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Strategies for Effective Engagement and Learning in the COVID-19 Environment

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Strategies for Effective Engagement and Learning in the Covid-19 Environment

Abstract

The COVID-19 pandemic forced the move from a traditional face-to-face classroom to a remote learning model. The success of the remote learning model is contingent upon several factors including appropriate learning materials. Instructors who were entrenched in the face-to-face teaching method had to make rapid adjustments to deliver learning materials and to engage students remotely. In contrast, instructors who had been using techniques to prepare students virtually before class time meeting were better positioned to pivot to the remote learning approach. The techniques and the materials developed by faculty from mathematics and aerospace engineering at an HBCU for effectively engaging students which include virtual pre-class preparation were adapted for the remote learning method during this pandemic. These techniques and materials were made available to faculty to assist their move from face-to-face to remote learning. The approach is shared in this paper. Math and aerospace engineering students' satisfaction with the approach was measured and the results are also included in this paper.

Introduction

The COVID-19 pandemic has given rise to several new terminologies and pedagogies. One such term is "remote-learning". The rapid move from face-to-face classes to a 'virtual' learning environment was unprecedented and full of challenges. While the online-learning paradigm is mature and reasonably well understood, a small number of faculty members are experienced in online learning pedagogy. Elements of a good face-to-face course include learning materials and assessments aligned with the student learning outcomes. The design of an online course not only has to ensure the inclusion of these elements, but also make appropriate use of technology for an effective virtual course delivery. Additionally, online courses have to be cognizant of the American Disabilities Act (1990) and Section 508 of the Workforce Rehabilitation Act requiring the provision of access and accommodations to students with disabilities [1]. The implementation of an effective online course therefore is the result of planned and deliberate activities. The various challenges of developing online courses have deterred faculty from embracing the pedagogy. A recent survey [2] of about 2000 faculty indicated that although there was steady increase in faculty experienced in online teaching, less than 50% faculty had taught at least one course online. In this backdrop, the challenges faced by faculty not experienced or having limited experience in online teaching while moving to a remote learning cannot be overstated. The quick pivot to remote learning course delivery did not allow faculty to go through the formal process of an online course design. The remote learning process was fraught with the well-known issues of virtual/online course delivery.

One of the major issues which plagues learning in general and even more so online learning, is student engagement which is an important parameter for student success. Engagement (affective, behavioral and cognitive; [3]) is also key to retention [4] – [6], learning [7], and the development of self-regulated learners [8], [9]. Educationally engaging activities had a proportionally higher positive impact on students from underserved groups [5].

Cognitive engagement can be considered as a proxy for learning [10]. (Pickering, 2007). According to [11] Blumenfeld, Kempler, and Krajcik (2016) elements of cognitive engagement are: Authenticity – relating with real life; Inquiry – collecting, analyzing, interpreting data; Collaboration – team work; and Technology. Thus, engaging online learners brings in added challenges which primarily center around communication and accessibility of content [12], [13].

This paper provides experiences of implementing strategies for effective engagement in a remote learning environment that were primarily designed for a flipped classroom. Challenges during COVID-19 pandemic with the remote instructions are discussed. This paper also provides results of the impact of the approach on students' engagement and motivation.

Method

The strategies to engage students in a remote learning environment were implemented in several lower-level math and aerospace engineering courses during the Spring and Fall 2020 semesters. The major change was a move from face-to-face to remote learning during the mid of the Spring semester (March) and the fall semester. The face-to face in-class active learning (peer-to-peer, white board activities, team projects/presentations etc.) had to be aligned with the virtual delivery/interaction modality. To encourage students prepare for the virtual lesson and watch the pre-class preparatory videos and other learning materials, graded short pre-class online quizzes using the learning management system and virtual in-class quizzes were administered. The authors had provided several professional development workshops to the faculty on these strategies prior to the decision to go to remote learning. Some faculty in math and aerospace engineering who had participated in the professional development indicated an interest in using these strategies in their remote teaching. These faculty members were assisted in implementing the strategies including the use of delivery strategies such as using iPads as virtual whiteboards during Zoom delivery. To assess the impact of the strategies, the students enrolled in the classes were surveyed. The survey was administered in the first week of the semester (pre-survey) and then was repeated at the end of the semester (post-survey) but prior to the final exam. In addition, these faculty were requested to identify the challenges that their students faced during the remote learning. The study was approved by the Institutional Review Board.

