AC 2010-1298: ATLAS - ACADEMIC TEACHING AND LEARNING ASSISTANTS STUDY: THE USE OF PEERS AS 'QUALITY MANAGERS' IN ENGINEERING CLASS INSTRUCTION

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ATLAS - Academic Teaching and Learning Assistants Study: The Use of Peers as 'Quality Managers' in Engineering Class Instruction

"Tell me, and I'll listen. Show me, and I'll understand. Involve me, and I'll learn."
~Teton Lakota Indian saying

Abstract

In recent years, teacher/student ratios (TSR) have been progressively declining in many higher educational environments. While the reduced TSR is not necessarily a drawback to the educational experience, it is generally believed –or perceived– that fewer students per qualified instructor can have a more positive effect on educational outcomes in terms of attention, learning efficiency, communication patterns, and overall student satisfaction. To simultaneously address issues of class size and course quality, the Academic Teaching and Learning Assistants Study (ATLAS) was developed at Northeastern University. ATLAS explores the effects of enlisting and training student peers from within an ongoing class to serve as "Quality Managers" for select lessons and labs in engineering courses.

These Quality Managers (QM's) act as instructional and supportive extensions of the professor in more complex course environments. Following preparations with the instructor and some independent work on the labs or activities, QM's serve as assistants and/or reference resources to their peers in the class to help guide selected lessons. More details are set out in the body of the paper in terms of QM selection, responsibilities, roles, and outcomes.

Participating students (*Quality Managers* and their course peers, referred to in this work as *general students*) completed an extensive questionnaire inquiring about the use of QM's in the classroom and, if applicable, their personal experience as a QM. The QM program was implemented across multiple academic levels: freshman (1st year), middler (3rd-year) and seniors (5th-year), and all levels participated in the feedback process. Empirical data gathered in the ATLAS initiative strongly supports the efficacy of the QM program and provides evidence that the use of Quality Managers has appreciably improved activities in classroom and lab settings and has enhanced the academic experience of the QM's themselves.

Introduction and Background

In their work on engineering education, Upadhyay *et al.*, state, "Quality consciousness has become a central theme for any human endeavor in today's competitive world. The system of higher education is not devoid of this concept."[9] Baldwin another educational advocate, refers to meeting the challenges in our current STEM classrooms and considers possible innovative solutions to such demands: "Today many of the efforts to strengthen undergraduate education in Science, Technology Engineering, and Math (STEM) fields continue to rely on individual faculty and small faculty groups who are committed to the cause of improving science or technology education in their department or institution."[2] Baldwin and Upadhyay provide an apt lens for this focus on raising educational quality and inspiration to seek out ways to accomplish this . In this paper, the Academic Teaching and Learning Assistants Study (ATLAS) describes one initiative that has effectively attempted to address some of the challenges that persist in STEM classroom and lab cultures through the use of strategic and guided peer-assisted instruction.

Use of student teaching and learning assistants, while not a novel concept in American colleges, has had a resurgence of interest and involvement in STEM settings. Coupled with social networking and peer collaboration in the framework of quality assurance, the ATLAS approach is intended to be both timely and significant.

As noted, concern about ensuring quality education is prevalent. Expectations from students and administration alike include the following factors: educational excellence, demonstrated competence, student-educator access, achievable and measurable learning goals and objectives, accountability, productivity, learning strategies that connect with real world experiences and students' individual learning preferences, and applied theory into action. Further challenges are presented in terms of class size, facilitation of lab design, managing increasing diversity in terms of the number and variety of students and learning styles. Give these challenges, we have a recipe that requires, when done well, innovation, creativity, and an understanding that the learning culture we create must serve each and every student and not just the majority "type".

Exploring educational and learning trends, class size implications, and characteristics of the current student generation will help inform us as we seek and plan for effectiveness and excellence in teaching. That in turn, will allow us insight into the functionality of using the ATLAS approach of utilizing classmates as QM's (Quality Managers) in class and laboratory settings.

Current Learning Trends and Motivation

Conclusions reached over the past two decades by multiple national reports indicate that undergraduate education in STEM fields needs improvement.[12] We are reminded, that despite the burgeoning technology that has provided additional access and capacity for learning, that the *concept of the classroom is still the center of the learning interaction and engagement*. While calls for online assessment tools that link students, faculty and administration continue, educational and sociological research still subscribe to the prevailing quality of *student-faculty interaction*. ATLAS provides a peer intermediary in the form of a Quality Manager that enhances the quality of the educational connection between instructor and general student. QM's bridge the gap in the learning culture by providing feedback on assignments, course difficulty, instructor and lesson effectiveness, and by enhancing the attainment of learning objectives and tracking these objectives within the context of the course curriculum. It is a systematic approach to address the calls for improvement. The following trends highlight current general educational adaptations. These trends lend support for QM application, providing necessary ingredients for relevance, retention, and engagement.

Departure from Traditional Lecture. Another commonly accepted notion developed in recent years has devoted attention to the merits of learning methods that go well beyond traditional lecture. Many professional organizations and educational societies are imploring their members and stakeholders to adopt more flexible, active, collaborative, and welcoming pedagogical practices that will reach out more effectively to diverse learners. Baldwin continues the dialogue on STEM learning, agreeing with Wieman who notes, "The traditional lecture is not an effective way to help students master basic scientific concepts essential to advanced study and work in STEM fields."[2,12] Despite its idealistic intent, it is not without challenges. Lack of resources to support instructional development, absence of incentives to research teaching and learning, growing class sizes, and limited rewards for course and instructional improvements have

discouraged some engineering professors from investing time and energy to upgrade their approaches to instruction. As daunting as these challenges are, the tenacious desire to improve STEM education has continued to surface, despite the economic barriers. This is illustrated not only in this project but in countless other ASEE initiatives that strive to improve and strengthen the climate of our educational system.

Teacher-Student Ratio. Given the reality of teaching large numbers of students with diverse backgrounds and interests and we try to prepare them for a rapidly changing world while being cognizant of the ever-growing demand for science and technology, Seymour and Hewitt remind us that "many undergraduate classes occur in large lecture halls where instructional practices are constrained… such constraints include: student-teacher dialogue limitations, heavily lecture-based formats that encourage passive learners, and memorization of facts and formulas that pass tests [yet] fail to achieve genuine understanding of STEM subject matter."[7]

The declining teacher-student ratio is the result of several factors, such as (1) diminishing resources for faculty and/or graduate teaching assistants, (2) an inclination toward enlisting only university faculty with the highest possible degree, (3) a trend toward learning methods that depend less on instructor-based pedagogy and foster either individual/solitary responsibility for learning or group-based education, and/or (4) improved and enhanced technology, materials, and activities in response to student-centered learning described in (3) above. While it would seem preferable to keep class sizes as small as reasonably possible, research has yielded differing opinions on the topic of class size.

Social Elements of Learning

Given the trend toward experiential learning, along with the interactive nature of many laboratory settings and the prevalence of teamwork in engineering, it is incumbent on educators to examine some of the social elements that interact in this context.

Student-Centered Curricula. In a move away from teacher-centered instruction styles, the focus is now on the learner coupled with a growing interest in the use of self and peer assessment methods.[5] In an article entitled "Assessment for Learning and Skill Development: The Case of Large Classes", Wanous *et al* illustrate a new goal of *involving students as far as possible in teaching, learning, and assessment activities* in their Professional Studies.[10] They include a quote from Ronald Dearing that states, "students will increasingly need to develop new capabilities and to manage their own development and learning throughout life … it is important that students are provided with opportunities for independent self reflective learning to prepare them for the workplace upon graduation…this is why giving students more responsibility for their learning and development is so vital." [10] ATLAS provides that opportunity to the QM's and the general students alike.

