20 Years of EPICS at Butler University: Experiences and Lessons Learned

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Abstract—**This research-to-practice full paper discusses experiences and lessons learned from our EPICS@BUTLER (Engineering Projects in Community Service at Butler) program. The program, housed within the department of Computer Science and Software Engineering, is part of a college of Liberal Arts and Sciences and serves a diverse population of students with multi-disciplinary backgrounds. The EPICS curriculum is driven by a team-based service-learning pedagogical model. EPICS teams learn how to work together effectively while addressing the immediate IT needs of our non-profit partner clients, navigating their budgetary restrictions, and coping with any lack of existing IT infrastructure.**

During the 2020/2021 academic year, we launched an empirical study to review and assess EPICS@BUTLER. The study's main goal was to learn from the past 20 years of running the EPICS program by soliciting input from all parties involved. We aimed to improve and expand our service-learning model within an LAS context. More specifically, this study included surveying alumni and current undergraduate students in order to understand the successes and areas of potential improvement within our program. In addition, we conducted one-on-one interviews with our community non-profit partners as well as volunteer team mentors to assess the program's effectiveness and community impact.

Based on the empirical data we gathered and analyzed, we discuss how the existing curriculum is effective at providing fulfilling experiences which help our alumni secure jobs after graduation. In addition, we found that the practice of allowing supervised teams to navigate their own EPICS projects helps them improve their professional maturity and interpersonal skills.

In summary, this paper discusses an empirical study and aims to leverage the results gathered from our surveys and interviews in order to present a plan for continuous improvement and modernization of our on-going EPICS program. In closing, our paper describes a concise roadmap and offers practical recommendations for implementing a similar EPICS program at other potentially interested academic institutions.

Keywords—Service-Learning, EPICS, Software Engineering, Course assessment, Teamwork

I. INTRODUCTION

The idea of EPICS (Engineering Projects in Community Service) originated at Purdue University's College of Engineering in 1995 [1]. A course was designed to allow students to receive academic credit in return for helping solve nonprofit organizations' real world technical needs. The program was successful and allowed students to gain social, professional, and technical expertise while supporting organizations which expressed a need for volunteer services [2]. After six years of success at Purdue, Butler University adapted the EPICS program with a focus on the disciplines of Computer Science and Software Engineering (CSSE). In doing so, one of the first EPICS programs housed within a college of Liberal Arts and Sciences (LAS) was established [3,4].

Over the past two decades, EPICS@BUTLER has matured into a fully-fledged service-learning program, having served more than 40 nonprofit clients with 80+ projects, all while providing a unique learning experience for over 500 undergraduate students [5]. During this time, the EPICS approach of service-learning and project-based education has proven to be a powerful pedagogical tool for engineering and computing education [6]. In turn, EPICS student teams have been able to provide tangible technical solutions for our partner nonprofit organizations.

During the summer of 2021, a research study was conducted in order to better understand which features of our EPICS program had the most impact on its success as well as what areas of the program could be further improved. The results of this study have produced some insights and recommendations supported by gathered qualitative and quantitative data, which we describe in detail in the upcoming sections.

The rest of this paper is organized as follows: section II provides a literature review and section III describes our EPICS course structure and its unique features. In section IV, we briefly present selected successful examples of our nonprofit partnerships. Section V outlines an empirical study assessing our EPICS@BUTLER program, highlighting our signature features, successes, key challenges, and lessons learned over the last two decades. Our paper concludes with section VI delineating a concise roadmap to help guide any interested readers in establishing an EPICS program at their own institution.

II. LITERATURE REVIEW

Previous research confirms the effectiveness of EPICS in teaching students important skills such as project management, communication, teamwork, and problem-solving. For instance, Coyle and Zoltowski note that EPICS has become an established entity in many different curricula [7]. Their data demonstrates that students' work on real-world projects provides a unique opportunity to practice skills that are difficult to fully develop in a classroom setting. Moreover, EPICS has

been shown to be an internationally effective tool in engineering programs and has been recognized for its value as a vehicle for Outcome-Based Education (OBE), which emphasizes the development of practical skills that can be applied in the workplace [8]. In general, established research testifies that students under service-learning programs enjoy a high degree of personal satisfaction and are pleased with their learning outcomes. For example, Astin et al. researched the efficacy of outreach programs and found that students who participate in service learning have higher levels of civic responsibility and a deeper understanding of social issues [9]. Currie-Mueller and Littlefield claim that students enjoy a service-learning experience and attest to its efficacy [10], while Darby et al. studied students' motivation in academic service-learning and found that students are motivated by opportunities to help others and, at the same time, gain practical experience [11].

