

# The Relationship Between Demographic Characteristics and Engagement in an Undergraduate Engineering Online Forum

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**Abstract**—This Research Category Full Paper explores the relationship between the demographic characteristics of students and their participation in an online forum. Online discussion forums have become widely used in undergraduate classrooms. They extend the learning space beyond the classroom and provide asynchronous opportunities for peer-to-peer collaborations. Past studies have suggested that online posting behavior plays a role in students' learning outcomes; however, the study of the demographic characteristics of students who do or do not participate in online discussions is limited. We address this research question here. We chose our demographic variables based on prior studies of students' general online behaviors, and therefore we compare gender, race/ethnicity and international status, as well as declared majors, with engagement in the online forum. The discussion forum provided a platform for the students to ask or answer their peers' questions about the course material and homework assignments. The setting for this study was a sophomore-level dynamics and vibrations class that incorporated active, blended, and collaborative learning strategies. We tracked an individual's posting behavior throughout a semester. Study participants were grouped by whether they posted to the discussion forum at least once, and the Chi-squared test of independence was used to determine the statistical significance of demographic differences across the participation groups. The data show that female students were significantly more likely to be involved in online discussions than their male counterparts. Also, White and Asian American students were overrepresented, and international and Hispanic students were underrepresented in the engaged group. Interestingly, students who were required to take this specific course as a graduation requirement do not show more engagement than those who took this class for general engineering credits. This work extends our knowledge of who uses online collaboration tools, and in the future, we will analyze the content of the engagement (posts and comments) and explore the influence of forum participation on the students' grades.

**Keywords**—Online Discussion Forums; Demographic Characteristics; Gender; Ethnicity; Online Participation.

## I. INTRODUCTION

Based on a 2002 survey of over 50 US online learning program directors, the proportion of students' online enrollment was projected to increase from 20.2% to 36.6%

over the last two decades [1]. In 2013, Allen and Seaman reported that enrollments in online courses increased with an annual rate of 17 percent, after ten years of tracking online education [2]. Compared with online study, the proportion of students who enrolled in blended courses was projected to increase faster, from 7.6% to 21.1% [1]. Since 2009, instructors in a large Midwestern university have developed and implemented an innovative Active, Blended, and Collaborative (ABC) learning environment called Freeform. This learning environment was applied to a sophomore-level undergraduate engineering course. Since the Freeform learning environment was first implemented, the rate at which students received a final grade of D, F, or Withdraw from the course has reduced, suggesting an improvement in the students' performance in the course; this improvement has been shown to be significant even when controlling for changes in the incoming students' preparation [3]. Given this, it is important to understand how students engage with the various learning resources available to them in the Freeform learning environment. The blended component of the learning environment includes many resources such as an online video library of worked examples, homework solutions, and an online discussion forum [4]. This latter resource is also a collaborative avenue for students to work together on course concepts.

In this paper, we investigate how participation in the online discussion forum as a binary variable relates to the students' demographic characteristics. We explore the differences between students who participated and who did not participate in the forum based on their gender, international status, race/ethnicity, and declared major. We test the correlations of these demographic characteristics with participation status to better understand how the diverse students in the class engage with what has been shown to be a supportive learning tool. To this end, the research question guiding this paper is:

*What is the relationship between students' participation status in the discussion forum (whether they do or do not post) and students' demographics (gender, nationality, race/ethnicity, and major)?*

Descriptive and inferential statistical analysis using a Chi-squared test of independence are used to explain the relationship between demographics and students' online

discussion forum participation. The result of this paper will help us to understand the students' participation in an online collaborative space, which is one part of a complex learning environment that combines Active, Blended, and Collaborative (ABC) learning.

