

STAFF SUMMARY SHEET

	TO	ACTION	SIGNATURE (Surname), GRADE AND DATE		TO	ACTION	SIGNATURE (Surname), GRADE AND DATE
1	DFCE	coord	<i>Timothy E. Frank</i> 4/11/2013	6			
2	DFER	approve	<i>Kraus, Col</i> 3/1/13	7			
3	DFCE	action		8			
4				9			
5				10			

SURNAME OF ACTION OFFICER AND GRADE	SYMBOL	PHONE	TYPIST'S INITIALS	SUSPENSE DATE
Frank, O-4	DFCE	333-9118	tef	20130401
SUBJECT Clearance for Material for Public Release				DATE
USAFA-DF-PA- 268				20130415

SUMMARY

1. **PURPOSE.** To provide security and policy review on the document at Tab 1 prior to release to the public.

2. **BACKGROUND.**
 Author: Maj Timothy Frank (DFCE)
 Title: An Experiment with Learning Contracts in Undergraduate Engineering Courses: Impacts on Student Commitment and Academic Performance

Circle one: Abstract Tech Report Journal Article Speech Paper Presentation Poster
 Thesis/Dissertation Book Other: _____

Check all that apply (For Communications Purposes):
 CRADA (Cooperative Research and Development Agreement) exists
 Photo/ Video Opportunities STEM-outreach Related New Invention/ Discovery/ Patent

Description: The authors experimented with learning contracts targeting underperforming students to see how commitment and academic performance is affected. The results show learning contracts can be a low cost, relatively simple means to increase commitment to course-related behaviors as well as student grades. The IRB approved this study.

Release Information: Maj Frank will submit this article for possible publication to the Journal of the Scholarship of Teaching and Learning.

Previous Clearance information: N/A

Recommended Distribution Statement: Distribution A: approved for public release, distribution unlimited

3. **DISCUSSION.** This paper is the result of a Scholarship of Teaching and Learning research project spanning two semesters and involving four instructors and three engineering courses.

4. **RECOMMENDATION.** DFCE and DFER approve for public release.

Timothy E. Frank
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Learning Contracts in Undergraduate Courses: Impacts on Student Behaviors and Academic Performance

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Abstract: This project studied the effect of individualized, voluntary learning contracts for 18 students who performed poorly in the first part of the semester. Contracts were hypothesized to increase commitment and motivation, and lead to changes in behaviors and course performance. Self-reported prioritization and learning-related behaviors (completion of homework and course readings), recorded office hour attendance, and exam performance were compared with low-performing students who had declined the contract offer, low-performing students in a control group, and high-performing students. Students who had signed contracts attended more office hours, were more likely to prioritize homework and reading, and showed a trend for more improvement on exam performance. Ultimately, learning contracts can be a low cost, low effort tool to increase student commitment, boost academic performance, and encourage self-direction.

Keywords: Learning contract, commitment, motivation, self-direction

I. Background.

Halfway through his first semester teaching engineering at the US Air Force Academy, one of the authors noticed his students' grades were well under the course average in comparison to all the other sections of the course. Was it him? Were his students doomed for failure, or could

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something be done to alter their destiny? While, Toncar and Anderson's (2010) study spanning 14 years suggested student performance on the first exam is strongly correlated with and a reliable predictor of overall course performance, he did not want to passively accept that his students would continue to underperform. After some thought and further observation, he realized many of his students were intellectually capable; however, they were college sophomores who may not have yet developed the skillsets of independent, self-directed learners.

Self-directed learners have the ability to learn independently by self-diagnosing their existing comprehension and actively pursuing new information or experience to fill knowledge gaps. In contrast, many novice learners view the learning experience as a one-way knowledge transfer, and it takes time to break the dependence many students have on teachers (Parkhurst, 1922). Thus, one overarching goal for teachers might be to develop their students into self-directed learners. Learning contracts are one method to help develop self-directedness (Knowles, 1973; Mohammed, 2010), even though their use can be strange and awkward at first (Knowles, 1987). They can instill self-discipline to get work done on time, introduce structure to the learning process while being flexible enough to apply to a wide variety of students, and help students start taking charge of their own learning (Knowles, 1980b). For example, Williams and Williams (1999) found that the average student devoted more time to learning and developed better time management skills when they signed a learning contract. Additionally, a sample of counselor education students indicated that learning contracts provided them with opportunities for self-directed learning and fostered greater accountability, responsibility, and commitment (O'Halloran and Delaney, 2011). Contract learning places emphasis on teacher-learner interaction and subject matter in a way that can promote near-term academic success and lasting

self-direction (Mazhindu, 1990). Chyung (2007) found that contracts may also encourage student motivation.

Academic success, self-directedness, and motivation seemed to be lacking in the author's example above, and, thus, learning contracts were implemented in the class. Following an initial positive experience that semester, the authors and some of their colleagues broadened the incorporation of learning contracts to three courses and more systematically investigated whether or not they could encourage self-direction through planting the seed of commitment, generating motivation, and ultimately bolstering academic performance of undergraduate engineering students.