Throughout the years, various publications detailing our particular EPICS program have been produced. Most notably, in 2012, the co-author compiled and published the experiences and lessons learned from the first ten years of EPICS@BUTLER [12]. The paper focused on the initial implementation of EPICS within the context of a college of LAS and the discoveries made alongside crafting such a program from the ground up. Our current research builds upon the previous effort by providing a more in-depth analysis and assessment of our EPICS program, using an empirical study to reflect upon the past decade of progress.

III. PROGRAM STRUCTURE

To familiarize the reader with our own instance of EPICS, we first describe our EPICS courses, followed by the logistics of forming and organizing teams as well as our program's institutional support.

A. Courses

EPICS@BUTLER entails a sequence of course designations: CS283, CS383 and CS483. All three courses run concurrently under one instructor and in the same classroom. Class is typically held twice a week throughout the semester, with each session lasting an hour and 15 minutes. During the first two weeks, invited nonprofit clients present potential projects, and students vote on which project they would like to work on. Once student teams are established, a team leader is selected, and students are assigned various roles. All teams use an agile methodology, called Scrum, to develop their projects over several time-boxed intervals, called Sprints, typically lasting a few weeks each [13]. During each Sprint, groups are expected to select a few project requirements, create a design document detailing specific tasks needed to accomplish those requirements, and assign those tasks to various team members. Depending on the nature the project, these tasks might include the selection and deployment of various software applications and technologies. The EPICS teams also design and execute various test cases to detect and fix any defects before the next release of their software system. This process is repeated in small increments until all requirements are implemented.

During class meetings, all teams are expected to perform a standup meeting and engage with the client as needed.

Remaining class time is usually devoted to working through roadblocks or collaborating on tasks. At the end of each week, a Weekly Status Report (WSR) is submitted by the team leader to the instructor, containing progress updates, issues, major accomplishments, and future goals. Occasionally, the instructor may host workshops for students, or have external mentors/advisors come in to discuss industry best practices. At the end of each Sprint, all teams present their progress to the class during a "Sprint Review", where they are expected to introduce their client, detail all the work they've accomplished, and demonstrate the current version of their software application. During each Sprint Review, the audience provides anonymous feedback to the presenting teams to help them improve their next Sprint presentation.

A key feature of our EPICS program is its ability to mimic real-life scenarios by providing an opportunity for our students to engage in long-term projects through the EPICS curriculum. More specifically, students may retake the EPICS courses on multiple occasions for additional credit. During the first enrollment, students are credited for a 200-level course. Should they choose to re-enroll, the course is credited at the 300 level, and if students decide to take the class for a third time, they receive a 400-level credit. At that time, they typically become the leaders of their teams. This practice has proved to be an effective mechanism for a smoother project continuity as well as a way to encourage students to commit to long-term projects. It is not unusual to see students who are passionate about their own projects electing to retake the course. They recruit and form a new team the following semester to continue their previous work. There are even cases where an existing project is picked up by an entirely new team. When new team members join an ongoing project, they can find and download any project-related items from a cloud repository. This ability to form a long-term commitment is a valuable experience for our students as they become familiar with various project management issues such as the moving target problem (i.e., continuously changing requirements) as well as project continuity issues (e.g., non-returning team members, poor team leadership, change of mentors or supervisors, and so on). Overall, navigating these challenges prepares EPICS students for interacting with real clients, conducting realistic projects, meeting strict expectations, and facing rigid constraints.

B. Team Projects

About 20-30 students enroll in our EPICS courses every semester. They are divided into teams of around 2-7 members and are assigned to work on specific projects. Our EPICS teams are vertically integrated to include first-year to fourth-year students. This enables teams to carry a wide variety of talents and interests while simultaneously increasing the likelihood that each team has a qualified team leader. Such teams are often multidisciplinary as the course is open to students in any major. The teams are supervised by a CSSE faculty member who is responsible for organizing the class and finding community partners for students to work with. Additionally, each team is guided by at least one designated external mentor from the client site, typically an IT personnel or other representative.