## II. LITERATURE REVIEW

### A. Online Discussion Forum

The current educational norm in residential higher education is that students have access to support during class hours and limited office hours. Students do not have many formal opportunities to interact with their instructors or peers outside of the class [5]. The introduction of an online discussion forum in a class provides a space open for all of the students in the class to communicate with their peers, teaching assistants (TAs), and even their instructors outside of class and office hours. Such a discussion forum provides a public space where ideas can be exchanged, questions can be shared, and information can be stored. Students can help each other by clarifying their misconceptions without temporal or geographical barriers [6]. Recently, online discussion forums have become more and more popular among undergraduate courses due to their asynchronous nature [7], [8]. Asynchronous communication does not require the simultaneous participation of all students and instructors. They can view the messages multiple times after they have been posted. In addition, Bullen has reported that an asynchronous discussion forum is an effective mode for critical thinking and analysis, as it encourages students to write down the thoughts and ideas that they learned in the course [9].

Learners' participation in online discussion forums has been widely discussed as a critical part of students' learning processes. Many studies have shown that students' participation in an online discussion forum enhances their learning performance, as measured by grades [10]–[13]. For example, Minichiello and Hailey have suggested that engaging in online learning forums is highly correlated to student performance in first-year calculus [6]. Another study was conducted to analyze discussion in an online course by Picciano, who found that students perceived a greater quality and quantity of learning as a result of participating in the discussions [14]. Most studies have focused on the relationship of students' participation in an online discussion forum with their academic performance. Given the positive relationship demonstrated in most prior work, it is then important to investigate whether all of the diverse groups of students in a course are engaging with this beneficial resource. Only a limited number of prior studies have focused on investigating the significance of students' demographic characteristics, and they suggest the importance of three key factors: gender, international status and race/ethnicity, and major.

### B. Gender

Most of the limited number of previous studies that including gender have shown that female students are more engaged on online discussion forums than their male counterparts. For instance, Savicki, Kelly and Ammon reported that female students were more active and posted longer messages [15]. Prinsen, Volman, and Terwel found that females posted more messages to an online discussion forum

than male students did [16]. Caspi examined the gender differences between face-to-face and online classrooms and found that women disproportionately posted messages on the online environment because they preferred texting or posting messages over speaking in person when communicating with their peers. This was attributed to their experience of communicating over the Internet, which offered a less male-dominated social experience [17]. We contribute to this area of scholarship by testing for differences in participation by gender in a course where both face-to-face peer collaboration and online peer collaboration are available.

The gender difference in online participation becomes diminished for graduate students. Another study showed that men and women participated equally in an online discussion forum based on a graduate level course [18]. In addition, Chuang, Hwang and Tsai found that the males engaged more on a web-based physics online forum than females, because they enjoyed the process of negotiation and discussion with others and demonstrated better adaptability to the Internet-based learning approach [19]. In summary, the limited prior studies correlating gender to discussion forum participation found that female students preferred online engagement to in-class discussion, but male students were more engaged in a solely online STEM course.

### C. Race/ethnicity and International Status

There are other important aspects that may be related to student participation. Ke completed a study on how students' ethnicities correlate to their participation in an online learning forum and concluded that students who were part of under-represented minority groups reported lower satisfaction with the web-based and distance-learning class [20]. Ku's work also documented that international students felt less comfortable discussing their questions in such a public, online space, and thus were underrepresented when participating in the online discussion forum [21]. Another study reported that Black and Hispanic students were significantly less engaged in an online STEM course [22]. In our study, we test for differences in race/ethnicity and international status, which, due to the way in which our university offices collect the data, often overlap.

### D. Major

Huang has reported that with prior knowledge, students' learning performance improved as they participated in an online discussion forum [23]. Yukselturk revealed that there was no relationship between the students' participation in the online discussion forum based on their age, education level, prior web-based learning experience, and domain knowledge [11]. However, there are not many studies that have examined students' major related to online participation. Given the lack of consensus on the importance of major, it is helpful for us to understand this relationship.

The importance of participation and interaction in STEM courses, especially on an online discussion forum is extensive in the literature. While most of the demographics studies on online discussion forums have examined their influence on students' participation in a complete blended environment, this paper focuses on an asynchronous discussion forum as part of an ABC learning environment. Students in this

TABLE I. Individual characteristics for which we test significant association with participation status. The number and percentage of students for each category are also shown. Categorization is based on available data as collected from university data system.

