A Work-in-Progress Study: Exploring Performance-Based Assessment in an Interdisciplinary Projects Program

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Work-in-Progress (WIP): Exploring Performance-Based Assessment (PBA) in a VIP Interdisciplinary Program

Abstract

With the increasing emphasis on project-based learning (PBL) and providing students with multidisciplinary teamwork experiences in engineering education, Vertically Integrated Projects (VIP) programs have become an integral part of curricula at many universities. These VIP programs enable engineering students to collaborate in interdisciplinary teams to design solutions for real-world projects involving stakeholders over multiple semesters. Although there are multiple advantages of VIP programs, their unique and flexible structure raises questions about effective assessment practices that capture the professional and engineering design skills students are expected to further develop in these programs. Performance-based assessment (PBA), defined as an assessment method that evaluates students' ability to apply classroom learning to real-world problems, provides a suitable approach to assessment in VIP programs involving PBL. Grounded in the principles of evaluating participants through projects, presentations, and real-world tasks, PBA measures not just outcomes, but also processes, teamwork, and individual contributions.

However, such approaches to evaluating student performance face challenges in undergraduate contexts where students are accustomed to frequent quantitative grading. These challenges are further complicated in interdisciplinary contexts where students and instructors bring differing methods and priorities to their work. This exploratory qualitative study seeks to understand students' perceptions of PBA and focuses on the research question: How do undergraduate students perceive and experience the use of PBA in an interdisciplinary project-based learning course? Participants for this study are students who have completed a semester in the Interdisciplinary Projects (IDPro) program, where students work on multi-semester client-based projects. Student participants' majors include several engineering disciplines (Aerospace, biomedical, Computer Science, Electrical and Computer engineering, Mechanical, and general engineering) as well as Chemistry, Cognitive and Behavioral Neuroscience, Computational and Systems Neuroscience, Computational Modeling and Data Analytics, Psychology, and Sociology. Data collection involves student responses to a post-class survey with open-ended questions about their assessment experiences, followed by a focus group to deepen insights. The data will be systematically coded, categorized, and examined using thematic analysis to determine patterns and themes. This work-in-progress study examines students' perceptions of PBA in an interdisciplinary project environment.

Introduction

In response to the growing emphasis on project-based learning (PBL) and the integration of multidisciplinary teamwork experiences within engineering education, Vertically Integrated Projects (VIP) programs have emerged as integral components of university curricula [1]. These programs allow students to collaborate within interdisciplinary or disciplinary teams, working on real-world projects alongside stakeholders over extended periods. While the advantages of VIP programs are evident, their distinctive and flexible structure prompts inquiries into effective assessment practices that can help students develop the professional, leadership, and research skills students are expected to enhance throughout their participation [2]. Performance-based assessment (PBA), defined as an evaluation approach assessing students' capacity to apply classroom knowledge to real-world problem-solving scenarios [3], [4], is aligned with the learning objectives of VIP programs. Landed in the principles of project evaluation, presentations, and the completion of authentic tasks, PBA not only measures outcomes but also examines processes, teamwork dynamics, and individual contributions [3], [4]. It thus offers potential as a suitable approach toward assessing student learning in VIP programs.

Nevertheless, implementing performance-based assessment (PBA) encounters inherent challenges within undergraduate contexts, characterized by a prevailing culture of frequent quantitative grading [5]. The traditional emphasis on numerical evaluation often clashes with the holistic nature of PBA, which seeks to measure a spectrum of skills and competencies developed through interdisciplinary collaboration in Vertically Integrated Projects (VIP) programs [1]. In undergraduate settings, students are conditioned to a system that primarily values numerical metrics, making the transition to a qualitative and process-oriented evaluation approach a significant pedagogical shift. This discrepancy in assessment methodologies poses a unique set of challenges that demand careful consideration and adaptation. The interdisciplinary nature of VIP programs introduces an additional layer of complexity, as students and instructors from diverse backgrounds bring varying methods and priorities to their collaborative work. Navigating these challenges requires a nuanced understanding of how to bridge the gap between the quantitative expectations of students and the qualitative demands of PBA. This work-in-progress paper aims to explain the steps of developing this research that explores students’ perceptions of PBA to effectively implement it within the undergraduate and interdisciplinary contexts of VIP programs

