Study Plans Promote Daily Review

By Tara Diehl and Regina Bobak

ABSTRACT: This paper analyzes how weekly study plans can increase student achievement in developmental mathematics courses at a four-year public institution of higher education. Quantitative data were collected regarding student completion of weekly study plans through an experimental methodology. Results show that students in the experimental group earned higher average grades across all categories (each exam and overall course grade) when compared to the control group. A discussion of findings and limitations is included.

Math instructors play an important role in contributing to student success.

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Developmental mathematics has been a topic of discussion at four-year institutions due to two main reasons: the number of students not successfully completing the courses inhibiting progression and the financial burden on the student who must complete courses that earn no graduation credit. According to a report by the National Center for Education Statistics (Chen, 2016), 58% of students beginning at four-year institutions completed all their developmental math, 22% completed some and 20% completed none. Universities continue to implement a number of strategies such as real-life applications of math, early alert systems, collaborative learning, self-paced computer assisted learning, acceleration models, and corequisite models to address the lack of student success. Developmental instruction addresses not only the remediation of math deficiencies but learning deficiencies as well. This study focuses on improving students' study skills in mathematics using weekly study plans.

Literature Review

There are a number of obstacles to college success including poor attendance, lack of motivation, work habits, and lack of adequate high school preparation. Students are coming to college not only unable to compute algebra but also unaware of the amount of time and effort needed to master these skills (Brothen & Wambach, 2012). Faculty and students alike recognize time management as a critical component to students' success.

Cafarella's (2014) study at an urban community college found that a majority of faculty participants thought that students did not spend enough time on their homework or reviewing class notes. Another study by Meer, Jansen, and Torenbeek (2010), conducted in two different countries on first-year students' time management, reported time management as a considerable concern. Students in the study mentioned knowing they would need to do more work, but that awareness did not lead to plans for handling the increased load; instead students put off doing necessary work.

Students have been shown to procrastinate because they lack organizational skills (Voge, 2007), but students could overcome procrastination by setting short and long-term goals, prioritizing responsibilities, and constructing to-do lists (Nasrullah & Khan, 2015). Short-term planning has involved daily and weekly activities. Nasrullah and Khan (2015) found a positive correlation between students' grades and short-term planning at a technical college in Pakistan. Hartwig and Dunlosky's (2012) study showed that high performers were more likely to plan their study activities ahead of time compared to low performers.

Bloom (1976, as cited in Boylan 2011) noted that 50% of the variance related to math success is due to cognitive skill and intelligence, 25% to quality of instruction, and 25% to affective characteristics. Paul Nolting stated in an interview that math instructors play an important role in contributing to student success in developmental math courses (Boylan, 2011). Van der Meer, Jansen, and Torenbeek (2010) suggested universities assist students in developing the necessary skills for time management.

Dunlosky (2013) examined strategies to boost learning and noted that studying the night before was not effective for long-term understanding and retention. He recommended using distributive practice: Students should set aside blocks of time throughout each week to study content. Presenting students with frequent deadlines has encouraged regular study habits and has discouraged cramming (Hagedorn, Sagher, & Siadat, 2000).

Purpose

Over the course of several semesters, the researcher-instructors (RIs) began to notice that students in their developmental mathematics classes were engaging in mathematics only on days when they had class. The researchers were also concerned that students were not retaining foundational information. They noticed that, as a result, the students struggled to learn new concepts because they could not recall the previous mathematical concepts. It appeared that the students were not prepared for how to study mathematics at the college level. The researchers considered whether developing weekly study plans that focused on reinforcing math daily and planning regular study

time would mitigate some of the concerns noted. The purpose of this research study was to compare exam grades and overall course grades of students developing and utilizing weekly study plans to students not developing and utilizing weekly study plans in developmental mathematics courses.

Methods

This quantitative study was undertaken at a four-year public institution of higher education in the northeastern United States. This institution has been part of a state system of higher education consisting of 14 institutions. At the time of the study the curriculum consisted of 57 undergraduate programs, 19 graduate programs (including two doctoral programs), and more than 66 minors. The institution enrolled 8,253 undergraduate and 671 graduate students.

