

## **The Success of Three-Attempt Testing on Students Learning Outcomes Despite the Deliverance by Different Faculty in an Engineering Course: Dynamics**

**Dr. Marino Nader, University of Central Florida**

Dr. Marino Nader is an Associate lecturer in the Mechanical and Aerospace Engineering Department at the University of Central Florida and has been working on digitizing courses and exams, creating different course modalities. Dr. Nader obtained his B.Eng., M.Eng. and Ph.D. from McGill University. His Ph.D. was done in conjunction with the Canadian Space Agency where he spent two years doing research and experiments. Upon completion of his Ph.D. he began working in the Aerospace Industry where he spent over 10 years as a Stress Analyst/Consultant. At present he enjoys working on Distributed Electric Propulsion (DEP) with his students, designing, analyzing, constructing and flying Unmanned Aerial Vehicles. Dr. Nader won a few awards in the past few years, among these are the College of Engineering Award of Excellence in Undergraduate Teaching (2023), Excellence in Faculty Academic Advising for the Department of Mechanical Engineering (2020). In addition, he is also a Co-PI on the NSF-supported HSI Implementation and Evaluation Project: Enhancing Student Success in Engineering Curriculum through Active e-Learning and High Impact Teaching Practices (ESSEnCe).

Dr. Fu is an assistant professor in the Mechanical and Aerospace Engineering department and Biionix cluster at UCF. He received his PhD from Arizona State University, MS from University at Buffalo, and BS from Tsinghua University. Dr. Fu's laboratory focuses on the neural control of human upper extremities using interdisciplinary approaches such as robotics, virtual reality, and neural imaging. His research on human manual dexterity has broad applications in brain-machine interfaces, neurorehabilitation, and assistive devices.

# **The Success of Three-Attempt Testing on Students Learning Outcomes Despite the Deliverance by Different Faculty in an Engineering Course: Dynamics**

**Marino Nader, Qiushi Fu**

Department of Mechanical and Aerospace Engineering, and  
University of Central Florida, Orlando, FL 32816-2362

## **Abstract**

It seems that multiple-attempt testing has its effects and benefits on students learning outcomes from the perspective of those who designed their courses in that fashion. However, the question remains whether it works with some other instructors for the same course design. The Spring 2022 *Dynamics* class of 157 students involved in this study, was given in class once a week in blended M-mode by a different instructor than the one who originally designed it, with minor changes. Three attempts, with randomized questions were given for each of the three tests performed remotely using LockDown Browser, Proctor Hub and Respondus monitor to maintain testing integrity. All attempts were performed digitally within a week using CANVAS Learning Management System (LMS), each attempt was instantly graded, and the results were immediately released for the students to seek help, where needed.

An increase in students' success improved with a minimum of 56% between the first and the third attempts. However, the overall success average students' success is 143%. This reflects higher students' learning outcomes. The three attempt testing decreases students' anxiety and prepares the students for a motivating scaffolded learning process with less stress than traditional methods. When comparing Spring semesters, 2022 to Spring 2021 delivered in class as Mixed mode and Virtually during COVID-19, respectively, the general trend of incremental improvement was consistent for all three attempts, be it in the number of students succeeding or the overall class average. Students were asked in class of their preference; they were all accord that the three-attempt testing was more agreeable than the one-attempt class test.

## **Keywords**

LockDown Browser, CANVAS, three-attempt tests, multiple testing, higher students' success.

## **Introduction**

Although the concept of multiple attempts homework may not be new as per K. K. Archer [1], its effect is emerging to be more robust in steering the students to higher grade achievement when used during higher-stake tests. Unfortunately, there are many students who lack learning skills, others lack the talent of tackling tests and exams. The latter, therefore, does not reflect students' knowledge about the course. Moreover, instead of working on their assignments sincerely, some students resume to cheating to meet their deadlines. These assignments should be used to practice with, to learn, grow and prepare for tests, these students seek fast resolution of quick assignments

submission by using Chegg [2] and the like, which in turn serve as cheating rather than learning mechanisms. Cheating as described by M. M. Lanier [3], A. Fask et al.[4] and P. Charlesworth et al.[5] can lead to grade inflation and integrity issues that may plague the education institution with an indignant reputation no one desires. To motivate the students and increase their grades and *knowledge*, G. Herman [6] suggests giving the students a second attempt to help them improve both. The concern was exacerbated by COVID-19 when the students were demotivated, as described by Y. Terada [7].

Accordingly, Nader & DeMara [8] studied the effect of the three-attempt testing a year earlier, in Spring 2021 and recognized the multiple positive effects of the methodology. One of these is that students were motivated with every attempt to do well, hoping for a better grade in the next one. The students then *learned by repetition* which resulted in higher retention as in Arora et al. [9]. More benefits of this procedure will be discussed later. The question remains what happens if we change the instructor? Could this process still bring about similar positive results? We note here it is the same subject: *Dynamics*, a very similar course but with few minor changes.

