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Teaching core engineering courses, Statics and Dynamics, considering different types of learners

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Abstract

Statics and Dynamics are complex core courses in the engineering program that display challenges facing our students. The diverse population in our classrooms demands a broader spectrum in instructional approaches. This project focuses on creating assorted resources to engage all students regardless of background in different ways of learning to create a solid base understanding of the material and increase success in future courses as well as in the students' future engineering careers. Our approaches include a granular course structure, different instructional technologies, support of learning assistants in the classroom, tutoring outside the classroom, and different forms of assessment and accessibility. The author has used mixed qualitative and quantitative approaches to measure the success of the statics and dynamics courses. The data collected includes 1) Students' exams and final grades for several terms 2) Quantitative and qualitative results of the Student Perception of Teaching Surveys (SPOTS), 3) Midterm Surveys, 4) Gateway Surveys.

Introduction

Statics and Dynamics are core courses for the Mechanical and Civil Engineering curriculum as well as service courses for Electrical Engineering. These courses are taken yearly by more than 900 students in our institution, Florida International University (FIU). For the Mechanical Engineering curriculum, Dynamics is a first-semester sophomore course that advances statics and multivariable calculus as direct prerequisites. Dynamics represents the gateway of four subsequent core courses that are prerequisites to each other and five other courses that run parallel in the curriculum. Dynamics is also the gateway to four courses in Civil Engineering. In consequence, students who fail to pass statics or dynamics in their first attempt will automatically fall behind in their four-year graduation goal unless they retake one of these courses during the summer session.
Students have to take statics in their second year of college when they still building their foundation in math and physics, and dynamics comes right after. There are numerous studies that indicate that students have difficulties understanding problems that involve forces and motion [1]. These difficulties become more evident when there is a broad diversity spectrum in the student population in the classroom. The diverse population in our classrooms demands a broader spectrum of instructional approaches.

The population at the College of Engineering & Computing at FIU is very diverse [2], the data for the fall 2020 term (from 6456 students) has the following characteristics of a total Undergraduate degree-seeking students enrolled:

- Admit Type: 41% First Time in College (FTIC), 54% Transfer, 5% Second Bachelor's
- Race/Ethnicity: 4% Asian, 10% Black, 64% Hispanic, 8% White, 14% Other/Unknown
- Gender: 20% Female, 80% Male
- Age: 45% 21 or younger, 33% 22-25, 13% 26-30, 9% 31 or older

- Enrollment: 60% full time, 40% part time
- First Generation Status: 19% first generation in college
- Pell Eligibility (low income): 41% Pell eligible
- Housing: 6% on-campus, 94% commuters
- Online Course Enrollment: 15% fully online, 54% partially online, 31% no online enrollment
- Birthplace: 59% US born, 41% immigrant or international students.

As shown by the data the Admit Type indicates that about half of students transferred from another school, and 41% are immigrants or international students. These two indicators reflect a reality within the classroom where there is a great difference in the background of the students, independently of gender or race. For many transferred students, statics represents one of the courses taken during their very first term at Florida International University, many of them come after a gap time and their base knowledge is not as solid as is needed for this class. Meanwhile, the students that started as freshmen (FTIC) have a stronger base in previous classes and are more socially integrated with other students. Then other variables show less diversity, but are also as important, with a majority of males (80%) and a race/ethnicity with a majority of Hispanics (64%). These indicators must be taken into consideration, to address these populations as well as the minorities in the classroom.

Florida International University is committed to delivering excellent teaching with three main pillars that focus on ***learning-centeredness,*** a focus on optimizing student learning, growth, and development; ***Evidence-based practice,*** instructional practices informed by existing educational research, and/or both quantitative and qualitative evidence collected while teaching; and **Inclusive teaching**, a pedagogical approach that celebrates diversity in the classroom and relies on instructional practices that aim to engage, motivate, and elevate the learning experience of all students [3].

It is well known that there are different types of learners, as first introduced by Flemings in his VARK model in 1987, and then used by many other researchers, as for example Prithishkumar and Michael [4] who concluded in their work, that "Students possess a wide diversity in learning preferences. This necessitates teachers to effectively deliver according to the needs of the student. Multiple modalities of information presentation are necessary to keep the attention and motivation of our students requiring a shift from the traditional large-group teacher-centric lecture method to an interactive, student-centric multimodal approach."

To offer an improved, inclusive class experience, we pursued engagement by creating a well-thought course structure and engaging course delivery using multiple methodologies. We believe that by including different interactive approaches, the diverse community of students will be served and will engage in the learning process, therefore will perform better in these difficult courses, and will have a solid base of knowledge to progress successfully in their careers as engineers.

Courses Design and Structure

The new generation is exposed to different virtual content with different visual tools and speeds as compared to the traditional learning environment. We, as instructors, must adapt our teaching

techniques to cover the expectation of students and engage this new generation. Therefore, an appropriate design of the course is essential.

The course design with a student-centered approach represented a key component of this project. We use best practices that include: 1) clear course structure, 2) alignment of critical course components, 3) lectures for theoretical components, 4) use of different technologies to produce reinforcement material for problem-solving, 5) well-designed worksheet for active learning session supported by learning assistants, and 6) different forms of assessment and accessibility.

In the process of course design, we used a backward design framework, which helped us gain a clear idea of the students' learning outcomes (SLO) and the ABET outcomes. We designed specific module learning objectives (MLO) and refined the learning activities and assessment in order to align with the SLO. We also included well-defined expectations for every assessed activity by establishing clear criteria using rubrics for all evaluated activities. Last but not least, by using accessibility features in all the course elements, we intend to target a diverse student population and benefit the learning community as a whole.

