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Redesigning the Flipped Mechanics of Materials Course to Support Diverse Learners

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Abstract

The Mechanics of Materials course has been offered in a "flipped" modality over the past 8 years. This course is an entry-level course required for several engineering majors such as Civil, Mechanical, Biomedical, Materials Science, and Manufacturing Engineering. The class has large enrollments of 100 to 120 students per section and an annual enrollment of 400 students. In the flipped course, the lectures were being delivered using pre-recorded videos. The in-person class time was used to present a brief recitation of the lecture material, discuss challenging concepts, and solve problems.

The course was redesigned in the summer of 2020 as part of a research project funded by the Engineering Education Center of the National Science Foundation to create an inclusive learning environment that empowers neurodiverse learners. It was attempted to achieve this goal by improving the accessibility of the content, promoting active (collaborative) learning, engaging students by using real world examples, and offering a variety of assessments in this course.

Actions such as adding captions to the pre-recorded videos, posting class notes, recording and live streaming the class, and using the class eBook were made to enhance the course accessibility.

Active learning such as think-pair-share strategy, collaborative problem-solving activities, and brainstorming were offered during class time to enhance peer-to-peer interactions, align students' progress with the class schedule, and improve student engagement. These active learning methods helped facilitate the instructor-student interaction which was previously challenging to provide in a large classroom.

To enable students to apply their knowledge in real world applications, a series of optional, small, strength-based projects (SBP) were added to the course. Students were able to contribute to the course based on their personal interests and expertise by completing small projects in which the application of a mechanics concept was demonstrated in a real-life example.

Multiple forms of assessment were offered to students allowing them to demonstrate their gained learning using alternative modalities. Class assessments included weekly homework assignments using the McGraw-Hill Connect platform, online weekly quizzes, midterm exams, and in-class teamwork problem solving. In addition, students were given a second chance to enhance their final grade by taking an optional final exam.

Students' feedback was collected by conducting an anonymous, comprehensive survey on the principles of Universal Design for Learning (UDL). Students were asked to rank different course components based on their perception of the effectiveness of each activity in their learning. This paper will discuss the implementation of different course components to enhance inclusivity and engagement in this large class. The results of the surveys and future work will be discussed.

Background and I-Course Standard

A flipped classroom offers many advantages to both faculty and students. Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa [1]. Mechanics of Materials course has been offered in a “flipped” modality since 2013 to enhance the quality of the course, share uniform resources to all students, and provide alternative learning resources for diverse learners. Herreid and Schiller explained the flipped classroom as an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom [2]. In this course, each lecture is presented with a pair of videos including a lecture video that presents the concept and formulations followed by a sample solving video where 2 or 3 problems are solved in a step-by-step format. Each lecture is 50 minutes long and the class meets three times per week. The class activities include a short lecture by the instructor about the topics of the day, followed by time for students to solve problems. The instructor and teacher assistants guide students during the problem-solving activities and present the correct solutions on the board.

The Mechanics of Materials course was selected to be re-designed using I-Course standard in the summer of 2020 as part of a research project funded by the Engineering Education Centers of the National Science Foundation. I-Course (the I stands for “inclusive”) was created as a framework to guide the course redesign process of the CEE (Civil and environmental Engineering) INCLUDE Working Group during the summer of 2020 and revised in 2021 [3]. The INCLUDE program aims to create a more inclusive learning environment for neurodivergent students, personalize the educational experience, and improve learning outcomes for all students [3]. I-Courses are anchored by a commitment to a strength-based approach and centered around three core course features: The Culture of Inclusion, Teaching and Learning, and Communication and Supports [3].

To meet the I-Course standards, actions such as offering active learning, real world examples, visual learning tools, alternative assessments, continuous student feedback, and enhancing content accessibility must be in place. That will be discussed in the following sections.

Content Accessibility

Visual learners prefer seeing information represented through visual aids that use methods other than words, such as graphs, charts, diagrams, and symbols. Auditory learners best learn through listening (lectures, discussions, tapes, etc.). Read/write learners prefer written words and gravitate toward text, dictionaries, reference works, and research [4]. To support all different types of learners, the course accessibility was enhanced by variety of actions.

