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BOARD # 306: Two Years of Lessons Learned from an NSF-IUSE Funded Vertically Integrated Projects (VIP) Program at University of Memphis

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Two Years of Lessons Learned from an NSF-IUSE Funded Vertically Integrated Projects (VIP) Program at University of Memphis

Vertically Integrated Projects (VIP) is an established learning model that was launched at University of Memphis (UofM), a public urban research university in the southeastern United States, in Fall 2022. Supported by an IUSE grant, this program is now in its third year, with 6 teams comprising 29 undergraduate participants. The VIP model involves active learning on faculty-led, team-based projects. Team members include first-year undergraduates through graduate students. Team members may have participated in VIP for one semester or up to three or more semesters. The VIP model enables tiered mentoring, from faculty to graduate students, graduate students to undergraduates, and more senior to newer students [1]. The goals of UofM's VIP program are to: (1) help build a more inclusive research culture; and (2) help students build STEM identity, as well as self-efficacy, mindset, and intentions to stay in engineering. The first goal is based on research about the positive impact of active learning and mentoring for recruiting and retaining women and other historically excluded groups in STEM [2]. The second goal builds on previous work on mentoring and community building on STEM Identity, while extending that work to related variables [3,4]. The purpose of this paper is to discuss challenges and opportunities in implementing the VIP model at the UofM from the perspective of the PIs, to report on the evaluation of the VIP program after two years, and summarize lessons learned as well as directions for moving forward.

This paper comprises three parts. In the first, we discuss the challenges and opportunities in implementing the VIP model at the UofM from the perspective of the PIs. This section focuses on issues involving recruiting faculty mentors and recruiting and retaining diverse undergraduates into the VIP program. In the second, we report results from focus groups conducted in the second year of the program with undergraduates, graduate student mentors, and faculty team leaders. This section focuses on motivations for joining the VIP program, perceived strengths and weaknesses of the program, and suggestions for improving the program. In the third, we summarize our research findings to date and discuss issues related to conducting research in this context and how we have adapted some of our research strategies in response to certain challenges. We conclude with lessons learned as well as directions for moving forward.

Challenges and opportunities

The VIP curriculum comprised four 1-credit hour courses to accommodate students at different stages of the program: 1) for honors first-year undergraduates; 2) for anyone in their first semester of VIP; 3) for those in their second semester; and 4) for those in their third semester or above. Departments in the College of Engineering (except for Civil Engineering) allowed students to count 3 credit hours of a technical elective toward their degree by completing 3 VIP courses (excluding the first-year honors course, which counts towards the honors program). Course sections were cross listed so that all VIP students can access the same material on CANVAS. These materials included a course syllabus with a letter-grading scheme, introductory units on best practices on how to engage in team-based research, mid and final peer-student evaluations, weekly journal assignments for students to reflect on their research experience, and pre- and post-surveys about the program. Each semester, course and scheduling information was provided to the registrar with sections for each participating faculty member and sometimes

errors needed to be corrected. We concluded that this procedure would not be sustainable as the program scales up and that more efficient procedures to schedule the courses would be needed.

Best practices and resources for the VIP program were adapted from the VIP Consortium annual meeting and website. Our VIP program started in Fall 2022 with two VIP teams led by the IUSE award co-PIs. The program expanded by adding a third team in Spring 2023, two teams in Fall 2023, and one team in Spring 2024, for a total of 6 teams in Fall 2024. VIP faculty project leads (3 women and 3 men) were from 4 departments: Biomedical Engineering, Civil Engineering, Electrical & Computer Engineering, and Mechanical Engineering. Faculty with a history of engaging undergraduates in their research were invited to participate. VIP faculty leads and their graduate student mentors were onboarded and trained in mentoring as they joined the program. In addition, at the start and end of each semester, VIP mentors met to discuss expectations and lessons learned. During these meetings, we found that some faculty leads did not follow all aspects of the adapted VIP model. One faculty lead did not hold formal team meetings or have students working on a team but instead assigned a graduate mentor to supervise each undergraduate. Another faculty lead did not use the provided syllabus and grading scheme. It was unclear if all faculty leads used the course material provided. Faculty adherence to the adapted VIP model was a challenge we aim to overcome as we scale up the program.