With a granular course structure, we divide the extensive subjects into small pockets of information that are more manageable for students. The courses, statics, and dynamics are organized in Modules on our web-based Learning Management System CANVAS, each module represents a chapter of our textbook. Each module is composed of a short narrated lecture presenting the theoretical background for each topic and several single problem-solving videos using LearningGlass ^{TM} as reinforcement material. For some modulus, the topics were divided into several parts, each including a theoretical lecture and a group of problems. The reinforcement material posted as videos represents an important component to serve those individuals that require more time to grasp the concepts, for whom the material was delivered too fast in the short class time.

The worksheets for active learning activities were designed by the instructor with the input of the learning assistants (LAs). The worksheets include three or four problems, each problem is introduced by a series of reflection questions that promote interaction and discussion between peers. Students are not only asked to solve the problem but to deliberate on what methodology is the most appropriate to solve it and why.

FIU is committed to high-quality teaching providing equal opportunities to all students independently of their background or personal conditions. The components in every course must be accessible to all learners. Our statics and dynamics courses have more than 95% accessibility on all the files (ADA compliant).

Courses Delivery

Both courses, statics, and dynamics are delivered in person, and online. The results presented in this paper are mainly for the in-person modality. During the pandemic time, starting spring 2020 until spring 2021, the “in-person” course was delivered synchronously remote using zoom and the online version was delivered completely asynchronously. For the in-person modality, both

courses meet twice a week for 75 minutes. Once a week the instructor lectures and solves problems in class and in the second meeting there are active learning activities.

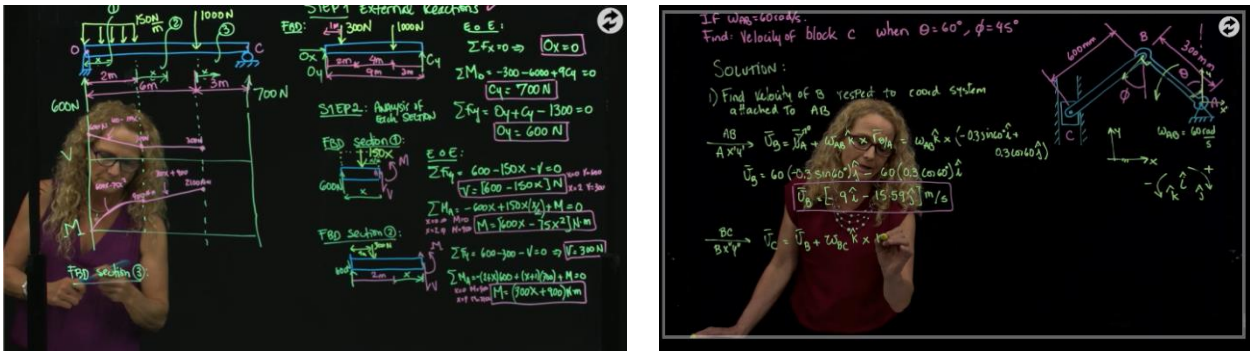
In the classroom, the instructor has the possibility to explain the theoretical background, relate problems to real-life situations, and show the ability and proficiency to solve the problems methodologically. The instructor's expertise is very valuable, and it is not replaced by other activities, but complemented. Many of the problems solved in class are posted on video as reinforcement. Engineering students must understand the math and physics behind the phenomena in order to use it for future applications in mechanical or civil engineering design, therefore the instructor's emphasis on the theoretical background is highly constructive.

The active learning sessions are designed for students to make the connection between theory and practice using worksheets designed for group discussion and problem-solving, as well as gain the skill of teamwork. These sessions are supported by learning assistants in class and outside class with office hours for more individual tutoring. There are well-known benefits to using learning assistants (LA) in the classroom [5], but there is not much work done to include the LAs in engineering courses. The role of LAs is different from the Teaching Assistant who supports the instructor, the LAs primary role is to help the student in their learning process. During these sessions, the instructor has the possibility to see students working and gain insight into which aspects of the topic are weak and have to be reinforced. Active learning sessions also give the instructor a space to provide personalized attention to students who need it most while learning assistants support group work.

As shown in the demographic data, 64% of students are from a Hispanic background, and since the learning assistant are also undergraduate students from the same institution, this percentual relation has been also noticed in the hired LAs. Students with still experience a language barrier with English have often attended office hours with Hispanic LAs and have been able to get the answers to their questions in Spanish.

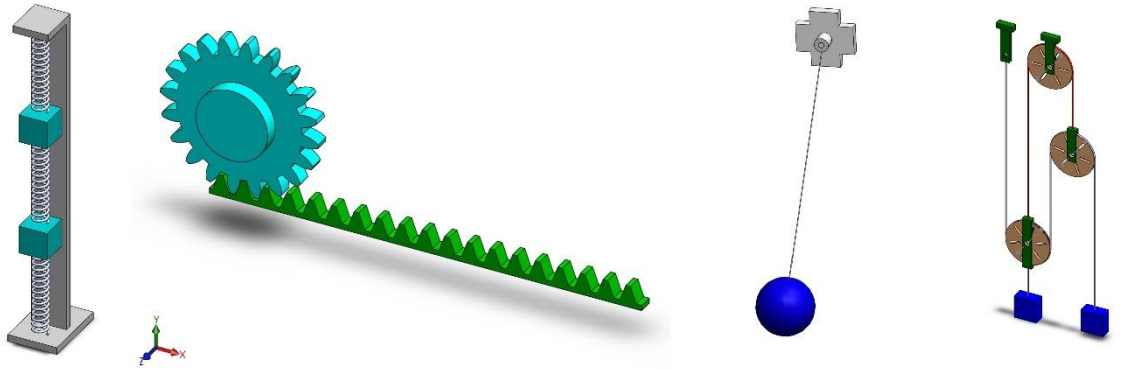
The reinforcement material includes: 1) Videos of narrated lectures by the instructor with theoretical background, mainly for hybrid or online courses, for in-person course theoretic lectures are given once a week followed by a problem-solving session 2) 85 and 86 high-quality videos of problem-solving using learning glass for statics and dynamics respectively, Examples: https://youtu.be/3R04_UsStds, https://youtu.be/3R04_UsStds), and 3) presentations with SolidWorks animations of dynamics typical problems including solution (Examples: https://youtu.be/a9WRjsG9SeE).

