ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #35896

Playing in the Sandbox: Developing Entrepreneurial Mindset Communication Skills in Introductory Programming Students

Dr. Stephany Coffman-Wolph, Ohio Northern University

Dr. Stephany Coffman-Wolph is an Assistant Professor at Ohio Northern University in the Department of Electrical, Computer Engineering, and Computer Science (ECCS). Research interests include: Artificial Intelligence, Fuzzy Logic, Game Theory, Teaching Computer Science, STEM Outreach, Increasing diversity in STEM (women and first generation), and Software Engineering.

Dr. John K. Estell, Ohio Northern University

Dr. John K. Estell is Professor of Computer Engineering and Computer Science at Ohio Northern University, where he teaches first-year programming and user interface design courses. He earned his BSCSE in computer science and engineering from The University of Toledo and both his MS and PhD in computer science from the University of Illinois at Urbana-Champaign. He believes that effective learning occurs when students are provided with active, hands-on experiences that tie real-world practice with theory. Much of his current research involves design education pedagogy, including applying the entrepreneurial mindset to first-year programming projects by developing educational software applications for real-world clients, and streamlining outcomes assessment processes.

Service to others plays a large role in his life; currently, Dr. Estell is a member of the American Society for Engineering Education (ASEE) Board of Directors as Chair of the Professional Interest Council (PIC) III. He has previously held multiple ASEE leadership positions within the First-Year Programs and Computers in Education divisions, and with the Interdivisional Cooperation and Interdivisional Town Hall Committees. Dr. Estell was elected in 2016 as a Fellow of ASEE in recognition of the breadth, richness, and quality of his contributions to the betterment of engineering education. He has received multiple ASEE Annual Conference Best Paper awards from the Computers in Education, First-Year Programs, and Design in Engineering Education Divisions. He has also been recognized by ASEE as the recipient of the 2005 Merl K. Miller Award and by the Kern Entrepreneurial Engineering Network (KEEN) with the 2018 ASEE Best Card Award. Dr. Estell received the ASEE First-Year Programs Division's Distinguished Service Award in 2019.

Dr. Estell is also active within the Accreditation Board for Engineering and Technology (ABET). He has been an ABET Expert since 2010, starting as a Program Evaluator (PEV) for both Computer Engineering and Computer Science. He served as a Computing Accreditation Commission (CAC) Commissioner from 2013 to 2021, including being on the CAC Executive Committee from 2016-19, and commenced serving as an Engineering Accreditation Commission (EAC) Commissioner in 2021. He has been on the Accreditation Council Training Committee since 2016, including serving as the PEV Training Subcommittee Chair since 2018. Estell has also been a regular presenter at the ABET Symposium since 2003, being an invited speaker on assessment and accreditation practices on several occasions. Dr. Estell was elected in 2021 as an ABET Fellow for his sustained contributions focused on harmonization across commissions.

Dr. Estell is a co-founder and Vice President of The Pledge of the Computing Professional, an organization promoting the notion of computing as a recognized profession at the time of graduation for students in computing-related programs.

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Stephany Coffman-Wolph and John K. Estell
Electrical & Computer Engineering and Computer Science Department
Ohio Northern University
Ada, Ohio 45810
Email: s-coffman-wolph@onu.edu, j-estell@onu.edu

Introduction

As one of the charter members of the Kern Entrepreneurial Engineering Network (KEEN), the Ohio Northern University College of Engineering has been at the forefront of incorporating elements of the entrepreneurial mindset (EM) into all of its programs' curricula. EM is a multi-faceted concept comprising a wide range of attitudes, characteristics, skills, and traits such as adaptability, creativity, critical thinking, curiosity, empathy, innovation, risk-taking, and value creation. As with other competencies, EM is most likely to accumulate if encountered throughout the curriculum instead of presented as a single activity in a single course. Accordingly, multiple courses were selected to introduce various EM competencies, including the second introductory programming course (CS2) taken by computer engineering and computer science majors.

For many years, CS2 has had a culminating design experience focused on educational software application development. When the decision was made to incorporate EM-based learning, this term project was modified to include real-world clients with educational outreach needs. This incorporated three critical aspects of EM: the curiosity associated with an open-ended problem, making connections through a variety of informational sources, and creating value for others through developing a deliverable product. However, this course modification exposed an unexpected complication: students experiencing significant discomfort when communicating with clients. To address this, a series of communicative tools were added, being introduced to the students before any meaningful client interactions by using a "sandbox" approach. By "playing in the sandbox," students can practice applying these tools in a judgment-free environment, having the freedom to fail gracefully and in private before meeting with their clients.