Variable	Description	Categories	Total number of students	Percentage
<b>Gender</b>	Binary simplification	Men	730	82.49%
		Women	155	17.51%
<b>Nationality</b>	International status of students	Domestic (USA)	651	73.56%
		International	234	26.44%
<b>Ethnicity</b>	Students' self-identified racial/ethnic classification (only reported for domestic students)	White	508	57.40%
		International	234	26.44%
		Asian American	61	6.89%
		URM	44	4.97%
		Others	38	4.29%
<b>Major</b>	Students' declared academic major when taking the course	Mechanical Engineering (ME)	715	80.79%
		Other Engineering (non-ME)	170	19.21%

environment met with their instructors and collaborated with peers in the classroom to work on group quizzes. In addition, some of the students live on campus and work with their peers regularly outside of the class. This study adds to the existing literature on how the students' demographic characteristics make a difference in their participation in the online discussion forum, especially when the students have multiple opportunities to meet with their peers inside and outside of the classroom.

Further, we focus on the dichotomous distinction between students who do not post at all and students who post one or more times. We draw this distinction, rather than looking at the number of posts a student makes, for multiple reasons. Over half of the students do not make a post at all. This was the case despite the forum being a rich problem-solving support space. It is crucial that we understand the differences in students who post. In particular, given the need to identify mechanisms for supporting students who are underrepresented in engineering, it is important for our team to understand the demographics of the students who do and do not post on the course forum.

### III. METHOD

#### A. Participants

The participants in this study were students who were enrolled in the Dynamics course in the Spring of 2015, Spring of 2016, and Fall of 2016 at a large Midwestern university. In total, there were 954 students who registered for the course in the three semesters. 885 out of 954 students (93%) consented to join the study.

#### B. Data Collection

This online discussion forum assigned each post on a thread a unique identification number (ID). As long as students posted a message, their posts were recorded with the unique ID and the student's school ID. Every post was extracted into a csv file along with relevant meta-information, which included the ID of the student who posted, whom the post was communicating with on the same thread, and the post time. In this class, the instructor always started a new thread by posting homework problems or lecture notes, and students could post their questions or opinions as comments under the instructor's post. Figure 1 below is a screenshot from the course online discussion forum (with identifying information

removed). After the instructor posted a homework question to start a new thread, the students could start to post their ideas or questions on this thread.

To determine the participation of the students on the online discussion forum, we counted the total number of posts from each student. If the student posted once or more, we counted them as a participant, and otherwise we counted them as a nonparticipant. In total, 360 students participated in the course's online discussion forum, and 525 students did not participate. The total number of messages sent during the three sampled semesters was 2237. These only included the students' posts and replies, as initial posts from instructors and teaching assistants were not included.

#### C. Methodology

The independent variables of students' demographic characteristics (gender, race/ethnicity, and major) were obtained from university data systems for students in the class who consented to participate in this research. The list of the independent variables, description, and categories of the variables are presented in Table I. We have combined race/ethnicity and international status, and summarized Hispanic, Latino, and African American as "URM (underrepresented minority)". We compared students from Mechanical Engineering (ME) to students from non-ME, which includes Agriculture and Biological Engineering (ABE), Nuclear Engineering (NE), Multidisciplinary Engineering, and Biomedical Engineering (BME), since the course is predominately composed of ME students.

Every enrolled student's profile data was imported into R. First, we filtered out students who did not consent to join in the study. Then, three data frames of user personal profile data, plus the number of posts a student made, were determined. As shown in Figure 2, we visualize the descriptive differences in gender representation of participants and nonparticipants as compared to the overall representation of the class. The first column shows the gender breakdown for students who did not post in the online forum ("Nonparticipants"); the second column represents the students who posted in the online forum at least once ("Participants"); and the third column shows the breakdown for all of the students enrolled in the class ("Total"). We use a similar process to visualize the demographic breakdowns for our other variables of interest. Manual validation was

done as we counted the number of students who posted less than 5 times, and we compared the result with that provided by R. Bar charts were generated for each of the selected demographics. Chi-squared tests of independence were then applied to test whether the observed proportions for a categorical variable were significantly related to whether or not students made a post in the online discussion forum [24].