When clients are onboarded as new EPICS participants, it is made clear that they are expected to commit the necessary time to mentor our students on a regular basis. To facilitate such mentorship, teams are expected to schedule regular meetings with the client both on campus and at the client site (if applicable). During the pandemic years, these meetings transitioned online, as students connected with clients via virtual video conferencing. Such meetings (both in person and online) have proved to be beneficial learning experiences for students, who are given the opportunity to hone their skills by interacting with real clients and observing actual industry practices. For instance, during a project which involved managing sensitive information, one client brought in their own security and compliance consultant to give the student team a lesson on the importance of data encryption and provide documentation on how such levels of security could be achieved [14].

Through EPICS, students have the opportunity to work with individuals from various technology and non-technology sectors and learn how to work collaboratively to address social issues. Gillespie et al. point out the impact of interdisciplinary teams on EPICS projects. They note that multifaceted teams are more effective at addressing complex problems because they bring together a variety of perspectives and skill sets [15]. One of the key features of EPICS is the use of multidisciplinary teams. EPICS projects typically involve students from a variety of majors, including engineering, computer science, business, and the arts. Over the years, many teams have capitalized on their diverse skill sets in order to produce versatile solutions. Some examples are given in Section IV.

Fundamentally, EPICS is centered around student-focused and student-driven team projects. Our teams operate under faculty supervision while having full autonomy to achieve their project goals using an agile approach. When students run into roadblocks, they are encouraged to reach out to the client mentor for guidance first. Students repeatedly engage with our EPICS program because they expect a different experience from the typical lecture-based pedagogical model. Through EPICS's self-driven learning approach, the student is afforded the freedom to choose and foster their own learning experiences by selecting and owning their project. This gives students the autonomy to explore topics that they are passionate about and to set goals that align with their personal and professional aspirations. We have observed that such freedom makes our EPICS participants self-motivated and encouraged to learn on their own and from their peers. Furthermore, EPICS provides a platform for a diverse range of projects. Students explore various niche technologies while applying widely used software development techniques taught in pre-requisite courses. This exposure to a range of technologies and methodologies helps develop a broad skill set that can be applied in a variety of contexts. Moreover, it allows students to gain experience in areas that they may not be exposed to in traditional coursework. We provide some data to support such claims in Section V.

C. Grading

EPICS is not designed to evaluate students with tests or homework. Instead, during the semester, the instructor conducts a peer evaluation survey, where team leaders evaluate their team members. At the same time, team members evaluate their team leaders. The instructor collects and uses this data along with their own evaluation of the performance in order to provide a midterm tentative grade to all participants along with recommendations to sustain or improve such a grade.

At the end of each semester, all teams prepare their final project demonstrations. This involves showcasing the completed project to the class and all our EPICS clients. The presentations are open to the public and usually include, among others, several CSSE department faculty members, representatives from our Dean's Office as well as other interested and potentially new future clients. Moreover, each team is expected to submit a final report, which summarizes the project's goals, milestones, and accomplishments, and includes detailed documentation of the final software system. The final report is graded on its ability to clearly communicate the project's goals and achievements, as well as the quality of the software system. Typically, this report, as well as all the code and any other related project artifacts (i.e., specification documents, architectural/design diagrams, prototypes, test cases, project plans, timelines, posters, presentation slides, videos, and links to websites) produced during the semester are uploaded to a cloud Git repository in order to facilitate record keeping and projects spanning over multiple semesters. Finally, each team is required to create a digital poster highlighting their work for display around the classroom and on school websites. To determine the final grade, the instructor collects and grades the team's final deliverables, including the final presentation, the final comprehensive project report, and the team's digital poster. Lastly, all clients are asked to provide some feedback about their team's performance. After the final presentations, each student participant receives a grade, which is calculated based on the following weights: 40% peer evaluations, 30% instructor's assessment, and 30% client satisfaction.

D. Institutional Support

Our EPICS program has been institutionalized within Butler University. More specifically, all EPICS courses are endorsed by Butler's Center for Citizenship and Community (CCC) and annotated by the Indianapolis Community Requirement (ICR) course indicator. Under the ICR, EPICS courses fulfill a requirement set forth by the Common Core Curriculum, an element of the Butler University graduation requirements wherein students must enroll in a range of LAS core classes, regardless of their major.