IDPro

Vertically Integrated Projects (VIP) initiatives serve as a platform enabling students to engage in extended projects spanning multiple semesters. This pedagogical approach aims to provide students with hands-on learning experiences, fostering collaboration between faculty and students. Students tackle substantial projects within a team framework, refining their research and leadership proficiencies [2]. The VIP program bridges theoretical knowledge acquired in coursework with practical applications, addressing real-world challenges specific to their fields

of study [6]. Active participation in VIP develops a spectrum of skills, ranging from creativity and resourcefulness to self-motivation and teamwork [7]. The Interdisciplinary Projects (IDPro) program was designed as a VIP program to promote interdisciplinary collaboration and provide experiential learning opportunities to students over multiple semesters. Students can engage in industry, research, service, and entrepreneurial projects. The interdisciplinary research program facilitates project-based learning involving community partners and mentor support, fostering communication and project management skills across disciplines. Our focus remained on ensuring that students not only acquired theoretical insights but also had the chance to apply them in real-world scenarios. Following the successful models of VIPs, we also want to provide a broader scale encompassing multiple disciplines.

VIP Benefits

VIP Program is a multifaceted educational initiative with profound benefits for both faculty and students. In the program, faculty members derive considerable advantages from VIP participation, as it facilitates the accomplishment of projects that significantly contribute to their ongoing research endeavors [8]. It also improves faculty scholarship and fosters an environment that promotes collaborative research [8]. Moreover, the VIP Program stands out as a cost-effective, scalable, and sustainable model for multidisciplinary project-based learning, as highlighted by Cullers et al. [7]. This pedagogical approach's richness is advantageous for faculty research and provides students with an immersive and dynamic learning experience [7]. This aligns with findings by Sonnenberg-Klein et al. [9], who observed a positive correlation between VIP program participation and students' improved abilities to collaborate in multidisciplinary teams, engage with diverse backgrounds, and apply technology relevant to their respective fields [9]). Furthermore, the VIP Program extends its impact to engineering students, who can earn credit for participating in multidisciplinary project-based courses while actively contributing to educational platforms [10]. This unique feature further emphasizes the program's commitment to developing technical skills and a broader understanding of educational design and implementation.

Performance-Based Assessment

A general definition of assessment includes the process of gathering, analyzing, and interpreting students' ability to achieve specific objectives, which serve as an integral component within the teaching and learning environment [11]. Generally, assessments are summative and formative a technical definition is defined as “serving a formative function when it elicits evidence that yields construct-referenced interpretations that form the basis for successful action in improving performance, whereas summative functions prioritize the consistency of meanings across contexts and individual” [12, p. 537]

In the 90s, there was a growing focus on assessment results and concerns about the common methods used to assess students, as well as how these results were being used [13]. This

increased interest in exploring different assessment approaches, especially complex, performance-based assessments [13]. Supporters of these alternative methods argue that it's crucial to rethink the criteria used to judge the quality of educational assessments, particularly those that match the expectations set by performance-based assessments [13]. Linnet and his colleagues advocate for a broader set of criteria in evaluating new educational assessment methods beyond traditional factors like efficiency and reliability. Emphasizing the importance of a more expansive view of validity, Linn suggests comprehensively assessing alternative methods like performance-based measures. Linn highlights the need to move beyond the sole emphasis on efficiency, reliability, and comparability, arguing the evolving nature of educational assessments. This shift in perspective calls for carefully examining assessment criteria that can effectively capture the diverse skills and competencies demonstrated through performance-based approaches. PBA is a type of assessment where students showcase what they've learned to their teachers. It comes in handy when educators want to assess how well students can solve problems and confidently express their thoughts aloud [14]. PBA proves beneficial when learning extends beyond problem-solving to include effective verbal communication of ideas. It also means to measure students' ability to apply the skills and knowledge learned from a unit or units of study [15]. Typically, the PBA challenges students to use their higher-order thinking skills to create a product or complete a process [4]. Performance-based assessment of group work is an effective way to evaluate the contributions of individuals within a group and assess the overall success of a collaborative project.

