PPOHA Project Evaluation:

Strengthening STEM Education of Latinx Students for Graduate Degree Completion*

(Evaluator Report on Year 2 Operation)

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Contents

Abstract

This report is developed with dual foci, (1) Justifying attainment of the grant milestones in Year 2, and (2) Supporting ongoing improvement of the program performance, to evaluate the second year operation of a five-year grant, "Promoting Excellence in Graduate Education and Increasing Hispanic STEM Related Degree Completion". Well-rounded findings from quantitative and qualitative approaches are gathered in four sections: Fulfillment of Year 2 benchmark is addressed in Section I to match the original milestones in the grant proposal. Based on conceptualization of a *Rate of Progress* indicator in Year 1 report, Section II is devoted to description of student tracking across program pipelines toward degree completion. Impact stories are gathered in Section III to provide in-depth faculty assessment of profound outcomes in *teaching, research*, and *mentorship* domains. The qualitative inquiry is further expanded in Section IV to support social network analyses of faculty collaboration across academic disciplines. Triangulation of the evaluation findings consistently indicates satisfactory performance of the PPOHA grant in Academic Year 2020-2021. The report concludes with three recommendations for future improvement.

PPOHA Project Evaluation:

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Academic Year (AY) 2020-2021 is the second year of the *Promoting Postbaccalaureate Opportunities for Hispanic Americans* (PPOHA) grant funding (Award Number P031M190029) at California State University, Bakersfield (CSUB). For the first time in history, the decennial census record indicates a Hispanic majority (54.9%) in the population of Kern County, the primary service area of CSUB.[1] As Lynnette Zelezny (2022), CSUB President, pointed out, "Grants and programs throughout the university's four schools seek to improve Latinx representation, particularly in STEM professions" (p. 3). In this context, timely support from the PPOHA project, *Promoting Excellence in Graduate Education and Increasing Hispanic STEM Related Degree Completion*, plays an important role to address the needs of expanding postbaccalaureate educational opportunities for, as well as improving the academic attainment of, Latinx students in STEM fields. Following the contract of five-year funding, grant activities in Year 2 are guided by dual goals of the original proposal:

1. Enhance and create additional capacity for the CSUB STEM graduate programs, which facilitates increased enrollment, provides needed student support, improves research facilities and engages faculty to better serve Hispanic graduate students through degree completion.
2. Develop a university-wide *graduate school-going* (GSG) culture through a robust and comprehensive program that encourages, supports, engages, and prepares students to pursue graduate education.

Authorization of Title V(b) program is grounded on the 2006 amendment of *Higher*

[1] https://www.bakersfield.com/news/people-of-hispanic-origin-become-majority-in-kern-county-in-2020-census/article_d37012d2-fbb6-11eb-b08c-830148e50386.html

Education Act of 1965 to support Hispanic Serving Institutions (HSI) that enroll at least 25% Latinx students.[2] In addition, implementation of the PPOHA project at CSUB conforms to current research literature – Shortly after the grant funding, more nationally-refereed publications surfaced in prominent journals, such as *Review of Educational Research* and *American Educational Research Journal*, to examine the "servingness" of HSIs with government funding. In particular, Garcia, Nunez, and Sansone (2019) argued that HSIs, as identified by the enrollment threshold, might not automatically carry a historical mission to serve Latinxs.

Furthermore, few HSIs enroll students of a single ethnic group (Contreras, Malcom, & Bensimon, 2008). Institutions of higher education are expected to respond to the changing demographics of student enrollment in their surrounding regions (Benítez, 1998). According to Garcia (2017), a Latinx-producing identity should be constructed at HSIs for "producing a significant (if not equitable) number of legitimized outcomes for Latinx students, despite the lack of a culture for supporting Latinx" (p. 121S). The enrollment-driven mission is essential to extending comprehensive services for students of Latino origin.

The Latinx-producing feature has been well-justified in the grant proposal of CSUB to target on enrollment increase, program enhancement, and closure of student ethnic gaps in STEM career preparation (see Goal 1). Furthermore, development of GSG culture in Goal 2 has resulted in expansion of education capacity building. In combination, the incorporation of faculty and staff as "empowerment agents" can "effectively support and empower minoritized students at HSIs, while striving to increase equitable outcomes for these populations" (Garcia & Ramirez, 2018, p. 378).

As suggested by an evidence-based tenet of *What Works Clearinghouse*, ongoing

[2] https://www2.ed.gov/programs/ppoha/legislation.html

efforts should be devoted to establishment of learning communities that are both *culturally informed* and *culturally enhancing* so that "active learning in a community-based setting can improve academic outcomes by increasing social and academic integration".[3] The university president embraced the importance of promoting diversity, i.e., "At the CSU, we know that diversity is not only our greatest asset; it is our superpower" (Zelezny, 2022, p. 3).