EPICS@BUTLER expands the traditional engineering-focused EPICS model to a greater liberal arts and sciences setting by incorporating elements such as story-craft, foreign language user interfaces, digital art, e-marketing strategy, etc. We have adapted EPICS in this way in order to create projects that are informed by the rich cultural competencies our LAS students gain in their other courses. It is worth mentioning that non-CSSE students typically enroll in our EPICS courses to fulfill their ICR requirement. However, we have observed that this variety of expertise encourages balanced and diverse perspectives within our EPICS teams. Some of the non-CSSE students who have taken EPICS courses so far include Foreign-

Language, Society and Technology, Actuarial Science, Data Science, Math, Statistics, Physics, Astronomy, and Engineering Dual Degree Program (EDDP) majors.

EPICS@BUTLER also maintains its own university-hosted website where interested parties can find related information. It provides a platform for students to showcase their projects, progress, and final outcomes to the Butler University community and the rest of the world. At the beginning of each semester, all teams are required to build their own webpage on the site where they are expected to post information about their project, client, and goals. Moreover, at the end of the semester, students are required to upload their final digital posters to their webpage, highlighting their accomplishments. Our EPICS website provides a comprehensive view of the various projects and achievements of the program, illustrating the positive impact it has had on the community and serving as a marketing apparatus for the CSSE department [4,5].

IV. COMMUNITY PARTNERSHIPS

In this section, we briefly describe a few selected EPICS projects. The first project showcases the successful development and deployment of a realistic and complex IT system. The second example demonstrates the involvement of international clients and the significance of the iterative design cycle, while the last example shows the effectiveness of multidisciplinary EPICS teams.

A. An Inventory Tracking and Checkout Management System

Helping Veterans and Families (HVAF) is a Veterans Affairs supported non-profit with a focus on ending veteran homelessness. The organization operates a pantry and homeless shelter in the local area which receives significant foot traffic during outreach days. Since 2015, EPICS@BUTLER has partnered with HVAF twice with the goal of modernizing HVAF's intake processes to better serve their pantry visitors. Both projects have focused on delivering an online, form-based system to track veteran needs as they enter the pantry and keep a record of any items received as they exit. During the second iteration, the scope of the project was expanded to include the development of timekeeping software to track volunteer hours as well as the prototyping of an e-learning hub to centralize HVAF's educational programs. The resulting student-built systems were intended to replace HVAF's previous, paper form-based approaches. After the project was completed, the student team volunteered to continue working with HVAF beyond the EPICS course to provide bug fixes and database maintenance. It is worth mentioning that we have seen similar and commendable volunteerism happening in other EPICS projects, where students decide to continue helping their nonprofits outside the classroom and without earning any academic credit and/or any other form of compensation.

B. A Portable Electronic Medical Record Application

Barnabas Task is a non-profit charity that provides medical assistance and professional health care support to low-income communities in the Dominican Republic (DR). Our EPICS teams collaborated with the Butler University College of Pharmacy and Health Sciences (COPHS) to deliver a novel Electronic Medical Record (EMR) system for use in walk-in clinics in the DR. This system would allow medical doctors and pharmacists to accurately track patients over the long term, enabling them to receive medical care quicker than was previously possible. Over the many successful iterations of this project, a number of EPICS participants decided to pursue work on-site in the DR through mission trips organized by Barnabas Task. These trips provided our EPICS students with a unique opportunity to hone both their technical and non-technical skills by interviewing clinic staff in order to gather feedback on the installation and use of the EMR system. Through the iterative design cycle offered by EPICS, this feedback informed multiple successive projects focused on improving the application's performance and accessibility. A related publication [16] describes how this project not only played a significant role in reducing wait times at partner walk-in clinics but also proved to be an impactful learning experience for the students involved.

C. An Educational Video Game for Persons with Learning Disabilities

Sycamore Services is a non-profit organization dedicated to offering individually designed educational services to persons with intellectual and developmental disabilities. In line with their mission statement, Sycamore Services expressed the need for educational content geared towards teaching students the ability to identify emotions in others. In response, our EPICS program set a goal of developing a gamified educational tool designed to teach proper etiquette during interpersonal interactions. The goal of this tool was to guide the player towards establishing positive interactions with others by engaging with an open-world video game while interacting with Non-Playable Characters (NPCs). Upon meeting an NPC, the player is prompted with a variety of dialog options. Their choices make an immediate impact on the NPC's facial expression and "mood" throughout the rest of the game. For example, should a player give harsh commands or respond disrespectfully to an NPC, the NPC will express their discontent and be less helpful to the player during the remainder of their playthrough. The tool aims to train positive interactions in the real world while providing an entertaining and appropriate game for students to play. The project has undergone many different phases, first focusing on story crafting with the help of an English Department faculty member, then world building with the modeling of landscape and building textures, and finally the development of NPCs with dynamic dialog and facial expression capabilities. This work has culminated in a playable prototype version currently being tested for use by the partner organization, serving as a testament to the combined capabilities of multidisciplinary teams.