Background

Competency-based education (CBE) was first introduced to postsecondary education in the early 1970s; interest in this approach has grown over the past decade due to various social, economic, and political factors regarding both the quality and cost of higher education in the United States.[1] Over the years, CBE has had multiple definitions and multiple interpretations; it was once snarkily referred to as "a bandwagon in search of a definition."[2] A recent operational definition, constructed from both literature review and key informant interviews, is "an outcome-based approach to education that incorporates modes of instructional delivery and assessment efforts designed to evaluate mastery of learning by students through their demonstration of the knowledge, attitudes, values, skills, and behaviors required for the degree sought."[3] As the future of education continues to be examined, there has been a growing call for going beyond the rote elements of knowledge-based learning to incorporate human skills into technical curricula. For example, a recent contributor to Forbes discussed the necessity of CBE for the future of work, as

the need for human skills will be "increasingly important as technology gets more capable of fulfilling repetitive tasks."[4] Within technical fields, the limitations of a knowledge-based view have become manifest, with employers often reporting that graduates lack the skills and attributes necessary to effectively perform in industry.[5] To help address this within the various computing fields, the Computing Curricula 2020 (CC2020) Task Force embraced the nature of competency as a salient feature of the CC2020 project, calling for developing curricula that are "more expressive in their learning goals" and address "the language of graduate job descriptions and industry needs" through incorporating components addressing those dispositions, skill levels, and practical tasks that are reasonably expected of graduates.[6]

Within the United States, a similar call has been made for incorporating an entrepreneurial mindset into undergraduate engineering curricula. EM is a multi-faceted concept comprising a wide range of characteristics, skills, and attitudes; its curricular presence is often implemented in ways that enable an institution to best leverage its resources, including faculty background, available partnerships, and funding opportunities.[7] As defined by KEEN, entrepreneurial mindset is a habit of mind geared toward action; a way of thinking about the world that empowers people to identify opportunities and create value in any context.[8] Network members from more than 50 affiliated institutions have applied the KEEN Framework[9] within their curricula to help students understand the importance of opportunity and impact in the context of design through the development of EM resources available via the Engineering Unleashed website.[8] The Framework cultivates *curiosity* about our changing world, empowers students to make *connections* from various informational sources, and promotes *creating value* for others through a combination of mindset and skillset learning outcomes. Additionally, the Framework provides a scaffolding for these outcomes that is founded on *character* and expressed through *collaboration* and *communication* to help ensure the development of engineers that can fully contribute to society. Among the justifications for EM's integration into the engineering curriculum are that it reinforces technical concepts (especially in design-related topics), helps promote greater inclusion within the profession, and develops a mindset oriented towards problem-solving, empathy, creativity, and valuing the expertise of others.[10] The KEEN Framework's "mindset+skillset" approach presents EM as a competency geared towards graduates creating value for their organizations and communities in successful and rewarding engineering careers.[9] To succinctly put it, EM is CBE.

KEEN's approach also benefits the development of computing professionals. Research investigating the EM of engineering and computer science students did not report any differences between these two groups.[11] The assessment of student work from EM modules deployed in a junior-level software engineering course was found to be of higher quality than previously experienced, with students reporting the activities being most helpful for designing, building, and testing real-world systems.[12] Assessment performed through a validated quantitative survey for a service-learning project featuring a software deliverable indicated that the addition of EM yielded a positive change in all 10 student attitude traits measured by the instrument when compared to prior results.[13] Others outside of KEEN have also reported positive results from incorporating EM into their respective curricula. Examples include Brandeis University teaching web and mobile development via an entrepreneurial bootcamp,[14] the University of Gothenberg organizing entrepreneurial experiences involving an external client in a software engineering

project course,[15] and Lipscomb University incorporating an entrepreneurship concentration into their Information Technology program.[16]

The computer science program at Ohio Northern University began its process of incorporating EM into selected courses in 2013, ramping up the process across the curriculum over the next several years. The CS2 course at Ohio Northern University, Programming 2, was selected in 2014 as the location where elements of EM would be first introduced to students in the program. Historically, Programming 2 has used the development of educational software applications as a culminating term project experience. To fully embrace an EM approach, real-world problems were introduced by recruiting on-campus clients with educational outreach needs, thereby leveraging available institutional resources. Student teams now had to identify opportunities, investigate the competition, create multiple potential solutions, employ criteria to determine the best approach forward, and come up with a deliverable – and throughout all this work with a real-world client with real-world needs. However, this uncovered an unexpected complication: a rise in student discomfort caused by the need for interpersonal interactions with those outside one's discipline. The presence of a client creates higher stakes for the Programming 2 students, both in terms of the required interactions plus the need for delivering a functional software application at the end of the term. Unfortunately, while the American K-12 system provides students with many opportunities to work in team environments, developmental experiences for both oral and written interpersonal communications with those outside of their educational environment are limited at best, leaving such skills underdeveloped.