Besides the Latinx-producing identity for HSI, Garcia (2017) advocates an *Ideal Latinx-Serving Identity*. More specifically, "These include graduation, graduate school enrollment, and employment for Latinx students. They also constructed an ideal Latinx-serving identity based on their desire to create a culture that produces legitimized outcomes" (Garcia, 2017, p. 119S). Altogether, the HSI topology (see Garcia, 2017; Garcia & Ramirez, 2018; Garcia, Nunez, & Sansone, 2019) is closely aligned with two goals of this PPOHA grant, i.e., *strengthening postbaccalaureate STEM education* and *developing GSG culture at CSUB*. As a Co-Director of the PPOHA grant projected, "Aspiring to become Hispanic-serving is certainly a broad goal of mine and the grant. I think that this is likely also goal of the university generally, … Ideally, the current grant puts us on a trajectory toward this goal."[4]

To support the ongoing improvement, pilot data have been gathered by the PPOHA grant team to monitor the *rate of progress* index in formative assessment. Impact stories from the federal grant support are aggregated from faculty reports to offer in-depth assessment of the program effectiveness. Networking effort is examined to assess partnership building across *teaching*, *research*, and *mentorship* domains. To facilitate the result triangulation from multiple aspects, the qualitative and quantitative data are presented in four sections. First, milestones for Year 2 are reviewed to confirm the project accomplishment according to the grant proposal. The

[3] https://ies.ed.gov/ncee/wwc/Intervention/797
[4] Personal communication with Professor Anna Jacobsen on 12/16/2021

rate of progress is subsequently configured to monitor student advancement through program pipelines. As an intermediate grant outcome in Year 2, impact stories are extracted in the third section to document project effectiveness. The fourth section is devoted to social network analyses of the partnership building across STEM disciplines. The report concludes with a recap of past recommendations, as well as justification of new recommendations, for future improvement.

I. Milestones of Grant Activities in Year 2

Following the PPOHA guideline,[5] effectiveness of HSI is measured not only by student outcomes, but also by the institutional impact in which universities sustain improvement of learning opportunities for Hispanic students. Toward that end, the CSUB grant team proposed seven milestones for Year 2 activities. Table 1 shows achievement of the milestone outcomes across seven result domains.

Table 1: Year 2 Milestone Attainment

Result Domains	Milestone Outcomes
1. Mentor program assessment	Nine assessment reports obtained from faculty members
2. Management meetings	Forty advisor meetings held for program administration
3. First evaluation report	Report for Year 1 operation archived in the ERIC database[6]
4. Second Grad Fair	Eleven graduate students participated in the competition[7]
5. Summer research program	Five faculty mentored research teams for this task
6. Grad student advisement	Five advisement meetings held for 59 students
7. GSC workshops	Data gathered on the effectiveness of 10 GSC workshops

The first result domain includes six components:

- Faculty research mentoring meetings and activities with advisees;
- PPOHA support in improving graduate student mentoring;
- Changes of the mentoring approaches from the past;
- Faculty peer interactions across multiple departments;
- Development of graduate culture at CSUB;
- Improvement of the Faculty Fellows program for student success.

[5] https://www2.ed.gov/programs/ppoha/index.html
[6] https://eric.ed.gov/?id=ED611787
[7] https://www.youtube.com/watch?v=i4QLCNpJ_rQ

Impact stories are derived from this domain to offer vivid description of mentorship outcomes in Section III. In addition, text analytics are conducted to gain an overall picture through the result aggregation.

The second result domain in Table 1 addresses the mechanism of timely advising services for graduate students. The third result domain refers to the Year 1 evaluation report that has been peer-reviewed *internally* by the grant management team and *externally* by the Education Resources Information Center (ERIC) of the U.S. Department of Education (Ibid. 6). A proposal extracted from the annual report is accepted for presentation at the 2022 annual meeting of the American Educational Research Association (Wang, 2022).

In the fourth result domain, *Second Grad Fair* has been documented by video recording (Ibid. 7). Beyond what was planned in the original proposal, the PPOHA project team participated in 14 Virtual Grad Fairs for student recruitment. The *Grad Slam* preparation also involved extensive collaborative efforts, including three training workshops with an average of 17 student attendees in each session.

Table 2: GSC Workshop Offering and Attendee Count

Theme	Attendee Count
Cal State Apply	34
Culminating Experiences	34
Financial Aid 101 for Graduate Students	69
GRE Workshop	7
Money Matters for Graduate Students	17
Overcoming Imposter Syndrome	33
Pre-Doctoral and Doctoral Funding	33
Resiliency and Transcendence	15
Finances of Graduate Education	88
Graduate Hidden Curriculum	17

Likewise, the summer research program is built on team efforts of student mentors to lead the STEM inquiries in the fifth result domain. Furthermore, graduate student advisements

are designated in the sixth result domain to engage both prospective and current undergraduate students toward graduate studies. In the seventh result domain, themes and attendee counts are listed in Table 2 for 10 Graduate Student Center (GSC) workshops. In addition, *STEM graduate excellence* workshops were offered to 55 students on *Demystifying Graduate School* and 27 students on *Skills for Graduate School Success*.