V. EMPIRICAL STUDY

In 2021, we launched an empirical study to assess the current health status of our EPICS program and find ways to further improve it. We targeted four groups of EPICS participants, including past and current EPICS non-profit partners (whom we refer to as "clients"), EPICS consultants, EPICS alumni, and current EPICS students. From our current participants (i.e., consultants, students, and clients), we hoped to gain knowledge

of specific pain points which exist in our program in order to generate ideas for improvement. On the other hand, polling from our alumni, we hoped to assess the program's effectiveness at preparing students for jobs within the IT industry, while simultaneously conducting the same satisfaction survey posed to the current students in order to track trends in learning outcomes.

A. Methods

One-on-one virtual interviews were conducted over Zoom [17] to gather detailed feedback from clients and consultants. We reached out to over 40 clients from the past 20 years, 15 of whom responded to the interview request. All 23 EPICS consultants were contacted, with 7 agreeing to an interview. In addition, a survey was prepared to gather feedback from EPICS alumni and current students. Alumni contact information was obtained from Butler's Advancement office, and out of the 193 emails sent out, 45 survey responses were received. Moreover, we contacted 72 current students, and 15 survey results were received. The Qualtrics XM survey builder [18] was used as a platform to design and implement both surveys, allowing for custom-tailored questions based on the respondent. Fig. 1 below summarizes the response rate by targeted group.
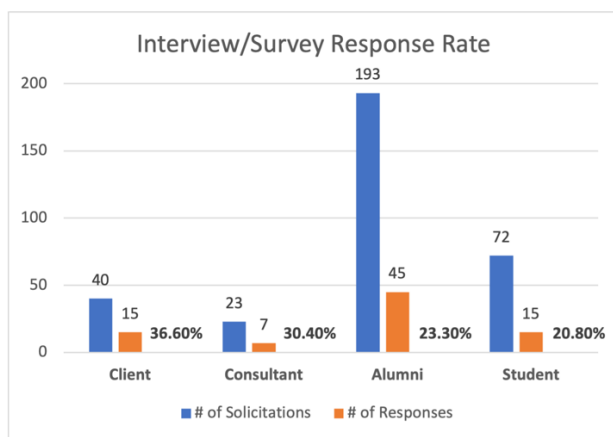

Fig. 1. Survey size and response rate by targeted participant group.

B. Client Feedback

The issue of effective communication was the first area of improvement identified by most clients. More specifically, three areas of communication issues were identified. The first issue was defined as unclear initial requirements from the client relating to project functionality and desired deliverables. The second issue identified was inconsistent two-way communication once the project was already underway, and the third issue regarded ambiguous student documentation in relation to the final product.

Our clients acknowledged their own difficulty in providing clear requirements that would allow proposed projects to be accomplished in a single semester. Regarding avenues of communication, earlier clients stressed the importance of both email-based and in-person contact with students, while more recent clients preferred a combination of email communication and regular virtual meetings, especially when it came to students demonstrating their projects. All clients agreed that student email practices posed one of the most serious challenges, with students often being unreachable in a timely manner or using unprofessional e-mail etiquette. Recent clients also expressed a desire for students to employ a greater use of structured calendar invites for virtual meetings, rather than one-off email reminders. Almost every client felt they needed greater levels of communication relating to the final product. Examples provided included a desire for more rigorous documentation, a written or digitally recorded tutorial explaining how to operate the software system produced, as well as troubleshooting tips.