Video Captions

A total of 34 lecture videos and 34 sample solving videos were developed for this flipped course in 2013. The Kaltura video recording application offers auto caption for the videos. However, the ADA’s (Americans with Disabilities Act) best-practices require captions to be 99% accurate [5]. Auto captions were added to all videos. Former undergraduate students of the course were hired during the summer to review and edit the captions and check the accuracy. These video captions benefit students who have trouble receiving and processing information in an auditory format.

Live Streaming the Class

The inclusive version of the course was offered in fall 2020 which coincided with the pandemic. Class was offered in a hybrid modality in which students had a choice of attending the class in-person or watching the class via livestream remotely. The class was broadcasted for distance-learners. The WebEx chatroom was used to allow distance students ask questions during the lecture. The recorded video of the class was posted to the class site (Blackboard) after each class. Therefore, students were able to re-watch the class materials at their own convenience.

The livestreaming was discontinued in the fall of 2021 as the university policy required all students to attend the class in-person.

Lecture notes

The contents of presented materials in the class's pre-lecture videos were saved as electronic files (PDFs) and posted under each video to support learners who preferred reading or writing.

The instructor uses Smart Notebook (instead of the classroom whiteboard) to present lectures and show problem solving. Smart Notebook enables the instructor to save the material as a PDF and post it to the class site. The lecture notes benefit students who need note taking assistance or those prefer reviewing the class materials later.

E-Books

The hard copy of the textbook McGraw-Hill was replaced with the electronic version (Connect) to accommodate students who prefer the audio version of the text. In addition, important mechanics concepts are highlighted in the book and practice questions are available for students to evaluate their learning. More than 70% of students enrolled in the fall of 2020, the spring of 2021 and the fall of 2021 agreed or strongly agreed in the mid-semester survey with the question of "I feel the McGraw-Hill Connect Smart book (optional reading assignments) help me learn the concepts better".

Active (Collaborative) Learning

A great number of engineering students work alone. But in the industry, teamwork is required most of the time. Incorporating Cooperative Learning (CL) into an engineering program gives students an opportunity to practice problem-solving and communication skills in a 'simulated' professional environment [6]. To improve student engagement and enhance peer-to-peer interactions, active learning strategies such as think-pair-share, collaborative problem-solving activities, and brainstorming were offered during class time. These active learning methods facilitated the instructor-student interaction which was challenging to provide in a large classroom.

Teamwork Problem Solving Activities

It was expected that an assessment activity to evaluate the students' learning (on the topic of the day) during class time may motivate students to watch videos before attending the class, promote peer interaction, and facilitate instructor-student interactions. Therefore, a low stake graded teamwork assignment was added to the class requirements.

Students are assigned to team of 3 to answer a question related to the topic of the day in 15 to 20 minutes. It enables students to practice a simulated mini exam (a timed activity with the same level of difficulty) in this low stake assignment. The instructor and teacher assistants check students' work, inform each team about mistakes, and provide guidance during this activity. This teamwork assignment is randomly offered once a week during the semester. The course was offered in hybrid/blended modality which was a combination of one online session and two in-person sessions during each week during the pandemic (fall 2020 and spring 2021). Blackboard Collaborate Ultra and its breakout groups feature were used during the online session to conduct the teamwork activity. Google Slides was used to share the problems containing embedded formulations and displaying steps with blank answer boxes in the online modality. The instructor and teacher assistants acted as moderators and were able to enter different breakout rooms to interact safely in this large, hybrid class during the pandemic.

Figure 1 summarizes the students' feedback on the effectiveness of this activity in their learning. The data was collected from the class mid semester surveys from three consecutive semesters when the inclusive class was implemented. The class enrollment in the fall semesters and the spring semester were 200 and 100, respectively. Between 40 to 50 percent of students responded to the mid-semester survey.

The data showed that between 76 to 93% of students agreed or strongly agreed that the teamwork problem solving activity was beneficial to their learning. An increase of 21% was observed in student's level of satisfaction with this activity from fall 2020 to fall 2021.