The single short concept video approach is aligned with the new modality of receiving information, where students can either watch the video several times or skip it if they already understand the topic. The learning glass represents a powerful tool that shows the instructor talking face-to-face writing on a glass board giving the sensation to the students as if they were in the same room (see figure 1), and the Solidwork animation with the problem solutions are a very effective representation of the problem (see figure 2), this later resource has been used only for one term and no assessment on student perception has been done.



a) Statics b) Dynamics

Figure 1. Learning Glass videos (screenshots)



a) Springs-mass system b) gear-rack c) pendulum d) pulley system

Figure 2. Solidwork animation of mechanical system

Student assessments

The courses provide different forms of assessments, Table 1 shows assessment activities with the percentage over total grade. For assignments and assessment, the course is supported by MyLab and Mastering from Pearson, which is a learning platform. The students have to do weekly assignments that involve six to eight problems that will serve as a practice to master the material learned in class. The students have several attempts to input the correct answer and the software provides tips and hints per request of the students. The platform has the advantage that grades the assignment and helps the instructor manage large classes.

For the exams, students also use the Pearson platform. My Lab and Mastering only records 100% of the grade when students enter the correct solution. For final grading on exams, the student must show their solution process on the given scratch paper per question. The students are asked to perform their work properly organized following a methodological process to solve the problem. The course includes well-defined expectations for every assessed activity by

establishing clear criteria using rubrics for all evaluated activities (see Table 2). For the midterms and final exam, each section of each problem will be evaluated, the grade will be adjusted by the instructor, and points will be added to the grade for work shown in the scratch paper following the criteria table.

Table 1. Assessment activities and Grading weight

Course requirements	**Dates**	**Points for Each**	**Weight**
First Exam	Week 6	100	25%
Second Exam	Week 12	100	25%
Comprehensive Final Exam	Week 16	150	35%
Worksheet – Active learning session	Once a week	1	5%
Assignments/discussion	Weekly	6-8	10%
Total			100

Table. 2 Grading Rubric for exams

Criteria	**Grade**
The methodology is selected correctly, with correct equations and final solution is presented on the scratch paper and entered correctly in My Lab and Mastering.	100 %
The methodology is selected correctly and shown on the scratch paper, with correct equations, only the solution of the equations is missing.	75 %
The methodology is selected correctly and shown on the scratch paper, equations are presented incorrectly but with some merits.	50 %
Only Correct FBD is presented, all forces are shown and labeled, or incomplete methodology selected and shown on the scratch paper.	25 %
Incorrect FBD or no recognized methodology is presented or it is very difficult to follow solution or no work is shown on the scratch paper.	0 %

Methodology and Data collection

The authors used a mixed-methods approach to assess the course structure and delivery. Three data sources were used to analyze the course

1. Students' grades from the first and second midterm, final exams, assignments, and final grades for six consecutive terms.
2. Student Perception of Teaching Surveys (SPOTS) results. This Survey is mandatory and administrated by the Center for the Advancement of Teaching (CAT), Florida International University, and is composed of nineteen questions. Eight original questions (Q1, Q2, Q8, Q9, Q10, Q12, Q13, & Q15) were established by Chancellor's Memorandum, CM-95-06. The remaining eleven questions were designed by CAT-FIU. The maximum grade for every question is 5.

3. Midterm Surveys and end-of-term Survey collected for seven sections, for statics between fall 2019 and fall 2021 and four sections of dynamics between fall 2019 and spring 2020. These surveys were prepared by the instructor for the years 2018 and 2019, and by the CAT-FIU for 2020 and 2021 (Gateway Survey). The questions give the students an opportunity to reflect on their exam performance and provide feedback on Students' grades from the first and second midterm, final exams, assignments, and final grades for six consecutive terms.

Data from summer 2018 until fall 2021 was collected and analyzed, only the most relevant results and graphs are shown in the result section.

Results

Quantitative results

As shown in Figure 3, performance increased steadily, from a 54% and 52% passing grade in fall 2018 to a 77% and 81% passing grade in spring 2020, in statics and dynamics respectively. The subsequent terms are somehow more erratic in behavior, which could be awarded to the delivery model due to the pandemic when all courses had to go to remote learning as shown in Tables 3 and 4. Considering these courses to be core courses in which historically students struggle in grasping all concepts, the results are acceptable. Of course, the instructor's expectation is to increase the passing rate percentage even more.

The support of the learning assistant was incorporated in statics starting in fall 2019 and in dynamics in spring 2021, as shown in tables 3 and 4, in both courses this represented an additional resource for the students.