To assist with developing interpersonal skills, since 2018 a set of EM-derived communicative tools have been introduced to the Programming 2 students using a "sandbox" approach, where teams learn in a self-contained, safe environment with the instructor serving as the client for a fictitious yet legitimate project. By working first in a sandbox, students learn to function as a team while applying these new communicative tools while having the freedom to fail gracefully, should misconceptions arise, into a cushion of instructor-supplied sand instead of the harsh, brutal concrete of reality. It is the authors' contention that such prior practice helps position students toward a more successful client experience.

Implementation in Programming 2

Programming 2, the CS2 course at Ohio Northern University, is a four-credit hour Java programming course that focuses on Object-Oriented Programming, GUI development, the event-driven programming paradigm, early professional skills and techniques, EM competencies, software development, and effective communication. The course meets weekly for three 50-minute lecture sessions and a 165-minute computer lab session. Programming 2 is the second course in a two-part sequence; the first course focuses on learning C++ programming, while the second focuses on advanced concepts and skills needed by professional programmers. Many topics can be placed into a CS2 programming course, but there are only 15 weeks during a semester. Therefore, the challenge is selecting content that best fits the program's educational objectives so as to attain significant impact, especially in preparation for future classes.

The CS2 course begins with an introduction to Java, the foci being placed on graphical user interfaces, event handling, and the object-oriented programming paradigm. Approximately seven weeks into the semester, the course switches gears and orients around building both teaming and

software application development skills. The students are first introduced to a case study based on the educational computer game *The Oregon Trail*, popularized first as a text-based game in the 1970s and then achieving "died of dysentery" notoriety when re-imagined for the Apple II microcomputer in the 1980s. This case study provides a sandbox environment venue for the student teams to practice using various communications-oriented development tools and techniques. Afterwards, the teams begin working with their clients, with their service-learning efforts culminating in a deliverable software application that meets expressed clients' needs.

Introduced Tools and Techniques

The following sections delve into the communications-oriented tools and techniques introduced in Programming 2 via the sandbox approach.

Story Mapping

The story map utilizes visual communication techniques "to build shared understanding for the members of the team"[17] by "breaking down big stories as you tell them."[18] Story mapping is an agile software development strategy that encourages students to "talk and doc"[18] by creating sticky notes (or cards) with crucial points, which makes it easier for teams to recall past conversations. These sticky notes can easily be rearranged or organized based on goals and priorities.[19]

Through the story mapping process, the team can identify holes or missing concepts within the design or with the team's conceptualizations of the problem, thereby encouraging development teams to focus on the breath of their story before tackling the depth to help avoid losing sight of the original story and never reaching the finish line.[18] After completing the breadth of the story, the development team focuses on the details and specific options through easily repositionable sticky notes (either using actual sticky notes or their electronic equivalent). This process allows all the team members to engage in "a good old-fashioned conversation and then organizing it in the form of a map."[18] Consequently, story mapping encourages the practice of several EM-associated skills – *e.g.*, adaptability, empathy, and critical thinking – while allowing a student to further develop informal interpersonal communication skills.

NABC

The NABC model was developed by SRI International; as described by Carlson and Wilmot,[20] it serves as a communicative tool for identifying important needs and proposing innovative value creation. It is based on the premise that the application of the following fundamental questions is sufficient for the early vetting of the potential of delivering customer value for a particular project:

- What are the important customer and market *needs*?
- What is a compelling *approach* for addressing these needs?
- What are the *benefits* that result from this approach?
- How are these benefits superior to the *competition* and alternatives?

Collectively, these questions form a quantifiable and understandable value proposition along the dimensions of Need, Approach, Benefits, and Competition, usually referred to as NABC. This tool provides a systematic approach toward performing an initial assessment of a product or service proposed for solving an identified need, and for communicating the results to interested

parties, thereby playing a central role in developing new innovations.[21] Although designed for practicing professionals, within education it has been successfully used as a framework for promoting technical writing skills[22] and for thinking creatively in organizing proposal (AKA elevator) pitches in various engineering design projects.[23, 24]

MVP

Frank Robinson first conceived the Minimum Viable Product (MVP) in 2001 as a visual form of customer engagement designed to maximize return on risk.[25] The process became popular when featured in Ries' book *The Lean Startup*[26] and is considered an essential step in the Lean Startup methodology. This step focuses on the software development team getting a working piece of software in front of the client as quickly as possible to gain essential insight that can be cycled back into the iterative design process of agile software development. This concept is used within Programming 2 to help students complete an "early prototype" containing minimal functionality, which is then shown to the client for their constructive feedback. An MVP-based approach thus promotes early communication between development team and client (or end-user) that helps minimize the risk of designing an unwanted product. Ries' book discusses and warns against developing an end product without a solid foundation within the marketplace.[26]

SWOT Analysis

The project begins by placing students into groups of 3-4 students using the CATME (Comprehensive Assessment of Team Member Effectiveness) software.[27] Groups are built by teaming students based on both scheduling and work/learning style preferences. After finishing the series of sandbox-related activities for introducing the EM competency techniques presented in this paper, students complete both reflective and peer evaluations using CATME. This is followed by a SWOT analysis that is first performed individually and then discussed collectively. This analysis allows the team to collectively examine their strengths and weaknesses, evaluating the extent to which they work well together as a team. An updated SWOT Report documenting these discussions is then submitted to the instructor for review and possible intervention if warranted. These activities are used to discover and address interpersonal issues before moving out of the safety of the sandbox and into the higher-stakes world of working with clients.