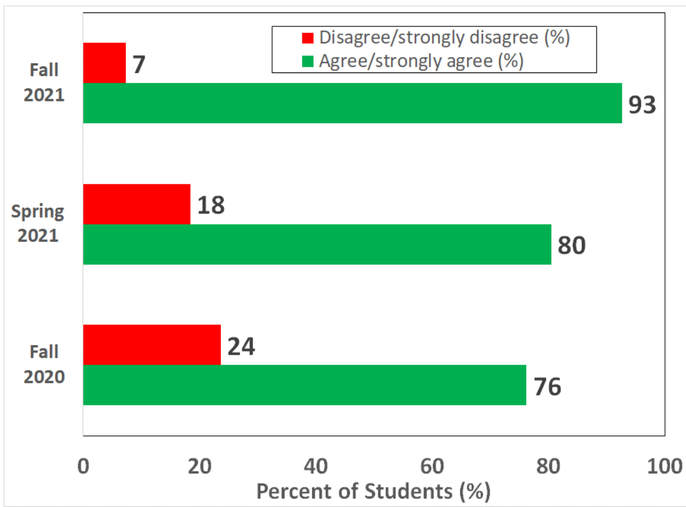


Figure 1. Student responses to the question of "The Teamwork problem solving activity is beneficial for my learning" in the mid semester survey.

An external evaluator (Horizon inc.) conducted a survey on the teamwork activity to evaluate different aspects of inclusive teaching. Student responses are displayed in Table 1 for one of the teamwork activities.

Table 1. Survey conducted by the external evaluator (TW8=Teamwork Activity 8)

Student Opinions Regarding TW8

	Percent of Respondents (N = 75)					
	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
I was provided with sufficient information/directions to complete this assessment.	4	0	0	0	17	79
The assessment allowed me to demonstrate my knowledge and/or skills.	1	1	3	8	35	52
The timeline for completing this assessment was reasonable.	0	1	8	15	27	49
This assessment allowed me to use my strengths/talents.	0	3	1	12	41	43
I enjoyed completing this assessment.	1	3	9	21	37	28
This assessment allowed me to use my creativity.	3	5	19	31	28	15
In hindsight, I wish I would have selected a different type of assessment format.	23	39	32	3	1	3

Most students agreed that the assessment allowed them to demonstrate their knowledge and/or skills and that they were provided with sufficient information/directions to complete the assessment. A large proportion of students also agreed that the assessment allowed them to use their creativity.

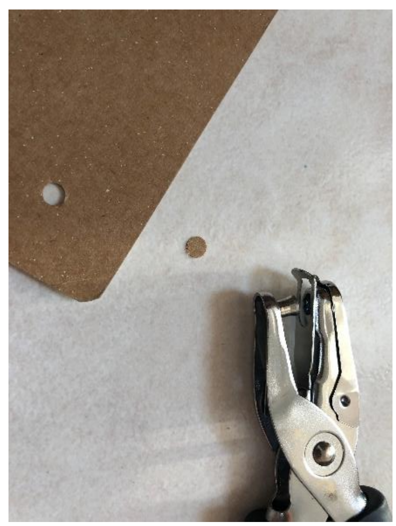
Brainstorming

Many of the mechanics concepts such as deformation under axial loading, deflection and rotation in beams, and column buckling can be taught by using the brainstorming technique. For this purpose, the instructor shares a sample with specific geometry, material, and loading. Students are asked to think and share suggestions to reduce a measured parameter (for example, deflection in a beam by changing the beam properties). The relationship between beam properties and deflection is formed gradually as students provide feedback during this activity.

Think-Pair-share

Think-pair-share technique allows the students to think individually, interact with their pair and share the information with all the students and their teacher. This technique helps students to improve and enhance their knowledge by sharing all the information, ideas, and skills [7]. Pictures from real-life examples relevant to the course topics are shared during class short recitation. Figures 2 (a) and (b) display examples of deflection in a baby toy and shearing stress due to hole punching, respectively. The mid semester survey revealed that more than 70% of students found real-life pictures helpful in their leaning and said that “Real life examples showcased how theories apply in the world around us, making concepts more understandable”.

(a)



(b)

Figure 2. Real life examples of engineering concepts, a) Deflection in a cantilever beam in a baby toy, b) Shearing stress in hole punching

Real World Examples

Universal Design Learning (UDL) principles suggest providing opportunities for active learning that build from real-world problems and multidimensional considerations [8]. Alternative methods are offered in this course enabling students to observe, identify and apply mechanics concepts in real world examples. These methods include a) sharing pictures of real-life examples relevant to mechanics during lectures, b) Test-your self-activity, c) strength-based projects.