The department in which the study occurred offered academic coursework and student success programs. The department programs included Academic Advisement, Act 101/EOP, TRIO Student Support Services, TRIO Upward Bound, Military Office, and Academic Support Services. The department offered credit bearing work in reading, writing, and mindfulness. The reading and writing courses are intended for students who demonstrate academic need in those areas based upon placement criteria. The department also offered noncredit bearing courses in mathematics for students not prepared at the level of college algebra or higher.

Entry into the developmental mathematics courses is based upon SAT/ACT scores and/or commercially developed placement test (depending on major). All of the coursework within the department is intended to assist students in developing the academic skills needed for the range of introductory courses that satisfy graduation requirements for either the general education program or the students' major. Although enrollment in many of the courses is determined by placement criteria, students are permitted to self-select any of the courses.

This study focused on the developmental mathematics courses of Introductory Algebra and Intermediate Algebra. Quantitative data for this study were collected in four sections of Introductory Algebra (offered Monday/Wednesday/Friday) and four sections of Intermediate Algebra (offered Tuesday/Thursday) during fall and spring of an academic year. All students enrolled in either Introductory Algebra or Intermediate Algebra were required to attend 2 hours of Math Lab (a peer support environment within the department to assist students in understanding course content) each week until midterm. Students with a grade of B or better in the course at midterm were no longer mandated to attend Math Lab. The courses met either three days per week for 50 minutes or two days per week for 75 minutes. The semesters were 15 weeks long including finals week.

Participants

The researchers used a purposeful sample of students enrolled in the RIs' courses. During the academic year, each RI taught two sections of Introductory Algebra (enrollment capped at 20 students) and two sections of Intermediate Algebra (enrollment capped at 25 students) each semester.

Demographic information on the participants was not collected to determine whether the various sections of the courses were similar since course enrollment for both courses was determined through placement data developed by the institution and applied to all university enrolled students. Because the IRs taught two sections of the same courses each semester offered during the same days and times throughout the data collection period, they selected one section to be designated as the treatment group and one section the control group for each course (see Table 1). Informed consent for the study was handled by a colleague and kept confidential since the researchers were also the course instructors. All informed consent forms were placed in a sealed envelope and not opened until after final grades were assigned for each semester.

Table 1

Course Enrollment

Course	Enrolled Students	Number Withdrawals	No Consent
Introductory Algebra (experimental group)	$N = 67$	$n = 13$	$n = 14$
Intermediate Algebra (experimental group)	$N = 96$	$n = 10$	$n = 12$
Introductory Algebra (control group)	$N = 76$	$n = 7$	$n = 5$
Intermediate Algebra (control group)	$N = 100$	$n = 5$	$n = 4$

Procedures

During the planning phases of the study, the IRs applied for an internal institutional grant to offset costs of the study. The internal grant covered the costs for the duplication of the researcher-designed study plans and the employment of two student workers at minimum wage for both fall and spring semesters. The researchers wanted the weekly study plans to be a tool to assist underprepared students in learning mathematics; however, the IRs did not want the study plans to interfere with class time or course objectives and also did not want to add additional responsibility to their already-packed schedules. Student employees were hired and were responsible for checking completion of both the student-created study plans and the supporting work for the study plans. The student employees signed confidentiality agreements and only had access to the study plans for students in the study.

During the fall semester the researchers provided all students in the treatment groups with spiral-bound planners developed and created by the researchers. Students were required to plan their study activities for individual weeks (Monday–Sunday). Study plans were due in the drop box in the Learning Management System (LMS) by noon of the Friday prior to each week so that students had their plan in place to begin working on Monday. Students were expected to complete the work they planned throughout the week. Since the study plans were structured Monday–Sunday, the supporting work was due the following Monday by noon in the drop box in the LMS. Students were expected to plan two different learning activities each weekday and one learning activity each Saturday and Sunday. Students would be engaging in mathematics daily with this structure.

The IRs instructed the students to begin their study plans by entering the nonnegotiable work for the week (i.e., homework assignments and online videos, if applicable). After the nonnegotiable work was entered, students were encouraged to look at the course calendar for any upcoming quizzes or exams. The researchers recommended that students choose five homework questions for each section on the upcoming quiz or exam and place that in their study plans as a learning activity. If there were no upcoming quizzes or exams students were encouraged to choose five homework questions to review from a section of homework that they had struggled with or had not reviewed recently. Five problems were recommended because the IRs did not want to overwhelm students and thought this number would feel manageable to them. The premise behind this study plan structure was to keep the students reviewing and refreshing mathematical concepts so they could reinforce current learning, relearn what they did not know, and prepare for quizzes and exams.