Quality of work was the next area for improvement identified by the clients. We define quality of work as the amount of time devoted to the project, the skill level of the team, and the degree of work completion. While most clients understood that the learning component of EPICS is of utmost importance and that quality of work isn't necessarily the priority, a few still expressed some dissatisfaction with their final product. According to these clients, students often overcommitted to delivering features or demos at the beginning of the semester, but made no similar commitment to time spent, which generally led to lower quality work. On the other hand, we found that clients can often underestimate the complexity of projects. They also tend to expect more out of teams composed of inexperienced participants than the team would reasonably be able to deliver, leading students to take shortcuts and leaving the client dissatisfied with the final result. For many clients, the issues surrounding unsuccessful EPICS projects could be summarized as poor project longevity. One client suggested that a guaranteed multi-semester engagement would ease these issues and therefore lead to a more effective partnership, noting:

> *"We need a long-term commitment from EPICS in order to feel comfortable."*

For several other clients, security consciousness was another weak point of particular concern. Worries ranged from students' lack of knowledge regarding software resiliency to more serious matters, like the potential for client or customer data being exposed due to improper or insufficient application security measures. Some clients don't properly understand the nature of these security risks themselves or aren't properly staffed to assess them. In these cases, clients requested that student teams undertake a greater level of oversight by actual professionals, such as the course consultants.

C. Consultant Feedback

EPICS consultants were the next group interviewed. They are typically alumni, past clients, or industry professionals who have pledged to donate their time and expertise to serve as team mentors. During their interviews, consultants indicated that students were not utilizing them as effectively as they could be. Some consultants expressed frustration with students who would come to them for help only once, and never return. Many also felt that students were hesitant to admit when they needed help and suggested that professors could do more to encourage students to seek out help when they need it. A few consultants

even felt that there were students who simply didn't care about their project and were only involved in EPICS for the class credit. In fact, only one of the interviewed consultants reported ever having regular contact with an EPICS team, illustrating that this resource has been largely underutilized. Most of the consultants expressed a desire to be more involved in the course and to be given more of a voice in the planning process; for example, they suggested implementing a requirement in the EPICS course where every team would be expected to contact a consultant at least once during the semester.

D. Student/Alumni Feedback

The survey results from EPICS alumni and current students were greatly illuminating. Students' main criticisms of the course centered around the lack of generally available student resources. Many students felt like they were simply thrown into the deep end of project development without enough structure or guidance from the course itself. Relating specifically to the inception of new projects, many students reported being uncertain on how to approach a client with questions, or what types of questions to ask in order to gain the best understanding of the client's wishes. Additionally, students described a lack of easy access to tangible instructional materials, such as email templates, guidelines on how to write effective documentation, and project management tips. Although the EPICS website has a page dedicated to listing such information, students felt that it needed updating, and that it was visually difficult to navigate.

When teams did not have a strong team leader to guide the group through these issues, unsuccessful projects were delivered as a result. The following quote from an alumni student expands on this notion.

"The success of the EPICS course as it was when I took it was entirely reliant on the strength of your team lead. That's a lot to put on an undergraduate student."

Despite these fallbacks, the majority of responses reflected the overwhelmingly positive experiences students received in the course. First, most students felt that engaging with EPICS had a positive impact on their ability to work in a team and to communicate with others. They also mentioned that this engagement was a positive learning experience in working with clients and real-world projects. In fact, when asked to rate the effectiveness of their EPICS experience alone in preparing them for a real-world work environment, respondents gave an average response of 3.38 on a 5-point Likert scale [19]. When the question was broadened to include the effectiveness of their entire learning experience at Butler, the average only increased to 3.78, demonstrating the significance that EPICS played in their preparedness.

Secondly, students reported that EPICS allowed them to learn a wide range of technologies and skills not commonly practiced in other courses. This ranged from animation software to database implementations to the art of project estimation. As one respondent put it:

"EPICS allowed us to create and bring to life solutions to real world problems in a way that other CSSE classes just didn't offer."

Expanding on this, Figures 2 and 3 below depict responses gathered from both our alumni and current students regarding their learning outcomes. Specifically, when asked if EPICS allowed them to learn or improve upon a technical skill, 84% of alumni respondents answered "yes", with the number growing to 93% for current students. Furthermore, when asked the same question about non-technical skills, both parties responded positively, with 87% answering "yes". These results highlight the consistency and growth of positive learning outcomes as our EPICS program has matured.
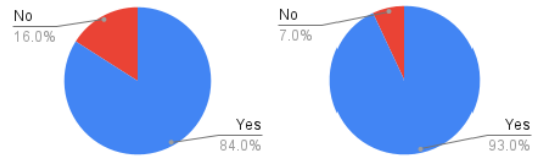

Fig. 2. Alumni vs. Student responses regarding learning technical skills.
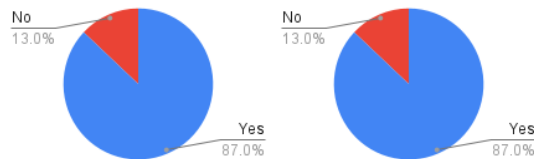

Fig. 3. Alumni vs. Student responses regarding learning non-technical skills.