Collaborative and Team-Based Learning. A slight departure from the more formalized peer instruction that will be discussed below is the concept of collaborative, team-based, or peer-*assisted* learning. Astin observes, "The single most important environmental influence on student development is the peer group… By judicious and imaginative use of peer groups, any college or university can substantially strengthen its impact on student learning and personal development."[1]

In the recent paper by Wanous, Maddalena Taras states that, "Increasing student involvement in group work, project work, oral presentations and task- and problem-based learning all contribute to turning the essential focus onto the student learning process…the key to unlocking this resource has proved to be the assessment process, which combines a team and individual agenda and which gives space for creative group and self reflection."[10] The assessment process is important but just one of the variables involved in the collaborative and socialized learning process. Further developed by L.K. Michaelsen, team-based learning illustrates the importance of in-class tasks that must "draw the students together collaboratively for learning… If the tasks fail to do this, teamwork and learning both suffer."[13]

The engineering discipline is driven by teamwork in many respects; it stands to reason that engineering education would adopt and embrace group work for labs and projects. It is natural then to promote and foster collaborative learning with peers. Developing an interactive learning style has become nearly essential to survival in engineering academics and into industry.

Peer-Assisted Teaching. The report "Peer Teaching: to Teach is to Learn Twice" informs us that peer teaching is not a new concept.[11] Historically, the Greeks used student leaders as *archons* and in the 19th century, English and American schoolmasters used older students to drill younger students in classrooms. Accordingly, the reasons why peer teaching has developed such a broad appeal are:

➢ Individuals who experience a course as a student and then return to the same course as a peer teacher develop an understanding of the material from very different perspectives.

➢ Peer teaching enhances college socialization by reinforcing and developing productive behavior patterns and intellectual values.

➢ The experience may instill a desire in peer teachers to pursue a career in teaching, either at the university level or younger.

➢ Whitman also utilizes two salient quotes that speak to the personal educational value of teaching others: "To teach is to learn twice, by French philosopher Joseph Joubert; and most educators know that "the best way to learn is to teach," credited to several sources.[11]

In the university setting, peer-assisted teaching, while comparably collegial, tends to be more formalized than the approaches described in the earlier **Collaborative and Team-Based Learning** section. Further, traditional peer-assisted teaching is not typically conducted by contemporaries/classmates of the enrolled students. This arrangement has been operationally defined as "the use of undergraduate teaching assistants, usually students who recently were successful in the course, and are useful because they provide a means to supplement large lecture courses with small discussion groups."[11] Historically, first reports of students teaching students appeared in the 1960's when faculty dissatisfaction emerged in response to large lecture courses in which the student's role was largely passive. Similar to the historical use of *archons* described above, undergraduate students serving as teaching assistants and facilitators and their beneficiaries –peer learners– were able to enjoy the following benefits:

➢ Both sets of participants play a more active role in the learning process.

➢ Peer teacher assistants benefit by reviewing and organizing the material taught and they gain a better understanding of the subject along with added contact with faculty.

➢ Peer teaching can be a means to recruit future educators, by experience for the peer teachers and by example for the peer learners.

➢ Peer teaching can be an effective means of motivation for learning, for both sets of participants.

In summary, if as educators we aspire to frame a collective class culture that involves students actively, cooperatively, and interactively, the implementation of the ATLAS Quality Manager program may offer the stage to do this. Some precedent has been set for the multiple advantages of this approach. This research provides further empirical and statistical support for a teaching approach that capitalizes on *organized, managed,* and *guided* peer-assisted education. If inquiry, self-reflection, and effective cognitive outcomes are important in your course management, the QM program provides a means to accomplish this; and if what goes on in your class setting really matters, ATLAS may be one performance catalyst that will have a lasting effect, intimately connecting students with relevant quality learning.

Quality Managers: Overview

Purpose. The term *Quality Managers* was introduced earlier at ASEE[8] and was primarily focused on obtaining feedback from students about the effectiveness of the professor, classroom elements, and course components. The application in this work is a departure from the original definition; as such, QM's are currently enrolled in the course of interest and assist the instructor in a manner that more resembles an assistive teaching role in addition to providing relevant feedback on the assignment or lab of interest. Furthermore, Quality Managers in the current case are course contemporaries –classmates– of their constituents, who are the general student population. This is unlike the peer teaching above that uses former students to facilitate learning. Working with the professor, QM's have a temporary responsibility for a particular class activity. Details are provided below on the roles and responsibilities of a Quality Manager.

Selection. QM's may be selected by the instructor in any of a variety of ways, but the most successful techniques use the following protocol: Initially, the instructor should identify desirable QM traits in potential candidates; many are listed in the **Results** section below. Each QM recruited should have demonstrated that he or she is highly responsible, attentive, mature, personable, and sufficiently confident while also exhibiting an inclination to serve and assist.

In first-year classes, QM's are *hand-selected* by the professor as the student population is still new to university learning culture. QM's in first-year classes are usually older students, transfers, or very mature freshman, performing at a high level while possessing strong social intelligence.

Middler third-year QM's have been *recruited* from the Honors pool or from students who have demonstrated the traits listed. These students are called together and the instructor presents the option to them. These prospects have opportunity to ask questions and accept or decline within a time frame of a few days. Thus far, all who have been invited have accepted.

For seniors, a *global invitation* is presented to the entire class if they choose to avail themselves of this opportunity. A sign-up sheet with a limited number of spaces (10 for a class of ~36) is circulated and prospective QM's will volunteer to participate. In the past, the list has been full. Historically students who did not sign up at the original invitation sought to do so later after the recruitment sheet had been circulated and collected.

Enlisting. To introduce the QM option clearly, the instructor must ensure that each prospective QM knows that their role is entirely voluntary. It is important to convey that QM's are not required to complete the assignment write-up or report, but that they will have read and/or completed the assignment activities in advance of class time. They will have the opportunity to teach and guide the class without any requirement to lecture or make a presentation. QM's are told that they will be gaining experience beyond that of typical classroom attendance and are encouraged to place this on their résumé as an activity or a work experience. Finally, while providing a grade to the QM for the assignment may be subjective, it is based on preparation, meetings, in-class contribution and feedback on the lab –both *a priori* and follow-up input– this is explained to the QM's at the time of recruitment.

Responsibilities. By the day the lab/activity is to be offered (*class time*), Quality Managers will have conducted most or all of the activities in advance and have furthered conferred with the instructor to edit and modify elements of the lesson in order to clarify and/or improve it. At class time, they typically assist in set up and have defined roles to help the class run smoothly. They then function as extensions of the professor by answering questions, delivering messages or instructions, handing out or collecting materials, or performing tasks that the entire class would not do (like compiling class data, timing an activity, or discharging capacitors). QM's help streamline the class experience and enhance the lesson objectives by serving as resources to guide their peers through their preparation and understanding of the class objectives. Each QM is equipped with a clipboard holding a single-sided printout of the class assignment and a colored pen to mark up the assignments with notes, corrections, and clarifications to be addressed at the instructor's earliest opportunity. Following class time, a brief feedback session may ensue to review anything that may require explanation. As such, that is the end of the QM's formal responsibilities.