### Course Delivery

The course is almost a replica of that given in Nader & DeMara [8] with two main changes: a different instructor and in-class delivery, as opposed to virtual delivery. The course under study was delivered in class as M-mode, i.e. students did some work before coming to class. Among the work was LearnSmart (LS) assignments, but the video HW was optional in this course, and it is assumed the students ignored them before coming to class due to lack of incentive to watch them. The after-class assignments were the regular long and rigorous ones expected in every traditional Dynamics course. All of the course material was based on the McGraw Hill text authored by P.J. Cornwell et al. [9]. The assignments were due a day or two before each test and the solutions were out for the students to review their material before they started the tests. Each test was comprised of 10 randomized problems out of questions' pools totaling 250 problems per test to mitigate cheating as in C.J. Lee [11]. In addition, each test was conducted in 90 minutes, using Respondus Monitor, Proctor Hub and LockDown Browser to ensure testing integrity.

After each attempt, students were allowed to see their Teaching Assistants (TA), to take a look at their tests to learn from each try in getting ready for another attempt, in order for them to succeed higher. On average, the TA would take less than 10 minutes with each student to review the test. The first two tests were run similarly to those in Nader & DeMara [8]. The third test was also similar except where minor changes were made to decrease the material proportion of the 3D-dynamics. All the tests had various question forms such as multiple-choice questions, True/False, numerical answers, multiple drop-down, ... etc., in accordance with T. Tian & R. F. DeMara [12]. The variation in the question types was done to ensure complete material examination and to avoid bias testing where some students get questions about certain topics and others do not. In this manner all students get questions based on the entire material they were to prepare for, without leaving anything out. Once a student completed an attempt, Canvas LMS immediately graded it using Computer-Based Assessment (CBA) as described in Nader & DeMara [8].

**Spring 2022 Results**

Figure 1 depicts the results of the percentage success for every new attempt. Success in this context is the number of students who obtained greater than 70% in each attempt. If we assume that students would take only one attempt, i.e. the first attempt (A1), then only 27% would succeed in Test 1 (T1), but as seen by A3, 47% of students succeeded in this same test. Similar comparison can be done with T2 and T3 where we realize a continuous success and an increase in improvement. Yet, one must realize that the overall success for T1, for example is still higher than 47%, for not all students continued to try T1 till the last attempt. The percentage participation is also shown to continuously decrease as the students were satisfied with their grades. Those who could not score well, persevered till the last attempt trying harder to pass. So then, what is the improvement or achievement in this endeavor? Why pursue it?

Percentage Students' Success	T1			T2			T3		
	A1	A2	A3	A1	A2	A3	A1	A2	A3
	27%	46%	46%	26%	45%	48%	24%	29%	37%
Percentage Participation	100%	82%	48%	100%	88%	54%	100%	73%	44%

Figure 1: Increase in Percentage of Students' Success (Spring 2022)

Improvement Success First to Third Attempt	T1	T2	T3	Average
	74%	82%	56%	70%

Figure 2: Percentage Increase in Success Between the First and the Third Attempts (within Excel Approximations)

Figure 2 shows the improvement percentage success for T1 to be 74%, 82% for T2, but only 56% in T3. T3's improvement is nonetheless, relatively lower because a lot of students realized they passed the course by the first attempt of T3, or got the grade they sought and were satisfied that they did not continue to improve their grade anymore. Also, some students worked, others had other courses/tests to care for. This comparison only shows the first to the last attempt, in a way to show the progressive grade amelioration with the percentage participation, but the overall success per test was still higher. The reason behind this is, say a student did worse in his/her last attempt, the better of the first two was chosen, i.e. the maximum out of three attempts is considered in each test. This is depicted by the last row of Figure 3, with the least overall improvement occurring in T3 was 113% and an average improvement in students' success of 143% for all three tests. In other words, Figure 3, shows the comparison between the first attempt and the best for all three attempts for T1, similarly for T2 and T3.

T1			T2			T3		
A1	Best of 3	Overall Improvement	A1	Best of 3	Overall Improvement	A1	Best of 3	Overall Improvement
27%	68%	154%	26%	69%	161%	24%	50%	113%

Figure 3: Improvement Success between the First Attempt to the overall success in each attempt

### Results' Comparisons

Figure 1 (Spring 2022) is compared to Figure 4 (Spring 2021), which was developed and delivered by the original course instructor. We see a similar constant improvement trend for students' success for each attempt, as well as a decrease in students' percentage participation.

