Meeting the Client: Learning the Capstone Student's Perspective through the Three-Intelligences Methodology

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Capstone design can have a powerful effect in preparing engineering students for their careers. It is also accompanied by varying levels of uncertainty as students often navigate uncharted territory. Recognizing that many capstone students have limited experience interacting with clients, a set of rubrics was previously developed to support capstone students in preparing for and executing their meetings with clients, especially the first meeting. While student feedback was positive regarding such tools, the tools' very nature could reduce critical thinking via rote application. Accordingly, the Three Intelligences Methodology -involving a planned three-phase guided interactive exercise- has been designed, developed, implemented, and evaluated to increase student engagement in and ownership of the rubrics, as well as to foster team building early in the capstone design experience. This paper reports on an exercise that applies the Three Intelligences Methodology to the initial client meeting in Capstone, presents some surprising results and lessons learned, outlines some best practices, and provides recommendations for applying the methodology or variants thereof elsewhere.

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Introduction and Motivation

Capstone design courses are often structured to provide applied learning opportunities that simulate real-world engineering experience, including interacting with clients.[1] The authors have previously developed a set of rubrics and an accompanying checklist to support students in preparing for and executing their meetings with clients, with particular focus on the initial meeting; the development and format of the tools have been documented in prior papers.[2,3] Student feedback from both formal and informal assessments conducted at multiple institutions show that students appreciated the structure of the tools and the guidance provided through them. However, the authors – who are also the rubric developers – shared concern that the tools' very nature could result in a "check-the-box" mentality, thereby reducing critical thinking if the students merely followed an established recipe. Moreover, capstone design instructors often seek specific tools and methods that can be applied across programs.[4] Given the importance of context, however, it is rare that specific "best practice" tools are universally available and applicable. The methodology discussed in this paper – hereafter termed the "Three-Intelligences Exercise" – can be considered a "best method" because it supplements an established foundation with student input to effectively adapt the tools for a specific context.

The Three-Intelligences Exercise: Preparing for the Initial Client Meeting

The Three-Intelligences Exercise developed by the authors and outlined here is designed to be completed within a single class period (~1-1.5 hours), and is divided into three phases, paced by the instructor, that are used to engage students' *individual*, *collaborative*, and *collective* intelligences. This example of initial client interaction preparation is best performed ***after*** the project and client are identified but ***before*** the initial meeting between students and client, or any preparatory activities thereof, are conducted.

The materials needed for this exercise are flexible - one can either use physical materials such as Post-it® notes with large paper or whiteboards, or use electronic boards such as Miro or Google Slides. Handouts or guiding e-docs can also be created for the individual portion of the exercise to help expedite that segment of this activity. Having a camera or phone to record pictures is also helpful if working with physical materials.

Phase 1 - Individual Intelligence

The initial phase in this process is designed to engage each student's *individual intelligence*, and operates at various levels of Bloom's Revised Taxonomy.[5] It begins by focusing on the particulars of the design project. First, in Phase 1A, students engage at the Remember and Understand levels by independently (*i.e.*, without any consultation with other class members) writing down responses regarding the project title, identifying the project's client, final recipient and beneficiaries, and a planned team meeting schedule. The next step, Phase 1B, is similarly designed to engage each student's individual intelligence at the Application level, with attention now being focused on the upcoming initial meeting between the student team and their client. On a separate sheet of paper, students are now asked to independently begin the meeting preparation process by writing their own short (no more than five words per item), enumerated bullet-point responses to the following prompts:

- What tasks (minimum of five) must be done before meeting the client or sponsor?
- What agenda items would you plan to cover in the initial meeting with your client?
- What tasks will need to be done in terms of follow-up after the initial meeting?

The final step in the individual intelligence stage, Phase 1C, involves each student at the Analyze and Evaluate levels. This is done by asking them to reflect on the following prompts, still without any consultation with others:

- What three questions would you most like to have answered during the initial meeting?
- What three things would you do to be prepared - and professional - for the initial meeting?
- What three qualities do you (individual or team) have to offer your client/sponsor that would please them?