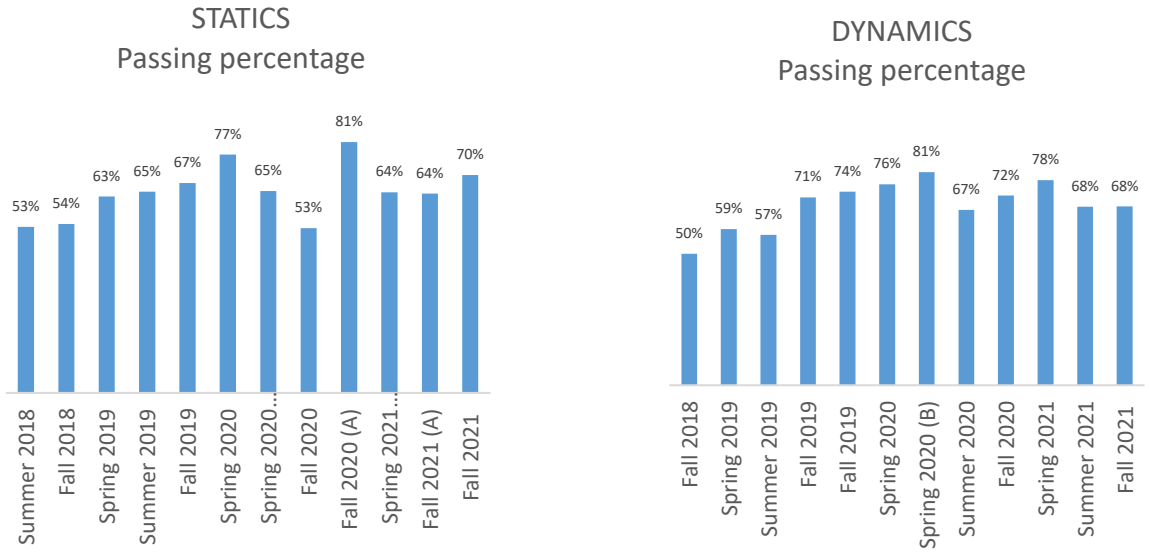


Figure 3 Performance comparison consecutive terms between Summer 2018 and Fall 2021

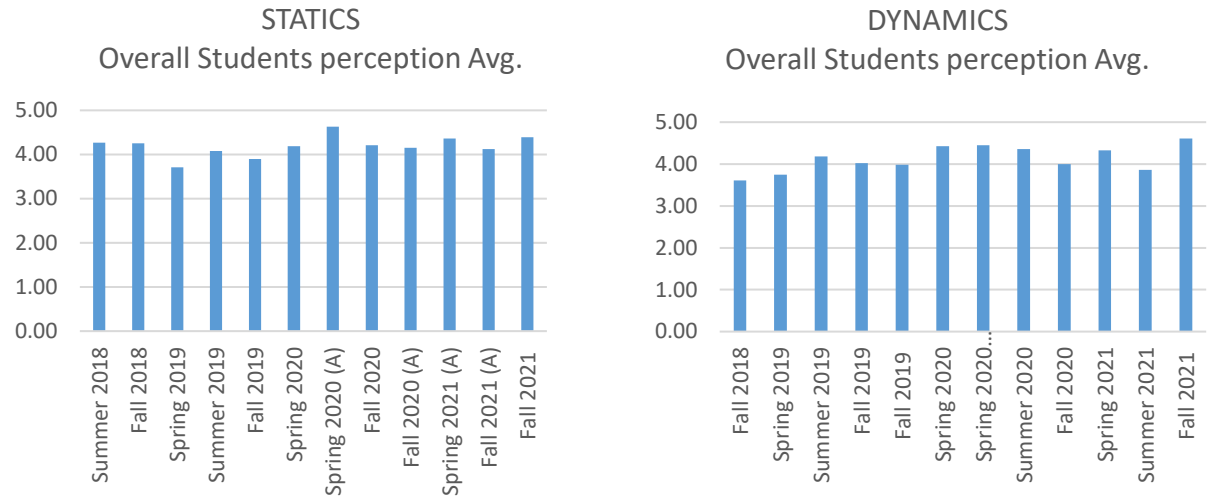


Figure 4 Overall Student Perception of Teaching (SPOTs) between Summer 2018 and Fall 2021

Figure 4 shows the average of the overall Student Perception of Teaching (SPOTs) over a maximum score of five. Students have evaluated both courses with a score above 4 points for all terms, with an average of 4.19 for statics and 4.16 for dynamics. Considering that these are core courses that students find difficult, this is a very good evaluation. There is a normal fluctuation term to term due to different groups of students each term, however, the variability is small.

Table 3. **Statics course:** enrollment, course delivery, student performance and perception

TERM	***Student Enrollment***	***Overall Students perception***	***Teaching methodology and resources***	***Pass***	***fail***	***IN***
Summer 2018	60	4.27	In person, lectures	53%	47%	0%
Fall 2018	59	4.25	In person, lectures	54%	46%	0%
Spring 2019	65	3.71	In person, lectures	63%	37%	0%
Summer 2019	68	4.08	In person, lectures	65%	35%	0%
Fall 2019	86	3.90	In person, lectures, LAs	67%	33%	0%
Spring 2020	64	4.19	In person, lectures, LAs	77%	23%	0%
Spring 2020(A)	37	4.63	In person, lectures, LAs	65%	22%	14%
Fall 2020	68	4.21	remote, lectures, LAs	53%	46%	1%
Fall 2020 (A)	31	4.15	remote, lectures, LAs, videos	81%	19%	0%
Spring 2021(A)	45	4.36	remote, lectures, LAs, videos	64%	20%	0%
Fall 2021 (A)	45	4.12	In person, lectures, LAs	64%	36%	0%
Fall 2021	40	4.39	In person, lectures, LAs	70%	30%	0%

