mathematics and then took college algebra (S2). This finding causes one to question the assumption that students who successfully complete remedial mathematics should be more likely than unsuccessful remedial students to pass college algebra.

In addition, Head and Lindsey (1984) noted that students who passed remedial mathematics and then took college algebra (S1) did not obtain significantly higher grades than students who failed college algebra, successfully completed remedial mathematics and then enroled in college algebra a second time (S3). Nor did S1 students evidence higher levels of achievement than students who failed college algebra and repeated it without remediation (S5). It should also be noted that the grades obtained by S3 and S5 students did not significantly differ.

Research suggests that undergraduate students in Newfoundland are often deficient in basic mathematics skills. For example, Crocker (1989) reported that their achievement in mathematics and science is consistently low when compared with students in other provincial and international jurisdictions. The author also noted that two different high school mathematics courses in Newfoundland are associated with varying levels of post-secondary achievement. Students enroled in the advanced high school mathematics course appear to obtain the preparedness necessary for university entrance and successfully complete university-level mathematics courses. However, students enroled in the academic mathematics course often enter university deficient in basic mathematics skills and experience a high failure rate in undergraduate mathematics courses (Crocker, 1989).

Since universities do not control the high school curriculum, post-secondary educators must look for other ways of ameliorating students' mathematical deficiencies. May, Dalzell, and Hall (1989) suggest that interventions should be targeted at improving students' basic math skills. For example, in the Fall of 1988 all incoming students at Memorial University of Newfoundland, Sir Wilfred Grenfell College, the Cabot and Marine Institutes, and the Western and Central Colleges were encouraged, but not required, to take the Mathematics Basic Skills Inventory (MSI). May et al. (1989) analyzed the performance of first-year students on the inventory over a two year period (1988-1989). Students' final grades in their mathematics courses were also investigated. The researchers found that students' basic math skills were positively correlated with their performance in first-year mathematics courses. Although contradictory to findings obtained by Head and Lindsey (1984), May et al. (1989) also maintained that remedial instruction was an integral step prior to a student repeating a failed course. They reported that without remediation (i.e., merely taking a course a second time) a student has an 80% chance of either failing or receiving a marginal pass. Since participation in the MSI was voluntary, the data did not represent a random sample of students. Thus, it would be imprudent to generalize the findings of this study to the population of students taking mathematics.

In the Fall of 1990, the MSI became compulsory for all students entering Memorial University of Newfoundland. However, there was no cutoff point for students entering regular undergraduate math courses. As a result, students may not have taken the MSI seriously.

In the Fall of 1993, the University Senate altered the admission requirements for one of its primary undergraduate mathematics courses (Math 1080[1]). To gain admission to this course, students had to satisfy one of the following criteria: a) at least 70% in high school academic mathematics; b) a passing grade in advanced high school mathematics; or c) a passing grade in academic mathematics and a minimum of 50% in the MSI. Registration in a remedial mathematics programme is now deemed mandatory for all students failing to satisfy one of these criteria.

The remedial mathematics programme presently offered at Memorial University of Newfoundland is entitled the Mathematical Skills Foundation Programme (MSFP) and consists of three non-credit courses (102F, 103F, and 104F). By providing tutorial assistance, this programme enables students to obtain basic arithmetic and algebraic skills. Students are required to demonstrate their command of mathematical operations using whole numbers, fractions, decimals, and algebraic and fractional expressions involving exponents, radicals, logarithms, and trigonometry.

Driven by the mastery concept of learning, students must be knowledgeable in basic mathematical skills before proceeding through the various levels of the remedial programme. Upon completion of each semester, the instructor will designate a change to 103F or 104F, if appropriate. This technique was found to produce superior levels of student achievement (Friedlander, 1982).

Two diagnostic surveys determine students' mathematical knowledge. The results of the surveys provide a blueprint for each student's individualized programme. As students are continually evaluated, there is no final examination. Final grades are based on both criterion-referenced tests which examine a specified set of learning modules as well as the student's attendance at scheduled tutorial sessions. A student must successfully complete all of the module test sections required by his or her programme.