Real-life Pictures

Pictures from real life examples that were relevant to the course topics were shared and discussed at the beginning of each lecture. Students were encouraged to use the think-pair-share method to identify the mechanics concepts in each picture. Later, they were asked to share relevant examples with the class. One of the students expressed in their student evaluation of teaching that

"the class is very reliant on equations, but I still understand what those equations mean in the real world and understand why this course is important for engineering in the field. Instructor makes the class interesting by using real world concepts or pictures of the things we are calculating."

Test-Yourself Activity

A numerical problem from a real-life example is posted under each lecture video in the course site. Students can apply their knowledge by solving a problem. The solution to the problem is available to students to evaluate their solutions. The students' opinion about the course tool was asked in the final class evaluation of teaching. More than 50% of students in the mid-semester survey expressed that they have used this tool and found it effective in their learning. Figure 3 displays an example of the test yourself activity.

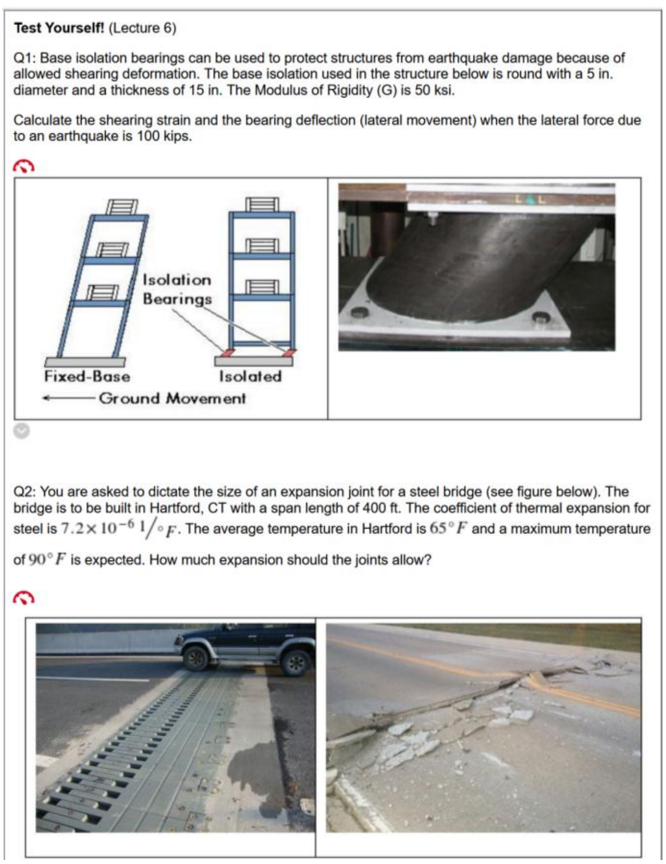


Figure. 3 Examples of the Test Yourself activity in the course site (topics of shearing strain and elongation due to change in temperature)

Strength-Based Projects

To enable students to apply their knowledge in the real world, a series of optional small strength-based projects (SBP) were added to the course. Students were able to contribute to the course based on their personal interests and expertise by completing small projects that application of a mechanics concept was demonstrated in a real-life example.

Students were prompted to identify one or more areas of interest such as photography, drawing, filming, sports, programming, computer gaming, comedy, woodworking, cooking, planting, poetry, reading, and/or puzzles. Google Forms was used to collect the students' information including their names, major, interests, and their potential project. Students were able to submit strength-based projects relevant to the topics covered every 4-5 weeks (approximately 3 chapters of the textbook).

Students created unique projects. Samples of the submitted projects are shown in Figure 4.