Performance-based type of assessment measures not only the final outcome but also the process, teamwork, and individual skills and contributions. Performance-based assessment is likely a suitable approach if a course uses a broader range of methods, such as projects, portfolios, simulations, presentations, observations, and real-world tasks. These assessments evaluate how well individuals or groups can perform tasks or solve problems in authentic contexts, reflecting their ability to apply their knowledge and skills. Portfolios, performance appraisals, reflection, and behavioral observations offer the most comprehensive information for assessing performance and professional skills. While students are identified as driven by assessment [3], many issues surrounding the identification and appraisal of reflection complicate a straightforward alignment of learning objectives with the desired goal of promoting this activity. Thus, similar to traditional competency-based assessment, students also face some challenges in performance-based assessment, especially in the interdisciplinary project course. In such cases, PBA becomes a valuable tool for teachers to evaluate how students can apply their knowledge in real-life scenarios and communicate their thoughts clearly and effectively [14].

According to the literature, there is a growing need to align assessment practices with evolving learning objectives and pedagogical approaches [3], [4] and in interdisciplinary undergraduate programs. With the development of interdisciplinary undergraduate research programs (IDpro), we want to ensure we are providing assessments that effectively capture the

diverse skills and competencies demonstrated through these complex, performance-based approaches. Traditional assessments often prioritize efficiency, reliability, and comparability, potentially falling short in evaluating the range of abilities required in interdisciplinary research contexts, such as problem-solving, critical thinking, communication, and collaboration. Understanding how PBA can assess and foster these essential skills is vital for enhancing student learning experiences and supporting multidisciplinary collaboration. This research can provide valuable insights into the implementation and potential improvements of PBA in interdisciplinary undergraduate programs The following research questions guiding this study include:

- RQ1) How do interdisciplinary undergraduate research students perceive the concept and practice of performance-based assessment?
- RQ2) What themes emerge from the students' experiences and understanding of performance-based assessment?

Methodology

The research follows an exploratory qualitative approach where we are seeking to understand perceptions and experiences related to performance-based assessment among interdisciplinary undergraduate research students. The purpose of this qualitative study is to explore the perceptions of interdisciplinary undergraduate research students regarding performance-based assessment. The following figure 1. shows each step of the research.