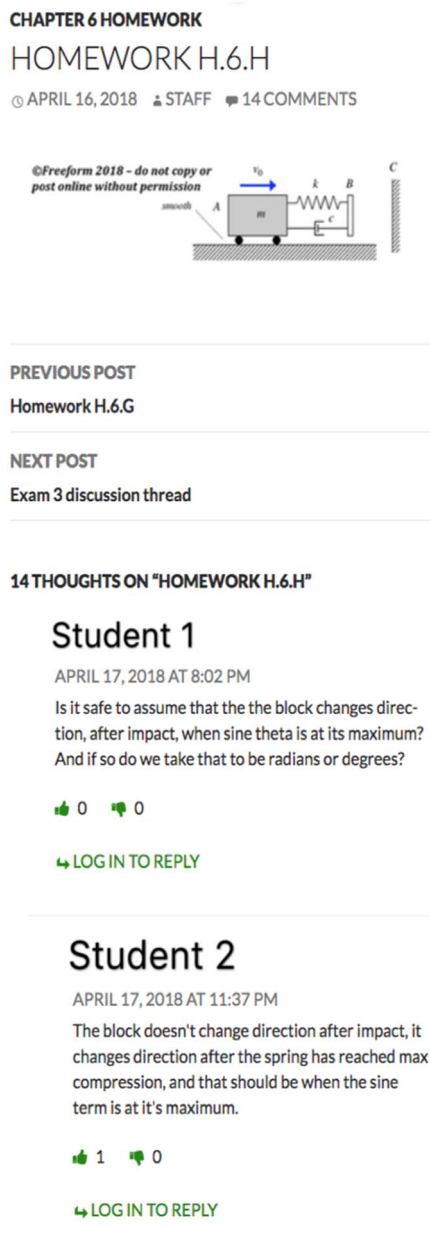


Fig. 1. A screenshot from the course online discussion forum. An instructor starts a thread by posting a homework question for example, and students can leave comments under this thread.

#### IV. RESULTS

The results of the study will be presented for each hypothesis we test: gender, race/ethnicity and international status, and major.

#### A. Gender Distribution

Female students are significantly more active in the discussion forum than male students. As shown in Figure 2, 23.89% of the participants in the discussion forum were female students, while only 17.54% of students enrolled in the class were female. The percentage value is less than that of the male students due to the unbalanced ratio of the engineering class. While men represent 76.11% of the participants in the discussion forum, they represent 82.49% of the total class enrollment. 55.4% of female students posted at least once in the online discussion forum, and female students were relatively more active in participating than their male counterparts. The significance of gender is similar to the result from previous studies of environments where women preferred online participation [11], [25]; this prior work showed that women are more active than male students on social network media and online discussion blogs.

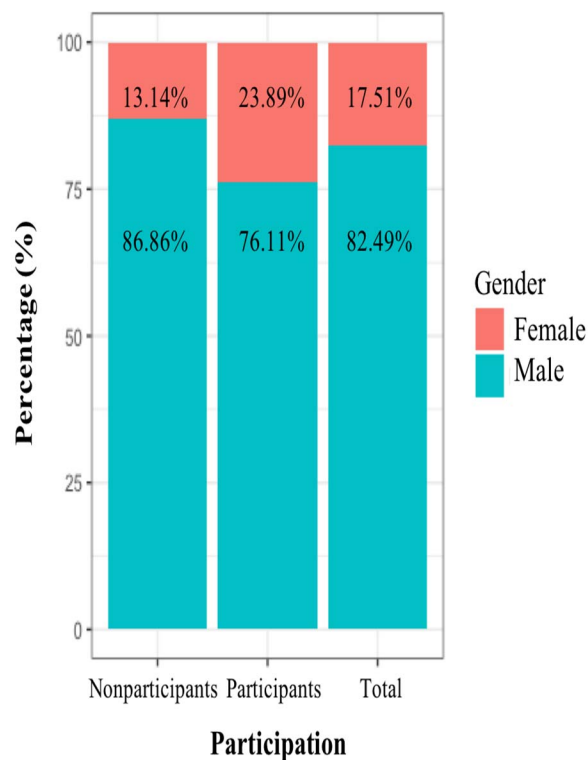


Fig. 2. Student gender distribution among participants, nonparticipants, and total. It is shown that 23.89% of participants were female students. Compared with the total female/male students ratio, female students were more active on the online discussion forum than their male counterparts.