II. Literature Review.

A. Commitment.

It's not uncommon for a student with high potential to underperform in the classroom. With many activities competing for a student's time, success comes with commitment. McKenzie-Mohr (2011) showed that commitment is most likely when the behaviors to which someone is committing are written, made public, and voluntary. Further, Firestone and Rosenblum (1988) suggested five strategies for maximizing commitment: relevance, respect, support, expectations, and influence. Our implementation of learning contracts was expected to support all of these criteria and strategies. Both the student and the instructor signed the contract, thus it was written and public (at least one person other than the student knew about it – the instructor). Students only signed if they wanted to do so; there was no penalty for not signing. The instructor provided relevance of the course material and support to the student to learn it. Mutual student-teacher respect was demonstrated through the process of individually creating and committing to the learning contract. The students each set their expectations for the next exam grade and put it

in writing, and the learning contract overtly empowered them to take control of their learning behaviors to influence their grade. Not fulfilling contract requirements would not only break a self-promise, but would also break a promise the student made to the instructor when they both signed the learning contract. We expected the act of committing to the learning contract had the potential to drive motivation.

B. Motivation.

Motivation has been shown to guide the intensity and persistence of learning behaviors (Ambrose, 2010). Unfortunately, not unlike other school environments, some students in our courses did not want to be enrolled in the targeted engineering courses, and they were clearly not motivated. Some had declared a non-technical major and decided they were not going to apply themselves to an engineering course. Others were comfortable in technical courses, but perhaps the material was uninteresting to them and they decided to put their time and effort into other courses. These unmotivated students were part of this study just like the many students who began with the motivation to work hard at the course material and genuinely wanted to learn and do their best.

We expected learning contracts to be motivational for several reasons. First, learning contracts highlight to students that deliberately performing certain learning tasks under their control such as reading, seeking help from peers, etc. would be likely to lead to academic success, rather than luck or chance, a link which has been shown as crucial to developing self-efficacy (Bandura, 1977; Elbow, 2009). Self-efficacy was made more likely through the customized plan that each learning contract student put together with the instructor. Self-efficacy, or self-confidence, can lead to an intrinsic motivation that can help drive the student to try harder (Bandura, 1977; Pintrich, 1994) and sustain behaviors that have been working for

them (Ambrose, et al., 2010). Self-efficacy is the most influential factor in ensuring a person's success in life (Costa and Kallick, 2004), and the stronger the efficacy expectations, the higher the likelihood of success (Bandura, 1977). Putting something achievable in writing, ensuring that it is clear and customized to the individual, having prior success, and believing success can be achieved again in the future can lead to further motivation for achievement.

Second, motivation will be enhanced in a supportive environment (Ambrose, 2010), which the face-to-face learning contract meeting and personalized contract text help make explicit. For example, Astin (1993) found that peer group interaction and student-faculty interaction are the first and second most positive contributors to self-reported intellectual and personal growth in the college environment. Related to positive interactions, Barlow (1974) found much higher levels of reported student-teacher rapport when learning contracts were implemented than when not. Instructor commitment can reinforce student commitment (Firestone and Rosenblum, 1988), which in turn will further enhance the positive motivational potential. For example, social work education students indicated they “felt bound and obligated by the mutual expectations,” and the learning contract motivated them to complete readings on time (Lemieux, 2001). Ultimately, however, we (instructors in general) hope that students choose to engage in behaviors that enhance learning, not because of a sense of obligation, but because they have internalized the benefits and have become self-directed learners.

C. Self-direction.

As college students, our participants were no longer novice learners, but likewise they did not universally exhibit a deep psychological need to be self-directing, bring resources from previous experience into the learning situation, learn in a life-centered manner, or seem self-motivated to learn, which Knowles (1980a) describes as characteristics of adult learners. Costa and Kallick

(2004) asked, “Are [instructors] preparing students for a life of tests or for the tests of life?” Self-direction is a highly valuable skill that involves the ability to learn independently and possess metacognitive ability. Successful self-direction tends to develop as part of a maturation process when transitioning from adolescent to adult learning (Cross, 1981), but unfortunately, self-directedness does not always come naturally; rather many “students should be shown how to become independent” (Herber and Nelson-Herber, 1987). We viewed most students in our study as being in such a transitional period of developing responsibility for their own learning (Mazhindu, 1990). Because of its combination of academic rigor with a multitude of outside responsibilities and influences, the college environment can offer rich opportunities to help students develop the type of self-direction required in successful adult learners. Of particular interest to the current study given that the learning contracts were used in engineering courses, Bary and Rees (2006) concluded that self-directedness is important to developing successful engineers.

Several behavioral characteristics have been associated with self-directed learning, the identification of which allows developmental efforts to be more targeted, increasing the likelihood of behavioral change (e.g. Buskist, Sikorski, Buckley, & Saville, 2002). For example, when comparing high-achieving high school students to other lower achievers, Zimmerman and Pons (1986) showed 93% of their 80 student subjects could correctly be classified into the high achieving or low achieving group simply by their self-regulation behaviors such as goal-setting, self-evaluating, organizing, seeking information, and seeking social assistance, all signs of self-directed learning. While rather rigid in nature, our learning contracts were designed to develop self-directedness through instilling self-directing behaviors in our students. For example, we explicitly encouraged the students to tap into the potential of peer teaching as well as instructor

mentoring during office hours. Furthermore, our learning contracts encouraged completing assignments and course readings, developing time management and prioritization skills, and using self-evaluating skills to plan productive office hour sessions.

