Online teaching best practices to better engage students with quantitative material

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ABSTRACT

It is well known engaged students perform better in any course (Nash, 2005, Angelino et. al 2007, Revere and Kovach 2011). However in the online classroom environment engaging students can be a challenge especially with quantitative material. With over 12 combined years of online teaching, the authors have collected useful data that help analyze current courses and discover patterns to enhance future endeavors. This paper establishes a list of best teaching practices specifically related to online teaching in an effort to better engage students and ultimately enhance the online educational experience. The primary focus of this paper looks at courses in which most of the material is quantitative in nature, the tools identified are easily applied across any curriculum. Though some of the tools are self-evident, such as clear and consistent communication, there are others that are less obvious that help to keep a class invigorating and students present.

Keywords: online teaching, quantitative material, teaching best practices, student engagement

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In the last decade online curriculum in higher education has experienced exponential growth. Many well respected colleges and universities nationwide now offer competitive online courses and degree programs for both undergraduate and graduate students. Researchers are discussing and debating educational methods and practices believed to be best for this relatively new online environment. While some traditional teaching methods, designed for the classroom, transition well into the online classroom, many do not. Hence, new and creative methods are needed. While creating these new methods, fundamental teaching and learning insights may be applied. For example, it is well known that engaged students learn better (Nash, 2005, Angelino et. al 2007, Revere and Kovach 2011). This is true in both traditional and online classrooms. However, the answer to the question, "How do we effectively engage students?" is very different for traditional and online students.

The intent of this paper is to identify best teaching practices specifically related to online teaching in an effort to better engage students and ultimately enhance the online educational experience. These practices were identified from several years of online teaching by the authors. Data was collected with the intent of analyzing current courses in which patterns that may enhance future endeavors were discovered. Data collection includes student feedback, class surveys, teaching experiments, and other measurable observations. The focus of these practices is on material quantitative in nature, however these tools are easily applied across any curriculum.

Our focus is on teaching quantitative material for the quantitative thinker. This does not include courses focused on "just numbers," where exact numerical answers are required but explanations are not. Due to the rising need for quantitative thinkers (McKinsey report, 2011), quantitative courses now require actionable applications based on the final numerical answer. In these courses, solutions are often estimates requiring discussion and most problems being solved are multi-faceted. Therefore, collaboration is necessary and automated responses are not meaningful to accurately gauge learning. Evidence of this is seen by the rise in graduate and undergraduate curriculum in applied quantitative methods such as analytics, decision science, business intelligent and others.

LITERATURE REVIEW

Within the online environment, the materials made available to students are often a mix between asynchronous (relying on students working at their own pace within a given time frame to understand and practice material) and synchronous (using class meetings in real time to enable interaction and more precise understanding of the material). Establishing relationships from within each medium is essential as it has been shown that strong relationships between faculty and students have consistently been viewed as a primary factor in student success and satisfaction (Fabry, 2009; Fedynich & Bain, 2011; Hartmann, Widner, & Carrick, 2013). As technology has advanced, many traditional colleges and universities are now also offering courses and complete degree-programs in a wide variety of disciplines online (Mills and Dheeraj, 2011, Council for Higher Education Accreditation 2002).

With an abundant amount of reviews identifying the universal use of workplace teams in U.S. businesses (Cannon-Bowers & Bowers, 2011; Devine, Clayton, Philips, Dunford, & Melner, 1999; DiazGranados et al., 2008), there is a belief that perhaps no skill is more important

for MBA students than teamwork - including functioning as a contributing member and leader (Hobson, Strupeck, Griffin, Szostek, & Rominger, 2014). With more institutions and students choosing to earn degrees from universities online in different states and regions, it becomes the task of the instructor to create an atmosphere of learning in which collaboration and teamwork are present. In the global market, graduates need to be able to work and communicate effectively within their organization collaborating with coworkers across the world. The goal in quantitative courses is to help students not only understand the underlying methods and analysis but also to be able to work together as a team to present the analysis accurately, concisely, and in terms the end user can understand all while meeting in virtual space.

This paper reiterates some key points already identified in many of the recent literature: such as the importance of making sure that there is a focus on interaction among students and instructor (Mills and Dheeraj, 2011) while also adding two new key pieces that enhance a positive experience for the students.

1. Making sure connections are being made among the students in such a way to help foster camaraderie as might be gained in the classroom.
2. Challenging students to answer all numerical questions with words, tables and figures accurately with a concise discussion.