Methodology and Assessment

Given the favorable observations and experiences in relation to a pilot QM initiative, the more structured ATLAS research program was undertaken through a comprehensive survey of involved students, both QM participants and their classmates. Assessment questions ranged from the perceptions of the selection process and responsibilities of the QM to the opinions of and personal reactions to the Quality Managers' involvement in the classroom. With the assistance of a Human Factors Research Specialist on the team, The ATLAS team developed a series of Likert-scale questions along with open-ended queries to learn from the students in their own words. Many multiple choice questions provided open fields, inviting the students to elaborate or explain further following a set of directed questions.

Analytical Tools. Standard analyses of the scale data involved generating descriptive statistics and conducting inferential statistical tests on the scores. For the open-ended answers, multipass content analyses were conducted to reveal response patterns. As appropriate, the data was stratified by such factors as academic level (class), GPA, and Honors involvement. Table 1 shows the relevant details of classes participated and the Quality Manager ratios for each class:

Table 1. ATLAS research: Courses Participating in Quality Manager Program.

Name of Course	Semester and Year	Academic Level	Number of Sections	Class Size*	# Labs using QM's & # of QM's used*
Engineering Design	Spring 2009	Freshman, Year 1	2	26, 29	2/4
Digital Simulation Techniques	Fall 2008	Middler, Year 3	1	22	5/6
Human-Machine Systems	Spring 2009	Senior, Year 5	1	37	4/10
Human-Machine Systems	Spring 2008	Senior, Year 5	1	36	4/8
A maximum of 4 QM's are used at one time for a particular lesson, typically 2 QM's are assigned per lesson.					

Each survey provided a general introduction page disclosing the objectives of the study. The first page for each course was customized, listing all of the labs or activities that used QM's for reference. The remainder of the questions are outlined in the Results section of this paper or will be addressed in future publications.

Results and Discussion

The survey results support the original impressions: response to the Quality Manager program has been overwhelmingly positive. From the perspective of the instructor, the caliber of the labs has been greatly enhanced; the students appreciated the assistance from their 'trained' peers, and the QM's responded favorably to their missions and responsibilities. As noted, all students were given the opportunity to provide ratings and opinions on the specific benefits and challenges of the QM program from their personal experiences and the findings are presented below. While this paper will focus on the responses and reactions of the *general student population* to the QM program, a brief overview of its effects on the professor and Quality Managers themselves will be presented first.

Professor's Outcomes. As noted, lab and class quality has improved appreciably from the instructor's viewpoint. This is a result of the advance input, in-class assistance, and post-class feedback from the QM's. Lab preparation and set-up has been better planned and implemented more smoothly than in the past with the QM's role in proofreading, helping with material preparation, and participating in arranging the classroom space as appropriate. In addition, the lab-time activities have been much smoother and in some cases, nearly choreographed with the advent of QM's. Since Quality Managers were able to clarify points of confusion, lead small discussions, and guide the teams in their progress along the intended solution paths, the instructor was able to (1) give attention to more students, (2) work with smaller groups both of which improved teacher-student ratio and/or (3) step back from the administrative details and observe the entire classroom dynamic to keep the class on track and note lesson points for later.

The professor also felt that liaising with Quality Managers before and during class improved the student-instructor relationship through forming a teaching team with a common goal for the good of the class. Also, QM participants expressed an appreciation for the efforts required to plan and orchestrate a complex lab activity within a class of 20-40 students. Further, non-QM students who understood what the professor was trying to accomplish acknowledged this effort as well.

Quality Managers' Reactions. While a detailed presentation of the Quality Mangers' responses will be reserved for a future publication, some notable results will be highlighted here. First, 100% of QM's surveyed felt that their relationship with the professor improved (69%) or slightly improved (31%) through participating as a Quality Manger. Also, 100% of the QM's felt that they were fairly rewarded for their work in the QM capacity. QM's grades were typically higher, than those of the general students as they earned them through demonstrating comprehension of the material in addition to their reliability and contribution before and during the class of interest. Finally, every single respondent who served as a QM stated that they would agree to be a Quality Manager again, 100%! This is very motivating, particularly given that their responses were confidential.

In terms of lead time, over two-thirds felt they had enough lead time, but the remaining indicated that they had slightly too little lead time to prepare and confer with the professor. Typically, the goal is to have the first meeting two weeks prior to the class in which the QM's will assist. This allows for as many interactions as necessary for the QM's to feel prepared and for the instructor to suitably modify any elements of the activities or assignment.

When allowed to provide multiple responses to how they felt about being a QM, over 90% were 'honored', over 30% 'felt fine' about the prospect and one person felt 'nervous' along with being honored. Also when asked to comment about any hesitation they felt about being a QM, over 75% said "None". The only concerns were about not being able to perform the labs as normal (15%) or not knowing the material well enough (8%).

Finally the QM's were queried as to how demanding, supportive, informative and prepared the professor was in relation to their initial expectations. For this set of questions, all responses were either "as expected" or in the positive direction, i.e., "less demanding," "more prepared." This is not only encouraging, but also provides incentive for the professor to select QM's judiciously, to be prepared, and to provide the proper assurances, job description, and support for the Quality Managers.

General Students' Responses. There were a few critiques and suggestions for refinement of the QM program from the student learners which will be discussed in a later section, along with management suggestions and recommendations. Here, relevant and compelling results from the general student population include the following analyses:

Flow of Class Activities. In response to whether they thought the activities went more smoothly as a result of the QM, 100% of responses from the general students were favorable or neutral, with 'Slightly Smoother' at 55% and 'Smoothly' at 22% with the remaining indicating 'No Different' as seen in Figure 1. Interestingly, the seniors and those with higher GPA's (3.5+) were most likely to indicate that the QM's had little effect on the class flow.
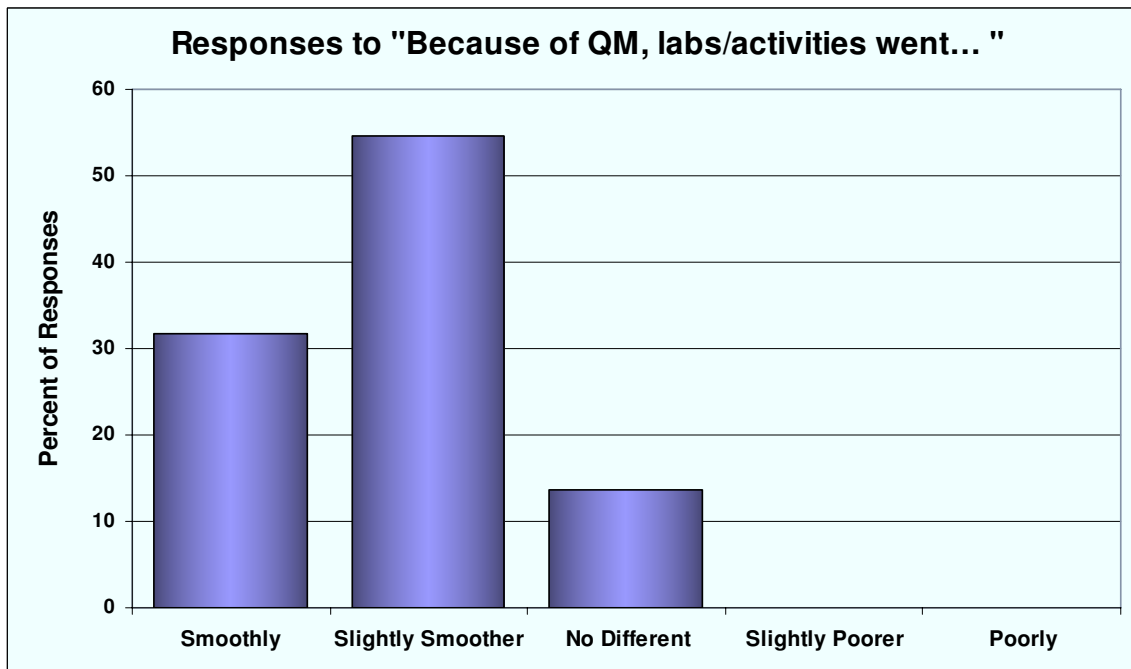
Figure 1. Responses to "In terms of logistics and class time: Because of the Quality Manager's preparation, presence, and assistance, I felt that the labs/activities went…"