Playing in the Sandbox: *The Oregon Trail*

To develop students' communication skills and practice EM competencies, each new tool is first introduced and practiced within a self-contained, safe environment, with the instructor serving as the client for a fictitious yet legitimate project. First-year students generally have minimal real-world client experience, nor do they have software development knowledge. Therefore, all of this preparation material provides a low-stakes environment for the students to explore unfamiliar concepts – NABC, MVP, team-based software development – before proceeding to a higher-stakes situation. In addition, using a historically known and widely used "vintage" computer game provides students the opportunity to practice research skills and provides a way to "check their answers" against the original game. This preparation allows the student to reach a comfortable position to design and create a successful service-learning application for their real-world clients. Finally, the case study of The Oregon Trail is chosen because it provides room for open-ended solutions but with more constraints present than those found in software engineering courses typically offered at the junior- or senior-level.

In lab, the students are introduced to the concept of simple persona development (technically, another communications tool, albeit not listed above). They are provided with a skeleton persona template, some basic persona background information, an example persona ("Brittney," provided in Figure 1) of a 6th grader studying the topic of the great Western migration in her American Social Studies class, and the following scenario: Brittney is working on a "Pack Your Wagon" group exercise for stocking a wagon with supplies prior to traveling on the Oregon Trail. Unfortunately, Brittney is experiencing conflicts with her teammates, making for a negative learning experience. Her Social Studies teacher (the client, whose role is played by one of the Programming 2 course instructors) is seeking an alternative, app-based method for students like Brittney to learn the materials. For added realism, the instructors provide an actual "Pack Your Wagon" Oregon Trail lesson plan[28] and various published articles related to the development of the original *The Oregon Trail* text-based computer game. A corresponding lab exercise has each student building a second persona for the supplied lesson plan, to both provide a different perspective and to practice their creative writing skills. These new personae are shared within teams to learn the essential EM skills of both giving and receiving constructive criticism – an important form of communication in the software development field. Collectively, these scenarios and personae provide the basis for the sandbox project's problem statement.