Some procedural changes were made for experimental sections in the spring semester, which was the second semester of data collection: Rather than submitting the supporting work in the drop box in the LMS, students stapled the supporting work to hard copies of their study plans and turned them in

during the first class of the week (Monday of Monday/Wednesday/Friday classes and Tuesday of Tuesday/Thursday classes). This change was made due to the IRs' finding that evaluating the supporting work electronically on the LMS had been cumbersome.

The two student workers employed each semester to assess the students' study plans and supporting work were required to check study plans for the required elements (homework assignments and review activities). If a study plan lacked any required element, the student employees were required to note that with constructive criticism in the LMS. The student workers also checked the degree to which students were completing the work they had outlined in their individual study plans. The study plans were worth one point each week and the supporting work two points, totaling three points per week. Students either earned all three of the credit points for completion of all elements or none if all of the work was not done. The researchers had assigned this small point value to the study plans and work to encourage students to complete them but not let the study plan grades influence overall course grades and study data. The three points for the study plan were included in the quantitative data used in the data analysis but were found to not influence course grades data.

In an effort to support the students in developing the appropriate skill set, the IRs created the first two weeks' study plans (per the guidelines) to provide a model for students to follow. During week three, the researchers created half the study plan for the week and required the students to finish planning the rest of the week. By week four students were expected to complete their own study plans. The authors were both instructor and researcher throughout the study. The classes, regardless of instructor, were taught using the same curriculum supplemented with Pearson's MyLab Math.

Findings

The purpose of this study was to compare exam grades and overall course grades of students developing and utilizing weekly study plans (experimental group) versus students not developing and utilizing weekly study plans (control group) in developmental mathematics courses. The data revealed that students in the experimental group earned higher average grades across all categories (each exam and overall course grade) when compared to the control group (see Table 2).

An independent samples *t*-test showed statistical significance between the experimental and the control group in the following measures:

- Exam 1 averages between the experimental (M = 77.93, SD = 14.60) and control group (M = 73.10, SD = 12.62); $t(137) = 2.092$, $p = 0.038$
- Exam 2 averages between the experimental (M = 72.66, SD = 17.78) and control group (M = 65.26, SD = 20.53); $t(137) = 2.241$, $p = 0.027$
- Final Exam averages between the experimental (M = 69.37, SD = 23.38) and control group (M = 58.23, SD = 25.76); $t(137) = 2.639$, $p = 0.009$
- Overall Course Grades between the experimental (M = 75.47, SD = 16.84) and control group (M = 66.96, SD = 19.31); $t(137) = 2.731$, $p = 0.007$

Table 2

Comparison of Exam Score Averages Between Experimental and Control Groups

Measure	Experimental Group (N = 62)	Control Group (N = 77)
Exam 1 Average	77.93	73.10
Exam 2 Average	72.66	65.26
Exam 3 Average	67.24	59.43
Exam 4 Average	74.00	66.70
Final Exam Average	69.37	58.23
Overall Course Grade	75.47	66.96

No statistically significant difference was found between the averages for exam 3 and exam 4.

- Exam 3 averages between the experimental (M = 67.24, SD = 23.78) and control group (M = 59.42, SD = 23.47); $t(137) = 1.94$, $p = 0.054$
- Exam 4 averages between the experimental (M = 74.0, SD = 22.41) and control group (M = 66.70, SD = 28.82); $t(137) = 1.635$, $p = 0.104$

Although the study was designed to compare the experimental group to the control group, further analysis of the experimental group indicated different levels of completion across the group. Differences in the percentage of study plans, and supporting work in the experimental group are shown in Table 3.

The researchers wondered if these different levels of participation in the experimental group should be looked at more closely. Were exam scores different at different levels of participation in making and following through with study plans? The data in Table 4 (p. 15) shows a comparison of the averages across all measures for each level of participation.