D. Incorporating Learning Contracts.

As summarized above, the existing literature suggests that learning contracts can be a means to get students on a path towards self-direction by increasing commitment and, thus, motivation and performance. With respect to implementation, however, there is a large amount of variance in practice. For example, the content of learning contracts varies widely (e.g. Barlow, 1974; Huff and Johnson, 1998; Williams and Williams, 1999; Chan and Wai-tong, 2000; Lemieux, 2001; Chyung, 2007; Litchfield, et al., 2007; O'Halloran and Delaney, 2011), where students might chose a specific topic to explore, commit to a certain number of assignments and their due dates, or agree to an evaluation procedure and grading rubric. In our case, the topics and quantity of assignments were fixed by the instructor based on course requirements; instead, individualized choice within our contracts focused on the type, timing and frequency of learning behaviors. According to Boak (1998), the use of learning contracts with common texts, tasks, delivery, and assignments is an appropriate application for early undergraduate students, where the learner's level of understanding in the topic is limited.

Implementation of learning contracts can also vary with respect to when a contract is offered, which students are targeted, and whether or not participation is voluntary. Unlike many other learning contract applications (e.g. Huff and Johnson, 1998; Chan and Wai-tong, 2000; Chyung, 2007; Litchfield, et al., 2007), our contracts were not offered at the beginning of the course; rather, they were offered approximately a third to half-way through the semester. By waiting to offer a contract until students had established a grade in the course (usually after the

first exam), students had the opportunity to succeed or fail, and poor performers were targeted as those who needed help and might most greatly benefit from signing a contract. There are many examples of learning contract implementation where all students were required to sign a contract (e.g. Barlow, 1974; Huff and Johnson, 1998; Williams and Williams, 1999; Chan and Wai-tong, 2000; Lemieux 2001; Chyung, 2007; Litchfield, et al., 2007), but because our study focused on learning behaviors, not course components or topics, we only targeted those students who performed poorly during the first part of the semester. Our decision to only target the lower performing students was supported by prior research (Dougherty, 1997; Williams and Williams, 1999; Lewis, 2004). Dougherty found that “interventions” when students performed poorly on organic chemistry exams helped boost academic performance on subsequent exams. We viewed the creation of each learning contract as an intervention, and the contract itself a get-well plan. Williams and Williams found that technology education students who performed at the lower levels gained more from learning contracts than those who performed well from the start. Further, Lewis (2004) had success with learning contracts in a college reading course by offering them only to students who performed poorly on a pre-test. The students in his experimental group significantly increased their scores on the post-test after signing a learning contract. Finally, in order to support the fostering of intrinsic motivation and development of self-efficacy rather than set a punitive tone, we made the signing of contracts voluntary. This voluntary nature was possible because the contract focused on behaviors that were under a students’ voluntary control, rather than aspects of a course structure, which would necessarily need to be determined for each student.

In a sense, learning contracts can be a way to establish a type of guided structure as described by Reeve (2006) in his study of rewards and motivation. He pointed out that,

sometimes, instructors' goals differ from their students, but by creating learning contracts, an instructor can establish conditions to make both the instructor's target behavior (e.g. learning through reading and homework) and the students' target outcome (e.g. a good grade) more likely. Thus, behaviors and outcomes would be mutually beneficial to the instructor and students. Aligned goals like these can lead to "powerful learning" (Ambrose, 2010) and increased self-efficacy.

III. Hypotheses.

Four hypotheses were developed to focus our understanding on how learning contracts might affect students. Because documented commitment can lead to motivation (Barlow, 1974; Boak, 1998), and motivation can encourage behavior (Ambrose, 2010), we hypothesized that signing a learning contract would increase the self-reported practice of course-related learning behaviors (likelihood to complete homework and read before class), and the prioritization given to these behaviors relative to others such as recreational or social activities (both as assessed using a feedback form). We also postulated students who signed a learning contract would be more likely to attend office hours than those who did not (all office hours meetings recorded by instructors). In turn, consistent with prior research (Astin, 1993), we expected they would show greater improvement following the first exam than those who did not sign a contract. Finally, because they had already shown poor performance and they had declined to make a contract commitment, we expected those students who were offered a contract but did not accept would show the least improvement from the first exam to the final.

IV. Method.

A. Participants.

A total of 204 students were enrolled in the participating courses, with a total of 18 signing learning contracts. There were eight students who refused a contract out of the twenty-six who were offered one. Four participating instructors across three courses (Engineering 101, Engineering Mechanics 220, and Civil Engineering 330) divided their students into experimental and control groups. Engineering 101 (ENGR 101) is a freshman-level course mandatory for students of all majors, Engineering Mechanics 220 (EM 220) is a sophomore-level course also mandatory for all students, and Civil Engineering 330 (CE 330) is a junior-level course only required for civil and environmental engineering majors. If an instructor taught two sections, one each was experimental and control. If they only taught one section of a course, alternating students in an alphabetized class roster would be assigned to each group. Instructor judgment on the best way to implement the learning contracts in each particular course led to some variance in whether an individual exam or overall course average at some point in the semester was used as the contract discriminator; regardless of the specific discriminator, the threshold of 75% was determined to be appropriate across all the courses. This threshold gave us a reasonable number of students to target, while also avoiding the students whose grades were high enough that they would be unlikely to need or be receptive to the idea of a contract. Table 1 shows the number of students enrolled with each instructor, the number that signed contracts, and the discriminator for each course section.