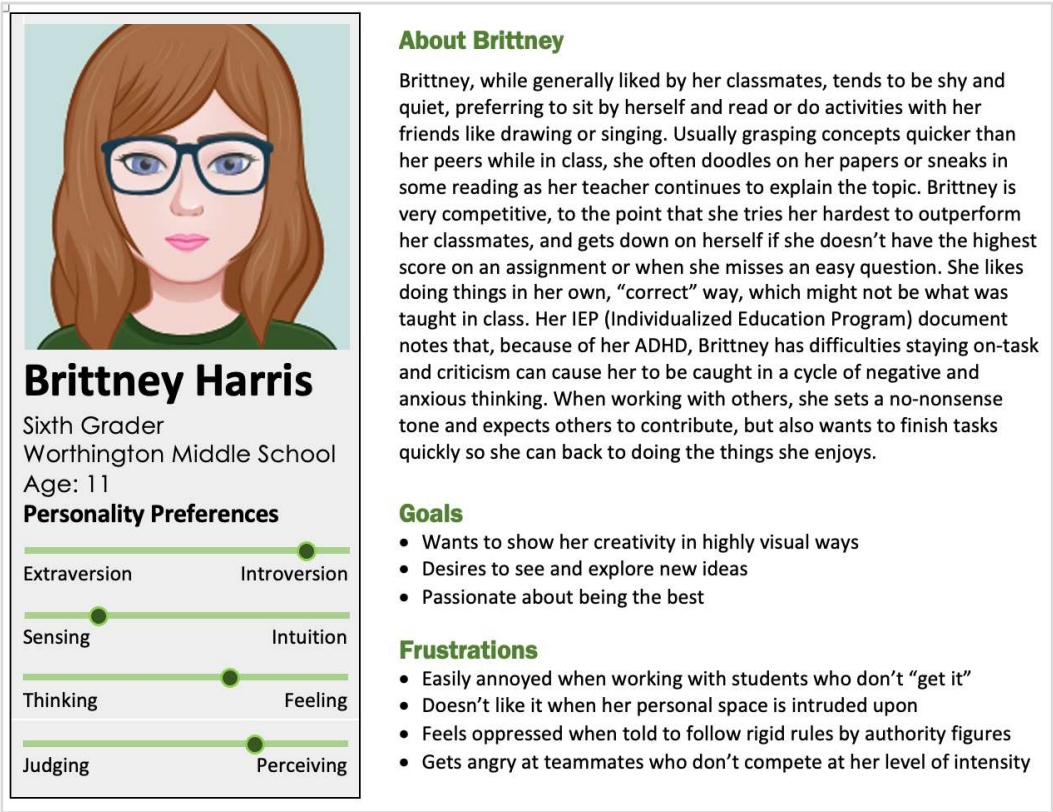

FIGURE 1. EXAMPLE PERSONA

First, teams create a story map based on the provided scenario and personae. While specifications vary from year to year, the student teams are then asked to sketch out the design of an educationally focused Oregon Trail-type computer game based on an NABC analysis, using the provided lesson plan as the competition. Story maps are now employed to help determine the

overall arc of the proposed application, from which an MVP is derived. The teams then work to both create an NABC-based elevator pitch (with a corresponding recorded video presentation) and implement the MVP version of their software application. The pitch is then presented, and the MVP app demoed, to the "client" – *i.e.*, their instructor. From this, the teams are provided with formative feedback regarding their performance. Note that, as the purpose of the sandbox approach is to practice using communication tools, there is no need for the students' Oregon Trail software application development to progress beyond the MVP stage. Afterward, the students "exit" the sandbox by completing individual and peer reflective evaluations via CATME, followed by their team's SWOT analysis.

Assessment

In the spring 2021 offering of Programming 2, 49 students enrolled in the two sections of the course were asked to voluntarily complete an online post-sandbox activity survey that included questions regarding the use of the NABC and MVP tools. This, along with direct measures conducted following the subsequent client-based service-learning term project conducted by the 14 teams that the students were organized into, provided the assessment data shown below.

Near the end of the semester, teams participate in a Software Application Fair – "App Fair" for short – where they undergo a critical design review of their term project through presentations to sets of external judges from a variety of disciplines, most of whom have no prior knowledge of the applications being developed for the clients. These presentations begin with an NABC-based elevator pitch that provides context, followed by a software demonstration; the judges are then free to interact with the teams regarding various aspects of their design. Due to COVID restrictions, for the last two years the App Fair has been held virtually using Google Meet. Because of this medium, it has been possible to require each team to record one of their judging sessions and submit it to the instructors for evaluating their application of the NABC model in their pitches. The results from applying a rubric to these videos that is designed to measure the four dimensions of an NABC pitch are shown in Figure 2. While most teams rated at the Proficiency level or better overall, several teams struggled with the Competition dimension of the pitch. This can be in large part due to the lack of an identifiable real-world competitor when developing educational software for one of Programming 2's typical clients.

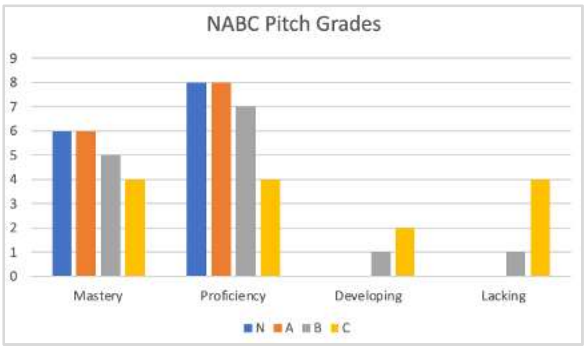

FIGURE 2. NABC ASSESSMENT[29]

The post-activity survey was used to gauge the extent to which students believe they benefited from using the various tools introduced via the sandbox approach in their client interactions.

Figures 3 and 4 examine the two halves of a communications channel between the teams and their clients: the ability for the students to present ideas regarding a design solution (Figure 3), and receiving useful feedback from the client (Figure 4). In their responses, the students indicated that both the NABC and MVP tools, learned through playing in the sandbox, positively assisted their efforts in effectively communicating their ideas to the client during the term project. Additionally, the students responded that both tools positively assisted their efforts to garner feedback from the client on their software application – another important form of communication and EM competency. In both cases, the use of the MVP tool did garner higher marks than did the NABC tool.