Both key pieces add to the online learning experience and help ensure students are competent in the course material. Current industry demands now require quantitative professionals to be good communicators, since these professionals are often required to provide insights on important decisions based on their quantitative results.

EXPLORATORY DATA ANALYSIS

A short eight question survey was distributed to online students in the Fall 2015 semester. Participation in this survey was strongly encouraged but not required. Students in multiple classes at two different universities participated in the survey. Responses were combined prior to analysis. The survey had seven questions used to assess online classroom experiences. Five of the seven questions were multiple choice and the remaining two were open ended. In an attempt to assess changes in attitude and possible effects of our courses, the survey included a pre and post class questionnaire. The pre class questions are included in the Appendix. The post class survey repeats these questions in the past tense. The purpose of the survey was to provide insights and measurements of student's online engagement. The first seven questions were designed to evaluate student expectations (pre-survey) and reality (post-survey) on engagement – both student to student and professor to student. The eighth and final question was designed to keep the student's identity anonymous but still allow for a possible pre and post pairwise comparison. Six students were identified as participants in both surveys with certainty. The survey was not intended to provide strong statistical results but rather an exploratory analysis that may help identify relationships among different types of engagements and students. Both the comments and multiple choice questions provided interesting points for discussion.

The results of this survey include responses from over 30 students. A descriptive data analysis using JMP provided interesting results. The overall distributions and counts per response can be found in Figure 1 of the Appendix. While the multiple choice questions were ordinal in nature, the answers were all given on a five point scale. For instance the first question asked the students how often they anticipated interacting with the professor. The responses ranged from one for no interaction up to five for intense interaction. A score of three was a

student who planned to interact a few times each week. Similar scaled questions were used to assess interaction with classmates during and after the course.

Though the interaction with professor (Q1) and with fellow students (Q3) was on the same scale, the responses for Q1 ranged from 1 to 5 while the responses for Q3 ranged from 2 to 4 – a much tighter distribution. Both held a relatively bell shape though it is important to remember the data is not continuous or truly numeric but instead ordinal where the number values do represent levels but the distance between the levels is not necessarily equidistant.

When looking at Q3 a third of the student responded that they expected to have minimal interaction with fellow classmates. Looking at just this core group, the responses they gave for other questions showed that they planned to have moderate to no interaction with the professor (Q1), planned to use email with minimal phone contact to work with fellow classmates (Q4) and were either neutral or in agreement with the statement that comparable levels of interaction can be given in an online class and traditional on campus course (Q6). This can be seen by looking at the dark portions of Figure 2 in the Appendix. Figure 3 in the Appendix identifies the seven students who intended to interact often with at least a small group and moderately with a larger group of fellow classmates (Q3). Most of these students plan to interact often with the professor (Q1), already know at least two classmates (Q2), intend to interact with fellow classmates beyond class, and were either neutral or in agreement with the statement that comparable levels of interaction can be given in an online class and traditional on campus course (Q6). Many survey results confirm expected trends although the correlation values for each question were relatively low, see Figure 4 in the Appendix. Because these data are ordinal in nature the values from Pearson's r are quite low. Since these data are not ranking, using Kendall's tau or Spearman's rho is not useful either. Therefore, the associations are more evident when looking at the descriptive statistics such as those outlined when discussing Figures 2 and 3. These expected trends include: students with high (low) levels of expected interaction with the professor (Q1) also have high (low) levels of expected interaction with classmates (Q3); students that expect to retain relationships in the future (Q5) also had moderately high interaction responses in all of the remaining questions.

Student's agreement (or disagreement) about levels of interaction between online and traditional on campus courses (Q6) are not strongly correlated with any surveyed response although Figures 2 and 3 show that both students with low and high interaction were either neutral or in agreement that online and traditional courses can have comparable levels of interaction. Despite weak correlation values, often students that rated high levels for interaction in questions 1, 2, 3, 4, and 5, also agree that the same interaction levels are possible online and in the classroom (Q6). Students that disagreed or were neutral that that the same interaction levels are possible online and in the classroom (Q6), showed no general pattern in their answers among the other questions.

Pre and post pairwise results were not possible with this dataset as only six students were identified with certainty to have answered both surveys. In future more classes, expanded questions, and more emphasis on having the students participate in the surveys should garner large enough sample sizes as to find significant results to assess interaction among students.