From our observations, the VIP program at UofM successfully created a sense of community and belonging among VIP participants. Faculty have noted that students who were very timid and had low self-confidence at the beginning of the experience appeared to achieve significant personal growth over the course of the three-semester sequence. Students became more willing to share their ideas and perspectives, eager to meet and chat with the team members, and were more confident in their ability to contribute to the team. Several VIP students who had no initial interest in further research pursuits have decided to pursue graduate school because of their VIP experience. Faculty mentors also noted that VIP students encouraged each other to join student organizations and were more engaged in departmental and college activities.

One challenge we experienced was related to the VIP model's inclusive design, which allowed first-year undergraduates through seniors to join a team with no academic or experience barriers to entry. The only requirement was that first-years be in the honors program. While this inclusivity was an overall positive aspect of the VIP model at UofM, we struggled in several cases to retain first-years on the teams. Several VIP programs elsewhere did not include first-years. Our approach provided an opportunity to first-years to experience the VIP program while earning credit for their first-year honors seminar course. Many first-years who joined a VIP team did so primarily to earn this required honors credit. They then needed three additional credit hours of VIP for a technical elective course. First-years were often overwhelmed with the transition from high school and the intense academic course load in their engineering major, including numerous labs. Several of the students (and perhaps more so first-years and sophomores) felt the VIP course was too time intensive for them at this stage of their academic career and chose not to continue with VIP after the initial 1-hour course.

Another challenge was the range of student capabilities and skillsets represented on a team. This variability made it difficult to identify interesting tasks for each student that provided an

opportunity for them to contribute to the team's progress. More novice students typically needed to remain focused throughout the first semester on literature review and acquiring basic research skills so that they could develop the foundation necessary to engage in more advanced activities. While faculty for all the VIP teams provided opportunities for these students to see what the more advanced undergraduates or graduate student mentors were doing, some were frustrated with the limited experience they had in the initial semester. Some students failed to show up and deliver their part of the team project, which was frustrating for other team members who were counting on these contributions.

A third challenge related to misalignment between VIP students' interests and the scope of their team's project. Students did not always understand the projects when they applied to join a VIP team. Some faculty tried to engage these students by letting them pursue their own interests that could expand the project's focus. Although this strategy was sometimes successful, it also led to distraction for the project and the team and additional work for the graduate students. We found that the range of student interests and skillsets on a team typically meant that substantial contributions to the project did not happen until late in a student's second or even in the third semester. A core principle of the VIP model has been that in the long term it helped advance faculty and graduate student research. However, because students' interests and skillsets were so varied, we found that that in many teams, the VIP effort was more of a 'labor of love' than a significant benefit to the research activity.

However, even if VIP activities did not always contribute significantly to faculty and graduate student research, the program contributed to undergraduate research exposure, especially contributing to their skills in oral and written communication. Many of the VIP students placed in on-campus events where undergraduate students can present their research, such as the Works in Progress Symposium and the Student Research Forum. A final challenge, therefore, was determining where VIP fits in terms of faculty workload, as it may not count toward their teaching load but also does not directly contribute to research output (especially early on).

Focus group findings

During the project's second year, we conducted three focus groups, one each with undergraduate VIP participants, graduate VIP mentors, and faculty VIP team leaders. Undergraduates indicated they were motivated to join the VIP program because of the opportunity to gain hands-on experience working on graduate student and faculty research, which they saw as an "honor" and "exciting." In addition to developing technical skills, they also felt they developed "soft skills" in communication and working in teams (which was consistent with our quantitative survey findings). They enjoyed working with their graduate student mentors, describing them as "helpful" and "encouraging" through "providing direction" and helping them think through "the process [of] how to answer a question." One student felt that working with graduate students helped to "humanize" the research process because "they don't know everything, [too]." Overall, they reported satisfaction with the VIP program but noted some logistical issues. They also reported feeling some disconnect between material covered in the course LMS and what they were doing in the VIP program (i.e., modules would cover the same material whether they were in their first or third semester in VIP).