Participants

The participants of this study were undergraduate students enrolled in Pre-Calculus Algebra and Trigonometry, Calculus 1, Introduction to Aerospace Engineering, and Aerodynamics I. A total of 115 students enrolled in the math courses (59 in Spring 20, and 56 in Fall 20) responded to both the pre and post surveys. In aerospace engineering, a total of 52 students (20 in Spring 20 and 32 in Fall 20) responded to both the pre and post surveys. All the students self-identified as African American.

Materials

Learning Materials: The materials included short (< 15 minute) videos explaining the basic concepts that were to be reinforced in the synchronous online class with hands-on problem solving and group work using zoom breakout rooms. The virtual in-class active-learning was implemented through solving of appropriately scaffolded problems at varying levels of Blooms taxonomy. Virtual peer-to-peer interactions were implemented through the use of Zoom breakout rooms.

Assessment Instruments: The impact on the students' motivation as a result of the learning environment, was measured using the Motivational Strategies and Learning Questionnaire (MSLQ) [14]. This instrument measures the dimensions of self-efficacy (5 items), intrinsic value (9 items), test anxiety (4 items), cognitive strategies (13 items) and self-regulation (9 items) on a 5-point Likert scale (1- Strongly Disagree, 2 - Disagree, 3 -Neutral, 4- Agree, 5 - Strongly Agree).

Results and Discussion

There were several challenges experienced during the move from face-to-face to a remote delivery. These challenges which were reported by the faculty included difficulties with internet connectivity, not having access to the internet, not having access to a computer, and the privacy concern of the remote learner. Pedagogical challenges of engagement, implementing active learning were compounded by the delivery mode of remote learning. For example, asking students to share their process for solving a problem (e.g writing formulas or drawing figures) using the virtual white board was frustrating unless they had access to a tablet. Similarly, certain aerospace engineering hands-on activity were not possible in the remote environment. When possible, phone cameras were improvised as 'document cameras' for students to share their work using paper and pencil. These challenges necessitated rethinking the active learning opportunities that were amenable to a remote learning environment. The impact of the pedagogical strategies for engagement in the remote learning environment were measured using the MSLQ survey. Results are reported for those students who took both the pre- and post-surveys. The comparisons of the averages of the pre-post responses were done using repeated measures two-tailed t-tests with a $p < 0.05$.

In the Spring 20 (SP20) semester, the strategies for engaging students were implemented in MATH 107 (Pre-Calculus Algebra), MATH 108 (Pre-Calculus Trigonometry), and MATH 207 (Calculus-I). In aerospace engineering, the strategies for effective engagement were implemented in AENG 200 (Introduction to Aerospace Engineering Lab), AENG 242 (Aerospace Structures-I) during SP20. In the Fall 20 (FA20) semester, the effective engagement strategies were implemented in MATH 107, MATH 108, MATH 110 (Pre-Calculus Algebra and Trigonometry), and MATH 207. The strategies were also implemented in AENG 100 (Introduction to Aerospace Engineering), AENG 244 (Aerodynamics-I), and AENG 342 (Aerospace Structures II) during the FA20 semester.

The average responses of the students enrolled in all the Math classes during each of the semester were analyzed (Fig. 1 and Table I). The improvements in all the five dimensions of the MSLQ were statistically significant ($p < 0.05$) as measured by the pre-and post- tests. It was observed that the students in the FA20 semester had a higher self-efficacy as compared to the students during the SP20 semester at the start of the semester. While students in both semesters increased their self-efficacy by the end of the semester, the FA20 students reported higher gain.

Similarly, the students in the FA20 semester reported lower test anxiety at the start of the semester as compared to the students in the SP 20 semester. Students in both semesters reported reduced test anxiety by the end of the semesters. The change (reduction in test anxiety) in this dimension was the largest of all dimensions. The largest standard deviation (SD) was noted in the responses to the test anxiety dimension in both semesters and both pre and post-tests.