Learning Potential. In terms of learning, 43% of students felt they learned slightly more and 23% reported they learned 'more' (the highest choice) because of the Quality Manger's role as shown in Figure 2. No one thought they learned less with the QM involvement. Once again, the seniors and those with higher GPA's were inclined to perceive their learning experience to be 'No Different' in light of the QM's involvement. This question specifically included the preparation and prior work of the QM's in addition to their in-class assistance.

Responses to "Because of QM, I learned… "

(Chart: Percent of Responses — More ≈ 23, Slightly More ≈ 43, The Same ≈ 34, Slightly Less ≈ 0, Less ≈ 0)
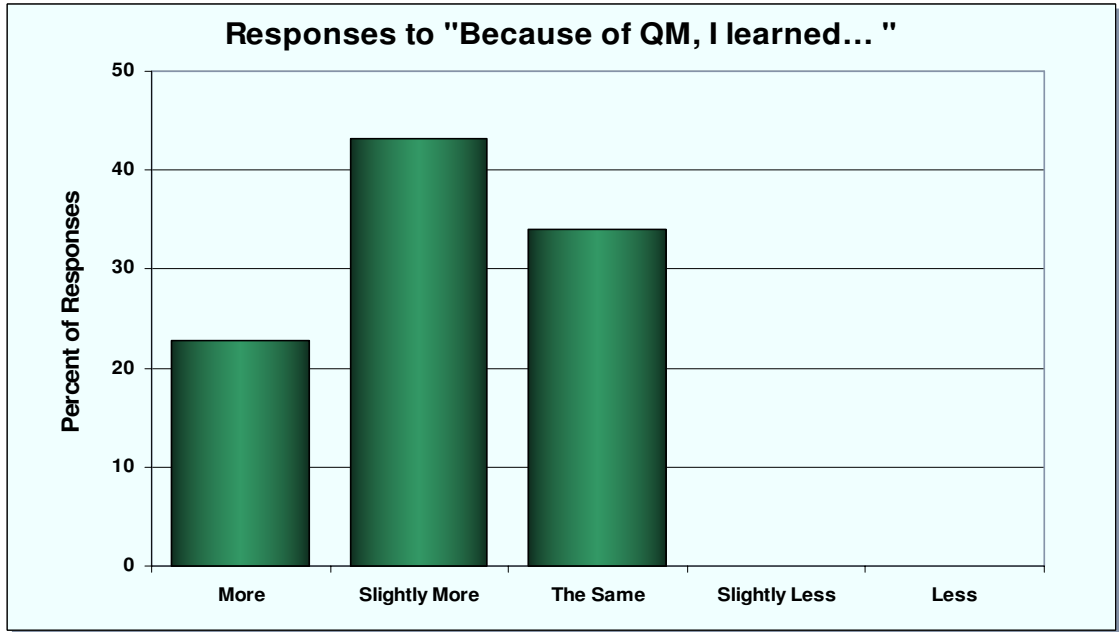
Figure 2. Responses to "In terms of learning and clarification: Because of the Quality Manager's preparation, presence, and assistance, I felt that from the labs/activities, I learned …"

Confidence in Material. A seen in Figure 3, students reported that with the QM involvement, their confidence in the course material was increased –either slightly or solidly (57% combined), and 43% had the impression that it was unchanged. This is an encouraging outcome in that a implied aim in embarking on a new initiative is to "do no harm" given that the more explicit objective naturally is to foster improvement. Once again, the set of students that were unchanged by QM involvement were the older students and those with high GPA's.
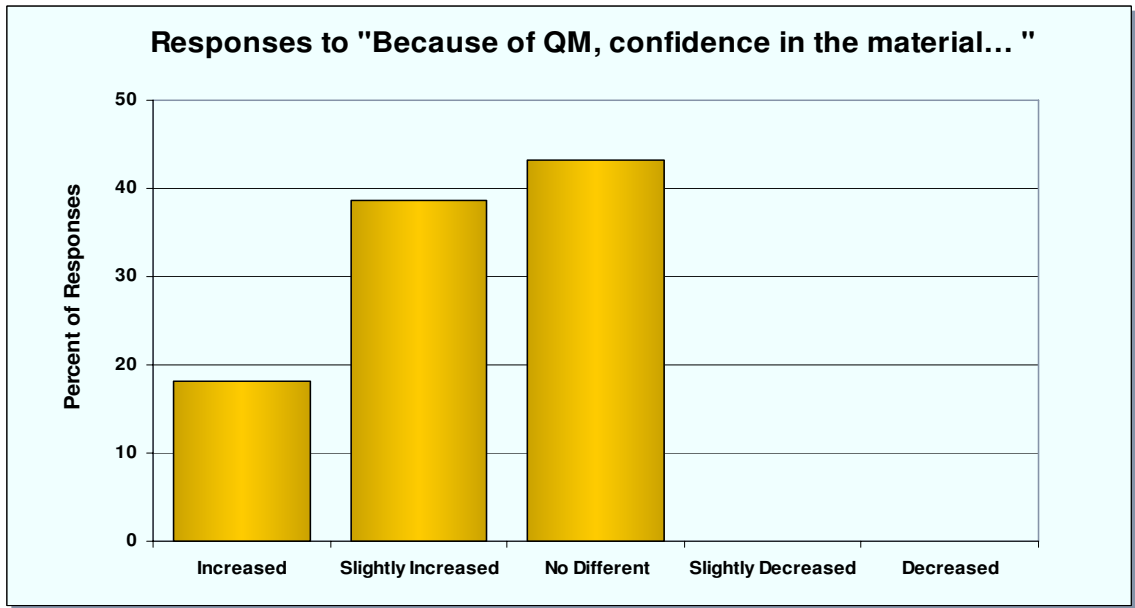

Responses to "Because of QM, confidence in the material… "

(Chart: Percent of Responses — Increased ≈ 18, Slightly Increased ≈ 38, No Different ≈ 43, Slightly Decreased ≈ 0, Decreased ≈ 0)

Figure 3. Responses to "As a result of the Quality Manager's preparation, presence, and assistance, my confidence in the course material was …"