Table 1. Students and courses involved in the study.

Course	Term	Instructor/ No. Sections	Total No. Students/ No. Offered Contract/ No. Signed Contract	Contract Discriminator
ENGR 101	Spring 2011	A/1	26 / 2 / 2	Course avg at lesson 32 of 40 less than 75%
ENGR 101	Fall 2011	B/2	47 / 6 / 2	Exam 1 (on lesson 17 of 40) less than 75%

ENGR 101	Fall 2011	C/2	44 / 2 / 0	Course avg at lesson 20 of 40 less than 75%
EM 220	Spring 2011	C/1	24 / 3 / 2	Exam 1 (on lesson 13 of 40) less than 75%
CE 330	Spring 2011	D/2	36 / 11 / 10	Exam 1 (on lesson 12 of 40) less than 75%
CE 330	Spring 2011	B/2	27 / 2 / 2	Exam 1 (on lesson 12 of 40) less than 75%

B. Materials.

Two forms were central to the study: the learning contract and the in-class feedback form. The first part of the contract incorporated several items based on previously identified best practices. The first sentence began with an admission that the student currently was not performing well and concluded with a statement that the student was willing to put in more time and effort to perform better. This admission required internal reflection as well as honesty and humility, similar to taking stock of “where they are at” as described by Malkin (1994) in the context of learning contracts in nursing school. The blunt admission statement was intended to ensure the student was aware of and prepared to face the problem, the first step to fixing it. The second part of the sentence was where the student voluntarily decided and explicitly committed to actively doing something to solve the problem as opposed to passively hoping the problem solved itself.

The following three sentences included explicit statements of behaviors that the student would agree to perform in his/her effort to improve in the course. These statements emphasized the individual effort and the self-directed components of being academically successful. First, the contract required the students to commit to completing all assignments and readings. While it might be obvious to the students that completing assignments would help learning and their course grade, for many college students, the benefit of completing the readings often seems less clear (Hobson, 2004). However, we believe that reading is essential for the independent learner

(Herber and Nelson-Herber, 1987), and hoped to help build good learning habits in the contract students.

The second explicit behavior included was that the student would ask others for help as necessary. This part of the contract did not specify who the “others” were. They could be classmates, other students, or the instructor. Many of our students have been successful in the past without seeking help from others, and they may view asking others for help as a sign of incompetence, or they simply have not made it part of their learning practice. The third explicit learning behavior included in the contract was that the student would come for office hours at a frequency of their choosing (they filled in a blank indicating their intended rate). The emphasis on interacting with others as part of their learning behaviors was based on evidence from peer learning as well as Herber and Herber-Nelson’s (1987) claim that having students “share their understanding of concepts” can become a motivational activity leading toward greater student independence. The paragraph closed with an explanation of the purpose of the behaviors, which was to ensure that the students “understand the concepts and have the chance to ask questions or get help with homework.”

Not only was student commitment a key component of the contract, but so was instructor commitment. We believed that the student needed to know he or she was not alone in the learning process, and thus, the contract emphasized the responsibilities of both parties in the student-teacher relationship. Using an explicit statement, the instructor committed to be available for the amount of time requested by the student “so that the material is learned.” This explicit focus on the instructor supporting the student’s learning completed a dual requirement identified by Firestone et al. (1987); they concluded that both a commitment to a student and to the role of teaching were necessary for effective learning to occur.

Finally, the contract specified that it would expire when two conditions were met: 1) the student achieved his or her personal goal for the subsequent exam, which they explicitly indicated on the contract *—and—* 2) the student informed the instructor he or she would like to terminate it. It was important to help guide the students in setting a challenging, but attainable goal based on their current course grade and how many more assignments were left in the semester. Our learning contracts were customized to each student based on their individualized course goals, and each contract prescribed a set of student and instructor responsibilities required to be successful. This practice follows Codde's (2006) guidelines that stated learning contracts should be individualized, include what is to be learned, how it will be learned, and how it will be verified. The second condition reinforced both that the student was in control of the contract and that the commitment would be ongoing until the contract was actively cancelled. At the bottom of the contract were spaces to indicate the date and for both the student and the instructor to sign.

The in-class feedback form contained questions that asked students to self-report behaviors that occurred within designated segments of the course. The pre-semester form was worded in future tense and asked about intentions for the upcoming semester. It was shorter in that it did not ask any questions that made reference to being offered or signing a learning contract. The five questions on the short form asked students to report their completion of homework assignments (which were not graded in all courses) and reading assignments (indicate number fully and partially completed for each), rate their likelihood to prioritize two types of learning behaviors (time to complete readings and homework, time to attend office hours) using a 5-point scale (never, rarely, occasionally, frequently, always), and finally, indicate whether or not it was important for them to do well in the class (no, somewhat, yes). No identifying information (name, code number, etc.) was requested on the forms. The form used at mid- and

end-of-semester included two additional questions that asked students to identify whether or not they had been offered and accepted a learning contract. The questions on this form were worded so that students only reported behaviors that had occurred since the previous feedback form was collected.