Memorial University's Division of Continuing Studies, in conjunction with the Math Learning Centre, offers a Personal and Professional Development Programme (PPD) which is similar to the MSFP. Although the programmes cover the same content, the PPD does not provide participants with a final letter grade.

The purpose of this thesis was to determine whether the MSFP improves student performance in subsequent mathematics courses. In addition, the effects that the MSFP and the PPD have on participants' attitudes toward mathematics were investigated.

Method

Data were obtained from records of all first-year students entering Memorial University of Newfoundland between 1988 and 1992. The following information was gathered from those records: graduating average in high school, final marks for Grade 12 academic and advanced (honours) mathematics courses[2], first and second semester final grades for all first-year university courses and final grades for all university mathematics courses. If a student had taken any mathematics or English[3] course more than once, the highest grade he or she obtained on those subsequent attempts was also examined[4].

Students' identification numbers were used to protect their anonymity. In addition, prior to the release of the data, the researcher signed an undertaking of confidentiality.

Students were then classified into one of two mutually exclusive groups: those who had taken the MSFP and those who had not.

1.1 Selection of the MSFP Sample

Student identification numbers were randomly selected from 53 alphabetical class listings of students who had taken the MSFP between 1988 and 1992. A random number of 10 or less was generated from each class list. This number determined the first student selected from that class. Proceeding from that first student number, every sixth identification number on the class list was included in the sample. This procedure was repeated for each class list. The total sample for the MSFP group was 194.

1.2 Selection of the Control (non-MSFP) Sample

The university registrar randomly generated a list of 435 students to be used in this study. Unfortunately, 131 of the students on this list could not be used because: a) their records indicated that they had taken the MSFP (20 cases); b) their transcripts were missing mathematics courses (11 cases); or c) their records consisted entirely of transfer credits and/or dropped/failed courses (100 cases). Thus, the total sample for the control (non-MSFP) group was 304.

1.3 Selection of Survey Sample

At the beginning and end of the 1993 Summer and Fall semesters, an attitudinal questionnaire was distributed to a convenience sample of 193 students in the MSFP and the PPD. Students were informed that participation was voluntary and that they could withdraw from the study at any time. In addition, they were requested to follow a prescribed coding system, outlined on the front of each questionnaire, to create their own personal identification number. This number allowed the researcher to match respondents' pre- and post-test questionnaire answers and also ensured that students' responses were confidential and anonymous.

A copy of the questionnaire is provided in Appendix A.

Results

2.1 Archival Data

An independent samples t-test was conducted to determine if students in the Mathematical Skills Foundation Programme (MSFP) or the control group obtained significantly different marks in Math 1080. It was found that MSFP students evidenced a lower average than the control group (M = 38.18 versus M = 48.36, respectively, $t(140.96) = -9.32$, $p < .004$).

An independent samples t-test was also conducted to determine if students in the MSFP or control group obtained significantly different marks in high school mathematics. Results indicated that the former had lower grades than the latter (MSFP $\underline{M}$ = 58.56 versus control group $\underline{M}$ = 70.65, $\underline{t}(250.97) = -10.00$, $\underline{p} < .0001$).

To investigate the effects of both high school mathematics and the MSFP on Math 1080 scores, a step-wise multiple regression was performed. The dependent variable was Math 1080 scores and the independent variables were group category (MSFP and control) and the grade obtained in high school academic mathematics (HMACAD). The analysis revealed that only one independent variable (HMACAD) contributed significantly to the predictability of MATH 1080 scores. The following formula emerged:

Math 1080 scores = .85HMACAD[5] - 19.21

Specifically, HMACAD accounted for 25% (adjusted $R^2 = .24$) of the variance in Math 1080 scores, $\underline{F}(1, 136) = 44.70$, $\underline{p} < .001$.