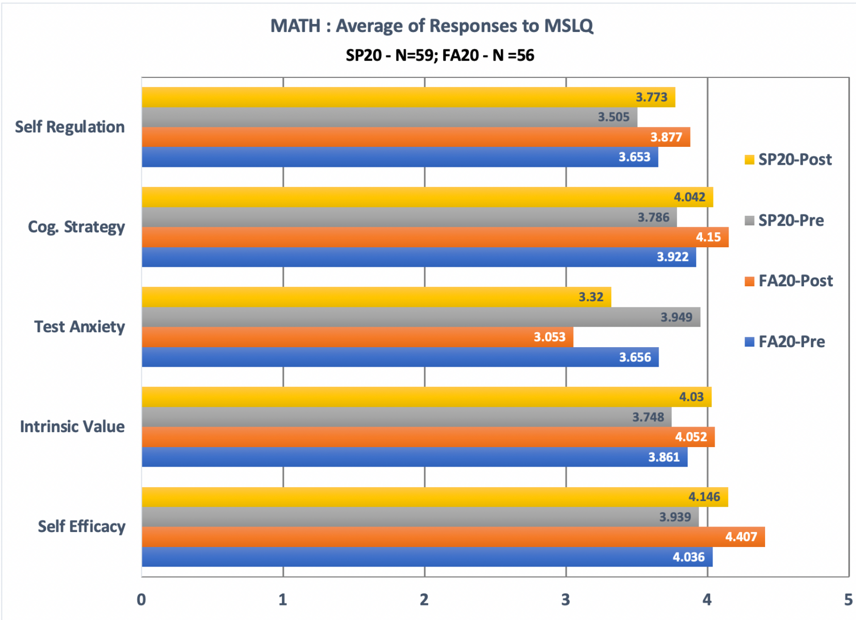

Figure 1: Comparison of Average Responses of Students Enrolled in all Math Courses

		Self Efficacy	Intrinsic Value	Test Anxiety	Cog. Strategy	Self Regulation
FA 20	Pretest Ave	4.036	3.861	3.656	3.922	3.653
	Pretest SD	0.625	0.505	0.900	0.363	0.439
	Posttest Ave	4.407	4.052	3.053	4.15	3.877
	Posttest SD	0.494	0.537	1.056	0.419	0.427
SP 20	Pretest Ave	3.939	3.748	3.949	3.786	3.505
	Pretest SD	0.743	0.574	0.765	0.410	0.472
	Posttest Ave	4.146	4.030	3.32	4.042	3.772
	Posttest SD	0.521	0.444	0.813	0.410	0.425

Table I: Comparison of Average Responses of Students Enrolled in all Math Courses

The analyses of the pre/post responses of the students in each of the Math courses in which the strategies for effective engagement were implemented, indicated trends that were similar to the aggregate data. As an example, the analysis for MATH 107 is shown in Fig. 2 and Table II. The students enrolled in FA20 were all incoming freshmen and almost all the students enrolled in SP20 were repeating the course. In both semesters, an improvement in all dimensions was observed. This improvement was statistically significant ($p < 0.05$) for all dimensions except for the self-efficacy dimension for the SP20 semester. Also, higher positive changes were observed in the FA20 semester (Fig. 2 and Table II) as compared to the SP20 semester. The largest change was observed in the test anxiety dimension. It was noted that students came in with higher test anxiety in the SP20 semester as compared to the FA20 semester. One reason for the higher test anxiety at the start of SP20 might be that these Math 107 students were repeating the course, so they were concerned about their success. The gain in self efficacy was higher in the students enrolled in FA20 semester as compared to the students of SP20. The largest standard deviation (SD) was noted in the responses to the test anxiety dimension in both semesters and both pre and post-tests.