#### B. Race/Ethnicity and International Status Distribution

Figure 3 shows the nationality and race/ethnicity distribution of the sample data. Our total class data shows that the students who identify as white American dominate the population (57.40%), followed by international students, and Asian Americans. Among all of the discussion forum participants, 62.22% identify as white Americans, and 54.10% of nonparticipants identify as white. As such, we can see that white Americans are over-represented in the participant population as compared to their representation in the course. Next, from column three, we can see that 26.44% of the total class students are international students, but this ratio decreases to 20.83% in the "Participants" column. As a result, international students look under-represented in the

discussion forum. Moreover, originally the class contains 6.89% of Asian Americans and 4.97% of URM. The ratio of Asian Americans in the “Participants” column increases to 8.06%, but the ratio of URM decreases to 4.44%. The analysis shows that Asian Americans are more involved in the online forum, and URM post less frequently (as compared to their representation in the class overall). This observation about relative participation rates is consistent with previous work [6], which found that under-represented students reported lower satisfaction with the web-based distance study. Their lower satisfaction may help to explain their lower participation rate. In this case, we did not look into the “other” group, which includes students who identify with 2 or more racial/ethnic groups, and “Unknown” students since the sample size was too small.

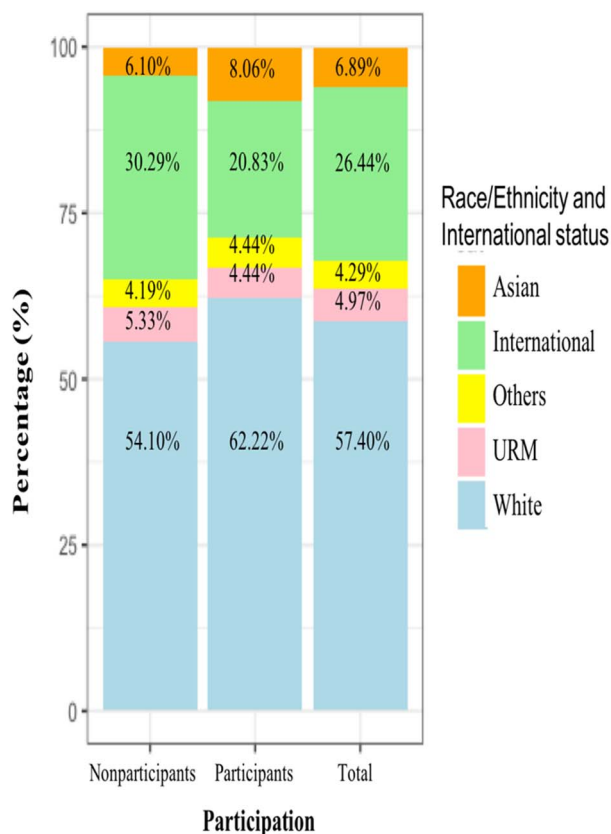


Fig. 3. Students' Race/Ethnicity and International Status Distribution. Among different racial/ethnic and international status groups, it is clear that White and Asian Americans are over-represented in participation in this online discussion forum. On the other hand, the international students (non-US citizens) and URM (Underrepresented Minority) American groups communicate relatively less online.

### C. Major Distribution

Figure 4 shows the distribution of students by major. This online discussion forum is designed for a Dynamics course, so not all engineering students are required to take the course. Some students take it as an elective. From the graph, we can see that there are overall approximately 80.79% mechanical engineering (ME) students, and 81.39% of participants are MEs. Those two ratios do not show a large practical difference. Later in this paper, we estimate Chi-squared tests of independence to help us determine whether students' majors are significantly related to their online participation, gender, international status and race/ethnicity, and major.