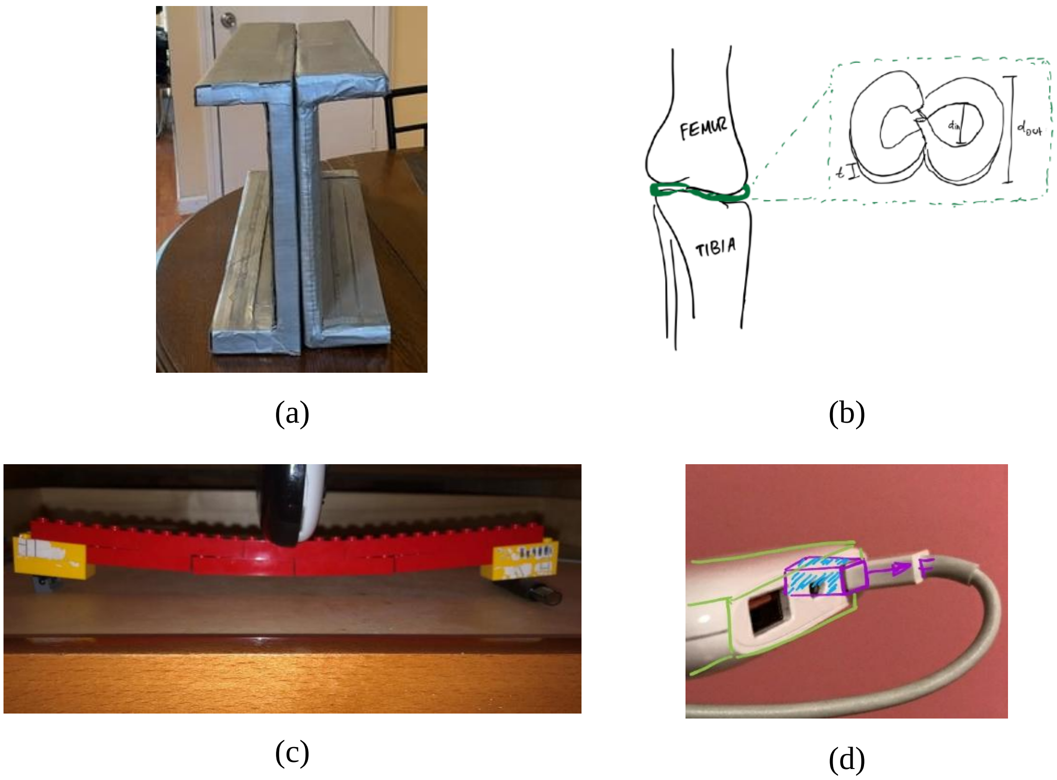


Figure 4. Sample SBP projects, a) Demo of built-up members, b) Normal stress in meniscus cartilage, c) Lego beam under bending, d) Shearing stress in a USB connector.

An anonymous post-project survey conducted using Google Forms at the end of the semester explored whether participating in SBPs have enhanced their feel of belonging, class engagement, understanding of the concepts, class participation, and skill of applying the concept in real life. Approximately 47% of invited students responded this survey. Table 2 shows the result of the survey in three consecutive semesters in which SBPs were offered.

Table 2. Summary of the students' response to the question if SBPs enhanced: (F=fall, SP=spring)

	Strongly Disagree (%)			Disagree (%)			Neutral (%)			Agree (%)			Strongly Agree (%)		
	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21
Feel of Belonging	0	0	0	0	0	5	6	0	0	47	29	25	47	71	70
Class Engagement	0	0	0	6	0	0	0	6	0	47	29	25	47	65	75
Understanding concepts	0	0	0	0	0	0	0	0	5	53	53	20	47	47	75
Applying concepts in Real life	0	0	0	0	0	5	12	6	0	24	6	10	65	82	85
Class Participation	0	0	0	0	6	0	6	0	0	47	29	20	47	71	80

More than 90% of students agreed or strongly agreed that their participation in strength-based projects enhanced their feel of belonging, class engagement, understanding, and the skill of applying concepts in real life.

Students were asked if they think similar strength-based projects are beneficial in other engineering courses. Approximately 70% of participants agreed or strongly agreed with this question. Students expressed that participating in strengths-based projects enabled them to contribute something towards the classroom, as well as apply academic principles to real-life situations. Knowing that their projects will be used in future courses for demonstration purposes make them feel even more important and enhance their feeling of belonging within the engineering field. Students reflected in their feedback that they were more creative with their ideas because they could choose projects which were aligned with their interests. One of the students mentioned

"I think the SBP projects made me think deeper about the concepts we learned in class and applying them to real life principles. It also made me more interested in the subjects because I could see where they came into play in my everyday life and the world around me."