Table 4. **Dynamics course:** enrollment, course delivery, student performance and perception

TERM	*Student Enrollment*	*Overall Students perception*	*Teaching methodology and resources*	*Pass*	*fail*	*IN*
Fall 2018	42	3.61	Online, videos	50%	50%	0%
Spring 2019	69	3.75	Online, videos	59%	41%	0%
Summer 2019	77	4.18	Online, videos	57%	40%	3%
Fall 2019	49	4.02	Online, videos	71%	29%	0%
Fall 2019	53	3.98	In person, lectures	74%	26%	0%
Spring 2020	72	4.43	Online, videos	76%	24%	0%
Spring 2020(B)	37	4.45	In person, lectures	81%	19%	0%
Summer 2020	84	4.36	Online, videos	67%	33%	0%
Fall 2020	61	4.00	Online, videos	72%	28%	0%
Spring 2021	59	4.33	Remote, Lectures and problem solving, LAs	78%	22%	0%
Summer 2021	56	3.86	Remote, Lectures and problem solving, LAs	68%	32%	0%
Fall 2021	33	4.61	In person, lectures, LAs	68%	32%	0%

Results from the midterm survey show that students welcome all different teaching approaches offered; every student learns differently and has a different preference. The graph in figure 5 shows that most of the approaches are used by a large group of students being the most helpful (results for spring 2021, 30 students responded to this midterm Survey): Attending Class 60.00%, Solving problems during class 50.00%, Attending to the active learning session with LA 50.00%, Watching videos posted 40.00%, Reviewing/Redoing in-class and posted problems 36.67%, Reviewing/Redoing homework examples 36.67%. It is noticed that the activity that the students found less helpful was reading the book by themselves. It is also significant that 60% of students found it very helpful to attend class, considering that in the past two years many courses had to move online due to the pandemic COVID 19, with this response the students are pointing out that they appreciate the activities developed in the physical classroom or in synchronously remote delivery of the course. These activities include the lectures by the instructor with solving problems session in one of the two weekly sessions and the active learning session in the second weekly meeting.

The results for the same question in other terms show similar behavior, leading to the conclusion that all the components will serve at least a group of students and all of them together will serve the diversity of students.

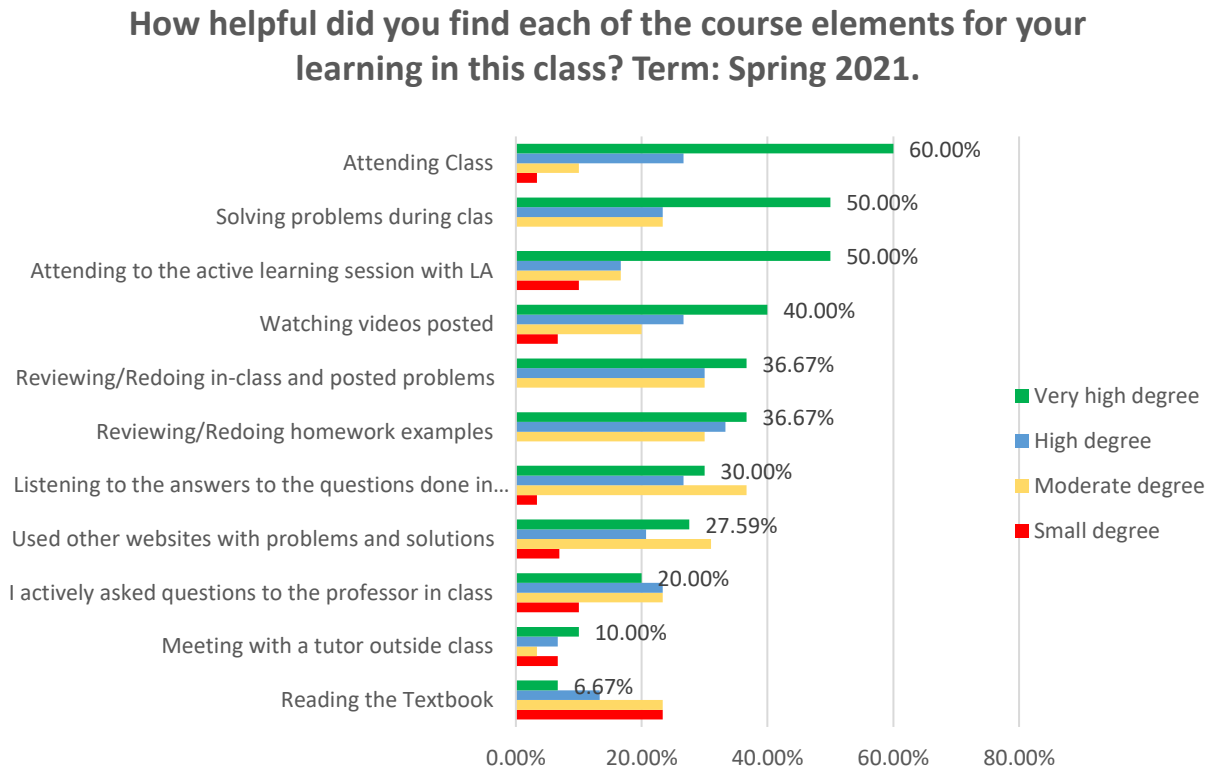


Figure 5 Results of the midterm survey. Question to evaluate the receptivity of the different teaching approaches.