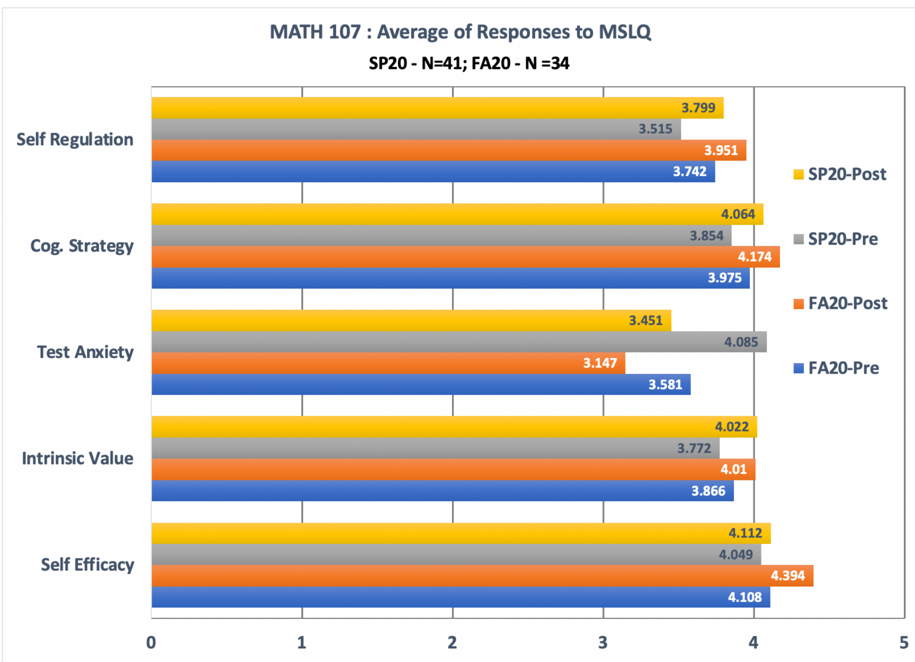

Figure 2: Comparison of Average Responses of Students Enrolled Math 107

		Self Efficacy	Intrinsic Value	Test Anxiety	Cog. Strategy	Self Regulation
FA 20	Pretest Ave	4.111	3.815	3.556	3.949	3.642
	Pretest SD	0.625	0.577	0.788	0.288	0.337
	Posttest Ave	4.394	4.01	3.147	4.174	3.951
	Posttest SD	0.529	0.582	1.079	0.699	0.453
SP 20	Pretest Ave	4.049	3.772	4.085	3.854	3.515
	Pretest SD	0.756	0.498	0.649	0.434	0.496
	Posttest Ave	4.112	4.022	3.451	4.064	3.799
	Posttest SD	0.504	0.454	0.757	0.400	0.405

Table II: Comparison of Average Responses of Students Enrolled in Math 107

The average responses of the students enrolled in all aerospace engineering classes during each of the semester were analyzed (Fig. 3 and Table III). In the SP20 semester, improvements in all the five dimensions of the MSLQ were statistically significant ($p < 0.05$) as measured by the pre- and post-tests. In the FA20 semester, while improvements in all the dimensions were observed, only the self-efficacy and self-regulation dimensions registered statistically significant improvements. Two items of the test anxiety dimension namely nervousness in a test, and worrying about tests, registered statistically significant improvements. It was observed that the students in the FA20 semester had a higher self-efficacy as compared to the students during the SP20 semester at the start of the semester. While students in both semesters increased their self-efficacy by the end of the semester, the SP20 students reported higher gain. Similarly, the students in the FA20 semester reported lower test anxiety at the start of the semester as compared to the students in the SP 20 semester. Students in both semesters reported reduced test anxiety by the end of the semesters. The reduction in test anxiety and increase in self-efficacy were the largest of all five dimensions. The largest standard deviation (SD) was noted in the responses to the test anxiety dimension in both semesters and both pre and post-tests.

Figure 3: Comparison of Average Responses of Students Enrolled in Aerospace Courses

		Self Efficacy	Intrinsic Value	Test Anxiety	Cog. Strategy	Self Regulation
FA 20	Pretest Ave	4.138	4.316	3.281	3.925	3.653
	Pretest SD	0.576	0.398	1.021	0.421	0.439
	Posttest Ave	4.463	4.413	3.086	4.002	3.877
	Posttest SD	0.429	0.344	1.158	0.473	0.427
SP 20	Pretest Ave	3.940	4.25	3.5	3.915	3.505
	Pretest SD	0.656	0.574	1.007	0.534	0.472
	Posttest Ave	4.46	4.389	3.0	4.192	3.772
	Posttest SD	0.486	0.444	0.946	0.441	0.425

Table III: Comparison of Average Responses of Students Enrolled in Aerospace Courses

The comparison of two aerospace engineering courses AENG 100 and AENG 200 (each one credit hour) provided useful insight (Fig. 4 and Table IV). The AENG 100 was taught in FA20 and consisted of first semester freshmen. The students in AENG 200 which was taught in SP20 consisted of freshmen in their second semester. The average of the responses to the items of self-efficacy of the first semester students was slightly higher than the second semester students at the start of the semester. However, by the end of the semester, the SP20 student responses indicated a higher gain in self-efficacy as compared to the FA20 students. The increase in self-efficacy was statistically significant for students in both courses. The test anxiety of the students in the FA20 semester was slightly lower than the students in the SP20 semester. The responses of the FA20 semester students indicated a reduction in their test anxiety by the end of the semester though not statistically significant. The SP20 semester students' text anxiety reduction by the end of the semester was statistically significant. Students in both courses entered with similar averages of responses to the items in the cognitive strategies dimension. However, the FA20 semester did not make much improvement in their understanding and use of cognitive strategies for learning. The gains made by the SP20 semester students were statistically significant. Students in both semesters made statistically significant gains in the average of responses to the items of self-regulation. The largest standard deviation (SD) was noted in the responses to the test anxiety dimension in both semesters and both pre and post-tests.