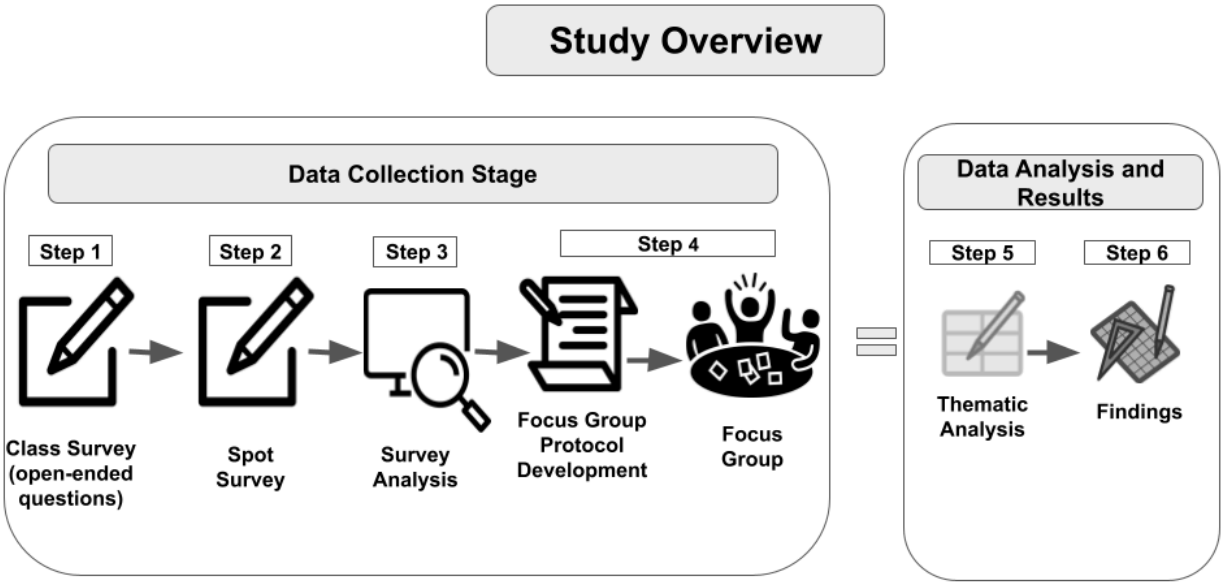

Figure 1. Study Overview

Participants and Data Collection

Interdisciplinary undergraduate research students from public research universities enrolled in IDPro will be invited to participate in the study. The selection criteria include students enrolled in the second semester of IDPro. Participants currently enrolled in the class will receive a post-class survey and respond to in-class open-ended questions regarding their experience with the assessment. The purpose of analyzing both the post-class survey and the in-class questionnaires is to formulate a cohesive protocol for the focus group. Additionally, approximately 30 to 40 participants may be selected to participate in subsequent focus group sessions, each lasting 15-20 minutes, which will be conducted within the classroom setting for each section.

Demographics

In terms of course enrollment, students from various majors expressed interest in joining the program “IDPro”. It's essential to note that these demographics do not represent the final participants of the study. The study is scheduled for Spring 2024, while the data in Table 1 was collected in the fall of 2023. The primary purpose of the table is to illustrate the potential disciplines that might be participating in the study. Regarding the course itself, we received 53 responses that show interest in the program. Table 1 displays the distribution of students' disciplines within the course.

Table 1. The Distribution of Students Disciplines

Disciplines	**Count**	**Percentage**
Aerospace Engineering	4	7.69%
Biomedical Engineering	1	1.92%
Chemistry	1	1.92%
Cognitive & Behavioral Neuroscience	2	3.85%
Cognitive and Behavioral Neuroscience	1	1.92%
Computational and Systems Neuroscience	2	3.85%
Computational Modeling & Data Analytics	7	13.46%
Computer Engineering	1	1.92%
Computer Science	13	25.00%
Electrical Engineering	6	11.54%
General Engineering	1	1.92%
Mechanical Engineering	5	9.62%

Neuroscience	1	1.92%
Physics	1	1.92%
Psychology	2	3.85%
Psychology & Criminology	1	1.92%
Robotics and Mechatronics	2	3.85%
Sociology and Political Science	1	1.92%

Data Collection and Analysis

A focus group will take place in the second semester of IDpro to further explore students' perceptions and collect more in-depth data. The focus group will have a duration of approximately 15-20 minutes. Questions and prompts for the focus group will be tailored based on the insights obtained from the initial survey responses. The data from both the post-class survey and the focus group will undergo thematic analysis, which involves systematically coding, categorizing, and identifying patterns or themes. Specifically, the researchers will familiarize themselves with the data by thoroughly reading the responses. They will then generate initial codes by identifying key concepts. Next, the codes will be grouped into potential themes, which will subsequently be reviewed in relation to the original data for validity. The researchers will clearly define and name each finalized theme. Ultimately, the synthesized findings will be reported to address the stated research questions

Lessons Learned So Far

While the full study is yet to be conducted, the planning process has already provided some valuable lessons. One key learning has been the importance of involving a diverse range of disciplines in the IDPro program, as reflected in the initial interest from students across various majors (Table 1). This diversity in backgrounds and perspectives is likely to enrich the insights obtained regarding performance-based assessment in interdisciplinary research. Another lesson has been the value of a multi-pronged data collection approach, combining surveys, open-ended questions, and focus groups. This triangulation of methods is expected to yield a more comprehensive understanding of students' perceptions and experiences, capturing both broad trends and nuanced perspectives.