Confidence in Professor. A positive outcome in response to the question "The professor's use of a student to help prepare and assist in class, made my confidence in the professor …" was that over half of students (55%) reported that their confidence increased. Results are presented in Figure 4 below. The remainder replied that it remained unchanged. The encouraging rationale given for an increase in professor confidence related to the students reporting that if the professor had the insight and perceptual inclination to gather input on the best approach from potential 'end-users,' this contributed to their sense of connectivity between professor and student in terms of the course material. It sends a message to the students that the views and inputs of students matter to their professor; the QM's are an embodiment of the fact that students matter.
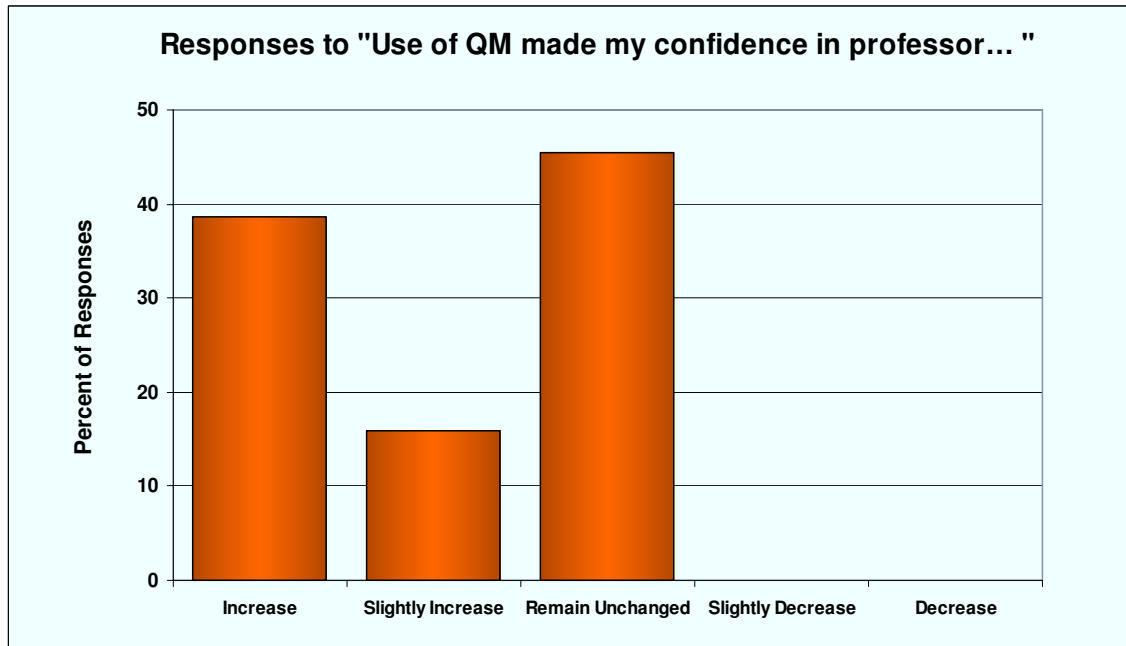

Figure 4. Responses to "The professor's use of a student to help prepare and assist in class, made my confidence in the professor …"

Availability of Peer QM's during the class time. Students were also able to respond to the presence and use of a QM in terms of their availability as a resource and their guiding role in the classroom. This question was more related to the QM's function in interpreting the assignment and assisting with the use of materials as opposed to actual knowledge acquisition or intellectual content of the lesson. Figure 5 shows that the responses to this inquiry were very affirmative in that 70% of the students felt that they were positively affected by their peers' guidance. There was an additional 11% that reportedly did not call on the QM's, but appreciated their presence as a potential resource to clarify the assignment. Providing an atmosphere that promotes confidence and clarity is an educational aid in and of itself.

Approximately 13% reported that QM's in the classroom made no difference to them whatsoever. These students felt that QM's neither assisted or nor affected their comprehension of the specific assignment and its objectives. Some of those respondents, however, acknowledged that that the quality was likely improved because of the advance involvement of the QM's even if their physical presence had no bearing how the material was understood at class time.

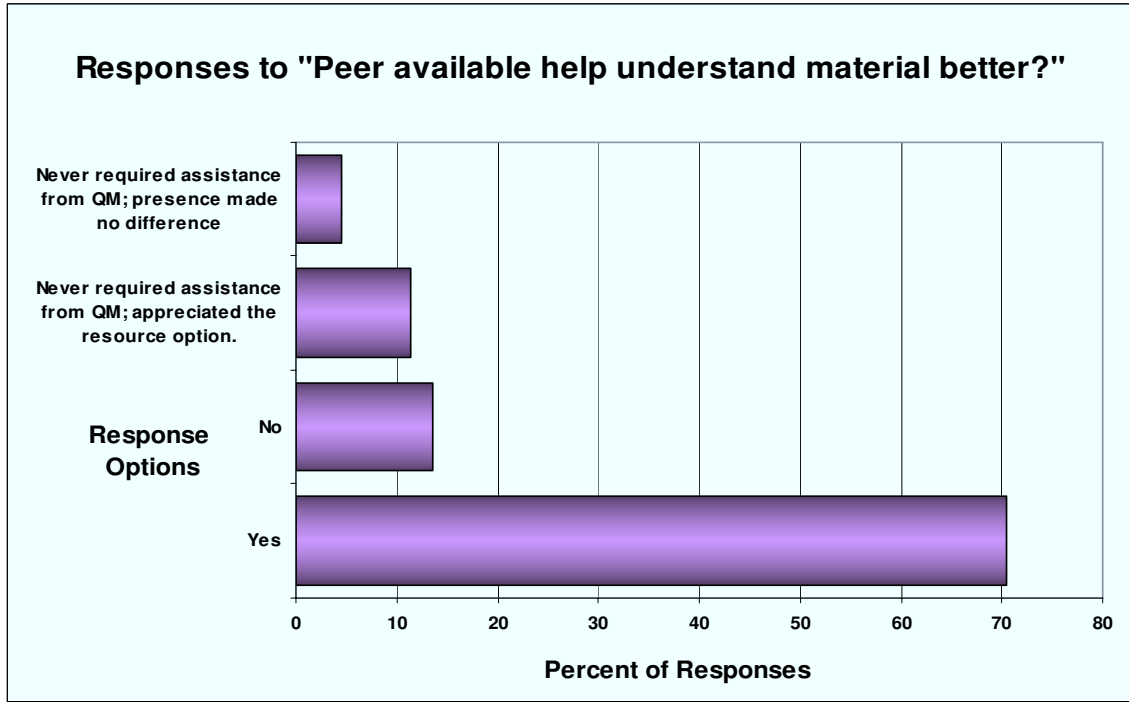One "sleeper" was unaware that QM's were even there.

Figure 5. Responses to " Did having a peer available (who had previewed the lab) better help you understand the material?"