Percentage Students' Success	T1			T2			T3		
	A1	A2	A3	A1	A2	A3	A1	A2	A3
	17%	25%	39%	19%	36%	52%	15%	27%	32%
Percentage Participation	100%	89%	71%	100%	87%	66%	100%	76%	44%

Figure 4: Increase in Percentage of Students' Success (Spring 2021)

For convenience, Figure 5 contains rearranged data for Spring 2022 to compare to the results obtained in Spring 2021 by the original course designer as in Figure 6 [8]. Both of these figures depict the class average for every attempt and not the students' success as in Figures 1 and 4.

Test	Attempt 1	Attempt 2	Attempt 3	Percentage Improvement
T1	53%	66%	67%	25%
T2	52%	64%	65%	24%
T3	51%	60%	61%	19%
<b>Class average</b>	<b>52%</b>	<b>63%</b>	<b>64%</b>	<b>23%</b>

Figure 5: Class Average Using Three-Attempt Tests (Spring 2022)

Test	Attempt 1	Attempt 2	Attempt 3	Percentage Improvement
T1	47%	56%	62%	31%
T2	45%	58%	68%	50%
T3	50%	59%	60%	21%
<b>Class average</b>	<b>48%</b>	<b>58%</b>	<b>64%</b>	<b>34%</b>

Figure 6: Class Average Using Three-Attempt Tests (Spring 2021) [8].

Again, the trends are very similar of persistent upward trend of class average and the values are close as well, perhaps except for the improvement in T2, although the average test results are close in values.

### Discussion and Conclusion

It seems that with the new condition of a different instructor and a few changes, the method kept its strength and effectiveness. A few reasons why it works constructively, is that the students do not have the anxiety they have with only one attempt for each test. They comfortably know they have other chances, even if they fail the first or even the second attempt. They tend to be motivated by the scaffolding this method brings about with each attempt as per L. A. Fish [13]. The tease of “perhaps this problem will come again in my next attempt” makes them re-study and seek help from their TAs or even investigate the available videos to learn from similar problems. The repetition of solving problems before every attempt enhances and retains knowledge, a method students realized to be fruitful in their learning and a technique they appear to adopt for future courses. Another advantage why students like it is that the students prefer to repeat the test than the entire course.

The average percentage success augmentation between the first and the third attempts for all three tests was 70% (Figure 2). The least of these occurs in T3, was 56% which is still significant. Moreover, the comparison results of Figures 1 and 4 as well as Figures 5 and 6 show similar trends of continuous increase and improvement in students' successes and averages, respectively. In view of the authors, this is an effective method regardless of who teaches the course. With their knowledge, the students will be more ready for upper classes and will take this training of learning by repetition with them to other courses and upper classes. The students agreed in class that they preferred the three-attempt testing to the paper-based one-attempt testing for this course, which paralleled and supported the excerpt survey in the Appendix from Nader & DeMara [8].

Appendix A [8]

Statement	Strongly Agreed	Agreed
Helped me take the test with less stress, knowing I have other chances.	85%	13%
Allowed me to go back to learn the material better before my next attempt, given a week-time for all 3 attempts.	82%	15%
It gave me the opportunity to know where I stand, before my next attempt.	80%	15%
It gave me the chance to recognize how much more I should learn before my next attempt.	80%	16%
It gave me the opportunity to focus on my weakness in order to do better.	78%	15%
In a way, I prefer the 3-test attempts for I rather repeat the test than the course.	91%	8%
It gave me the chance to repeat the test instead of the repeating the entire course.	85%	12%
The fact that I could go back and ask about a problem I saw in the test to learn it before my next attempt advanced my knowledge of the subject, despite the fact that it would or would not show up in my next attempt.	78%	18%
It assisted me to grow in knowledge.	76%	19%
It allowed me to do better in the course.	78%	16%
It created a learning-based environment.	75%	20%
I learned a great deal using this method, irrespective of my grade.	73%	21%
In comparison to the one attempt, the 3-test attempts is not a hit or a miss.	61%	24%
In comparison to the one attempt, the 3-test attempts assess the student's knowledge correctly, given the few chances during a week.	69%	25%
It is useless because no matter how much I tried, I still got the same grade.	1%	3%
It is useless because it opened up for cheating without learning.	0%	2%
I prefer the 3-test attempts it to help students learn the material better.	80%	18%
All-in-all the 3-test attempts is a more fun learning style.	68%	22%
All-in-all the 3-test attempts is a more enjoyable learning style.	74%	21%
All-in-all the 3-test attempts is my worst experience, since I did not learn much more.	0.5%	1%
All-in-all the 3-test attempts is my worst experience, since I did not improve my grade much.	0.5%	3%
In the future, I hope to see more courses offered with 3-test attempts during a full week.	81%	12%