Given that students' grades in high school mathematics are correlated with whether or not they enrol in a remedial mathematics programme ($\underline{r} = .55$, $\underline{p} < .01$), it is possible that HMACAD is using up all the variance that the group category shares with MATH 1080. In addition, it is also feasible that there is an interaction between students' grades in HMACAD and the group category (MSFP/control)[6]. For example, the benefits students obtain from the MSFP may vary in accordance with their mathematical proficiency.

To examine these possibilities, a multiple regression analysis was conducted forcing group category (MSFP/control) as the first entry. When group was entered as the first variable, the R^2 change was 4%; this change was significant. On the second step, HMACAD was entered. The R^2 change was 21% which was also significant. However, after HMACAD was entered the contribution of group category was no longer significant (t = -1.02, p = ns). In addition, the R^2 change for the interaction between the variables entered on the third step was less than 1% and was not significant. Thus, the effects of the MSFP did not differ in accordance with students' initial mathematical ability (see Table 1).

Insert Table 1 about here

The change in the contribution of group category after the addition of HMACAD suggests that the initial impact was the result of the correlation between these two variables. Specifically, students' decision to enrol in the MSFP is based, at least in part, on their performance in HMACAD. As noted above, there was a significant difference in average high school mathematics grades between students in the remedial and control groups. Further evidence of this difference was found in the lower partial correlation of group category with Math 1080 grades once HMACAD was entered.

Before HMACAD was entered, the correlation was .21 ($p < .02$); after it was entered, the partial correlation for group category changed to -.08 (p = ns).

Another step-wise multiple regression was performed using Math 1080 scores as the dependent variable and group category (MSFP/control) and overall high school average (AVG) as the independent variables. This analysis revealed that only AVG contributed significantly to the predictability of MATH 1080 scores. The following formula emerged:

$$\text{Math 1080 scores} = 1.7\text{AVG}^7 - 79.81$$

Specifically, AVG accounted for 31% (adjusted $R^2 = .31$) of the variance in Math 1080 scores, $F(1,191) = 86.61$, $p < .001$.

Multiple regression forcing the entry of variables into the equation yielded somewhat different results. The contribution of group category was similar to that noted with the previous analysis. However, when the interaction between group category and AVG was entered it did account for a significant amount of variance (R^2 change 3% F change = 6.26, $p < .02$) (see Table 2).

Insert Table 2 about here

To examine this interaction, regression equations were derived for each group. The equations were:

$$\text{MSFP: M1080} = .56\ (\text{AVG}) - 2.28$$

$$\text{Control: M1080} = 1.57\ (\text{AVG}) - 71.88$$

These results suggest that students with a low high school average who enrol in the MSFP are more likely to obtain higher marks in Math 1080 than their academic counterparts in the control group. It should be noted that the impact of the MSFP diminishes as students' high school average increases. However, this finding may be meaningless as it appears unlikely that individuals who are academically proficient in high school would enrol in remedial mathematics.

An independent samples t-test was also conducted to determine whether MSFP students who enroled in Math 1080 evidenced higher levels of achievement than students who took Math 1080, failed and then repeated the course. It was found that MSFP students did not perform as well as those who failed and then repeated Math 1080 (M = 38.18 versus M =53.80, respectively, $t(93.99) = -2.61$, $p = .011$).

These results, when viewed in conjunction with one another, provide mixed support for the MSFP. It is possible, however, that the most dramatic effects of this programme may be observed with students who are weakest in mathematics. To examine this possibility, students in the MSFP or control group who had a final mark of 65 or less in high school academic mathematics were compared. An independent samples t-test revealed that the groups did not significantly differ in their Math 1080 grades (MSFP $\underline{M}$ = 30.21 versus control $\underline{M}$ = 29.82, $\underline{t}(48.08)$ =.06, $\underline{p} > .05$)[8,9].