C. Procedures

Each instructor treated all students in their courses the same; they were taught the same material through the same methods and given the same assignments. At the beginning of the semester, before each exam, and on the last day of class, all students were given the in-class feedback forms. Students kept their completed forms so that they could be turned in as a bundle on the last day of class. This was done so that we could link data across the semester without asking for names or other identifying information. Prior to the time when learning contracts were offered to those students meeting the criteria given above, the short version of the feedback form was used. Following the offering of contracts, all questions were included on the feedback forms.

Following the first exam (or at the time indicated above in Table 1), students in the experimental group who earned less than a 75% were asked via email to attend a one-on-one meeting with the instructor to discuss how they were doing in the class. The meeting provided the instructor an opportunity to get to know each student and learn why each of them thought they were struggling in the course. During the meeting, the instructor introduced the concept of a learning contract and offered to develop a customized one with the student at that time. According to Barbour and Czarnecki (1973), a one-on-one student-teacher discussion is the key to a successful contract. In our study, this one-on-one meeting facilitated both “priming” and a “needs analysis” as described by Boak (1998). Priming involves a clear explanation of what a learning contract is and how it would be used, while the needs analysis customizes the contract

and its specific terms and goals. Once both the instructor and student signed the contract, the student kept the original, the instructor a copy, and the contract was complete. On average, the initial meetings lasted 15 minutes. Students in the control group were not offered learning contracts; however, they were afforded the same instructor availability and access to peer and instructor assistance.

At no time during the semester did any instructor encourage or discourage the students to follow the learning contracts. Complete onus was on the student to come in for office hours and there was no explicit penalty for not following the terms of the contract or reward for following it. Office hours lasted anywhere from five minutes to an hour depending on student need. The instructors remained available to all contract eligible students regardless of whether they signed or denied the contract and regardless of how closely they followed it. Throughout the semester, instructors tracked how frequently all students attended office hours, and recorded first and final exam scores for analysis.

V. Results

None of the eighteen students on contract chose to terminate their contract during the course of the semester. Overall, we had three types of data: self-report data from the feedback forms, recorded office hour attendance from the instructors, and grades on the exams. Because the feedback forms were anonymous, only two groups were compared: those on contract and those not on contract within the experimental group. Note that “those not on contract” included students with low scores who declined to sign a contract as well as those who scored high enough to not be offered a contract. These two groups were not distinguishable due to the wording on the feedback form that simply asked whether or not students were on a contract. Further, because many students lost the feedback forms they completed earlier in the semester,

only the feedback forms from the last day of class were analysed. Additionally, one of the instructors neglected to hand out the final feedback form (ENGR 101, Spring 2011). Ultimately, we received 15 feedback forms from the “on contract” group and 50 from the “not on contract” group. Finally, we know at least one student mis-categorized his/her status as being on contract because three students indicated “on contract” responses in one particular section when only two students in that section actually signed a contract. There is no way to determine which of those three hadn’t signed a contract in order to re-categorize it, but it seems that at least in his/her mind, a contract existed, which may be the crucial aspect, i.e. a state of mind based on commitment to perceived expectations. Thus, rather than discarding all three, we kept all three in the learning contract data group.

A. Self-reported Completion of Assignments and Time Prioritization.

As expected, more of the students on contract reported completing all of the assigned homework during the final segment of the course than those not on contract (98% to 91%, respectively), while more students not on contract reported completing some or no homework. (See Figure 1a.)

A 2-factor Chi Square analysis indicated a marginally significant difference $X^2(2)=5.6, p=.06$.

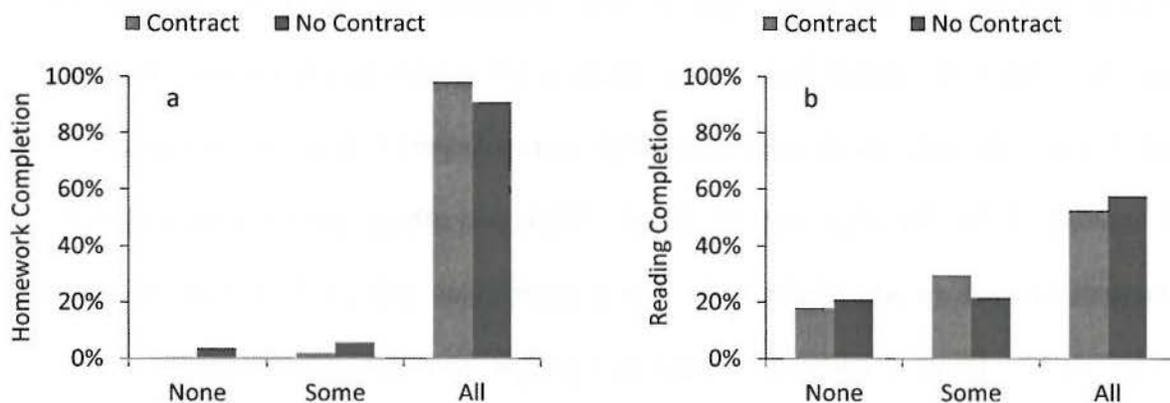


Figure 1. a) Self-reported percentage homework completion during final segment of course.

b) Self-reported percentage reading assignment completion during final segment of course.