Visual Learning Tools

The instructor built simple foam models to show design details and potential loadings and stresses. They displayed and interacted with the foam models during lectures to visually show deformation and failure modes. More than 80% of students reflected in the SET (Student Evaluation of Teaching) that these foam models were very helpful in their learning. However, they suggested that letting them interact with the models would be more beneficial.

Augmented reality (AR) was used to provide 3 dimensional (3D) models for challenging problems that former students may have had trouble with. SketchUp 3D modeling software was used to build the corresponding models. The models were launched and stored in an online application (Sketchfab) and shared with students. The Final SET revealed that 70% of students found the 3D models helpful with their performance when it was presented and explained about by the instructor during the lecture. Figure 5 displays an example of a foam model and an AR model used for this course.

(a)

(b)

Figure 5. a) Foam models to demonstrate shearing stress in punching, b) Augmented Reality using Sketchfab.

Assessments

I-course standards suggest that in an inclusive course, multiple forms of assessment (including exams, quizzes, homework, individual or group projects, term papers etc.) should be offered to students, allowing them to demonstrate their gained learning using alternative modalities [3]. Class assessments in this course included weekly homework assignments using McGraw-Hill Connect, online weekly quizzes, midterm exams, and in-class teamwork problem solving. In addition, students were given a second chance to enhance their final grade by taking an optional final exam. The weight of each assessment in the students 'final grade' is shown in Table 3.

Table 3. Weight of assessments in the Mechanics of Materials course

Course Components	**Weight**
McGraw-Hill Connect Homework	25%
Quizzes	15%
Teamwork problem solving	15%
Midterm exams (3 sets)	45%
**Final exam (Optional)	Grade can be replaced with the lowest Midterm exam

McGraw-Hill Connect

Online assignments via the eBook (McGraw-Hill Connect) were implemented in the course to address past challenges, including delayed feedback, the time-consuming task of grading for large enrollments, and plagiarism. Online assignment platform offers algorithmic, auto graded homework assignments. All students answer the same problem; however, the numerical parameters are different. This system prevents students from copying solutions. Students can check their work before submission and get access to the textbook resources. In addition, the auto grading feature eliminates the number of hours required for grading. It allows teacher assistants to dedicate their time to provide more one-and-one interactions to students. Solution to homework is available after the deadline. Students provided very positive feedback to this new platform. 82% of students expressed in the class mid semester survey that online homework is a better learning tool compared to the traditional submission (paper or electronic file). The only downside is that students cannot receive partial credit since they only insert the final answer for each problem.

Online Quizzes

Multiple choice online quizzes are offered at the end of each chapter. The objective is to offer an evaluation tool on the concepts covered every 7-10 days. Students have 2 attempts for each quiz. The wrong answers are displayed after the first attempt. Therefore, they can enhance their performance by addressing the errors in the 2nd attempt.

Teamwork Problem Solving Activities

Teamwork problem solving activities are both serving as a low stake assessment and an active learning tool in this course. The implementation and the students' feedback are shared earlier in this paper under "Active Learning". Approximately 12 sets of activities are offered to students during the semester. This activity is 15% of the students' final grade. The activity is offered randomly without notification to encourage students to be prepared for this assessment. The class policy allows students to complete up to two makeup teamwork activities during the semester if they are absent during the lecture.

Exams

There are 3 midterm exams offered. Each exam covers 3 chapters of the textbook and worth is 15% of the final grade. It was observed that the students' final grade is significantly affected if they perform poorly in some midterm exams. The instructor believes that students should be given a second opportunity to learn and be examined repeatedly until they master that topic. With the new policy, the final exam is optional. Students who have received satisfying grades in the 3 midterm exams will be exempt from the final exam. This policy encourages many students to work hard during the semester and perform well consistently. Other students can take the final exam and use its grade to be replaced with their lowest midterm exam. Students expressed that this policy kept them motivated and hopeful that by working hard, they could still do well in the course. Between 23 to 30 percent of enrolled students chose to attend the final exam to enhance their final grade (Table 4). The data collected from 3 consecutive semesters showed that students enhanced their final grade by an average of 4 points with a range of 0 to 14.5 points by using this policy.