The students with 100% participation had the highest exam score averages in all measures and for all participation levels. Students who completed most assignments (the $70\% \leq x \leq 99\%$ participation group) had the next highest averages on all measures except exam one. Students who completed fewer assignments (the < 70% group) and the control group scored similarly across all measures.

To determine statistical significance of these differences, researchers conducted a one-way between-subjects ANOVA to compare the effect of creating and utilizing weekly study plans on exam and course grades based upon the different levels of participation outlined in Table 3. The ANOVA revealed that there was a statistically significant effect of study plan usage across all measures:

- Exam 1 average [$F(3, 135) = 3.140$, $p = 0.028$]
- Exam 2 average [$F(3, 135) = 3.703$, $p = 0.013$]
- Exam 3 average [$F(3, 135) = 5.023$, $p = 0.002$]
- Exam 4 average [$F(3, 135) = 2.774$, $p = 0.044$]

Table 3

Participation Levels

Level	N	Description
100% participation	10	These students completed a study plan for each week of the semester.
70% ≤ x ≤ 99% participation	17	These students completed study plans for 10 – 13 weeks during the semester.
< 70% participation	35	These students completed study plans for 1 – 9 weeks during the semester.
No participation	77	These students were in the control group and did not develop and utilize weekly study plans.

Table 4

Comparison of Exam Score Averages Among the Participation Levels

Measure	100% (*N* = 10)	70% ≤ x ≤ 99% (*N* = 17)	< 70% (*N* = 35)	Control (*N* = 77)
Exam 1 average	**86.20**	**74.65**	**77.17**	**73.10**
Exam 2 average	**86.10**	**70.71**	**69.77**	**65.26**
Exam 3 average	**84.90**	**72.88**	**59.46**	**59.43**
Exam 4 average	**89.60**	**76.71**	**68.23**	**66.70**
Final Exam average	**88.00**	**76.00**	**60.83**	**58.23**
Overall Course Grade	**92.80**	**80.76**	**67.94**	66.96

- Final Exam average [F(3, 135) = 6.446, p = 0.000]
- Overall Course Grade [F(3, 135) = 8.899, p = 0.000]

Due to the statistically significant results found via the between-subjects ANOVA, the IRs completed the Games-Howell post hoc test of significance. The Games-Howell post hoc test was selected because it does not rely on equal variances and sample sizes, and is recommended over other post hoc tests such as Tukey's test, which requires equal variances. The post hoc comparisons using the Games-Howell test indicated that there was a significant difference between the groups on the following measures:

- 100% participation versus 70% ≤ x ≤ 99% participation:
  - Exam 2 Average (p = 0.046) mean difference 15.394
  - Overall Course Average (p = 0.008) mean difference 12.035
- 100% participation versus < 70% participation
  - Exam 2 average (p = 0.008) mean difference 16.329
  - Exam 3 average (p = 0.002) mean difference 25.443
  - Exam 4 average (p = 0.001) mean difference 21.371
  - Final Exam average (p = 0.000) mean difference 21.171
  - Overall Course Grade (p = 0.000) mean difference 24.857
- 100% participation versus control group
  - Exam 1 average (p = 0.034) mean difference 13.096
  - Exam 2 average (p = 0.000) mean difference 20.840
  - Exam 3 average (p = 0.001) mean difference 25.471
  - Exam 4 average (p = 0.000) mean difference 22.899
  - Final Exam average (p = 0.000) mean difference 29.766
  - Overall Course Grade (p = 0.000) mean difference 25.839
- 70% ≤ x ≤ 99% participation versus < 70% participation
  - Final Exam average (p = 0.049) mean difference 15.171
  - Overall Course Grade (p = 0.006) mean difference 12.822
- 70% ≤ x ≤ 99% participation versus control group
  - Final Exam average (p = 0.003) mean difference 17.766
  - Overall Course Grade (p = 0.000) mean difference 13.804

The Games-Howell post hoc test did not find any statistically significant differences between the < 70% participation group and the control group across any measures.