Future Steps and Work

The next major step will be conducting the post-class survey and in-class open-ended questionnaires with students currently enrolled in the IDPro program's second semester. Analyzing these initial responses will be crucial in formulating an effective protocol and question guide for the subsequent focus group sessions. Careful review and synthesis of the survey and open-ended data will help identify key areas of inquiry and themes to explore further during the focus groups. Once the focus group protocol is finalized, the researchers plan to select a representative sample of 30 to 40 participants from the IDPro cohort to participate in the 15-20 minute focus group sessions. These sessions will be conducted within the classroom setting, allowing for a familiar and convenient environment for students to share their perspectives. For future work, conducting a longitudinal study that follows the same cohort of students throughout their entire IDPro experience could provide valuable insights into how perceptions and attitudes toward performance-based assessment evolve over time. Also, incorporating the perspectives of instructors and faculty members involved in IDPro could lead to a more holistic understanding of performance-based assessment. Their experiences and strategies in designing and implementing PBA could inform potential improvements to the assessment practices

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Conclusion

This ongoing work emphasizes the importance of matching assessment practices with changes in education, especially for Vertically Integrated Projects (VIP) programs. Exploring performance-based assessment (PBA) as a way to evaluate the diverse skills and abilities developed through interdisciplinary teamwork in VIP is critical, as it can improve these educational initiatives [2]. The paper acknowledges challenges with bringing PBA into undergraduate settings, where the common culture of quantitative grading often clashes with PBA's holistic, qualitative nature. The interdisciplinary aspect further complicates things, as diverse backgrounds have varied assessment methods and priorities. Bridging this gap requires careful adaptation and nuanced understanding for a meaningful transition from quantitative expectations to qualitative, process-focused evaluations [5].

The 1990s history highlighted growing interest in alternative assessments, especially PBAs, challenging the traditional focus on efficiency and reliability. This paradigm shift calls for rethinking assessment criteria to capture the multifaceted skills PBA demonstrates [13]. Introducing PBA to evaluate group work in VIP is an effective way to assess the final outcome and the process, team dynamics, and individual contributions [4]. The key PBA elements for group work stress using various methods like projects, portfolios, simulations, presentations, observations, and real-world tasks [3]. This research is expected to provide valuable insights on implementing PBA in VIP, offering guidance on addressing challenges and optimizing practices to foster the development of professional, leadership, and research skills among students. As education continues to evolve, this timely study explores assessment approaches that align with the goals of project-based learning and interdisciplinary collaboration in engineering education.

References

[1] B. Aazhang *et al.*, "Vertically Integrated Projects (VIP) Programs: Multidisciplinary Projects with Homes in Any Discipline," in *2017 ASEE Annual Conference & Exposition Proceedings*, Columbus, Ohio: ASEE Conferences, Jun. 2017, p. 29103. doi: 10.18260/1-2--29103.

[2] M. Baxter *et al.*, "On project-based learning through the vertically-integrated projects program," in *2011 Frontiers in Education Conference (FIE)*, Oct. 2011, pp. T1F-1-T1F-7. doi: 10.1109/FIE.2011.6143064.

[3] J. Biggs, "What the Student Does: teaching for enhanced learning," *High. Educ. Res. Dev.*, vol. 18, pp. 57–75, Apr. 1999, doi: 10.1080/07294360.2012.642839.