Table 4. Final exam attendance and its impacts on the students' final grade

Semester	Enrollment	Attended Final exam	Average increase in the final grade (points)	Max increase in the Final Grade (points)
Fall 2020	166	39 (23%)	4.5	13
Spring 2021	74	20 (27%)	4.5	13
Fall 2021	199	59 (30%)	3.5	14.5

Continuous Student Feedback

It is required for an inclusive course to have a feedback mechanism in place to collect student feedback (i.e. a class suggestion board or quick survey with sticky notes) [3]. There were four platforms used in this course to collect student feedback on the different aspects of the course including 1) daily feedback 2) midsemester feedback, 3) student evaluation of teaching and 4) surveys on inclusivity conducted by an external evaluator.

Daily feedback

A Google application called Jamboard was used in multiple intervals during the semesters and after some of the lectures. This application facilitates an interactive environment for students to write a one-minute essay after each class. Students were able to use electronic sticky notes to share their comments after each lecture. In the one-minute essay, students were asked to list the muddiest points of the lecture or the topic that they learned the best. They could also provide any feedback to the instructor about the class such as teaching pace, class organization, and assessments. The QR code of the Jamboard link was displayed on the board, allowing students to scan and access the app on their smartphone.

Midsemester feedback

An anonymous survey including customized questions about the effectiveness of the course contents, teaching pace, class modality, and level of student engagement with the course were designed in the course site using Blackboard's survey tool. The survey included open ended questions in which students could provide suggestions to the class and write a self-reflection to enhance their performance in the course. The survey was shared with students in the 5th week of the semester. Approximately 50% of the enrolled students participated. Figure 6 shows a summary of the students' responses to the question "if different class components were beneficial to your learning". The data collected from one of the class sections (100 students enrollment) in the fall of 2021. The same pattern was observed in data collected from other cohorts.

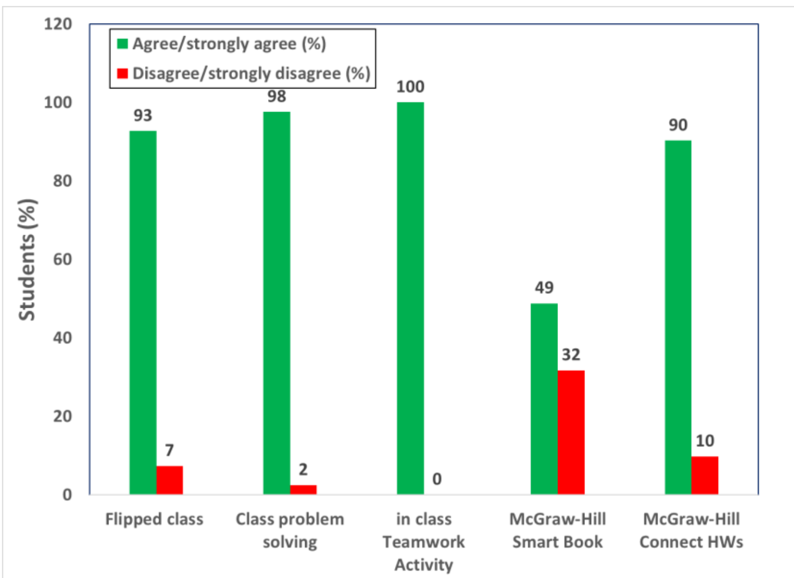


Figure 6. Results of the midsemester survey in the fall of 2021 (students' feedback about effectiveness of different course components) learning.

Student Evaluation of Teaching

A Student Evaluation of Teaching (SET) was conducted by the institution at the end of the semester in which students could provide feedback about their learning experience in the course.

Between 39-47% of the enrolled students responded (200 students in fall and 100 students in spring) this survey in the fall of 2020, the spring of 2021, and the fall of 2021. Table 5 summarize the SET results for a few selective questions relevant to universal design learning principals. The majority of students agreed or strongly agreed with the statements in SET.