Figure 6 shows the results of the question that captures the perception of the students regarding the support of the learning assistant. The results come from the gateway survey, provided by the Center for the Advancement of Teaching of FIU, and passed to students at the end of the term, 26 and 27 students responded to the Survey in spring 2021 (two sections) and 28 students responded in fall 2021. The data shows that students agree in a very high percentage that the learning assistants help the student understand the course material and help the student when they get stuck.

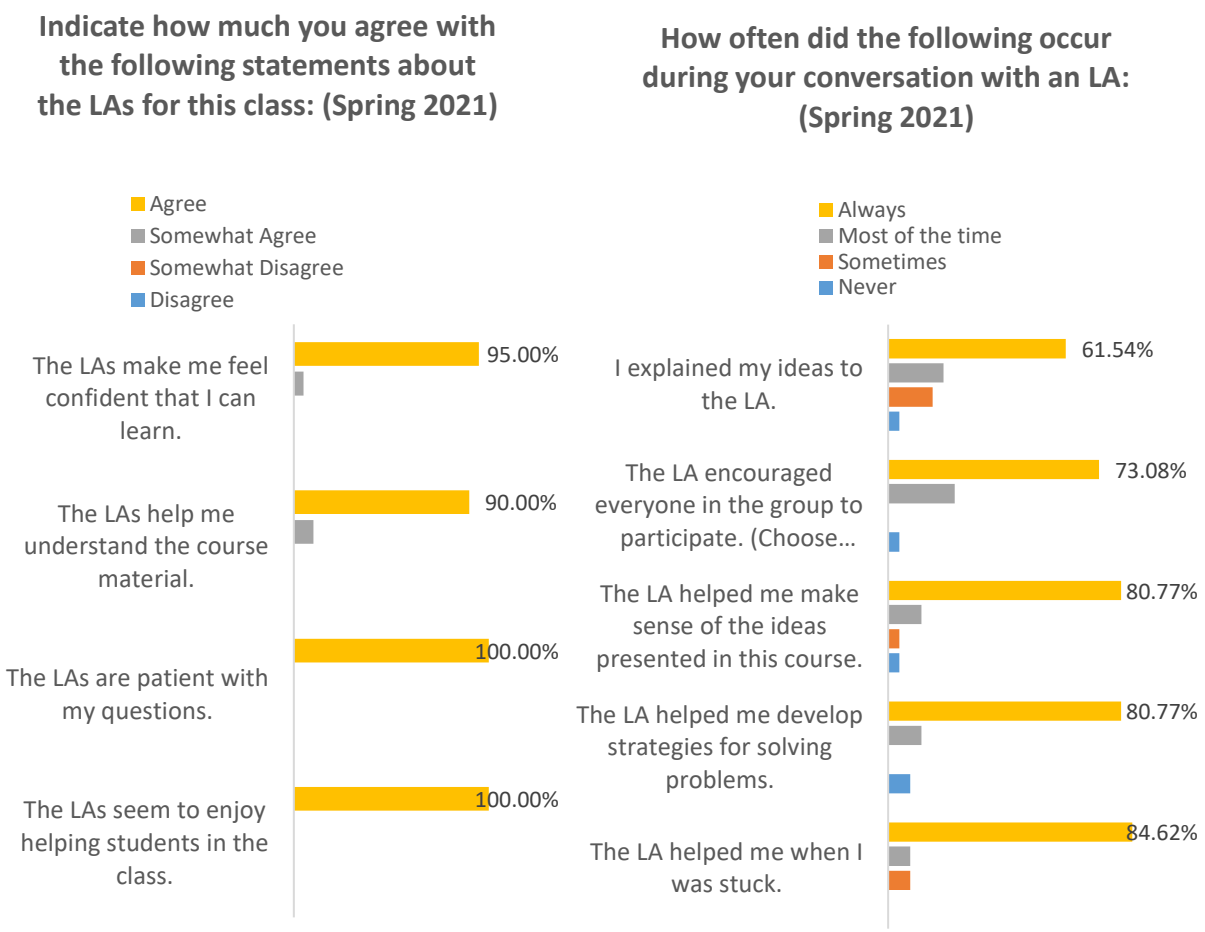


Figure 6 Results of the midterm survey. Question to evaluate the students' perception of the Learning Assistants

Qualitative data: Students' opinion

The opinion of the students is very valuable, the opinion of the students was gathered for Spring 2021 and fall 2021 for statics course and dynamics courses, also using the gateway Survey. In Tables 5 and 6, the answer to the question: *We want to know! What aspect of this course was most helpful to you?* Please explain briefly, which is shown for Spring 2021 for statics course and dynamics course. The answers show appreciation for the videos and the LAs work.

Table 5. Students' opinion for STATIC course Spring 2021 term

We want to know! What aspect of this course was most helpful to you?
My classmates
I feel like working with the LAs on the worksheets after each class was the best and most helpful.
Worksheets
I guess the example videos
the LA's, the posted videos, and the homework having a practice mode after problems are completed.
Since I am a mechanical engineer major, everything on this fours will be helpful for me in the future

The videos of the professor explaining how to solve the problems and the classes including the LA sessions in class.
After the Professor went over the concept, she did a few problems with us and I feel like those really helped me understand the situations.
learning on my own. but it's hard when you take antidepressants
The problems in class were very helpful, although sometimes the professor went a little too fast, and I didn't think of my question until later
The tutors were very helpful for learning the material at the accelerated pace
The web site used is bad and if you get stuck , it offers zero help.
Both the professor and the LAs were extremely patient and helpful when it came to answering students' questions and re-explaining some of the content a student may not have understood at first.
The video examples
The LA's helping with classwork definitely helped. The homework was very difficult for me though.
The La's, the way the profesor organized the material and the extra videos on canvas
The LA sessions at the end were very helpful, it was away of checking i had understood what we had done in class
The example problems and the LAs
The LA sessions and lectures and worksheets
The most helpful aspect was solving the problems together with the professor then working with the LAs on a separate worksheet and the LAs separate tutoring hours throughout the week.