Chi-square analysis was then used to examine whether students in the MSFP were less likely than students in the control group to participate in advanced university-level mathematics courses. Results indicated that students in the MSFP were less likely than students in the control group to take Math 1080 [41% versus 56%, respectively, X^2 (1, N = 498) = 10.20, $\underline{p} < .01$]; Math 1081 [14% versus 34%, X^2 (1, N = 498) = 23.77, $\underline{p} < .01$]; or any second-year mathematics course [1% versus 8%, X^2 (1, N = 498) = 7.04, $\underline{p} < .01$].

2.2 Questionnaire Data

A 2 X 2 (male/female - summer/fall semester) repeated measures analysis of variance (ANOVA) was conducted on each of the 18 items contained in the attitudinal questionnaire. This analysis was used to determined whether students' attitudes toward mathematics changed as they progressed through the MSFP and whether any detectable change varied by sex or semester.

Significant sex differences were observed for five of the eighteen items on the attitudinal questionnaire. Specifically, females were more likely than males to: 1) feel less competent when manipulating numbers, $\underline{F}(1, 132) = 5.37$, $\underline{p} = .022$; 2) find mathematics difficult, $\underline{F}(1, 134) = 5.04$, $\underline{p} = .026$; 3) feel less comfortable when converting measures to and from the metric system, $F(1, 132) = 12.10$, $p < .001$; 4) feel less comfortable when helping a child with his or her mathematics homework, $F(1, 123) = 5.39$, $p = .022$; and 5) believe that completion of the MSFP was vital in the attainment of educational goals, $F(1,135) = 5.36$, $p = .022$.

Additional analyses revealed that over the course of the programme students were: 1) less likely to anticipate being able to successfully complete the programme, $F(1, 135) = 6.41$, $p = .012$; 2) less likely to feel that the programme was important for attaining educational goals, $F(1, 135) = 5.18$, $p = .024$; and 3) more likely to feel comfortable converting measures to and from the metric system, $F(1,132) = 8.28$, $p < .005$.

An additional item on the questionnaire asked students to rate their mathematical skills. A repeated measures ANOVA produced a significant interaction between the sex of the subject and his or her progression through the MSFP [$F(1, 130) = 7.52$, $p < .007$]. This interaction suggests that, as the MSFP progressed, male students rated their math skills more favourably than did female students.

A complete listing of students' responses on the questionnaire, stratified by sex, is presented in Table 3.

Insert Table 3 about here

3.0 Discussion

On average, the results of this thesis suggest that the MSFP does not have a positive measurable effect on students entering Math 1080. For example, MSFP students evidenced lower levels of achievement than students who took Math 1080, failed, and repeated the course. In addition, MSFP students and controls (matched on performance in high school academic mathematics) did not significantly differ in their Math 1080 grades. Moreover, a multiple regression analysis revealed that students' enrolment in the MSFP was not a significant predictor of achievement in Math 1080.

It is interesting to note that many students in the MSFP did not enrol in more advanced mathematics courses. As mentioned earlier, the proportion of remedial students who enroled in a second year mathematics course was approximately 1%. This finding suggests that students do not use the MSFP as a springboard to more advanced courses in mathematics.

In addition, results from the attitudinal questionnaire suggest that research is needed to identify the causal agents underlying females' perceptions of inadequacy in mathematics. Obviously, remedial programmes must ensure that they are responsive to the needs of all students and must engage in pedagogic practices which are free from gender bias.

Finally, it should be noted that the results of this thesis are congruent with those reported by Ross and Lacey

(1983) in their more extensive analysis of remediation. Specifically, these authors noted that the remedial programmes offered at Memorial University of Newfoundland were ineffective and did not enhance performance above what would have been expected based on high school academic achievement.

In sum, it is projected that enrolment in remedial programmes will continue to increase throughout the 1990s (Tomlinson, 1989). Therefore, it is imperative that educational institutions, particularly universities, provide students with quality remedial programmes which will enable them to overcome deficits in skill areas such as mathematics. For many students, remedial education serves as a conduit to employment that is both financially and psychologically rewarding (Tomlinson, 1989). In addition, successful remedial programmes increase the number of students eligible for careers in mathematical and/or technical fields, thereby filling the economic and scientific needs of our society.