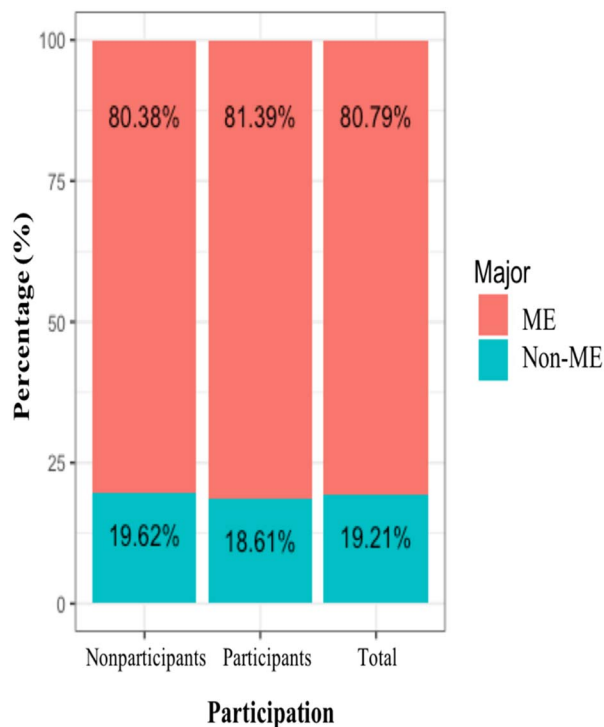


Fig. 4. Major Distribution among participants, nonparticipants, and all students. ME represents Mechanical Engineering, non-ME includes agricultural and biological engineering, nuclear engineering, biomedical engineering and multi-disciplinary engineering. From the graph, there is not a distinguished difference between the ratio of MEs among participants and among total enrolled students.

### D. Chi-Squared Test of Independence

In order to more rigorously examine our research question, the demographic relationships were tested using two-way contingency table analysis (Chi-squared for independence).

The Chi-squared test revealed that student participation in the discussion forum was statistically significantly related to gender ( $p < 0.001$ ) and race/ethnicity/international status ( $p = 0.024$ ). However, the result showed that there was no relationship between students' online participation and declared major ( $p = 0.709$ ). Students' gender had the strongest correlation to their participation in the online discussion forum (Cramer's  $V = 0.139$ ). Table II summarizes the various individual characteristics of students based on their participation status in the blog.

## V. DISCUSSION AND ANALYSIS

### A. Discussion

Discussion forums in education are intended to both support learning and foster an online community. It is important to develop a research understanding of how these goals can be reached. Communication and interaction between students have been shown to increase student success and help to increase the quality of instruction. In other words, one of the key components of the students' learning experience is meaningful interaction with peers and teachers [26]. Students' participation in an online discussion forum is a measurement for both course engagement and

TABLE II. Individual characteristics for which we test for significant association with students' participation in the online discussion forum

	<i>Participants</i>	<i>Nonparticipants</i>	<i>Total</i>	$\chi^2$	<i>P</i> *	<i>Cramer's V</i>
<b>Gender</b>				16.333	<<0.001	0.139
<b>Female</b>	86	69	155			
<b>Male</b>	274	456	730			
	<i>Participants</i>	<i>Nonparticipants</i>	<i>Total</i>	$\chi^2$	<i>P</i> *	<i>Cramer's V</i>
<b>Race/ethnicity and international Status</b>				11.236	0.024	0.113
<b>White American</b>	224	284	508			
<b>Asian American</b>	29	32	61			
<b>International</b>	75	159	234			
<b>URM</b>	16	28	44			
<b>Other/Unknown</b>	16	22	38			
	<i>Participants</i>	<i>Nonparticipants</i>	<i>Total</i>	$\chi^2$	<i>P</i> *	<i>Cramer's V</i>
<b>Major</b>				0.140	0.709	0.013
<b>ME</b>	293	422	715			
<b>Non-ME</b>	67	103	170			
<b>Total</b>	360	525	885			

\* $\alpha = 0.05$

collaboration with peers. There are a number of factors affecting participation in an asynchronous online discussion forum. This study laid the groundwork for the closer study of students' online discussion forum engagement by examining differences in participation by demographic factors.