These findings concluded with many alumni testifying that EPICS delivered concrete work experiences that aided them in establishing a career in CSSE. Though only 62% of alumni reported listing an EPICS project on their resume, 75% of alumni surveyed claimed to have used their EPICS experience as a talking point during a job interview. A common theme highlighted in our responses was the benefit of taking the course multiple times. One respondent noted:

"Being able to say that I had experience with multiple "real-world" clients (due to taking multiple semesters of EPICS) on "real" applications was a huge selling point in getting hired for a job - I was told as much after being hired."

Another alumnus touted the leadership opportunity EPICS provides as a career jump starter:

"My leadership role within EPICS positioned me as an interviewee not only with requisite technical skills but also promotability into management."

When asked about how EPICS could be improved, respondents suggested placing more emphasis on directly teaching project management skills, opportunities for networking with professionals in relevant fields, and providing

students with resources for finding internship and job opportunities through EPICS.

E. Effects of the Pandemic

During the pandemic, most students who participated in EPICS virtually had mixed feelings about their experience. Survey results showed that the transition to distance learning due to COVID-19 was difficult for many. Some students expressed frustration with the lack of in-person interaction and the difficulty of coordinating work virtually. However, many felt that the online format actually allowed for more flexibility in terms of scheduling and communication. In fact, 100% of team leaders reported remote class sessions as still being useful and productive. While that figure did fall slightly when polling team members, a healthy 75% of the remaining students concurred with their leader's assessment.

When asked to describe an average virtual session, team leaders talked about using the time to check in on progress and assign tasks rather than work directly on the project. Often, team leaders would let their members leave early, allowing for the rest of the class period to be used as time to work on assigned tasks. Regarding the issue of not being able to visit the client in person, only 20% of groups stated that it was a hindrance to their ability to effectively work on/complete the project. Additionally, 87% of alumni respondents said that the CSSE curricula should prepare students for a future that includes working remotely, indicating that some of the pedagogical tools developed for use during the pandemic may continue to be useful in post-pandemic times. When asked about how EPICS could be improved post-pandemic, students suggested seeking more opportunities for in-person meetings and networking, increasing communication and feedback from project mentors and advisors, and renewing the possibility for working on-location at the client site.

F. Recommendations

In order to address the needs identified in the previous subsections, three distinct recommendations have been made.

The first involves a complete overhaul of the EPICS website to include a great number of additional resources. These would include tips on what types of questions to ask when attempting to evaluate client requirements, email templates to encourage and facilitate better professional email and scheduling etiquette, and examples of proper documentation and instructional videos. The hope is that students would be exposed to these materials over the course of the semester and learn to implement the suggested strategies in their own projects, alleviating the pain points surrounding communication brought up above.

The next proposed recommendation is to implement a system where EPICS consultants have a much more direct role to play in student projects, perhaps in a similar position as the client mentor. This has successfully been implemented in other software engineering courses in the past, and 100% of the consultants interviewed were willing to commit to extra involvement. As part of this proposal, we would also dedicate some class sessions to learning directly from consultants, likely in a lecture format. For example, depending on their area of expertise, the consultant could impart knowledge about architecture design, application security, or a specific programming language. It is important to note that these lectures should not be held too frequently, however, as recent research has shown that students disprefer the lecture format in an EPICS course [20].

Finally, we recommend the continued use of virtual meeting software for client interactions, as it has shown to be effective in replacing most in-person client visits while enabling the rapid demonstration of prototypes and gathering of feedback. This should save clients time and encourage students to participate in more regular communication with their client partner.

VI. A REVISED ROADMAP

In a previous publication [12] the co-author proposed a roadmap in order to help guide other institutions in crafting a similar EPICS program within an LAS college. Here, we briefly describe an updated roadmap based on the results of our empirical study and the lessons learned during these past 10 additional years. Our revised roadmap is meant to serve as food-for-thought (not strict criteria), and it is presented below as a set of related questions. Please note that the previous publication includes a comprehensive list of documents (such as rubrics, templates, etc.) which may be used by others to build their own course materials.

A. Feasibility Questions

- What does Service and Experiential Learning mean to you and your institution?

- Is there a community service requirement for all students at your institution?

- How can EPICS be implemented at various levels within your university (e.g. college, department) effectively?