Upon further analysis, the IRs noted differences within the experimental group related to the full or partial completion of the weekly study plans. The groups with 100% and 70% ≤ x ≤ 99% participation levels had earned significantly higher overall course grades than did the control group. The students in the 100% and 70% ≤ x ≤ 99% participation groups showed significantly different performance on two measures, the 100% group and the < 70% group differed on five measures, the 100% and the control group differed on all six measures, the 70% ≤ x ≤ 99% and the < 70% group differed on two measures, and the 70% ≤ x ≤ 99% and the control group also differed on two measures. The data show that the larger the difference in the level of participation in the study plans, the more significant difference across measures.

Discussion

In addition to the normal course requirements, students completing the study plans were continually reviewing content and objectives. The study plan requirements asked students to purposefully incorporate reviews for all quizzes and exams. When students were not completing quiz and exam reviews, they were instructed to select previous concepts to review, which was intended to help students to stay current with course content. This review appears to have been beneficial for the students who utilized a weekly study plan: These students earned higher grades across all exams and a higher overall course grade, with statistically significant results on four of the six measures. Students using the weekly study plans were purposeful and directed in their studying efforts. These intentional study efforts may have encouraged organizational and time management skills. In order for students to fulfill the requirements for the study plans, they needed to think about and prepare for their studying efforts for the upcoming week. Once the study plans were designed, they may have helped students to manage their time and incorporate study sessions into their daily routine. Based upon the statistical significance found between the experimental group and the control group, this study found a positive correlation between short-term planning and students' grades, as in Nasrullah and Kahn's (2015) study.

Students in our study who completed the weekly study plan 100% of the time earned higher averages on all measures than students of all other participation levels. It is likely that the students with 100% participation may have had more time and resources to complete the study plans each week. There was no significant difference in exam scores between the <70% and the control group. The lack of statistical significance between the < 70% participation group and the control group may be a result of the low levels of participation in study activity in both groups, which would seem to reflect the same behaviors noted in Hartwig and Dunlosky's study (2012). This interpretation leads us to conclude that students in our developmental mathematics sections need to participate at least 70% of the time to have significantly higher exam and course grades. Results of this study suggest that consistently planning and engaging in study time is an important factor in a student's success.

Students who did not participate at least 70% of the time may have found the study plans stressful and time consuming. Perhaps they felt that the study plans were adding additional work to their already busy schedules. They may also have had difficulty planning a week ahead while keeping up with the work for their other classes as well as any responsibilities that they might have outside their course schedule. Due to the many demands placed on college students, it may have also been challenging to

remember to submit their work as it was in addition to their regular course load. The structure of the weekly study plans required students to be highly organized. They were planning the next week's work while still active in the current week. This juxtaposition may have been confusing for students. Students also had to know when to upload their study plans and supporting work into the LMS, which may have been a confounding factor for some students.

An interesting breakdown occurred between the 70% ≤ x ≤ 99% participation group with both the < 70% and control group. There was significant difference on the final exam and the overall course grade. This finding could be the result of less review and preparation by the < 70% participation group and control group. One condition of the weekly study plans was that students were to be continually reviewing concepts over the course of the semester. Perhaps this constant review contributed to the significance found here. One of the strategies to boost learning is to use distributive practice (Dunlosky, 2013), which the weekly study plan accomplished throughout the semester.

Limitations

This study had a number of limitations. One limitation was that the authors were both course instructors and researchers. Although the students had been informed that no bias would influence their grades within the course, students' participation or nonparticipation may have been a result of their anxiety about how their information would be used. Also, although both instructors followed the course curriculum, this study did not attempt to account for the differences and possible effects of each instructor's teaching style. In addition, the researchers did not conduct between-groups analysis at the beginning of the semester since the students were placed into the courses based upon institutional placement criteria. The university developed placement criteria led the researchers to believe that consistent criteria were used to determine student enrollment into the courses used for the study.

No claim is made for generalizability of the study. This study was undertaken at a four-year public institution in the northeastern United States that has a 76% admission rate. The qualities and characteristics of this institution and department may not be transferable to other higher education settings. Another limitation is the small number of participants: A larger sample over several years would give readers more confidence in the study's findings.

The final limitation of the study may be related to the students' attitude towards being in a developmental math course. They may have been reluctant to apply extra effort in a noncredit bearing course.