Phase 2 - Collaborative Intelligence

At this stage of the exercise, students are asked to engage their collaborative intelligence by working together to identify their team findings from the second set of tasks above in 1B. Here, two different colors of sticky notes are needed. Students are instructed to use one color of notes to record any elements two or more members had in common, and a second color of notes to record the remaining items they deem appropriate for their project that were suggested by only one team member. When completed, these notes are then applied to an organizational background (such as a whiteboard or flipchart page) that starts with the project's title. It is broken down into three primary categories: Preparation/Before tasks, Agenda/During items, and Follow-up/After tasks. The final task of this phase engages the students at Bloom's Creative level in that they are now taking various elements and forming them into a functional whole.

Phase 3 - Collective Intelligence

While the task of preparing to meet with a client/sponsor is new to many, if not all, students, it is not a novel problem without a solution.[6] Here, the students are introduced to the concept of *collective intelligence*, which occurs when we allow ourselves to be informed by those who have previously addressed an issue or task by interacting with sources that are more experienced and more informed. At this critical juncture, the students are presented with the established Initial Meeting Student-Client Interaction Rubric[2], (the "Rubric" - available at https://bit.ly/3sYIam9), designed through a validated, iterative, and interactive process that included input from capstone faculty and industrial advisors to capture what were considered to be key performance objectives to be attained before, during, and after a meeting.

The students are next asked to review the collective wisdom embodied within the document presented to them in light of their collaborative outlines. They then work at Bloom's Evaluating and Analyzing levels to identify new items based on their previous phases (or which naturally arise from the review) and add them to the list of sticky notes using the third color where they best fit. Following this set of additions, each team should discuss and rearrange the sets of notes into the most logical sequence for each section; additional items can be written directly onto the pad or in another color if desired. Once a steady state is reached, each team places their names somewhere on the resultant document and takes a photo of the results and submits it to the instructor or uploads it to a Learning Management site. Teams revisit the physical or digital poster to finalize the plan for the initial client meeting: the list of tasks to be performed before, during, and after the meeting can now be developed into a set of action items assigned to various members of the team. In addition, the agenda for the initial meeting can be further adjusted and transcribed into a more formal and structured document, which is then distributed to all team members, the capstone advisor, and potentially the client prior to the initial meeting.

The benefit of this three-phase process is that it allows the capstone students to contribute their individual and collaborative intelligences to the collective intelligence along various vectors of diversity, including but not limited to life experiences, cultural view, specifics regarding the project, frames of thinking, and the needs of the client. Figure 1 shows a sample final in-class document with the multiple colors of Post-it® notes from one team. This will guide their client interactions.

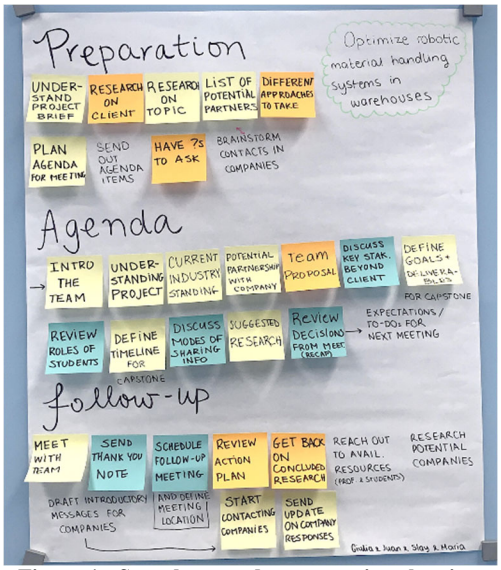

Figure 1 - Sample team documentation showing individual (pale yellow), collaborative (orange), and rubric-based collective (blue) contributions.