The results of this study confirm that female students are significantly more active in participating in an online discussion forum as compared to males. Other qualitative studies help us to further understand why this significant difference is observed. Prinsen, Volman, and Terwel reported that female students show higher likelihood of reading what others have posted on the discussion forum, which motivates them send and respond to more messages than males do [14]. Tsai conducted a study to compare male and female students' participation in an online discussion forum in a blended learning environment, and the author found that female students perceived more freedom in thinking in online discussion, and they thus were more active on the online discussion. Visual clues were reported as important for male students as they interact with peers in group discussions and for idea elaboration, so they preferred to communicate with their peers face-to-face [27]. These studies not only help to explain why we may see this significant difference, but also why the online collaboration tool in this course can serve as an important mode of communication for women who are underrepresented in engineering degree programs.

There are few prior studies related to race/ethnicity and online participation, despite the fact that we show in this study that race/ethnicity and international status play an important role in online participation. The result confirmed that white and Asian Americans were more engaged in the online discussion forum; on the other hand, international students and under-represented minority Americans showed less active participation. The finding of relatively lower participation held by the URM students is consistent with the finding of Ke in 2013 and Angiello in 2002 that minority students were less active online [20], [28]. Ke and Kwak explained that minority students, especially Latinos and

Native Americans, expressed uneasiness with posting in online discussion forums because they were unsure of their peers' online identities by just reading the posts and did not always feel the discussion was welcoming. Along the same line, some researchers have conducted case studies of online learning and found that the students from language and cultural group that are high-context (i.e., high-context languages depending on incorporation of body language, tone of voice), such as Latinos, are underrepresented on the online discussion forum. This is because information was communicated primarily through explicit verbal expression on the online discussion forum instead of high-context languages [29], [30]. Rovai examined differences in race/ethnicity in online spaces more deeply and found that online learners who have a stronger sense of community and identify with others in the online space might feel less isolated and have greater satisfaction with the asynchronous program [31]. His studies explain well why white Americans were very engaged, since more than half of the class identified as white/domestic students, so it was easy for them to find a sense of community with other white students in the online discussion forum. Students' major in our study was not correlated to their participation in the online discussion forum. There is not conclusive evidence from previous studies of this phenomenon, so we will try to further understand and analyze this result in the future.

In our broaden research program, the results of the study and future work will be used to help instructors improve the design of online discussion forum. Based on our findings and prior literature, one implication of our work could be giving students the option to decide whether or not they want to post anonymously. By doing this, students who would benefit from bonds with others they can identify in the class would be able to share and see others' names. Students who are not confident in posting in public or are afraid to post due to language issues could also participate without showing identifying information.

## VI. LIMITATION

The generalizability of our findings is limited by sampling and data collection considerations. Only one course (over several semesters) from one institution was included in the study. Despite the large number of participants, the course environment we study is highly unique, so the results would likely be limited to generalize to other similarly resource-rich Active, Blended, and Collaborative environments. In the future we will be able to include students' data from additional semesters, including those for which we have implemented improvements to the collaborative blog space.

Our data on URM status and students who identify as 2 or more racial/ethnic groups or Unknown is limited, and we need more data to make more accurate conclusions. In further work, we can disaggregate the demographics of students within the URM group.

In this study, we only look at students' participation status. The frequency of participation is not studied here. In addition, participation is measured simply by checking a student's posts. If students participate in the online discussion forum by simply looking at others' posts without posting any of their ideas or questions, we did not count them as participants. As long as a student posts a message, we count them as a participant. However, a post's content has not been taken into consideration. There are some cases where the students just reply with a short message to the professor and never interact with their peers. Moreover, in this specific discussion forum, only instructors can start a thread and students can respond with comments. Since some posts may not be considered as meaningful as others, future studies will focus on each post's content to better understand the nature of student engagement.

## VII. CONCLUSION

In this paper, bar chart visualizations and validation checks have been used to describe the relationship between students' demographic characteristics and their participation in the online discussion forum under the ABC learning environment. Inferential statistics were used to estimate the significance of the relationship. We showed that female students are more likely to be involved than their male counterparts. Also, White and Asian Americans are overrepresented, but international and Underrepresented Minority (URM) students are underrepresented in the engaged group. Future work will qualitatively analyze the content of posts and explore the influence of forum participation on grades via a regression model.

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