The results are less compelling with respect to self-reported reading behaviors, which may support the above presupposition that the value of homework completion and reading completion are viewed differently by students. More specifically, those not on contract reported greater likelihoods to both complete all the assigned readings or none of the readings, while those on contract were more likely to complete some of the readings. (See Figure 1b.) One explanation for this is that the group not on contract included the students who scored well on first exam as well as those who performed poorly but declined to sign a contract. Those who scored well might have already had well-developed learning and study behaviors, which contributed to the relatively high percentage of students not on contract who reported completing all of the reading assignments. Meanwhile, those who declined the contracts might be least likely to complete the assigned readings; their poor performance suggests poor learning behaviors, and they did not commit to changing their behaviors. A 2-factor Chi Square analysis indicated no difference $X^2(2)=2.0, p=.43$.

An examination of the feedback form responses to questions about time-prioritization indicated that students on contract more often prioritized time for homework and reading, and for office hours than those not on contract. As shown in Figure 2a, 86.7% of students on contract responded that they either “frequently” or “always” prioritized time for homework and reading compared to 62.0% not on contract. A 2-factor Chi Square analysis indicated a significant difference $X^2(3)=23.6, p<.0001$. Figure 2b indicates similar time prioritization for attending office hours; 60.0% of students on contract responded that they either “frequently” or “always” prioritized time for office hours versus 42.0% of those not on contract. A 2-factor Chi Square analysis indicated a significant difference $X^2(4)=21.5, p<.001$. The statistical mode for students on contract was that they frequently prioritized time for both of these course related behaviors,

while the mode for students not on contract was to occasionally prioritize time for both of these course related behaviors.

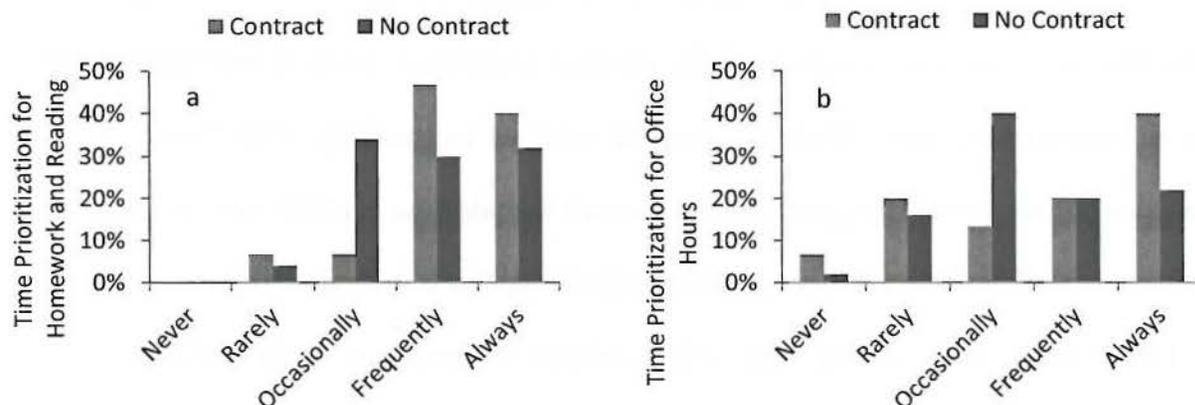


Figure 2. a) Self-reported time prioritization for homework and reading during the final segment of the course. b) Self-reported time prioritization for office hours during the final segment of the course.

B. Attendance at Office Hours

Due to the anonymity in the feedback forms, office hours attendance was the most effective way to determine how closely students followed their learning contracts. “Success of contract learning depends on the student’s own enthusiasm and commitment to the agreement” (Mazhindu, 1990, p.106). Only one of the eighteen students who signed a contract came according to their prescribed contract frequency. With such a small sample size, however, we could not statistically determine whether those who more closely followed their contract performed better academically than those who followed the contract less closely. Thus, we grouped all contract students together and compared them to the other groups. For these data, we categorized students into four groups: those who performed below 75% and who did sign a contract (On Contract), those who performed below 75% but declined a contract (Declined

Contract), those who performed below 75% but were not offered a contract (Control Group Low Performers), and those who performed above 75% (High Scorers; combined from both the control group and the experimental group). Table 2 summarizes the office hours attendance for the four groups throughout the entire semester.

As expected based on both our initial prediction and the self-reported data above, students on contract more often met with their instructor during office hours. Overall, students on contract averaged 4.5 office hour sessions per semester, while the other groups averaged less than one visit per student. Especially notable is the fact that, among those who declined a contract, there were no office hour visits. Maybe they were embarrassed they declined the contract or maybe they felt like they were not welcome back in the instructor’s office. Or, since most students not on contract did not attend many office hour sessions, those eight students are no different from the others not on contract.

Table 2. Office hour sessions comparison between groups throughout the entire semester.

Group	No. Students	No. Office Hour Sessions	Avg. No. of Sessions per Student
On Contract	18	81	4.5
Declined Contract	8	0	0.00
Control Group Low Performers	26	20	0.77
High Scorers	152	70	0.46

In order to test for group differences, we performed a 3-level, single-factor ANOVA using each of the six participating sections as the “participants” in the analysis, so that each section contributed an average number of office hour sessions per student for each of the four student groups. There was a significant difference in the average number of office hour sessions across the four groups, $F(3, 20) = 16.69, p < .0001$. A Tukey HSD post Hoc analysis indicated that the On Contract group attended significantly more ($p < .01$) sessions than the other three

groups, and that the other three groups were not significantly different in their rates of attendance. This suggests the On Contract students were more self-motivated and willing to seek out assistance than their peers.