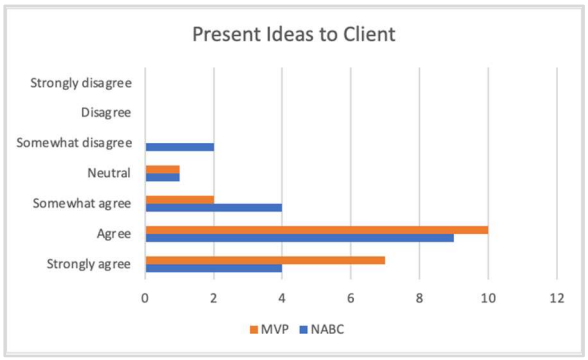

FIGURE 3. IDEA PRESENTATION

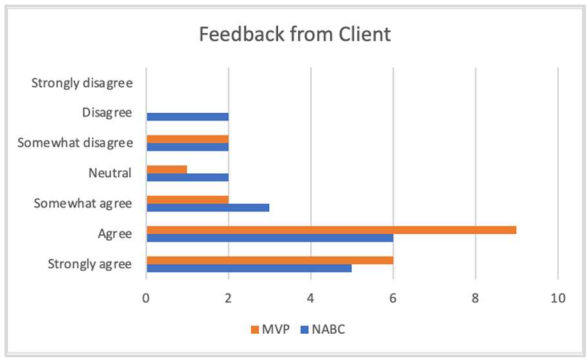

FIGURE 4. GETTING FEEDBACK

The students were also directly asked their opinions of the use of the sandbox approach (Figure 5) for learning how to use the MVP and NABC tools. These results were strongly positive, with 80% of the respondents indicating that the sandbox was an effective method of presenting the NABC model while 95% indicated that the sandbox was an effective method of presenting the MVP model. Regarding the balance between "business" (*i.e.*, EM-derived tools such as MVP and NABC) versus programming content overall in the CS2 course (Figure 6), students exhibited mixed feelings. However, while the overall responses shaded toward having slightly more business content than desired, no student reported an extreme in either direction. Thus, it does appear that students are finding the content they are being taught in the sandbox and then applied within the term project to be beneficial in overcoming their various client-related inhibitions regarding communication on technical topics with those outside of their field.

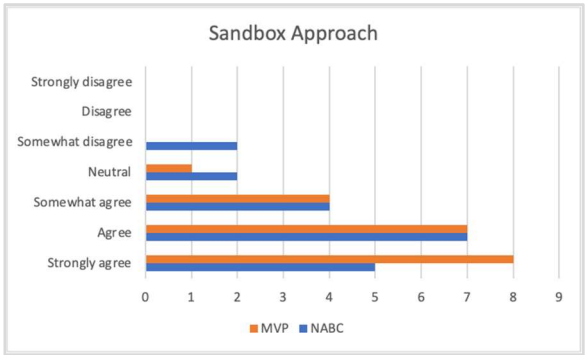

FIGURE 5. SANDBOX APPROACH[29]

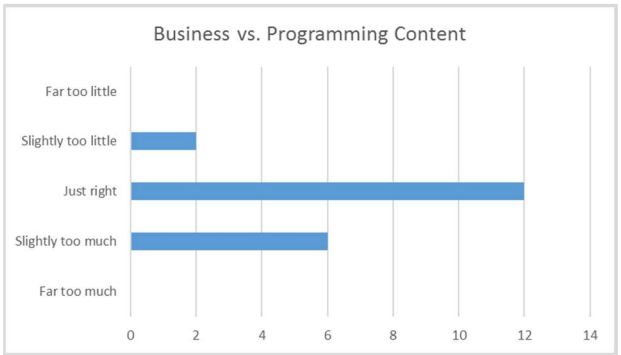

FIGURE 6. BALANCE OF CONTENT

Student Comments

As part of the post-activity survey administered to the students, they were asked to provide qualitative for feedback regarding the extent to which the sandbox environment provided a good introduction towards learning how to apply the MVP and NABC models. Student responses tended to overall favor the MVP, a more programming-heavy concept, over the presentations of NABC. Additionally, several students stated that there was room for improvement regarding both the initial demonstration and the related sandbox assignments for NABC, personas, and story mapping. SWOT analysis was also viewed positively by several of the teams. One team struggled during the sandbox phase, but engaging in the SWOT analysis and reflection activity helped those students to become a strong team during the client phase.

In terms of feedback regarding the personas, story mapping, and other techniques of EM competency, the students did not provide specific remarks. Some comments opined that the course focuses entirely too much on the "business" side and less on the programming, especially in the second half of the semester. Such comments are not surprising, as there are those who expect to find 100% programming content in a programming course. Overall, the students indicated that the course, as structured, is helping them prepare for a successful future, and "the things that we were being introduced to were very beneficial." As one student so eloquently put it: "I found the real-world comparison to be useful in preparing me for the future."

Faculty Reflection

The authors hope to further improve and increase the EM competencies material within this course. New lectures and lab exercises are planned to reinforce NABC concepts (especially "competition") and allow for practice of mini-elevator pitches earlier in the semester during future offerings of Programming 2. The instructors believe the sandbox approach has been highly successful and results in both better client-student interactions and greater satisfaction with the project deliverables. Using the Oregon Trail game as the sandbox's theme will also continue; however, some aspects will be modified next year to incorporate a discussion on diversity and equality that aligns with the newly updated and more accurate version of *The Oregon Trail* now available as part of Apple Arcade.[30]

Conclusions

Based on the data from both the formative and summative assessments, the sandbox technique appears to be a viable way to introduce the various EM competencies and communication skills needed by the Programming 2 students. This safer environment allows them to practice their communication skills among their peers and the instructors for feedback and suggestions for improvement before the stakes are raised to real-world clients. While there are still improvements that can be made, the authors believe this is a successful technique worthy of future pursuits and research, as both our students' ability to communicate and their comfort level in working with clients have improved over the semester. Furthermore, this research demonstrates that EM competencies can be successfully integrated into the first-year, thereby providing a solid foundation for those EM-oriented courses found later in the curriculum.