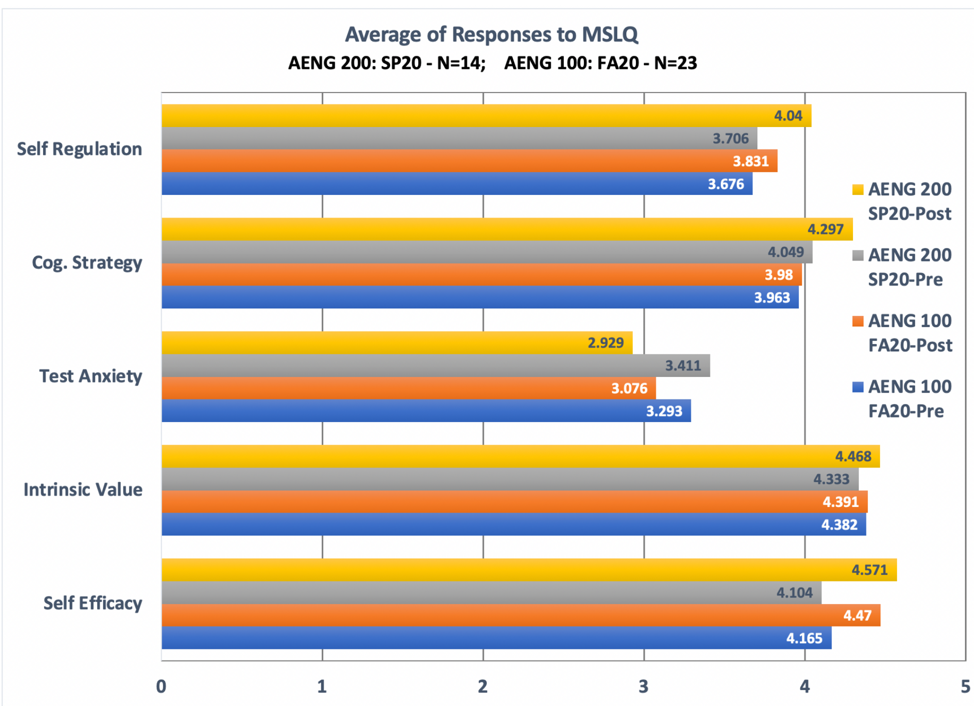

Figure 4: Comparison of Average Responses of Students Enrolled in AENG 100 and AENG 200

		Self Efficacy	Intrinsic Value	Test Anxiety	Cog. Strategy	Self Regulation
FA 20	Pretest Ave	4.165	4.382	3.293	3.963	3.676
	Pretest SD	0.558	0.314	0.958	0.415	0.477
	Posttest Ave	4.470	4.391	3.076	3.980	3.831
	Posttest SD	0.458	0.333	1.127	0.515	0.499
SP 20	Pretest Ave	4.014	4.333	3.411	4.049	3.706
	Pretest SD	0.620	0.382	0.875	0.574	0.686
	Posttest Ave	4.571	4.468	2.929	4.297	4.040
	Posttest SD	0.429	0.311	0.901	0.488	0.659

Table IV: Comparison of Average Responses of Students Enrolled in Aerospace Courses

Note that the cohorts in the SP and FA semesters are not similar. For example, students in MATH 107, and AENG 100 in FA20 are incoming Freshmen, whereas the students in the MATH 107 and AENG 200 in SP20 had already spent at least a semester in college which might confound a comparative study.

Summary and Conclusions

The materials and methodologies developed for effective engagement were successfully deployed in the remote learning environment necessitated by the COVID-19 pandemic. Statistically significant gains in the various dimensions of the Motivational Strategies and Learning Questionnaire (MSLQ) were observed. The data analysis also provided insight in areas of emphasis such as cognitive strategies for learning, self-regulation for first semester students. Lower average of the responses to items on the intrinsic value dimension of students in the math courses as compared to average of students in the aerospace engineering classes indicates opportunity for better explanation of the importance of the math classes in their upper-level math and major courses.

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