C. Grades.

For the purposes of analyzing grades, the participating students were grouped into the same four categories used above when analyzing the number of office hour sessions: On Contract, Declined Contract, Control Group Low Performers, and High Scorers. We calculated the mean raw improvement from the first exam (or appropriate discriminator) to the final exam for each of the four groups and conducted statistical analyses. See Table 3 for averages for all four groups.

Table 3. Grade improvement comparisons.

Group	Exam 1 (or discriminator) Avg.	Final Exam Avg.	Raw Improvement from Exam 1 to Final (positive number is good)	No. Students
On Contract	64.0%	71.2%	+7.2	18
Declined Contract	72.4%	76.7%	+4.3	8
Control Group Low Performers	67.5%	69.9%	+2.4	26
High Scorers	85.8%	80.7%	-5.1	152

Perhaps the most prominent observation is that the On Contract group improved 7.2 percentage points from the first exam to the final, starting lower and finishing higher than the Control Group Low Performers, who improved 2.4 percentage points. This supports our hypothesis that those who sign a contract would show greater improvement following the first exam than those who did not sign a contract. A 4-level, single-factor ANOVA showed a significant effect, $F(3,203)=10.42$, $p<.0001$. However, the only significant differences shown using the Tukey HSD post hoc were between those on not on contract due to high performance and both those on contract and those who declined the contract. In other words, there was no

significant difference in the amount of change from exam 1 to the final between the low scorer control group and those on contract. However, fourteen of eighteen students (78%) on contract improved their grade while only sixteen of twenty six (62%) in the low scorers control group improved; these data suggest improvement at a 74% confidence interval using the sign test.

Contrary to our final hypothesis, the Declined Contract group did not show the least improvement from exam 1 through the final. The data in Table 3 also hint at why the eight students who declined the contract might have made that decision. While they were below the 75% performance threshold, their Exam 1 grades were significantly higher than those who did choose to sign the contract, $t(24)=-2.24$, $p=.01$ (using a t-test for unequal variances). We also acknowledge that some of the change that occurred between exam 1 and the final for all groups might reflect regression to the mean, with low scorers improving on average and high scorers showing an average decline. However, the pattern of significant group differences (e.g. those on contract different from high scorers, but those in the control group not different from high scorers) suggests that regression to the mean does not fully explain the data trends observed.

VI. Implications and Conclusions.

While the learning contracts only showed grade improvement at a 74% confidence interval, which may not be as high as typical statistically significant findings, for an implementation that is low cost, the potential is great, especially when combined with the highly significant shift in learning-related behaviors (e.g. homework completion, prioritization, attendance at office hours). These behaviors precede the actual performance increases, so with only about two months of time under contract, the grade shift may not have been fully realized within the bounds of the single semester. Despite the relatively short amount of time students were on contract in this study, the notion that the first test is a predictor of the final grade (Toncar and Anderson, 2010) need not necessarily be a student's destiny if an intervention such as a learning contract is used.

At the core of the learning contract is a plan to accomplish a goal via specific behaviors. The results of this study indicate a relationship between commitment, motivation, positive decision making, taking action, and achievement. Research as noted earlier (e.g. Bandura, 1977; Pintrich, 1994) suggests achievement leads to increased self-efficacy. Therefore, we propose the student self-direction cycle as shown in Figure 3.

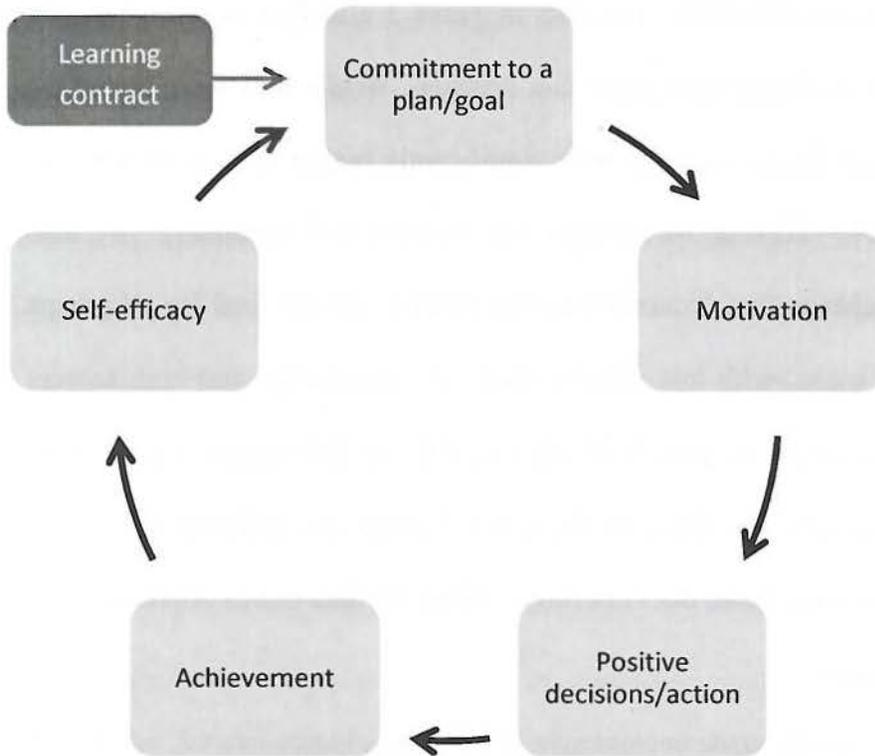


Figure 3. Student self-direction cycle.