As seen in Figures 2 and 3, an argument for two groupings of students can be made - a group of students that intend to be engaged with classmates and the professor, and a group of students that does not intend to be engaged. The second group may not intend to be unengaged but rather may not see the need or advantage of engaging in an online class. These students may view themselves as independent learners and perhaps prefer a mostly asynchronous course.

When considering the comments from students to help make the class more engaged, a couple of themes seemed to arise often. First, the use of the chat feature during online class allowed students to communicate in a fashion similar to a traditional classroom with the added bonus of initial anonymity. Student's claim: "I feel more comfortable using a chat feature compared to (speaking in) a traditional on campus class" and "Online courses also allow students who may be too shy to raise their hands in traditional course more interactive (when) online using the chat feature." Second, group projects allowed students to get to know one another and share knowledge. Comments re-enforce that these projects are necessary for students to engage, such as: "You can't replace the face time you have in a traditional on-campus course. However, I did feel like I was able to connect with the other people in my group." Moreover, comments from classmates after the case studies all agreed that the team work helped translate new knowledge from class into the real world, for instance "Both case studies helped me see the practical nature of the statistics we were calculating in class. And helped me realized that it does have a real-world application, and is not done in a vacuum".

Overall, the student feedback, which was consistent across the students who chose to answer, helped to solidify the key points found in both the multiple choice questions as well as the comments collected in the survey. Though formally surveyed and collected in this semester, similar comments have been collected over multiple years of teaching online courses which have then been incorporated into course content. Plans are set for further data collection to enhance and expand on the results found and discussed in this paper.

SUGGESTED BEST PRACTICES AND HOW TO IMPLEMENT THEM

After thoughtful consideration of the exploratory data analysis results and past online teaching experiences and student evaluations, the following list of best practices was created. This list was intentionally kept brief to highlight the most effective and perhaps some underutilized practices while focusing on the two added key points discussed earlier: (1) Making sure connections are being made among the students in such a way to help foster camaraderie as might be gained in the classroom. (2) Challenging students to answer all numerical questions with words, tables and figures accurately with a concise discussion.

The following four best practices are given in detail.

1. Create an atmosphere where students get to know at least two other classmates. This speaks directly to the first key point. Team assignments and discussion boards are popular methods currently used. In an online class, you are providing an experience in addition to delivering the course material. This will force student to learn how to communicate online and form distance relationships with people while working on an assignment, thus enhancing the student's learning experience. It will also provide students with a human resource besides you, the Professor.
2. Provide real life and current world situations for numerical analysis examples and projects. The professor should supply a variety of visuals, audio and multimedia tools and allow time in each lesson to tie topics together in order to enable students to see the bigger picture. For quantitative courses, the bigger picture is how to organize, display, and discuss the numeric results in such a way as to provide actionable decisions to realistic problems.
3. Break up the readings with purposeful visuals. Due to the need for extensive reading on the part of the student to make up for lost class time, it is imperative for the instructor

when possible, and appropriate, to break up this reading with purposeful visuals. However, be cautious of meaningless images that distract from the material. For example, when teaching regression there are many ways to approach the topic with breakout materials including: a view of the data in Excel, an interactive display of the residuals that the students can control, a youtube video of how influential points affect the model, a color coded scatter plot of categorical variables, and a current or relevant problem where regression was used to determine a solution. However, breaking out a graphic with discussion for every number that appears in the output from the regression model, including the formulas that were used to create each estimate, can quickly confuse the student leaving them more worried about recreating calculations instead of focusing on understanding the strength and usefulness of the model.

4. Communicate with your online students several times a week. At the beginning of the course be clear on technology resources and limitations. Provide step by step guides to course resources and student expectations. Be available to your online students. When there is no interaction or limited engagement online student may feel alone. Email is not enough have virtual online meetings and office hours, identify a time where phone calls are welcomed. If you are unavailable, students will seek out answers and information from sources that may be incorrect, misleading or unreliable. There is the potential to lose control over the quality of the information students are using as they search for extra complemental or supplemental course material. Being available does not mean teaching each student one on one, but instead allowing the instructor to point the student in the correct direction for other resources both within and beyond that which is included in the course.