Results and Discussion

A Three-Intelligences Exercise was conducted with 22 capstone design teams across two capstone courses at Northeastern University and found that the elements on the teams' final documents fell into three primary categories. First, students independently identified elements that matched those already on the Rubric. Next, teams identified items from the Rubric that they had missed, choosing to add them during Phase 3 as fitting. Finally, teams listed items that were not found on the Rubric, thus providing important new insight and student perspective on preparing for the initial client meeting. Content analysis was conducted to establish common and categorical patterns among responses.[7]

Top elements in common with the Rubric.
A Kolomorogorov Smirnov test of homogeneity showed that the percentages of included elements was normally distributed across the teams, N=22, p=.026. On average, the teams included 38% of the applicable items on the Rubric, with the most common elements in common being 'sending the agenda' (68%) and 'researching company/client' (67%) *in advance of the meeting*, 'discussing needs and project context' (64%) and 'defining expectations and success factors' (64%) *during the meeting.* For *after the meeting*, 'articulating next steps' (68%) and 'sending a recap' (50%) were the top elements in common.

Most missed elements from the Rubric.
Certain items were on the Rubric that many teams tended to overlook originally (O=Original percentage) and then add in later during the collective phase after receiving the Rubric (A=Added percentage). These elements provided insight as to the students' areas of focus. Notable items with low representation by the teams were 'discussing key stakeholders and beneficiaries beyond the client' (O=14%, A=50%), 'researching competitors and similar organizations' (O=18%, A=41%), and 'addressing legal issues like IP, NDA, and HIPAA (O=4%, A=50%).

Elements *not* found on the Rubric that *were* included by students.
This category is the most telling, valuable, and surprising aspect of the Three-Intelligences Exercise. Clear patterns emerged around several elements and activities that students had identified but were not listed on the Rubric. The profile of these items revealed areas of concern and the need for clarification on behalf of the capstone students, as summarized in focus areas below:

Orientation - Students wanted to establish identity and learn about the organization first-hand. Independent items included "Introduce ourselves and capabilities", "Tour facility", and "Observe operations".

Initiative and Boundaries - Students wanted to gauge the levels of freedom and trust afforded as well as any restrictions or limitations imposed. Topics included "Do we need to be onboarded?" and "Are we allowed to access the production area unsupervised?"

Problem Overview - Students wanted to understand current issues and challenges, prior solution efforts, and what constitutes a favorable future outcome. Items included "What is your biggest concern/pain point/unmet need?", "What have you tried in the past?", and "What does short and long-term success look like?"

Technical Requirements - Students wanted to identify the necessary expertise to acquire, allay concerns about access to data – or gain permission and ability to collect it as necessary. Comments included "Do we need to learn AnyLogic?", "How will we learn about the patient registration process?", "Will we be given historical data?", and "Will we be permitted to collect occurrence sampling data?"

Figure 2 shows the priorities of the various concerns across the four categories above using four distinct colors. Some are stratified by sub-areas of focus. Initiative and Boundaries are collapsed into a single data set below as many of the entries contained both aspects, questioning what is allowed/prohibited.

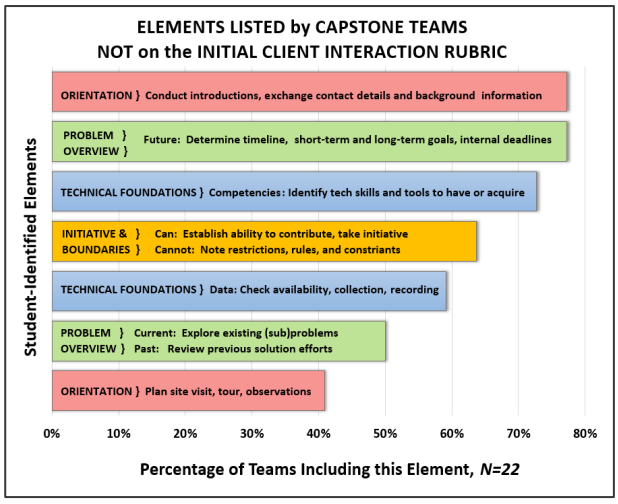

Figure 2 - Items listed by student teams that were not explicitly on the established Rubric

Multiple benefits of the Three Intelligences approach
As seen above, applying the Three-Intelligences Exercise to the initial client meeting helped students better prepare for their initial client interactions and helped frame high quality meetings. Equally important, and somewhat unexpectedly, the exercise also provided useful insights into student concerns and perspectives regarding the start of their projects, especially related to areas of student uncertainty, initiative, work boundaries, orientation with the client and organization, and required skill sets.