While other sources of motivation besides commitment and other drivers for positive decisions exist, we suggest the above figure describes an important cycle that pertains to students' learning behaviors. Learning contracts were successful in providing an onramp to the self-direction cycle by acting as an avenue to commit to something. The commitment led to increased motivation, which helped students decide to practice course-related behaviors. The course-related behaviors outlined in the learning contract drove increased academic achievement.

Self-efficacy can increase as performance increases, and the learning cycle can spiral all over again, channelling novice learners into self-directed adult learners.

Although our data support the benefits of incorporating a learning contract, there are many possible aspects of the learning contract process that could have mediated the observed benefits. First, the face to face meeting to create the contract might have helped establish rapport and create a supportive environment for effective learning. But, this initial supportive social exchange does not seem to be the crucial component, because those who declined a contract did not return for any office hours and they showed less (though non-significantly different) increase in grades than those on contract.

A second possibility is that solidifying the commitment on paper may have been the difference between good intentions and deliberate action, and could have been a motivator itself. The act of signing a contract was clearly important because those on contract outperformed the other three groups in grade improvement (though not significantly in every case). Further, while almost one hundred percent of all students in the participating courses indicated on their end-of-semester feedback form that it was important for them to do well in the class, only those who signed learning contracts indicated they were more likely to prioritize time for course-related tasks like reading, homework, and office hours than the control group. They also took the time to follow through with their commitment and attend office hours. Therefore, we suggest the benefits of a learning contract are at least somewhat linked to the act of signing.

How much follow-through, and on which components (e.g. reading or meeting with instructor), is enough to yield improvement in course performance? Because our contract group sample size was relatively small, no relationship could be determined between how well students followed the contracts and their changes in behavior and grades. Anecdotally, the only student

who completely followed her learning contract with respect to office hour meetings did not improve her grade; thus complete follow-through with respect to that component is certainly not a guarantee of academic success. Though not a unanimous conclusion from the body of literature, some previous research suggests hours spent studying is positively related to academic outcomes including graduating with honors, standardized test scores, and self-reported increases in cognitive and affective skills (Astin, 1993). Thus, some of the other learning behaviors targeted in the contracts may be more important than meeting with the instructor. Perhaps as the semester progressed, students better learned what they needed to be successful, and thus, deviated from the contract. For example, they might have realized that if they read more regularly, they did not need to attend as many office hours meetings as they first believed when they created the contract. An area of further research could be to study how the extent to which a learning contract is followed affects behavior change and grade improvement.

Another question stemming from this project is: What student and course characteristics might impact the benefits from learning contracts? Although not a focus of our implementation, because we incorporated learning contracts in a variety of courses, we were able to observe that student class year combined with some basic course characteristics influenced the likelihood to sign a contract. Students in the freshman level course (ENGR 101) were more likely to refuse to sign a learning contract when compared to the sophomore (EM 220) and junior (CE 330) level students; four of ten in ENGR 101 signed, two of three in EM 220 signed, and twelve of thirteen in CE 330 signed. About half of the assignments in the freshman-level course were group projects, whereas group projects represented a smaller percentage of the grade in the sophomore level course and none of the grade in the junior level course. It is impossible to determine whether the academic maturity of the student (class year) or the course characteristic (more

individual or group work) was more influential in the rate of contract signing, but it would be of interest to examine in future studies. A better understanding of these factors would allow instructors to estimate the possible benefit of learning contracts when considering to implement them. Additionally, subsequent research might want to explore the ways learning contracts could be effectively used for groups of students who are working together on projects. To date, the learning contracts research is focused on individual impact.

Another important question to systematically address is how to best incorporate learning contracts across courses and over time in a student's academic career. For example, without prodding, one student in this study asked an instructor the following semester to establish a learning contract on the first day of class. This request was promising in the sense that he recognized the contract was successful, self-identified what he thought he needed to be successful again, and exhibited metacognitive awareness in doing so. However, it is unlikely that the same contract would yield the same benefits given his already accomplished gains in self-regulation and learning behaviors from the previous semester. Rather, as a student matures into an adult learner, the amount of structure and the types of behaviors addressed in the contract should shift, ultimately leading the student to become self-directed learners who don't need contracts. This line of thought supports the research (Anderson, et al., 1996; Barlow, 1974; Chan and Wai-tong, 1999; Williams and Williams, 1999)) that contract individualization is critical to ensure the learning contract matches student need, because students in our courses will be at different levels of development with respect to self-directed learning. Further, as the student transitions into an adult learner, the learning contract could allow for more freedom of choice (e.g. Barlow, 1974 and Litchfield, 2007), coupling an increase in commitment with the benefits of increased intrinsic motivation.

In sum, much has been learned about the potential benefits of incorporating learning contracts, but much is yet to be determined. Overall, our results show that learning contracts are a low cost, low effort tool that can increase student commitment, promote learning-related behaviors, and boost academic performance. We recommend that instructors consider using this tool in their courses where they sense student motivation and commitment might be lower than desired or when academic performance is poor.

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