Available Resources

To best deliver meaningful value, experiential reports such as this should readily supply all interested readers with those materials developed "in-house" as an aid for any potential adoption efforts. Accordingly, a "Card" – *i.e.*, an information repository – has been created for this paper on the Engineering Unleashed website operated by KEEN.[31] This card provides instructional materials for covering the EM competencies along with all of the materials mentioned in this paper, including those developed "in-house" such as the rubrics, personas, etc. These materials can be freely downloaded, reviewed, adopted, and if desired modified, by anyone for use in their courses under the Creative Commons CC BY-NC license.[32]

Acknowledgements

The proposal for this study, entitled "Students' views on adapting business tools for software development and communication with clients," was granted exempt review status (under category #1: educational strategies, curricula, or classroom management methods) by the Institutional Review Board (IRB) of Ohio Northern University under protocol #SC-EN-022621-1.

Bibliography

1. Diane M. Burnette. 2016. The Renewal of Competency-Based Education: A Review of the Literature. *J. Continuing Higher Education,* 64, 2, 84-93. DOI: https://doi.org/10.1080/07377363.2016.1177704
2. William G. Spady. 1977. Competency based education: A bandwagon in search of a definition. *Educational Researcher,* 6, 1, 9-14.
3. Jennifer Gervais. 2016. The operational definition of competency-based education. *J. of Competency-Based Education*, 1,2, 98–106. DOI: https://doi.org/10.1002/cbe2.1011
4. Charles Towers-Clark. 2021. Why Competence-Based Education is Necessary for the Future of Work. Retrieved January 18, 2022 from https://www.forbes.com/sites/charlestowersclark/2021/05/14/why-competence-based-education-is-necessary-for-the-future-of-work
5. Eran Lasser. 2020. Tech Skills Gap Versus Tech Skills Shortage. Retrieved January 18, 2022 from https://www.td.org/insights/tech-skills-gap-versus-tech-skills-shortage
6. CC2020 Task Force. 2020. *Computing Curricula 2020: Paradigms for Global Computing Education.* Association for Computing Machinery, New York, NY.
7. Gary Lichtenstein and Sarah Zappe. 2017. Defining and Assessing Entrepreneurial Mindset: Ingredients for Success. Retrieved January 18, 2022 from https://venturewell.org/assessing-entrepreneurial-mindset
8. The Kern Family Foundation. 2021. Welcome to Engineering Unleashed. Retrieved January 18, 2022 from https://engineeringunleashed.com
9. The Kern Family Foundation. 2021. The Framework for Entrepreneurially Minded Learning. Retrieved January 18, 2022 from https://engineeringunleashed.com/framework
10. Jennifer M. Bekki, Mark Huerta, Jeremi S. London, Doug Melton, Margot Vigeant, and Julia M. Williams. 2018. Opinion: Why EM? The Potential Benefits of Instilling an Entrepreneurial Mindset. *Advances in Engineering Education*, 7, 1, 1-11.
11. Cheryl Q. Li, Ronald S. Harichandran, Nadiye O. Erdil, Jean Nocito-Gobel, and Maria-Isabel Carnasciali. 2018. Investigating the Entrepreneurial Mindset of Engineering and Computer Science Students. *2018 ASEE Annual Conference & Exposition*, June 2018, Salt Lake City, UT. ASEE Conferences, Washington, DC. https://peer.asee.org/30726
12. Ben Tribelhorn, Heather Dillon, Andrew M. Nuxoll, and Nicole C. Ralston. 2021. Connecting Entrepreneurial Mindset to Software Development. *2021 ASEE Virtual Annual Conference Content Access*, Virtual Conference, July 2021. ASEE Conferences, Washington, DC. https://peer.asee.org/36838