Table 6. Students' opinion for DYNAMICS course Spring 2021 term

We want to know! What aspect of this course was most helpful to you?
Dr. Muller-Karger was extremely helpful with her example videos and help sessionz
Th course was great, Carmen is a great instructor, I learned a lot.
homework's and assignments were really helpful
With the LAs there helping, the class felt easier and not as much of a struggle.
The LA sessions. That's where we are not pressed for time like we are in the lecture and have time to process and practice what we learned with the professor.
the LAs and the videos of the professor doing some problems
The office hours
Mastering homework problems were the closest to test problems.
Definitely the group LA sessions that's when we are most active and get to see where we are mentally within the chapters and our mistakes
The LAs and the Professor were very helpful
Professor Carmen video examples, and Maria as my TA always helped me learn and understand
The posted example videos were the most helpful part of this course. However, they would not play with my house's wifi. I had to go to other places to watch them.
The TA sections right after every class
Problems solved in class, especially during review sessions before tests. This helped me to make better sense of problem-solving strategies
Everything was beneficial. Class, videos, LAs, HW. This class is super fast but we all knew it and were advised. Just need to put the work into it
The most helpful aspects of this course was the the group activity done in class with the LAs and the extra tutoring sessions they provide during the semester. As well as the professor explaining theory and then solving examples in class, the videos of problem solving, recorded lectures, pdf of lecture notes was helpful.

In the tables 7 and 8 the answer to the question*: Additional comments about LAs in this class (optional)*, is shown for two terms Spring 2021 for statics course and dynamics course. The student expressed great appreciation for the learning assistant in both courses.

Table 7. Students' opinion for STATICS course Spring 2021 term, regarding the Learning Assistant support

Additional comments about LAs in this class (optional):
Most effective part of class for me because I was able to work out the solutions in time with other students. Following along in class was also helpful if I was able to study the material beforehand.
Our LA Anna was great, the helped a ton!
Very helpful although somewhat challenging online since most people (including me) turned off our videos. It's hard to keep the video on when you're living with a big family but I felt like it could have been better if we had interacted more with the LA's somehow.
LAs were essential to doing well in this course, they were extremely helpful.
My LA Anna Was amazing
Ana was great. She really explained things well and helped me understand the subject.
They are a good contribution to this class. Because of the amount of material needed to learn, meeting with the La's was a one oro one experience with the students.
Very knowledgeable, having the last part of the class with them made a big difference to my understanding
Best LA's
I feel having LAs is extremely vital especially in a short pace course. Anna Cerquiera Violo is absolutely amazing!!!

Table 8. Students' opinion for DYNAMICS course Spring 2021 term, regarding the Learning Assistant support

Additional comments about LAs in this class (optional):
they helped me understand the material better
Fantastic work by the LA
The LAs were very helpful, I adore Arianna. She is so kind hearted and wants the best for us. She went as far as giving tips as to how she studied for the exam in order to help us. She gave us heads up about various topics and what to expect moving forward. She is THE BEST.
Maria is amazing, she helped me understand dynamics big time. I owe her a lot, i am feeling confident i can get an A or at least a B because of my work ethic and her in all honesty
They are helpful
My LA Anna Cerquiero was extremely helpful in this short face paced course filled with a lot of topics to cover. She provided insight to the areas I was lacking in and guided me on how to look at the problems we went over together. I believe an LA should be implemented in all classes!

Tables 9 and 10 show the answer to the question: *We are always trying to make improvements to help students learn. What changes would you suggest to improve this course? What would have helped you learn?,* There are many suggestions from the students; some find the course fine as is, and some still find the material overwhelming.
Even though results shown in tables 7 and 8 indicate that many of the students truly appreciate the active learning session with LAs, the reinforcement material posted as videos, and the lectures given by the instructor, the opinion of the students in table 9 and 10 indicate that statics and dynamics remain a big challenge to students.

Table 9 Students' opinion for STATICS course Spring 2021 term, suggestion on how to improve the course.

We are always trying to make improvements to help students learn. What changes would you suggest to improve this course? What would have helped you learn?
In person meetings allow for more interaction between the students and the teacher/LAs. Other than that, the professor managed her content in the meetings and even addition online content very well and allowed for students to learn and study according to their needs.
Record the Classes

More homework questions that scaled a little more gently. I feel like I'm doing a very simple problem only to face one that I find extremely difficult. I would also appreciate the work and solutions for homework problems to be displayed after it's due date.
Maybe meet three times a week, with the same amount of class time, to teach the chapter more
Nothing
Everything the professor provided was an excellent resource for me to learn in and outside of class.
Im not sure
The exams were very unforgiving and small mistakes or errors could harm scores without making it easily known how the student could improve.
Probably more time in class going over more difficult problems but she has a bunch of those videos online. There's not much i would personally say needs improving .
Maybe include more practice problems and give more time or fewer questions for the in-class assignment.
not try to make people question live based off the material
make worksheets due at 11:59 not at 3pm...
Maybe going over a couple more examples but that are a bit more difficult. Where the difficulty level would match that of the online homework and tests. But overall I wouldn't really change anything.
I believe the professor has a great system to facilitate learning, the lectures, LA's, worksheets and the homework were all in perfect balance to learn and succeed in this class. Overall the subject matter is challenging, everything necessary to succeed was in our reach. I wouldn't change the way the class was conducted.
Adding a lab to this course would be great, as the additional credit would allot time to further understand the material, this is a very fundamental course
I think the class is great, however id like some of the examples given in class to scale up in difficulty. Making the last example hard will help students understand how to approach a more difficult question when given to them either on a test or even the worksheets
Not make the exams such edge case problems.
More review videos on canvas.
Doing more examples during class time
more worksheets with less questions in them, unless we are allowed to submit by the end of the day not in an hour or the end of class. somtimes i work too much and dont have the time. more partial credit?
Slower lectures
I believe the instructor has done everything needed to succeed in learning and understanding the course material.