Open-ended responses. In open-ended responses, students felt that the QM's were sufficiently prepared to assist and generally had no hesitations calling on them for guidance. As seen in Figure 6 below, the most common viewpoint on the QM role was 'Assistant' or 'Helper.' Along with the responses to the question of perceived role, the notion of being at ease calling on qualified peers for in-class guidance was an overwhelmingly notable theme that contributed to class atmosphere. In a related content analysis, the words 'comfortable' and 'approachable' appeared more than any others.
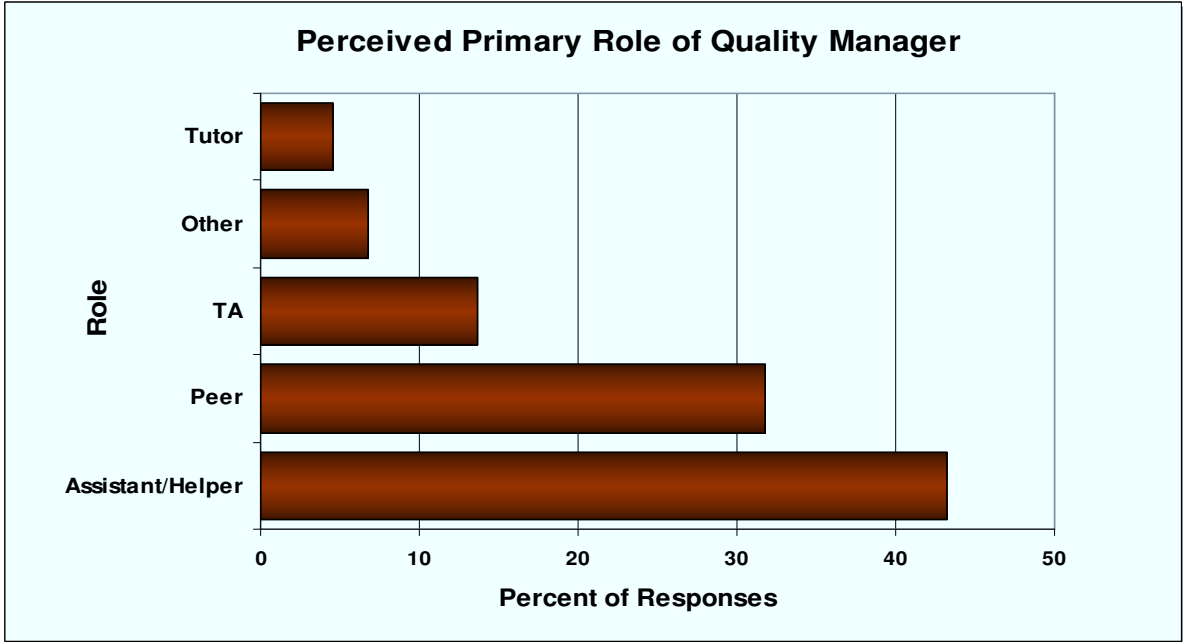
Figure 6. Responses to "In terms of the Quality Manager role, did you regard the Quality Manager primarily as a …"

QM Traits. Further open-ended inquiries were made about the preferred characteristics of Quality Managers as well as undesirable traits for QM's. These results are seen in Figures 7 and 8. Students could provide up to 5 traits using their own descriptors, so the percentages reflect the frequency with individuals listed the given trait or a close synonym. Multipass content analyses were conducted revealing very clear profiles for both good and poor QM traits. It was very interesting to note that the students listed being *personable* and *approachable* as a leading quality to possess in the QM role, even ahead of being *prepared* and *knowledgeable*.
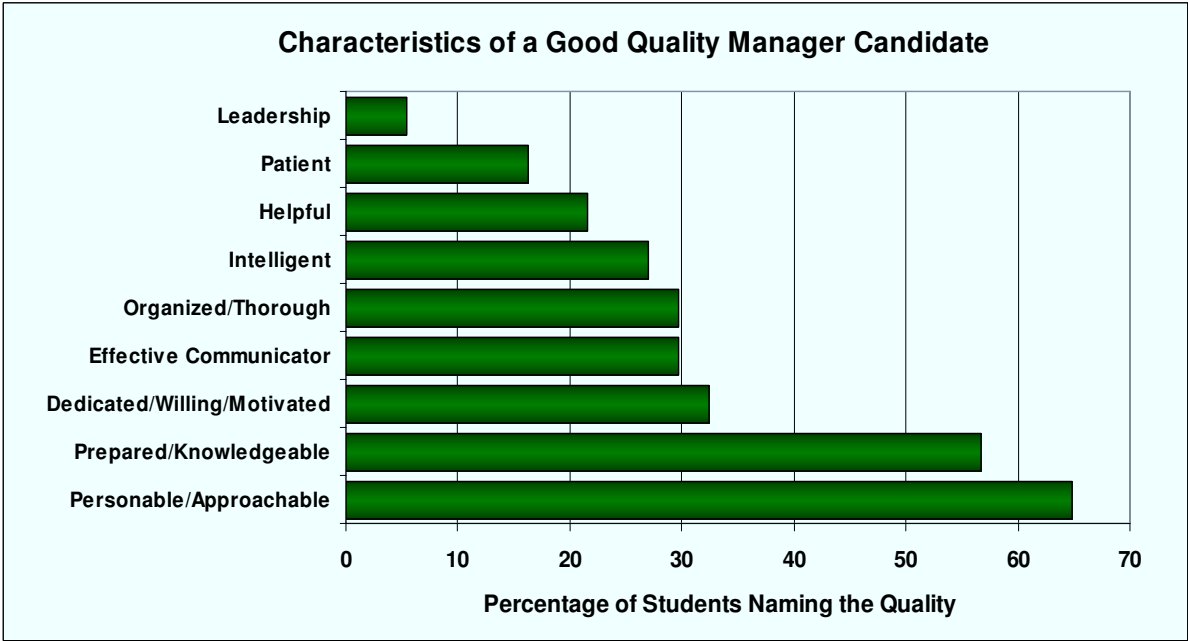

Figure 7. Open responses to "What characteristics of a Quality Manager would make them a good candidate to assist in class? (list up to 5)."

There are no major surprises in the listing or traits that would make a poor quality manager, although it is a bit curious to note that the notion of lacking knowledge was not at the top of the list. A healthy reminder to us as educators is that students expect those teaching them to be organized and reliable, communicative and personable, helpful and inspiring. Mostly, they appreciate a person who is personable in addition to being knowledgeable.

In the analysis of open-ended responses, there were no reports of any Quality Manager detracting from the assignment objectives or learning focus in terms of providing incorrect instructions or misinformation. This factor *must* be emphasized to the QM's –that they are not required to have all the answers; rather they are free to confer with the professor or refer the team directly to the professor at any time.

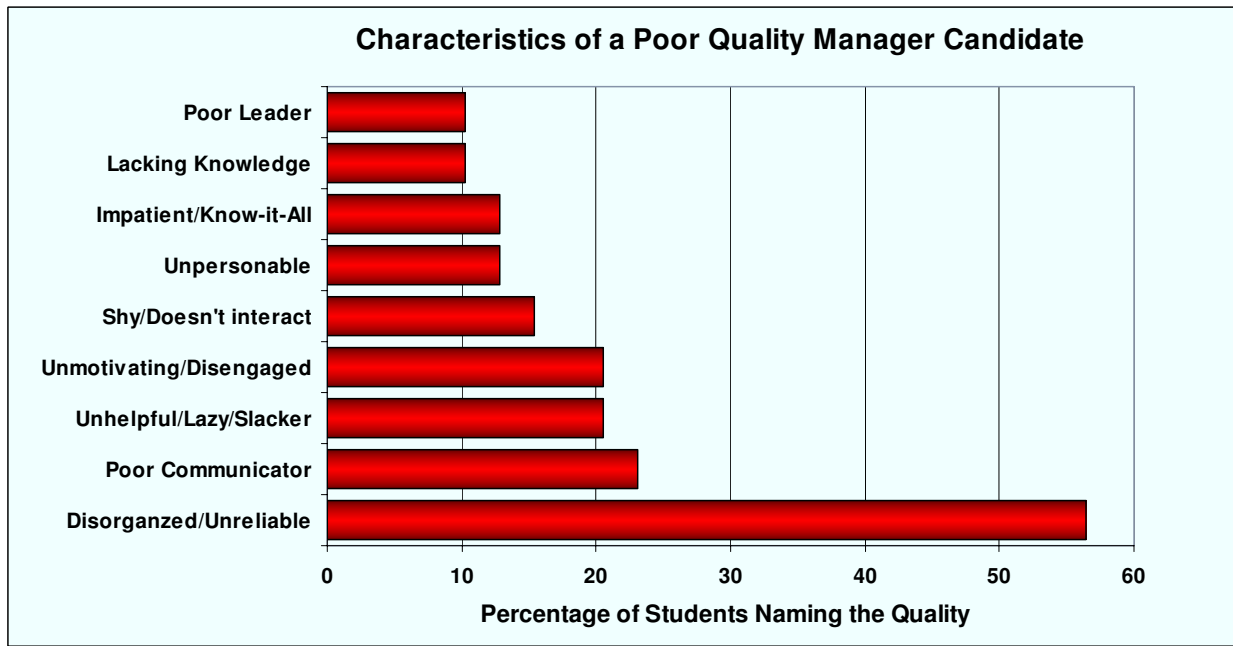**Characteristics of a Poor Quality Manager Candidate**