Implications for Practice and Future Research

This study provided insight into the usefulness of structured weekly study plans within two developmental math classes. It may be beneficial to examine the structure of designing the next week's study plan while still active within the current week. For those instructors considering incorporating weekly study plans into their own courses, the IRs recommend finding ways to make this approach sustainable for both faculty and students. Cost and assessment are also additive factors as an internal grant was used in this study to pay for the materials (the spiral-bound student planners) as well as to employ the student workers to assess the study plans and supporting work.

It is important to establish the appropriate resources to create the study plans as well as to assess them without adding a significant amount of work to already-busy faculty and student schedules. Faculty may consider encouraging students to complete and submit study plans online and/or allocate time in class to work on their study plans. They may also want to consider incorporating an option for students to revise study plans based on feedback from plan evaluations. Because neither course, Intermediate Algebra or Introductory Algebra, bore credit towards graduation, all but the 10 students in the experimental group who submitted all study plans and supporting materials may have had little motivation to succeed. Students may have strategized their study time to focus on credit-bearing courses if, in their judgement, completing weekly study plans required too much time to apply to a developmental course. A qualitative study inquiring into students' study behaviors and attitudes might reveal information useful for implementation of a study plan component and the interpretation of the quantitative findings of the current inquiry.

The IRs recommend finding ways to make this approach sustainable for both faculty and students.

This study focused only on quantitative data using the evaluation of completed study plans over the course of a semester. Revisions of study plan work were not permitted and data collection was based upon completion of the study plans. Further research could examine the quality of study plan completion and whether revisions would be helpful. Additionally, the incorporation of qualitative data would further inform the study. It would be interesting to find out how students feel about the study plans and if they found them helpful. Did students wait until the end of the week to complete the work? If so, is there a difference between doing a little work each day and completing it all at once?

The IRs also suggest the inclusion of pre- and posttesting to determine if students developed time management or study skills throughout the study. In addition, follow-up research would be beneficial to investigate if the skills learned in creating and utilizing weekly study plans were transferable to promote success in future math courses. Future research should explore the characteristics of this study in courses outside of developmental mathematics, specifically college-level courses such as college algebra, statistics, and calculus as well as other nonmathematical courses. Additional research regarding study plans should further consider their impact in corequisite courses and math pathways.

Conclusion

The students in this study were supported as they transitioned from dependence on the course instructor for the development of study plans to independence in study planning and implementation. This is an important learning outcome in regards to developmental mathematics students, who are often portrayed as dependent learners. This study required students to take ownership of their learning and not rely on the professor alone for guidance. Rather, the weekly study plans nudged learners to engage in daily practice to assist in understanding course content. This practice was designed to incorporate short study sessions daily through the review of five problems per concept.

The study demonstrates that the creation and utilization of weekly study plans helps students achieve higher exam and course grades. The continual planning of study time may also contribute to the development of time management skills as well as organization skills since students are continually planning their study activities a week ahead. However, the findings imply that students need to complete at least 70% of the assigned study behaviors in order to earn significantly higher results. The students who participated at that 70% level or above earned higher exam grades and overall course grades. The greatest impact on student achievement was noted for students who utilized the weekly study plans at 100% completion. This study supports the idea that planning study time has a positive correlation to success in these developmental math courses.

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For Your Information

March **1-4, 2021 –** League for Innovation in the Community College's virtual learning summit 2021. For more information visit https://www.league.org/inn2021

21-24, 2021 – Association for the Coaching and Tutoring Profession (ACTP) 17th Annual Conference. For more information visit https://www.myactp.com/conferences/2021-tampa/

29-April 1, 2021 – Teaching Academic Survival and Success 2021 Annual Conference Convention has been cancelled. For more information visit http://tassconference.org/index.php

May **29-June 1, 2021 –** National Institute for Staff & Organizational Development's (NISOD) Annual Conference on Teaching and Leadership Excellence at the JW Marriott in Austin, Texas. For more information visit https://www.nisod.org/face-to-face/conference/

June **15-18, 2021** National Organization for Student Success (NOSS) annual conference "Bet on Student Success" at the Westgate Resort and Casino in Las Vegas, NV. For more information visit https://thenoss.org/page-18175

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October **6-9, 2021 –** National Academic Advising Association's (NACADA) International Conference at the Duke Energy Center in Cincinnati, OH For more information visit https://nacada.ksu.edu/Events/Annual-Conference/Upcoming-Annual-Conferences.aspx

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