Footnotes

[1] Math 1080 was developed for graduates of high school academic mathematics. This course introduces post-secondary level calculus at a slower pace thereby providing students with sufficient time to upgrade their algebraic skills.

[2] Due to the lack of enrolment in the MSFP by high school honours students, these data were not used in subsequent analyses. Specifically, of the 79 high school mathematics honours students, only 4 (5%) took the MSFP. In contrast, 99 (38%) of the 259 students who passed high school academic mathematics went on to take the MSFP.

[3] English marks were examined because research suggests that performance in this discipline is a reliable predictor of general performance in first-year university courses (Ross & Lacey, 1983).

[4] Identifying a single measure which most accurately captures what an individual has learned is a complex and, most likely, irresolvable debate. However, it is the author's contention that the highest grade received by a student represents the maximal amount that he or she has learned. For example, a student who receives a mark of 70 after taking Math 1080 three times should theoretically possess the same level of mathematical knowledge as a student who receives a mark of 70 the first time he or she takes the course.

Footnotes (cont'd)

[5] The t value for the HMACAD beta weight was 6.69, $p < .00001$.

[6] I wish to thank an anonymous reviewer for drawing my attention to these two possibilities.

[7] The t value for the AVG beta weight was 9.31, $p < .00001$.

[8] A similar analysis was conducted examining control and MSFP students who obtained a final mark greater than 65 in high school academic mathematics. A significant difference between the two groups was not obtained.

[9] It should be noted that statistical analyses based on extreme scores may be susceptible to regression to the mean.

References

Chang, P.T. (1983). College developmental mathematics: A national survey. (Report No. JC 830 439). Paper presented at the Annual Convention of the Mathematical Association of America, Southeastern Section (Charleston, SC, April 15-16, 1983) and the National Convention of the American Mathematical Association of Two-Year Colleges (Orlando, FL, November 10-13, 1983). (ERIC Document Reproduction Service No. ED 234 841)

Cohen, A.M. (1984). Mathematics in today's community college. (Report No. JC 840 221). Paper presented at the Sloan Foundation Conference on New Directions in Two-Year College Mathematics (Atherton, CA, July 11-14, 1984). (ERIC Document Reproduction Service No. ED 244 656)

Cox, G.L. (1990). Characteristics related to student performance in a college remedial self-paced mathematics laboratory. (Report No. SE 051 253). Lansing, MI. (ERIC Document Reproduction Service No. ED 316 422)

Crocker, R. (1989). Towards an achieving society: Final report of the task force on mathematics and science education. St. John's, NFLD.

Cuneo, D.O. (1985). Non-remedial low math students' performance in precalculus: Preliminary data. (Rep . - No. SE 048 683). New York, NY: Exxon Education Foun .ion. (ERIC Document Reproduction Service No. ED 287 723)

Eisenberg, T. (1981). Remedial mathematics and open admissions. School Science and Mathematics, 81, 341-346.

Fischer, F.E. (1989). Diagnostic-prescriptive teaching mathematics: An historical overview. (Report No. SE 052 471). ERIC Document Reproduction Service No. ED 341 552.

Friedlander, J. (1982). Should remediation be mandatory? Community College Review, 9, 56-64.

Head, L.Q., & Lindsey, J.D. (1984). Remedial math: Its effect on the final grade in algebra. Improving College and University Teaching, 32, 146-149.

Kenshaft, K. (1990). Recruitment and retention of students in undergraduate mathematics. College Mathematics Journal, 37(1), 291-301.