[4] M. Chun, "Taking Teaching to (Performance) Task: Linking Pedagogical and Assessment Practices," *Change Mag. High. Learn.*, vol. 42, no. 2, pp. 22–29, Feb. 2010, doi: 10.1080/00091381003590795.

[5] J. Morton, A. Cumming, and H. Cameron, "Performance-based assessment in undergraduate medical education," *Clin. Teach.*, vol. 4, no. 1, pp. 36–41, 2007, doi: 10.1111/j.1743-498X.2007.00138.x.

[6] N. Ramirez and C. B. Zoltowski, "First-Year Experiences – How the Vertically Integrated Projects (VIP) Model Addresses Grand Challenges and ABET Outcomes," in *2022 IEEE Frontiers in Education Conference (FIE)*, Oct. 2022, pp. 1–4. doi: 10.1109/FIE56618.2022.9962409.

[7] J. Cullers, W. Hughes, and D. Llewellyn, "Vertically Integrated Projects (VIP) Programs: Multidisciplinary Projects with Homes in Any Discipline," *2017 ASEE Annu. Conf. Expo.*, Jun. 2017, [Online]. Available: https://scholarworks.boisestate.edu/mse_facpubs/311

[8] J. Allebach, E. Coyle, and J. Krueger, "The Vertically Integrated Projects (Vip) Program In Ece At Purdue: Fully Integrating Undergraduate Education And Graduate Research," in *2006 Annual Conference & Exposition Proceedings*, Chicago, Illinois: ASEE Conferences, Jun. 2006, p. 11.1336.1-11.1336.16. doi: 10.18260/1-2--1421.

[9] J. Sonnenberg-Klein, R. T. Abler, E. J. Coyle, and H. H. Ai, "Multidisciplinary Vertically Integrated Teams: Social Network Analysis of Peer Evaluations for Vertically Integrated Projects (VIP) Program Teams," presented at the 2017 ASEE Annual Conference & Exposition, Jun. 2017. Accessed: Nov. 28, 2023. [Online]. Available: https://peer.asee.org/multidisciplinary-vertically-integrated-teams-social-network-analysis-of-peer-evaluations-for-vertically-integrated-projects-vip-program-teams

[10] A. Ferri, B. Ferri, R. Lineberg, K. Ferri, Z. Crawford, and J. Tamayo, "Use of a Vertically Integrated Project Team to Develop Hands-On Learning Modules," in *2017 ASEE Annual Conference & Exposition Proceedings*, Columbus, Ohio: ASEE Conferences, Jun. 2017, p. 29063. doi: 10.18260/1-2--29063.

[11] G. Shiel and D. Murchan, "Understanding and Applying Assessment in Education," Apr. 2017. Accessed: Jan. 07, 2024. [Online].

[12] D. Wiliam and P. Black, "Meanings and Consequences: a basis for distinguishing formative and summative functions of assessment?," *Br. Educ. Res. J.*, vol. 22, no. 5, pp. 537–548, Dec. 1996, doi: 10.1080/0141192960220502.

[13] R. L. Linn, E. L. Baker, and S. B. Dunbar, "Complex, Performance-Based Assessment: Expectations and Validation Criteria," *Educ. Res.*, vol. 20, no. 8, pp. 15–21, Nov. 1991, doi: 10.3102/0013189X020008015.

[14] A.- Umam, F. P. Mauludi, and M. K. Wardana, “STUDENTS’ PERCEPTION OF PERFOMANCE-BASED ASSESSMENT APPLICATION IN HIGHER EDUCATION,” *J. Engl. Lang. Learn.*, vol. 5, no. 2, Nov. 2021, doi: 10.31949/jell.v5i2.3334.
[15] T. Palm, “Performance Assessment and Authentic Assessment: A Conceptual Analysis of the Literature,” *Pract. Assess. Res. Eval.*, vol. 13, Jan. 2008.