13. John K. Estell, David Reeping, and Heather Sapp. 2016. Curiosity, Connection, Creating Value: Improving Service Learning by Applying the Entrepreneurial Mindset. *2016 ASEE Annual Conference & Exposition*, New Orleans, LA, June 2016. ASEE Conferences, Washington, DC. https://peer.asee.org/26621
14. Timothy J. Hickey and Pito Salas. 2013. The entrepreneur's bootcamp: a new model for teaching web/mobile development and software entrepreneurship. In *Proceedings of the 44th ACM Technical Symposium on Computer Science Education (SIGCSE '13).* Association for Computing Machinery, New York, NY, 549–554. DOI: https://doi.org/10.1145/2445196.2445361
15. Håkan Burden, Jan-Philipp Steghöfer, and Oskar Hagvall Svensson. 2019. Facilitating entrepreneurial experiences through a software engineering project course. In *Proceedings of the 41st International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET '19).* IEEE Press, Piscataway, NJ, 28–37. DOI: https://doi.org/10.1109/ICSE-SEET.2019.00012
16. Jeff Crawford, Ken Mayer, and Fortune Mhlanga. 2013. Incorporating an entrepreneurship concentration into the undergraduate IT curriculum. In *Proceedings of the 14th Annual ACM SIGITE Conference on Information Technology Education (SIGITE '13).* Association for Computing Machinery, New York, NY, 183–188. DOI: https://doi.org/10.1145/2512276.2512284
17. Alexandru Bolboaca. 2017. 3 uses for story maps to build a better product. Retrieved January 18, 2022 from https://mozaicworks.com/blog/3-uses-story-maps-build-better-product
18. Jeff Patton and Peter Economy. 2014. *User Story Mapping: Discover the Whole Story, Build the Right Product*. O'Reilly Media, Inc., Sebastopol, CA.
19. Jeff Patton & Associates. 2015. Story Mapping Quick Reference. Retrieved January 18, 2022 from https://www.jpattonassociates.com/story-mapping-quick-ref
20. Curtis R. Carlson and William W. Wilmot. 2006. *Innovation: The Five Disciplines for Creating What Customers Want*. Crown Business, New York, NY.
21. Curtis Carlson, Len Polizzotto, and Glenn R. Gaudette. 2019. The "NABC's" of Value Propositions. *IEEE Eng. Manage. Rev.* 47, 3, 15-20. DOI: https://doi.org/10.1109/EMR.2019.2932321
22. Heath J. LeBlanc and Firas Hassan. 2017. A spiral approach to teach value propositions using the NABC framework in core engineering courses. In *2017 IEEE Frontiers in Educ. Conf. (FIE) Proceedings*, Indianapolis, IN, October 2017. IEEE Press, Piscataway, NJ. DOI: https://doi.org/10.1109/FIE.2017.8190583
23. Chao Wang. 2020. Do Open-ended Design Projects Motivate First-year Engineering Students? *2020 ASEE Virtual Annual Conference Content Access,* Virtual Conference, June 2020. ASEE Conferences, Washington, DC. https://peer.asee.org/34473
24. Ronald S. Harichandran, Nadiye O. Erdil, Maria-Isabel Carnasciali, Cheryl Q. Li, Jean Nocito-Gobel, and Aadityasinh Rana. 2019. EML Indices to Assess Student Learning through Integrated e-Learning Modules. *2019 ASEE Annual Conference & Exposition*, Tampa, FL, June 2019. ASEE Conferences, Washington, DC. https://peer.asee.org/32704
25. SyncDev. A Proven Methodology to Maximize Return on Risk. Retrieved January 18, 2022 from http://www.syncdev.com/minimum-viable-product
26. Eric Ries. 2011. *The Lean Startup*. Crown Business, New York, NY.
27. Richard A. Layton, Misty L. Loughry, Matthew W. Ohland, and George D. Ricco. 2010. Design and Validation of a Web-Based System for Assigning Members to Teams using Instructor-Specified Criteria. *Advances in Engineering Education* 2, 1, 1-28.
28. Bureau of Land Management, Vale District. 2016. The Oregon Trail: An Education Resource Guide - 2016 Edition. Retrieved January 18, 2022 from https://www.blm.gov/teachers/activities/documents/Oregon_Trail_Education_Resource_Guide.pdf
29. John K. Estell and Stephany Coffman-Wolph. 2021. Scoping Design Parameters for Educational Software Development with the Entrepreneurial Mindset. In *2021 IEEE Frontiers in Educ. Conf. (FIE) Proceedings*, Lincoln, NE, October 2021. IEEE Press, Piscataway, NJ. DOI: https://doi.org/10.1109/FIE49875.2021.9637370
30. Anna King, 2021. A New Spin On A Classic Video Game Gives Native Americans Better Representation. (May 12, 2021). Retrieved January 18, 2022 from http://www.npr.org/2021/05/12/996007048/no-bows-and-arrows-and-no-broken-english-on-the-updated-oregon-trail
31. John K. Estell and Stephany Coffman-Wolph. 2022. Playing in the Sandbox: Developing EM Communication Skills in Introductory Programming Students. Engineering Unleashed, https://engineeringunleashed.com/card/edit/3065
32. Creative Commons. Attribution-NonCommercial 4.0 International (CC BY-NC 4.0). Retrieved January 18, 2022 from https://creativecommons.org/licenses/by-nc/4.0/