Figure 8. Open responses to "What characteristics of a Quality Manager would make them a poor candidate to assist in class? (list up to 5)."

All of the student-generated responses lend valuable insight for the instructor as to how to select the QM's: Along with intellectual and independent qualities required to master the material in advance of their classmates and a willingness to serve, QM's should also possess social skills that the faculty must observe and identify in advance.

Class Size. Not surprisingly, students will accept a larger class size with the use of Quality Managers. Figure 9 shows the shift from smaller class sizes for the sole professor to larger enrollments if professors avail themselves of a qualified QM. This is generally good news in light of growing class sizes and a continued movement in the direction of active and hands-on learning. Since experiential learning tends to require additional planning, coordination, and attention, enlisting QM's can foster a more managed and less chaotic learning environment.

Commentary for this question shows that while the students generally appreciate smaller class sizes as a conscious choice, there is also an appreciation for the opportunity to work in teams and benefit from interaction with many other classmates. As one student commented:

"It is preferable to have as small of a class as possible, such that the professor may educate as directly to individual students as possible. However in a setting where groups of students work together frequently, slightly larger class sizes would allow students exposure to more ideas from a group setting…."
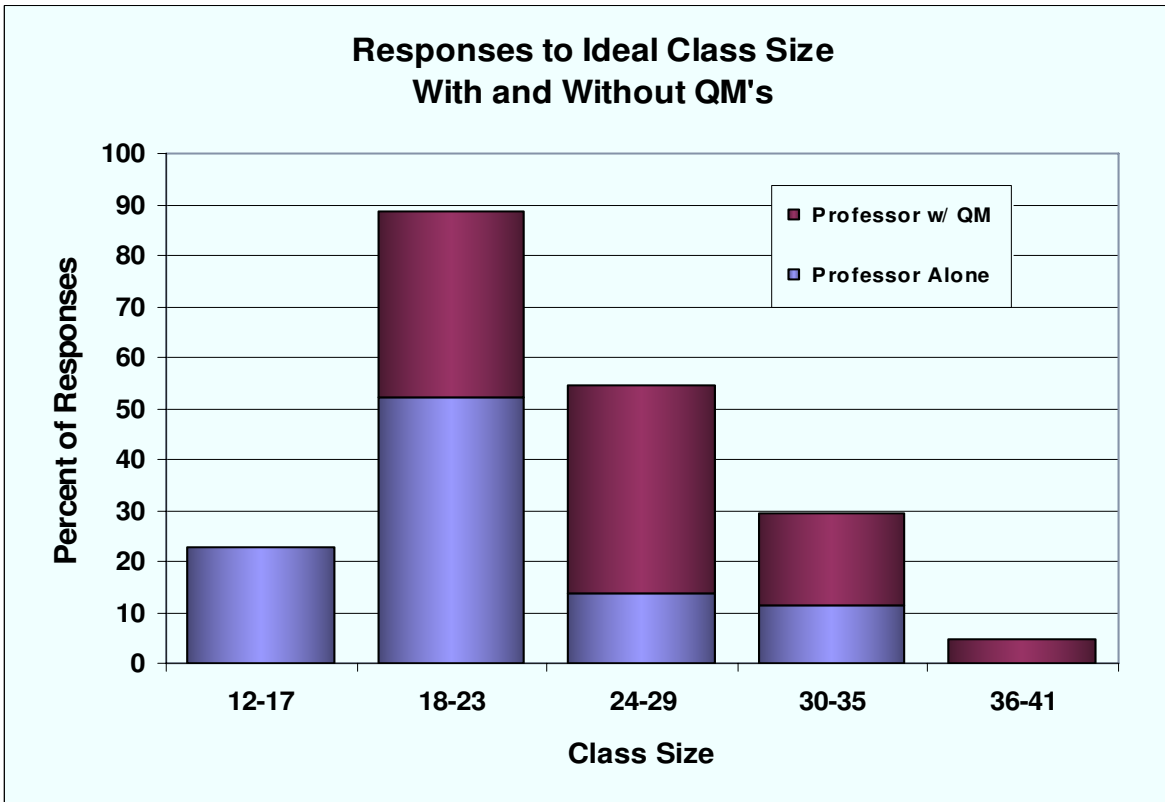

Figure 9. Responses to (a) "With a Professor <u>and Quality Manager(s)</u>: Realistically, for this course, what do you believe to be the ideal class size to foster course material comprehension?" and (b) "With the Professor as the <u>sole instructor</u>: Realistically, for this course, what do you believe to be the ideal class size to foster course material comprehension?"

Critiques and Management Suggestions

As noted, there were a few critiques for using Quality Managers; these should be acknowledged and addressed. The representative ones are listed below with the authors' suggestions (following the →) for managing challenges or dispelling any misconceptions that may arise.

➢ Professor broke up existing lab teams or work groups resulting in more work for those who were "abandoned" and not serving as a QM → Make an allowance for the grading and expectations and allow QM to provide guidance to their teammates. Identify QM team member on assignment or lab report to remind the professor of the altered team dynamic.

➢ Quality Managers were chosen to make the professor's job easier or to do the professor's job for them → During sign-up, clearly explain to the class the motivation for using Quality Managers.

That is, the course can incorporate more interesting, memorable and illustrative learning experiences with additional peer assistance. It is for *them* and the course quality.

➢ Quality Manager's major incentive was to not have to do that lab in its entirety → As the instructor, that should not be the selling point. Explain that the QM's have responsibilities that require them to demonstrate comprehension of the material in a way that differs from a written assignment.

➢ Quality Manger may grade or evaluate student's work → Be very clear with the class and the QM's that their role is to serve the class and course objectives by helping the instructor do a better job. They do not take on any of faculty *responsibilities* whatsoever, including grading.

➢ There is an impression of favoritism The professor is inclined to select the more outgoing, accomplished, dedicated students to meet the challenge of the QM requirements. → This is likely to be true, but does not amount to favoritism. This may be unavoidable in the lower academic levels in which the professor guides the QM selection in order to choose the most qualified individuals who have earned the opportunity by demonstrating their capabilities.

➢ From QM's: Professor did not provide quite enough lead time for the QM to prepare → Since the QM's are new to the lab and lesson and it is a future topic for them, the instructor will need to provide enough lead time for them to have a total of at least 3 QM-professor interactions in advance of class time: the initial meeting, time to clarify along the way, and then opportunity for them to provide feedback to you. If at all possible, starting 2 weeks prior to the lab has worked best to allow for multiple interactions, even if they are informal.