We found that using this inclusive, non-prescriptive approach incorporating student input fostered greater buy-in and promoted diversity of thought. It also helped to close the commonly seen gap created by a mismatch of expectations between students and clients.[7] This resulted better-prepared teams and tailored tools that were more suitably aligned to the particulars of each project, including the needs of clients and students alike. As such, this exercise has been replicated across several programs and re-evaluated to help inform subsequent versions of the ever-evolving Initial Student-Client Interaction Rubric.

This Three-Intelligences Exercise also has multiple benefits in general, regardless of application topic. First, it promotes individual and student ownership in the process of setting and understanding key criteria. Encouraging and providing for student engagement avoids the scenario in which students are prescriptively given specific requirements up front and subsequently tune out. Second, it helps students calibrate with the mindsets of their teammates, professors, and potentially others. Thus, it promotes team cohesion as students collaborate, acknowledging commonalities as well as recognizing the value of multiple viewpoints. Third, it allows the instructor to add value by interacting with the teams during the collective intelligence process, spotlighting overlap (what students already listed) and filling in the gaps (what students did not list). Fourth, it helps faculty develop insights to students' concerns, trepidations, and uncertainties. Finally, it allows the instructor to track patterns in student data over the years, adjust Capstone orientation messaging, modify future assignments, and provide guidance accordingly to best fit the institutional context and student experience.

Conclusions and Future Recommendations

In this paper, we describe an exercise developed to help capstone students prepare for their initial client meeting. Through three phases (representing each of individual, collaborative, and collective intelligences), students work first alone, next with their teammates, and then with provided materials to develop a set of guiding criteria and prompts tailored to their specific context. These phases together constitute an inclusive methodology that welcomes and encompasses students' input. Results from the initial client meeting application showed very high levels of student buy-in and also pointed to areas of student concern and uncertainty that will prepare instructors to address these concerns either pre-emptively and/or with added insight. Further, the student input can serve to inform future versions of the Initial Student-Client Meeting Rubric.

The Three-Intelligences method outlined above is rich in transferability across several axes. Staying with the "initial client meeting" application, the exercise can easily be implemented in capstone courses at other institutions or at similar client-oriented courses earlier in the curriculum. While the format is flexible, we recommend conducting the exercise in person during a full class period (~1-1.5 hours) to provide sufficient time for each of the distinct phases and to enable interaction between the instructor and the different teams. More broadly, a variant of the Three-Intelligences approach can be applied to any number of situations or assignments that would benefit from student buy-in and multiple viewpoints. As a starting point within the capstone design context, we recommend applying the Three-Intelligences methodology to oral presentation guidelines, final report contents, or preparation for extended site visit. However, we also recognize the potential for student fatigue with any single approach, so it is recommended to limit usage to no more than two or three times per course.

Repeated implementation of this Three-Intelligences approach with different teams across different disciplines and institutions will undoubtedly result in modifications of the Initial Student-Client Interaction Rubric itself. We welcome input and feedback from other educators who utilize the Initial Client Interaction Rubric and Three-Intelligences Exercise in their capstone courses.

References

1. S. Howe *et al.*, "The 2015 Capstone Design Survey Results: Current Practices and Changes over Time," *IJEE,* 33(5), 2017. pp. 1393-1421.
2. J. Estell *et al.*, "Client-Interaction Tools: Supporting Student Professionalism on Client-Based Capstone Design Projects," *IJEE,* 35(6B), 2019. pp. 1953-1968.
3. J. Estell and S. Howe, "Development and Use of a Client Interaction Rubric for Formative Assessment," *ASEE*, 2017.
4. T. Honor, J. Passow, and C. H. Passow, "What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review," *JEE*, 106(3), 2017. pp. 475-526.
5. D. R. Krathwohl and L. W. Anderson, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Longman, 2009.
6. S. Reifenberg and S. Long, "Negotiating the Client-based Capstone Experience," *IJTLHE*, 29(3), 2017, pp. 580-588.
7. J. Fereday and E. Muir-Cochrane, "Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development," *IJQM*, 5(1), 2006.