Graduate student mentors were motivated to join their faculty advisor's VIP team because of a desire to work with and mentor undergraduates. Overall, they were satisfied with their experience as mentors and would recommend it to other graduate students. However, they felt that, from their perspective, the program structure was not always clear. They indicated that, at least for some teams, there was not a clear plan for the semester early on or they did not have meetings specifically for VIP (but more general lab meetings). In other cases, they had difficulty setting regular meeting times with their mentees outside of required weekly meetings. Similarly, there was uncertainty about how much time they could ask of undergraduates outside of the required meeting (given that it is a one-credit hour class). One graduate student expressed anxiety about involving undergraduates in their research ("just grab one of 'em […] and have 'em help you with X, Y, Z. […] But it's like I'm here to provide some structure and encouragement rather than trust [an undergraduate to] run this machine and tell me the results."). They also indicated that while they understood VIP undergraduates should be given more specific pieces (or "mini-projects") to clarify what they are working on and are responsible for, this was difficult for them to do.

Faculty indicated they were motivated to join the VIP program to recruit and train undergraduates (who may then become graduate students) into their labs. They also reported that they observed good camaraderie among VIP students and positive interactions between undergraduates, graduates, and post-docs. Challenges observed by faculty included students' lack of time to work on VIP, lack of alignment between student interest and VIP projects, and (like the graduate students) lack of certainty about how much time should be expected from students enrolled in a one credit hour course. Faculty team leaders echoed undergraduates in reporting that a strength of the program was in teaching communication skills in both presentations and publications that were part of the VIP program.

Survey and journal findings

In our quantitative surveys, we found no evidence that participation in the VIP program was associated with participants' STEM identity, self-efficacy, or mindset, nor was it associated with intentions to stay in engineering as a major or career. Survey results showed participants overall felt the VIP program helped them develop STEM knowledge/skills and that their self-perceived competence increased in some skills. These findings were limited due to the small sample sizes and biases associated with self-selection into VIP and social desirability in completing the surveys. However, we did see consistency between the survey results and what was reported in focus groups (e.g., communication and group work skills were among those that the survey results showed increases in self-perceived competence).

VIP participants also produced weekly written journals reflecting on their experiences in the program, which we intended to analyze qualitatively. In year one, we found that some students were reluctant to write much so we made changes to the prompt and added a rubric to help encourage more writing in these journals. While this strategy was successful in increasing the average word count for the journals, we still found that overall, the journals were brief and not a rich source of qualitative data. We therefore adapted our research strategy to quantitatively analyze these journals using computer-assisted text analysis.

Lessons learned and directions for moving forward

After two years of our implementation of the VIP model at UofM, our observations and research/evaluation data have highlighted key areas for improvement to enhance its effectiveness and long-term impact. First, expectations for the VIP program need to be communicated more clearly to ensure full understanding and consistent implementation of the VIP model. Consistent implementation relies on faculty team leaders fully embracing the VIP model. This consistency would provide graduate student mentors with clearer expectations for their roles with undergraduates and help ensure undergraduates understand their time commitments and responsibilities as VIP team members. In turn, this consistency should also reduce undergraduate frustrations about course materials that may not always align with team projects. Second, expected outcomes for VIP should focus more on "soft skills" associated with research (interpersonal and group communication, presentation and writing skills, time-management, etc.) so that undergraduates understand that they will not jump directly into technical research tasks and may appreciate the value of their VIP experience even if their interests are not directly related to their team project. Such a shift would require developing communication skills outcomes and assessment methods. These assessments would allow for program evaluation that goes beyond faculty leads' impressions and students' self-perceptions, providing more objective measures of students' growth. Finally, faculty and graduate student mentors may need to be better prepared for the challenges of working with novice undergraduates on their projects. Our observations suggest that the benefits to faculty and graduate student research take time, with meaningful contributions becoming more apparent in the second or third year of a VIP team's development.

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