## References

- [1]. Archer, K. K. (2018). Do Multiple Homework Attempts Increase Student Learning? A Quantitative Study. *The American Economist*. 63(2):056943451877479, DOI:10.1177/0569434518774790. Colangelo College of Business, Grand Canyon University, 3300 W Camelback Road, Phoenix, AZ 85061-1097, USA.
- [2]. Chegg Inc., website <https://www.chegg.com> , accessed on September 12, 2022.
- [3]. Lanier, M. M.(2006). Academic Integrity and Distance Learning, *Journal of Criminal justice Education*, 17:2, 244-261, DOI: 10. 1080/10511250600866166
- [4]. Fask, A., Englander, F., & Wang, Z. (2014). Do online Exams Facilitate Cheating? An Experiment Designed to Separate Possible Cheating from the Effect of the Online Test Taking Environment. *J Acad Ethic*, 12:101–112 DOI 10.1007/s10805-014-9207-1
- [5]. Charlesworth, P., Charlesworth, D.D., & Vician, C. (2006) Students’ Perspectives of the influence of Web-Enhanced Coursework on Incidences of Cheating, *Journal of Chemical Education*, vol. 83 No.9.
- [6]. Herman, G. L., Cai, Z., Bretl, T., Zilles, C., & West, M. (2020, August). Comparison of Grade Replacement and Weighted Averages for Second-Chance Exams. In *Proceedings of the 2020 ACM Conference on International Computing Education Research* (pp. 56-66).
- [7]. Terada, Y. (2020). Covid-19’s Impact on Students’ Academic and Mental Well-Being. *Edutopia*, website: <https://www.edutopia.org>, accessed on September 12, 2022.
- [8]. Nader, M. & DeMara, R.F (2022). The Impact on Learning Outcomes using Three-Attempt Tests in an Engineering Undergraduate Core Course: Dynamics. Proceedings of the ASEE Southeast Section Conference, No. 59. This work was published and presented in March, 2022. <https://sites.asee.org/se/wp-content/uploads/sites/56/2022/03/2022ASEESE59.pdf>
- [9]. Arora, M. L., Rho, Y. Jin, & Masson, C. (2013). Longitudinal study of online statics homework as a method to improve learning. *Journal of STEM Education: Innovations and Research*, v14 No.1, p.36-44.
- [10]. Phillip J. Cornwell, Ferdinand P. Beer, E. Russell, Jr. Johnston and Brian Self (2015). *Vector Mechanics for Engineers: Dynamics*, 11<sup>th</sup> Ed. McGraw-Hill Education, P.O. Box 182605, Columbus, OH 43218, <https://www.mheducation.com>
- [11]. Lee, C. J. (2018). Automated Randomization of Test Problems for Cheating Prevention. *World Journal of Research and Review (WJRR)*. ISSN:2455-3956, V.3, Issue-2, Feb. 2018, p.10-15.
- [12]. Tian, T., & DeMara, R.F (2018). High-Fidelity Digitized Assessment of Heat Transfer Fundamentals using a Tiered Delivery Strategy,” in *Proceedings of American Association for Engineering Education Annual Conference (ASEE-18)*, Salt Lake City, UT, USA.
- [13]. Fish, L. A. (2015). Undergraduate students computer-managed homework versus in-class performance for different testing formats. *Business Education Innovation Journal*, 7, 5-14.

## **Marino Nader**

Marino Nader is an Associate lecturer in the Mechanical and Aerospace Engineering Department at the University of Central Florida and has been working on digitizing courses and exams, creating different course modalities. Dr. Nader obtained his B.Eng., M.Eng. and Ph.D. from McGill University. His Ph.D. was done in conjunction with the Canadian Space Agency where he spent two years doing research and experiments. Upon completion of his Ph.D. he began working in the Aerospace Industry where he spent over 10 years as a Stress Analyst/Consultant. At present he enjoys working on Distributed Electric Propulsion (DEP) with his students, designing, analyzing, constructing and flying Unmanned Aerial Vehicles. Dr. Nader won a few awards in the past few years, among these are the College of Engineering Award of Excellence in Undergraduate Teaching (2023), Excellence in Faculty Academic Advising for the Department of Mechanical Engineering (2020). In addition, he is also a Co-PI on the NSF-supported HSI Implementation and Evaluation Project: Enhancing Student Success in Engineering Curriculum through Active e-Learning and High Impact Teaching Practices (ESSEnCe).

## **Qiushi Fu**

Dr. Fu is an assistant professor in the Mechanical and Aerospace Engineering department and Biionix cluster at UCF. He received his PhD from Arizona State University, MS from University at Buffalo, and BS from Tsinghua University. Dr. Fu's laboratory focuses on the neural control of human upper extremities using interdisciplinary approaches such as robotics, virtual reality, and neural imaging. His research on human manual dexterity has broad applications in brain-machine interfaces, neurorehabilitation, and assistive devices.