Kolzow, L.C. (1986). Study of academic progress by students at Harper after enrolling in developmental courses. (Report No. JC 860 086). Palatine, Il: William Rainey Harper College, Office of Planning and Research. (ERIC Document Reproduction Service No. ED 265 914)

Lee, L.N., Lee, M.M., & Davidson, J.A. (1985). Remedial math at the college level: A pilot study. (Report No. SE 046 405). Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Biloxi, MS, November, 1985). (ERIC Document Reproduction Service No. ED 266 022)

Lovell, L.M., & Fletcher, R.K. Jr. (1989). Remedial developmental studies mathematics as a predictor of college mathematics. (Report No. SE 051 105). Paper presented at the Annual Meeting of the Tennessee Academy of Science (Nashville, TN, November 17, 1989). (ERIC Document Reproduction Service No. ED 314 248)

May, S., Dalzell, C., & Hall, E.(1989). Prerequisite skills and success in mathematics. St. John's: Memorial University of Newfoundland, Department of Mathematics and Statistics.

Ross, A.S., & Lacey, B. (1983). A regression discontinuity analysis of a remedial education programme. Canadian Journal of Higher Education, 32, 1-15.

Sparks, J.R., & Davis, C. (1977). A systems analysis and evaluation of a Junior College developmental studies programme. (Report No. JC 770 231). Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, April 7, 1977). (ERIC Document Reproduction Service No. ED 136 892)

Tomlinson, L.M. (1989). Post secondary developmental programmes: A traditional agenda with new imperatives. (Report No. HE 023 150). Washington, DC: ERIC Clearinghouse on Higher Education. (ERIC Document Reproduction Service No. ED 317 101)

Wepner, G. (1987). Evaluation of a post secondary remedial mathematics programme. Journal of Developmental Education, 11(1), 6-9.

Table 1

Multiple Regression of Performance in Math 1080 with Group Category and Performance in High School Academic Mathematics as Predictors

Variable	b	t-value	MultipleR	R^2 Change
Group	10.34	2.52*	.21	.04
HMACAD	.94	6.14*	.50	.21
Group X HMACAD	.60	1.16	.51	.01

Overall R^2 .260

note: *p <.01

Table 2

Multiple Regression of Performance in Math 1080 with Group Category and Academic Average in High School as Predictors

Variable	b	t-value	MultipleR	R^2 Change
Group	10.34	2.52*	.21	.04
AVG	1.56	6.67*	.53	.24
Group X AVG	.26	2.50*	.56	.03

Overall R^2 .313

note: *p <.01

Table 3

Responses on Attitudinal Questionnaire Stratified by Sex

Questions	Males Entry	Males Exit	Males Avg.	Females Entry	Females Exit	Females Avg.
Q1	4.8	4.7	4.7	4.6	4.7	4.7
Q2	3.9	3.9	3.9	3.8	3.0	3.7
Q3*	3.3	3.4	3.4	3.0	2.4	2.8
Q4*	3.6	2.6	3.5	3.4	3.3	3.4
Q5	4.8	4.6	4.7	4.8	4.7	4.7
Q6*	3.2	3.1	3.2	2.7	2.7	2.7
Q7+	4.6	4.3	4.4	4.4	4.2	4.3
Q8	2.9	2.8	2.8	3.1	3.0	3.1
Q9	3.8	3.9	3.8	3.9	4.0	3.9
Q10	3.9	4.0	3.9	3.9	3.9	3.9
Q11**+	3.3	3.7	3.5	2.7	3.0	2.8
Q12	3.9	3.9	3.9	3.5	3.5	3.5
Q13	4.2	4.2	4.1	4.1	4.2	4.1
Q14	1.0	2.9	1.9	0.9	0.8	0.8
Q15++*	3.0	3.5	3.2	3.1	3.3	3.2
Q16+	2.6	2.4	2.5	2.6	2.6	2.6
Q17*+	2.8	2.5	2.6	2.8	2.7	2.7
Q18	2.6	2.5	2.5	2.6	2.6	2.6

Sex $^{*}p<.05$. $^{**}p<.01$. Treatment $^{+}p<.05$. $^{++}p<.01$.

Note. Questions and scales appear in Appendix A.

Appendix A

INSTRUCTIONS TO STUDENTS

This questionnaire is not a test. It is an opportunity for you to express your thoughts and feelings regarding this math upgrading course.

You will be asked to fill out two separate questionnaires; one at the beginning of the course and one upon completing the course.