These best practices will help increase the quality of your online course. They may also have benefits in your traditional on campus courses as well. As you start to implement these practices, start small. Try one or two new ideas each semester and build on your successes while you rethink and revise unsuccessful attempts. Reach out to students, information technology personal and other professors for suggestions or feedback. Often students will know the newest trending technology, have insights from work, or real life experiences that can enhance a class with only a slight change on the part of the instructor. Things such as non-traditional teaching software or real world problems students are currently dealing with at work, might allow for deeper and more meaningful teaching. Consider trying new things. Explain to the class you are trying something new to help enhance their learning and ask for feedback along the way. Most students will appreciate your honestly and new attempt.

FUTURE RESEARCH

Learning more about what tools are being used and how often student are engaged in online courses is of interest. Two main area of future research for the authors include identifying the use of prerecorded video lectures beyond class and enhancing online student team dynamics. It is the opinion of the authors that both are essential in online education and both when used effectively, can add great value to the student, course and university.

Prerecorded video lectures are becoming very common in online courses. Tracking the amount of time students spend watching and re-watching course videos is of interest. Is this significantly correlated with performance, as expected? Is time spent watching these videos negatively correlated with time spent engaging with classmates? What is a good balance

between the asynchronous video material and synchronous teaching material? To answer some of these questions, the amount of time students dedicate to learning course material and completing course assignments should be considered – perhaps as a constrained variable with a fixed upper limit. Currently, tools such as BlackBoard Collaborate™ allow the instructor to identify how long each students spends viewing online course material inside BlackBoard. Being able to identify the amount of time spent in each section, and specifically where in each section will allow the instructor to see where more material may be necessary. In post class discussions and comment, all students claimed to have watched each teaching video multiple times – during class, while working on homework, and while reviewing or working on the final. Technology then provides online students with a tool that in class students do not have – total recall of what a professor said about a specific topic in real time. Instead of taking notes, students can watch and work at the same pace as the professor and when they are confused, they can go back and repeat the lesson. It is of interest to compare retention and in depth explanations of analyzes between an online class with a traditional class.

Online student team assignments are critical for teaching students how to work effectively in the new and growing virtual space. How are leaders identified in this new environment? What new leadership, communication and team skills are needed? Just as teaching method needs to be re-thought in this environment, so do our expectations of good team skills. Often students complain of the challenges of working in teams when students can often hide behind a computer and more easily ignore email requests and responsibilities from teammates. Instructors often learn or suspect an individual or only a very small portion of the team is committed to assignment. Although this can be an issue in a traditional class, the authors find this much more frequent in online courses. Data from formal students suggested that while they were able to really get to know a couple of people in class with team assignments, switching up teams mid semester might allow them to foster even more relationships. In future classes, it would be interesting to see how responses from post course surveys change in such an environment.

CONCLUSION

This paper establishes a list of very usable best teaching practices for online teaching in an effort to better engage students and ultimately enhance the online educational experience. These practices are (1) Create an atmosphere where students get to know at least two other classmates. (2) Applying numbers to real life and current world situations. (3) Use a variety of visuals, audio and multimedia tools. (4) Constantly communicate with your online students. While the primary focus of this paper is courses where most of the material is quantitative in nature, these tools are easily applied across any curriculum and may also benefit traditional on campus courses. That is because these were created to enhance (online) student engagement, a known factor in student performance.

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Appendix: Online Course Survey

1. In this online course, how much interaction do you expect to have with your professor outside of required or scheduled online course meetings?
   a. I do not expect to have much contact with my professor outside of class.
   b. I expect to interact with my professor about once a week by email.
   c. I expect to interact with my professor a few times a week by email.
   d. I expect to interact with my professor a few times a week by email and occasionally by phone or video conference.
   e. I expect to interact with my professor a few times a week by email and at least once a week by phone or video conference.

2. How many of your classmates do you know in this course?

3. In this online course, how much interaction do you expect to have with your classmates? In the following options, only occasionally may mean about once a week while often would imply 3 or more times a week.
   a. I expect to have minimal or no contact with my classmates.
   b. I expect to occasionally interact with only a small group of my classmates
   c. I expect to interact often with only a small group of my classmates
   d. I expect to interact very often with only a small group of my classmates and only occasionally with other students outside of this group
   e. I expect to interact often with all of my classmates

4. In this online course, when I interact with other students I expect most of our interactions to will be by
   a. only email.
   b. mostly email with an occasional phone calls or document sharing tool (such as google docs).
   c. a combination of email, phone calls, document sharing tools and video conferencing (Skype, Adobe Connect or another software), where some of these method are used often while others are only used occasionally.
   d. a combination of email, phone calls, document sharing tools and video conferencing were all methods are used often.