Table 10 Students' opinion for DYNAMICS course Spring 2021 term, suggestion on how to improve the course.

We are always trying to make improvements to help students learn. What changes would you suggest to improve this course? What would have helped you learn?
None
Changes are not using Mastering Engineering Pearson, it comes with a lot of errors and sometimes is not working properly,
everything was good for me to learn well
I understand this is a fast-paced course, but the homework assignments amount should be decreased to account for that pace.
I think it's well set up for the amount of time we have to learn the material.
less questions in the actual homework that are worth points (like 5 questions was a good amount to complete during the week).
Better online platform
none
More class time I suppose, in order for Mrs Muller to teach the material and have more time with the LAs
shrinking course material
It is overall a very difficult course to learn. The only thing I can think of is to lower the passing grade like in physics class where 55 is a C because this class is much harder then the physics 1 and 2 so it would help take some of the stress and worry off of the students.
This is a very challenging course and in my opinion it comes down to how the material is presented to students and how engaging it is. As an online student, my instructor had AMAZING example videos but very confusing and not engaging lecture videos. I went from learning concepts to just trying to learn how to manipulate the numbers in the problem to get a correct answer. It's like I have all the information but missing valuable connection to key concepts.
More example videos would have been helpful. I also wish they were uploaded differently because the mediasite platform was impossible to load most of the time. The lecture videos were somewhat helpful, but the explanations were very brief. I would have benefitted from lectures recorded in a similar style to the example videos (traditional lecture with the board), and including examples so that I could see how the concepts applied side-by-side.

none
No changes at all
Sometimes because there is so much to cover in so little the professor did move through the theory portion at a very face past at times. So it was easy to get lost, but she did stop to answer any questions as well as having external resources available to the students made up for it.

Reflections and conclusions

Teaching the diverse population that FIU serves represents a challenge. In the same classroom, the instructor has students with a very strong math and physics background and also some students with a very weak foundation. There is a high percentage of Hispanic students, a minority of female students, about half of the population come transferred from another school and take statics during the first term in our institution, while the other half have taken the math and physics foundation courses in our institution. Offering extra support in and outside the classroom, with tutoring and reinforcement material aims to raise the level of comprehension, and engagement and reach those students that need more help.

Providing the different approaches described in this paper, the proposed course design enhances students' learning experience by:

- Deep understanding: Engineering students must understand the math and physics behind the phenomena in order to use it for future applications in mechanical or civil engineering design. With theoretical lectures and solving key examples in the class by the instructor, the student will have exposure to the experience on the topic, and the ability to solve the problem methodologically.
- Increasing motivation: Multimedia, simulation and interactivity, and virtual interaction provides a variety of opportunities for different individual learning capacities.
- Developing critical thinking: by having the student make the connection between theory and practice using worksheets designed for group discussion and problem-solving, and giving them the support of the learning assistant in class and outside class with an office hour for tutoring.
- Developing a sense of community: by having students work in groups during active learning sessions, students learn from each other while networking with their peers. Not only the learning assistants or instructor can assist a student that is behind, but peers that encouraged to discuss the topic among them can help another student to feel part of a group of students capable to solve the problems.
- Individual attention: during active learning sessions, while the learning assistants are supporting group discussions and problem-solving, the instructor has the opportunity to walk around the classroom and help the individuals that are struggling, this is an opportunity to reach those minorities or unrepresented students that my become unnoticed during a general lecture when only the students that are prepared answer the questions asked to the class.

Based on the success rate from these courses, we would like to keep improving the learning experience for statics and dynamics and develop more engagement material. The author will continue teaching the courses. In spring 2022 three sections of statics are being incorporated to the learning assistant program, and all students will have access to the reinforcement virtual material. This represents an average of 180 students per term.

Many of the students truly appreciate the different resources offered and are grateful for the active learning session with the learning assistant. However, there are still students that find the courses very challenging, which indicates that more must be done to support students in these core engineering courses.

The growth projection includes improvement on the worksheets for class-work with the support of the learning assistants, as well as expansion in our reinforcement material with the problem-solving videos and the animations of physical problems. The use of animations and videos of the physical demonstration will provide a hands-on experience, both will be the seed for discussion forums using real-life examples.

For further analysis, the data obtained from Surveys will be complemented with usage data of the material posted. The new analytics tool tracks and reports student activity within CANVAS and evaluates individual participation and performance on the course [6]. The data shows if students are engaging with the course material and can even serve as a tool to identify at-risk students based on their participation and grades.

According to the shared vision provided by selected engineering educators on the Vision 2030 task force at ASEE "our students need to lead not only technically but also socially, politically, and ethically. In addition to technical skills, our future engineers need to be given communication and people skills, business sense, a global perspective …" [7]. This vision is attended with the appropriate design of worksheets that incentive discussions and critical thinking.

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