Table 5: Results of the student evaluation of teaching (SET) (F=fall, SP=spring)

	Strongly Disagree (%)			Disagree (%)			Neutral (%)			Agree (%)			Strongly Agree (%)		
	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21	F20	SP21	F21
The methods of evaluating student learning seemed appropriate.	3	0	3	2	0	0	2	3	1	34	17	28	61	80	69
The course content was well organized.	2	0	1	3	0	0	3	0	4	19	11	17	74	89	79
The course objectives were clear.	2	0	1	0	0	0	3	0	3	30	17	21	66	83	76
The course objectives were met.	2	0	1	0	0	0	3	3	3	30	17	20	66	80	77
The course materials made a valuable contribution.	2	0	1	2	0	1	11	3	4	31	11	22	55	86	72
The pace of the course seemed appropriate	2	0	3	3	3	0	5	3	4	33	18	31	58	76	63
The instructor stimulated interest in the subject.	2	0	3	2	0	1	6	3	4	21	14	16	71	83	77
The instructor was accessible to students.	2	0	3	0	0	0	8	6	1	19	14	15	72	80	82
The instructor's teaching methods promoted student Learning.	3	0	1	0	0	1	8	0	4	9	11	12	73	89	83

The instructor had the opportunity to add three customized questions about the course. Additional questions were designed to collect the students' input about teamwork activities, the most helpful components of the course, and suggested alternatives for the exam assessments. Table 6 summarizes the students' feedback about the most and the least helpful components of the course in their learning.

Table 6: The students' response to the question "What components of the course helped your learning the most?"

	Rate of Response (%)	Lecture videos (%)	Sample solving Videos (%)	Test yourself problems (%)	Class discussion (%)	Teamwork activity (%)	Office hours (%)	SBP (%)	HW assignmnts (%)	Class notes (%)
Fall 2020	39	45	38	9	19	33	3	0	30	0
Spring 2021	47	46	49	0	17	20	0	3	23	0
Fall 2021	44	30	25	2	20	43	2	14	23	34

Students found pre-recorded videos and teamwork activities the most helpful and office hours and test yourself problems the least helpful to their learning.

Surveys conducted by an External Evaluator

The external evaluator of the NSF-funded project administered a survey focused on the strength-based projects and teamwork activities in fall 2021. This survey is currently being administered in spring 2022 to gather information on additional class components. Table 1 shows results of survey conducted on teamwork activity

Conclusions

The Mechanics of Materials course was redesigned in the summer of 2020 to meet the UDL principles and offer an inclusive learning environment to diverse learners.

The course accessibility was enhanced by adding captions to videos, using an eBook, live streaming, and providing the electronic file of class notes. Active learning techniques such as teamwork problem solving, using think-pair-share, and brainstorming were used to facilitate peer interactions and share real life examples for mechanics concepts. 76% to 93% of students agreed or strongly agreed that teamwork problem solving is beneficial to their learning.

Alternative tools were used to familiarize students with the application of mechanics' concepts in the real-world including strength-based projects and test yourself problems. More than 90% of students agreed or strongly agreed that participation in strength-based projects enhanced their feel of belonging, class engagement, understanding of the concepts, and the skill of applying concepts in real life.

Alternative assessments were offered to allow students to demonstrate their leaning in multiple ways. An optional final exam offered a second chance to students to enhance their grade by average of 4 points.

Multiple mechanisms were placed to collect student feedback about the course and the instructor's performance. The survey results revealed that the majority of students were satisfied with the course structure and resources, and they found the course engaging.

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Reviewer comments:

Overall, well written and organized paper. Following are my comments.
1) More references could be cited. There are many articles related to inclusive teaching, Flipped classrooms, etc.

Response: More references were added to the paper.
2) Minor grammar issue, should be easily fixed after review.

Response: Paper was reviewed again.

3)When talking about inclusive, many people think about diverse students' demographic. Any classroom can contribute to an inclusive climate. The paper focus on diverse teaching methods, i.e. apply universal design principles, bring in real world examples, etc., which are great to help students understand the course content. Are there relative research/survey were conducted to reflect that the redesigned course improved the classroom climate so that students are comfortable to participate in all class activities?

Response: only students who participated in Strength-Based project were asked if they participate more in class discussion. More than 90% agreed or strongly agreed that SBP enhanced their class participation.