Refinements and Implementation Suggestions

In addition to the advice above under **Critiques and Management Suggestions,** the following recommendations will also help the instructor administer the QM initiative smoothly for all concerned. As such, these guidelines are directed to the instructing faculty.

➢ Throughout the process: Be willing to show your genuine enthusiasm for the opportunities that this initiative can provide for all concerned. It is a positive and beneficial enterprise on many levels and this can be conveyed through your attitude as the course facilitator.

➢ During sign-up: Make the selection process and expected roles transparent to all students and consider allowing all students to sign up for consideration. Also explain the motivation as described above.

➢ During prep meetings: Explicitly review the final outcome and objectives of the assignment or lab and the roles QM's will play in leading the class to those aims. If the QM's understand the goals at the outset, they immediately start to create a common vision with the instructor.

➢ During prep meetings: Strongly encourage QM's to critique and suggest modifications and clarifications in the written assignments. Allow them to electronically proofread, edit, and comment within the document. Some QM's were initially hesitant to critique the instructor, so express to them that it is a responsibility with which they have been entrusted.

➢ During prep meetings: Emphasize to the QMs that they are not meant to know all the answers to potential questions, nor are they meant to provide answers to questions that are supposed to be discovered and determined by the students as part of the assignment.

➤ At class time: Equip each Quality Manager with a colored pen and a clipboard holding a one-sided printout of the assignment handout. They will have been instructed to listen and take notes on any opportunities to edit the directions, instructions, and assignment elements for the future. They are to submit this after class with notes on it and any ideas for improvement.

➤ At class time: Once again, convey to the class the role of the QM – where and when it starts and stops in terms of guidance. QM's will ensure that all participants have the materials they need to conduct the lab or assignment. QM's are there to clarify assignment mechanics, instructions, and objectives. They will not be solution sources and will not conduct the activity for them.

➤ At class time: Enlist the assistance of all students to suggest to the QM's –and the instructor– any changes and clarifications that would improve the assignment and instructions. As such the QM will record their classmates' input to deliver to the instructor. In this way, the QM's serve their classmates and function as an intermediary or representative.

➤ After the class/lab: Meet briefly with the QM's to replay the mechanics of the class activity to identify what would make it go more smoothly in terms of logistics and review the written notes, edits, critiques, and suggestions for improvements.

➤ After the class/lab: Make the changes and updates in the materials and instructions for future use. Thank the Quality Managers for their specific contributions.

➤ After the class/lab: As the instructor, when you enter grades for the given assignment, grade the QM's appropriately according to their reliability, preparation, input, follow-through, contributions, and your perception of their level of content comprehension. You will have conveyed these criteria at the outset as well.

Future Analyses to be Addressed

Quality Managers. Extensive survey data was also collected from those who served as Quality Managers and detailed analyses have been conducted. While a future paper may be dedicated to these valuable outcomes, the findings were very positive and have been noted in the **Results and Discussion** section above.

Social and Interactive Learning Styles. Data was gathered on all respondents' self-reported social learning preferences in accordance with the Grash-Reichman Learning Styles Paradigm. Anthony Grasha and Sheryl Riechmann developed the Student Learning Styles Scale to measure the preferences of college and high school students in interacting with instructors and student peers. Social Style preferences appear along 3 dimensions, or continua: *Participant/Avoidant, Collaborative/Competitive,* and *Independent/Dependent*. These will be further explored in follow-up work to help determine the social learning profiles of students in our engineering classes and to identify any patterns that may support the selection and/or use of QM's from the standpoint of educational approaches.[6]

Professor's Teaching Style. The professor that developed the Quality Manager peer-guided program and the ATLAS research initiative participated in the Grasha-Reichman Teaching Style survey.[4, 5] This was completed for each course taught in the engineering program that used QM's. This highly-validated metric provides scores for the instructor's role in each course in each of the following categories: *Expert, Formal Authority, Personal Model, Facilitator,* and/or *Delegator*. This also has provided insight as to the best approach for selecting and deploying Quality Managers for each particular course paradigm and will be presented in future work.

Traits of the Current Student Generation. While we are cautious in making generalizations about characteristics of any particular population, there are social, educational, and technological phenomena and trends that bear on how our current learners are being formed. This relates to communication styles, collaborative philosophies, independence and social networking, and how these affect expected and preferred styles of interaction and learning inside the classroom. Some of the arbitrary generational delimiters include: *BabyBoomers, Generation X, Millennials, Echo-Boomers, Generation NeXt, the Net Generation, Neo-Millennials.* The list goes on describing significant cultural shifts that shape our young adults. An extensive review of the current generational factors and associated qualities has been conducted by the authors, lending further insight to the value of social and peer-based learning models. This background research also supports the judicious and selective use of Quality Managers in the university classroom to enhance the learning experience for all concerned.

Conclusion

The Academic Teaching and Learning Assistants Study (ATLAS) method evaluates the use of classmate-guided instruction using Quality Managers to blend collective learning in engineering lab settings. This has been accomplished by having students serve as peer teaching assistants in selected classes for complex hands-on learning experiences. Their deeper value lies in the fact that the QM's role goes beyond the in-class guidance they offer; they also provide *a priori* feedback to the instructor on a particular lesson by proofreading and working though the lesson in advance. Then the QM's assist in guiding the lab or activity by functioning as a technical extension of the instructor and by serving as a liaison between the students and the instructor. In addition, QM's are able to clarify elements of the instructions and/or lesson objectives to their classmates, having already familiarized themselves with the material. Quality Managers have a valuable role in representing their peer student population by beta testing a complex assignment to improve its quality and by helping the professor tune in to the class from a student's perspective.

Not only did ATLAS yield strong data advocating the value of QM's to the general students in the classroom, but there was compelling statistical support for the value of the experience for the Quality Managers themselves. They were provided an opportunity to take responsibility for their own and their peers' educational process, rising to the challenge and pressure of this with dedication. Finally, the use of Quality Managers has had a positive impact on student-professor relationships, *directly* with QM's and *indirectly* with all students through enhanced perception of the professor's genuine desire to connect the class material more closely with the students.

In summary, statistical analyses on survey values and content analyses on open-ended responses yield results strongly supporting the QM initiative. Constructive feedback has been used to improve the program and generate basic guidelines for faculty to implement a similar initiative in their engineering classes as appropriate. As a result of this work, recommendations are made for implementing ATLAS findings in a productive way, such as how to select quality managers, how to communicate their role to general students and QM's alike, how to avoid potential pitfalls, how to adequately prepare and appropriately compensate Quality Managers, and further thoughts on how to successfully manage the classroom activities using QM's. This paves the way for new engineering educators to adopt the nth generation of a teaching strategy that has already been vetted and can be applied easily and effectively in our growing classes.

This collaborative, peer-based and student-centered approach integrates a shared vision that we can gain from each other in the classroom culture. Transformational understanding is actively promoted in interactions at every level. Instructors, peer assistants, and general students seem to genuinely benefit from this paradigm. As such, this teaching strategy has immediate application for new instructors and seasoned instructors seeking meaningful ways to actively, collaboratively, and experientially engage engineering students at all stages from freshmen to senior year. QM application in selected classroom contexts seems to be a win-win situation for all stakeholders. Teaming with students to teach is academically satisfying, sustains our profession, and is thoroughly enjoyable.

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The survey format and questions can be made available by contacting the first author on this paper.