To ensure your answers are kept as confidential as possible, the following coding system will be used. When you fill out a questionnaire put your personal code number on it. You are the only one who knows your code number. To make up a code number take the last four numbers of your phone number and put, at the end, the number of brothers or sisters you have.

For instance a person whose telephone number was 737-8028 and who had 3 brothers and 2 sisters would have as a code number:

8	0	2	8	5	

Write your code number in the boxes and keep them in a safe place. Use these numbers **only** on questionnaires you fill out for the evaluation.

My code number:

Please read all instructions carefully and answer each question as honestly as possible.

Thank you for your participation.

PART A

Do Not sign your name to the questionnaire

Please answer the following:

1) Have you attended other math upgrading courses?

yes -------   no -------(if no, skip 2)

If yes,

2) What math upgrading courses did you attend?

Mathematical Skills Upgrading Programme for Adults at the Math Learning Centre:

Once before -------
More than once -------
Never -------

Mathematical Skills Upgrading for High School Students at the Math Learning Centre:

Once before -------
More than once -------
Never -------
Adult Basic Education (ABE) ------------------------
Other ------------------------

3) Do you plan on taking subsequent math courses?

yes -------   no -------(if no, skip 4 & 5)

If yes,

4) What math courses do you intend taking?

5) Where do you intend taking these courses?

Appendix A (cont'd)

6) Are you currently employed?

yes -------   no -------

If yes,

Full-time -------   Part-time -------

7) Are you a student?

yes -------   no -------

If yes,

	Part-time	Full-time
Memorial University	-------	-------
Fisher Institute	-------	-------
Cabot College	-------	-------
Marine Institute	-------	-------
Avalon Com.College	-------	-------
Eastern Com. College	-------	-------
Central Com. College	-------	-------
Labrador Com. College	-------	-------
Western Com. College	-------	-------
Private Trade or Technical School	-------	-------
Adult Ed. Centres	-------	-------
Other________________	-------	-------

8) How did you find out about this course?

9) Sex -------

10) Age -------

Appendix A (cont'd)

PART B

Instructions — For each of the following, place the appropriate number beside each question.

1 = strongly agree
2 = agree
3 = don't know
4 = disagree
5 = strongly disagree

1. Mathematics is vital for entry into many careers. ______
2. Starting this programme was a big step for me. -------
3. When I have a task to do where I have to manipulate numbers I do not feel competent. -------
4. I am unable to think clearly when doing mathematics. -------
5. I hope that completing this programme will improve my mathematical ability and experience. -------
6. For some reason, even though I study, math seems unusually hard for me. -------
7. I anticipate that I will be able to complete this programme successfully. -------
8. Upgrading my mathematical ability will increase my chances for promotion in my present job. -------

Appendix A (cont'd)

Instructions For each of the following, place the appropriate number beside each question.

1 = very comfortable
2 = comfortable
3 = don't know
4 = uncomfortable
5 = very uncomfortable

9. How comfortable do you feel in each of the following situations?

balancing a cheque book	---------
balancing a bank statement	---------
converting measures to and from metric	---------
helping child with math homework	---------
attending math classes	---------

Instructions Please answer the following question.

10. Occasionally, my math skills interfere with achieving my goals.

Yes ----- No----- Don't know-----

Instructions Please circle the appropriate **letter** for the following question.

11. If you had to give your math skills a grade, what grade would you give them?

A B C D F

Appendix A (cont'd)

Instructions For each of the following, place the appropriate number beside each question.

1 = very important
2 = important
3 = not at all important

12. How important is completing this course for reaching your career goals? -------

13. How important is completing this course for attaining your educational goals? -------

14. How important is completing this course for increasing your self-confidence in math? -------

PART C

Instructions Please answer the following questions as concisely and honestly as possible.

1. When or where will you be using the math skills you acquire in this course?

2. Have there been positive experiences that increased your interest in math?

3. Have there been negative experiences that decreased your interest in math?

4. Specifically, why did you enrol in this programme?