5. After this course (or program) how much interaction do you expect to have with your classmates?
   a. I doubt I will keep in touch with any of my classmates.
   b. Perhaps I will occasionally communicate with one or two of my classmates.
   c. I expect to keep in touch as acquaintances or distance friends with two or more classmates.
   d. I expect to become close friends with at least one of my classmates.

6. (Please choose one answer below to the following statement) I feel comparable levels of interaction can be given in an online class and traditional on campus course.
   a. Strongly Disagree

b. Somewhat Disagree
c. Neutral
d. Somewhat Agree
e. Strongly Agree

7. Please expand on your opinion of the comment: I feel comparable levels of interaction can be given in an online class and traditional on campus course. (Why or Why not?)

8. What is the make and color of your car?

Appendix: Data Analysis Displays

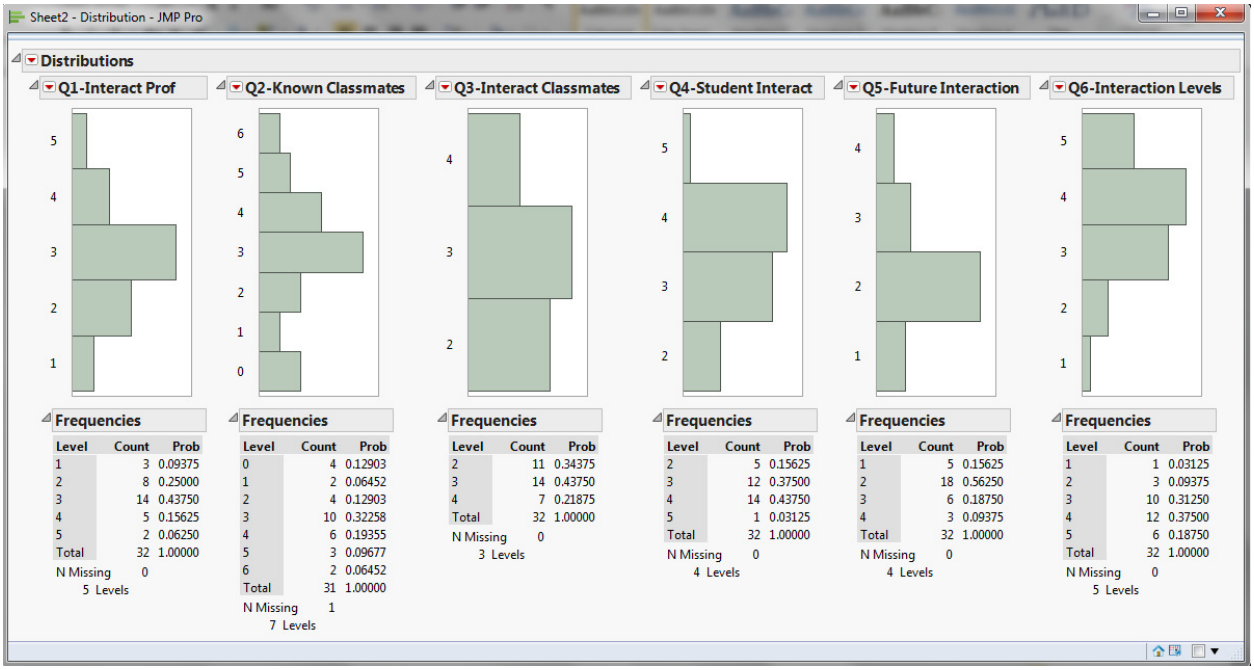

Figure 1 Distribution and Frequency Counts of each multiple choice question in the survey