- How would it affect your own academic program?

- How can you integrate it in your curriculum?

- How would your students and your faculty benefit from an EPICS program?

- Can you conduct a cost/benefit analysis in order to determine all necessary resources required to create an EPICS program and its long-term benefit to your institution?

B. Awareness Questions

- How can you socialize the concept of EPICS at your institution?

- How do you effectively communicate the short- and long-term goals of your proposed EPICS program to everyone involved, including students?

- Can you form a service-learning committee within your department and/or college?

- Is it possible to put together an advisory board with members from your community and alumni who can be your EPICS advocates and may help you seek external funding?

- How difficult is it to secure a commitment from your institution's upper management or administration to support your EPICS program?

- Is there an office at your institution that coordinates student volunteerism, service-learning, and/or other similar outreach activities?

- Are you ready and willing to start devising an effective mechanism for creating meaningful partnerships with non-profit organizations in your community? (It is our experience that sustaining healthy relationships with community partners is critical for the success of an EPICS program.)

- Can you organize a bi-annual lunch/dinner/appreciation evening and invite all of the EPICS community partners and students at the end of every semester? (This could coincide with the final presentations.)

C. Curriculum Questions

- Can you create an EPICS course which counts toward your major requirements for graduation?

- Can you allow first, second, third, and fourth-year students to enroll in an EPICS course?

- Is it possible to allow your students to register for EPICS over several semesters for additional credit?

- Can you allow other majors, besides your own, to participate in EPICS? What prerequisite courses should students need to have before enrolling in your EPICS courses?

- Does your curriculum already prepare students to use collaborative methodologies/technologies like Agile, Git, or alternatives? (These skills can be taught during class, as long as adequate time is still given to the teams to work in their groups.)

D. Operational Questions

- Can you identify the right faculty member(s) to teach your new EPICS course(s)? (The selected individual(s) must be enthusiastic about service-learning and have a genuine interest in engaging with the community and helping others in need. EPICS supervisors need to demonstrate some flexibility and act more in a mentor/coach role rather than as a traditional instructor.)

- Can EPICS instructors be given appropriate teaching load credit preferably equivalent to a course per semester? Would that count towards tenure and promotion?

- Can you find effective ways to advertise your new EPICS course(s) to all your students and to recruit interested students?

- Is it possible to offer various EPICS related scholarships and awards at the end of each year?

- Can you establish and conduct annual surveys to receive feedback from your EPICS students and nonprofit clients? (This will hopefully help you assess and improve your program.)

VII. CONCLUSION

During the 20th anniversary of our EPICS program at Butler University, we conducted an empirical study in order to gather and analyze feedback received from all our EPICS participants (clients, consultants, alumni, and current students). The outcome of our study was twofold. Firstly, several areas of strength were highlighted and secondly, a list of recommendations was compiled for improving our EPICS program.

Primarily, the feedback gathered from our participants confirmed the multifaceted benefits of our EPICS program, emphasizing the power of community service as a pedagogical tool. We recognized the program's potential to create rewarding student experiences and strong resume building activities such as the cultivation of real-world technical expertise and the accomplishment of a goal via team driven methodologies. We showcased how these efforts have given birth to legitimately useful software products for our non-profit clients. Ultimately, through our surveys and interviews, we also discovered inefficiencies in our program and worked to create recommended solutions to these pitfalls.

The first key recommendation was to provide more training options to our students so that they may continuously improve their communication and project management skills. This should incorporate self-driven learning options through an overhaul of the student resources section on our EPICS website as well separate workshops or classroom-based lectures.

Another, equally important recommendation was to provide more structure and guidance for students throughout the course. We envision an EPICS program that utilizes consultants more effectively to ensure a higher standard of professionalism. In addition, setting clear expectations and timelines for project deliverables early in the semester should be encouraged. More specific recommendations are proposed for improving communication between clients and students. This could include mandating more frequent updates and progress reports, as well as using tools such as calendar invites to promote scheduling regular meetings with clients.

We are currently in the process of implementing these recommendations in order to strengthen our EPICS@BUTLER program. We plan to continue to fine-tune and enhance the EPICS model to maximize its impact on our students and non-profit partners. Finally, we wish to propagate this model's success to the greatest extent possible. To help facilitate this, we presented a set of questions as a guide towards crafting a new EPICS program at any interested academic institution. It is our hope that our findings inspire others to create or improve such a program of their own.

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