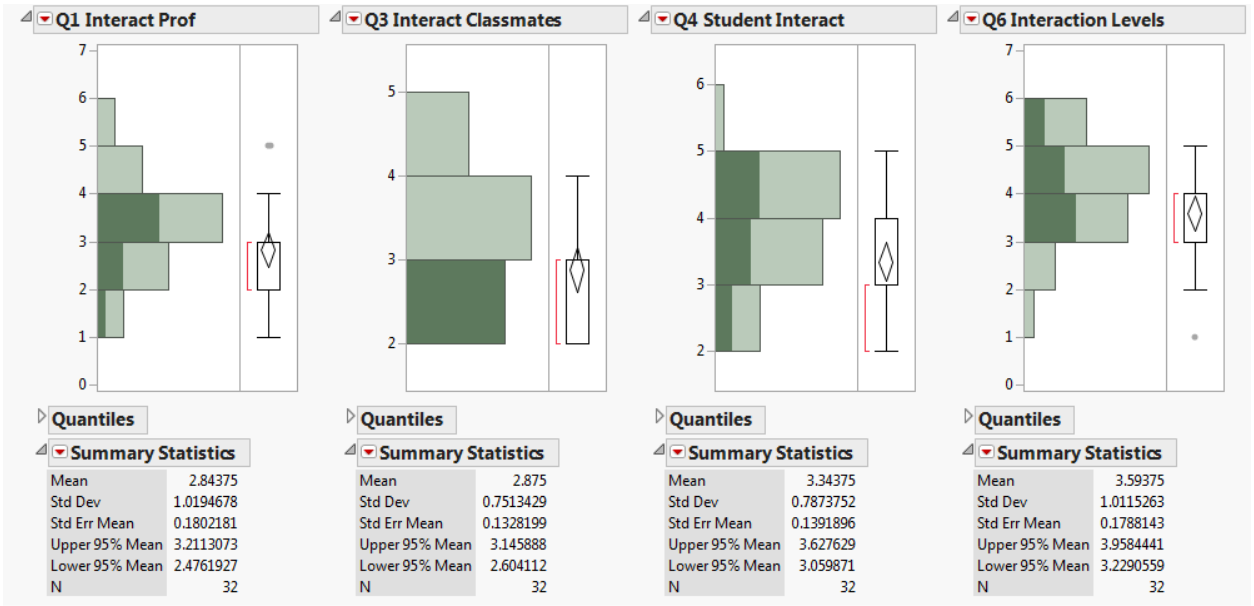

Figure 2 Multiple choice responses to questions 1, 3, 4, and 6 where the dark areas are the responses given from the students who claimed to have minimal interaction with classmates.

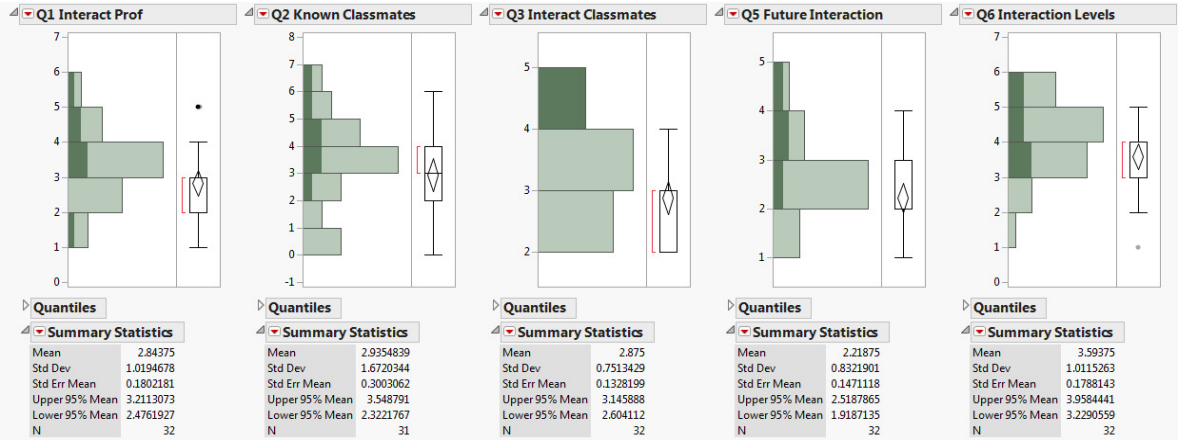

Figure 3 Multiple choice responses to questions 1, 2, 3, 5, and 6 where the dark areas are the responses given from the students who claimed to have minimal interaction with classmates.

	Q1	Q2	Q3	Q4	Q5	Q6
Q1: Interact Professor	1.000					
Q2: Known Classmates	0.151	1.000				
Q3: Interact Classmates	0.268	0.176	1.000			
Q4: Student Interact	-0.051	0.125	0.130	1.000		
Q5: Future Interaction	0.346	0.306	0.509	0.423	1.000	
Q6: Interaction Levels	0.030	0.087	0.016	-0.143	0.186	1.000

Figure 4 Correlation Matrix of each multiple choice question.