Throughout the second year, evaluation data have been gathered from 18 workshops, three for *Grad Slam*, 10 on *GSC themes*, two for *Student Orientation*, and three on *Fostering Research* and *STEM Excellence* (Tables 3 & 4). The results are presented separately according to the data collection platforms between SurveyMonkey and Qualtrics. While the SurveyMonkey data indicate workshop usefulness, Qualtrics surveys are based on one question: *How likely is it that you would recommend the event to a friend or colleague?* The feedback is used to classify respondents into *Promoter*, *Detractor*, and *Passives* categories.

Table 3: Mode of Participant Responses from Thirteen Workshops

Theme	N	Mode	
		Location	Percent
Grad Slam 101: Getting Started	8	Extremely Useful	100
201: Memorable Messaging & Visceral Visuals for Impact	1	Moderately Useful	100
301: Communicating with Confidence	7	Extremely Useful	57
GSC Workshop: Culminating Experiences	31	Extremely Useful	48
GSC Workshop: Finances of Graduate Education	38	Extremely Useful	49
GSC Workshop: GRE Preparation	5	Extremely Useful	100
GSC Workshop: Overcoming Imposter Syndrome	16	Extremely Useful	88
GSC Workshop: Pre-Doctoral and Doctoral Funding	3	Very Useful	67
GSC Workshop: Resiliency and Transcendence	7	Extremely Useful	83
STEM Excellence: Demystifying Graduate School	25	Extremely Useful	72
STEM Excellence: Skills for Graduate School Success	10	Extremely Useful	60
New Graduate Student Orientation (9/13/2021)	19	Extremely Useful	90
New Graduate Student Orientation (2/4/2021)	10	Extremely Useful	40

In examining the ranking data on event *usefulness* or *promotion*, Devlin (2018) cautioned that “Finding appropriate scales to use in research can be a challenge” (p. 2). With the discrete

response options in a multiple-choice format, researchers have challenged an *equal interval assumption* for the scale averaging (Göb, McCollin, & Ramalhoto, 2007). Instead, Iannario (2012) suggested mode as a viable alternative since "sample mode is a functional of relative frequencies" (p. 172), which fit the structure of categorical responses.

The *usefulness* scale from SurveyMonkey contains five categories, *extremely useful*, *very useful*, *moderately useful*, *slightly useful*, and *not at all useful*. In representing the most frequent response, mode has been found from the data analysis in the *extremely useful* category across 11 workshops (Table 3). The modes also represent the answer choice from 40-100% of the respondents (see Table 3), far above the average of 20% count for the five-point scale under a uniform distribution. In contrast, modes for the remaining two workshops appear in *moderately useful* and *Very Useful* categories (Table 3). The data were gathered from one or three students, which made the ratings less reliable than the *extremely useful* outcome from the aforementioned 11 workshops.

Likewise, the Qualtrics scale unanimously identified workshop respondents as *promoters* in Table 4. The mode represents 63-91% of the survey data across five workshops to confirm the majority support for these learning events.

Table 4: Mode of Survey Data from Five Workshops on the Qualtrics Scale

Theme	N	Mode	
		Location	Percent
GSC Workshop: Cal State Apply	4	Promoter	75
GSC Workshop: Financial Aid 101	15	Promoter	91
GSC Workshop: The Graduate Hidden Curriculum	5	Promoter	80
GSC Workshop: Money Matters for Graduate Students	9	Promoter	63
Fostering Research	12	Promoter	82

In summary, quality of the service delivery is demonstrated by fulfillment of seven milestones in Table 1. Survey data also indicate positive ratings on various workshop offerings

(see Tables 3 & 4). In particular, these accomplishments are made during an unprecedented period of COVID-19 in which timely acquisition of equipment and supplies occurred at STEM labs. In Year 2, an M.S. degree program is approved in *Computer Science* one year ahead of the original schedule. Through effective communications with a program officer at Washington, DC, the grant team addressed to the urgent need of establishing laboratory facility for this new program. As President Zelezny (2022) highlighted,

> The goal [of PPOHA project] is to enhance and create additional capacity by increasing enrollment, providing needed student support, improving research facilities, and engaging faculty to better serve Hispanic/Latinx graduate students through degree completion. But the real mission is simple: To encourage more of our students to pursue graduate education. (p. 3)

CSUB has attached great importance to this mission statement. As a result, the local capacity building and service delivery are closely aligned with a logic model of the grant to strengthen STEM education quality for graduate students, particularly these coming from Latino background with low socioeconomic status.

II. Tracking of Student Progress in STEM Program Pipelines

In formative evaluation, tracking student progress is intended to sustain program improvement. Between student admission and program completion, a mechanism of data collection has been introduced to monitor student growth toward attainment of two grant objectives:

1. By September 2024, there will be a 20% increase in the number of Hispanics and other underrepresented students that enroll in CSUB's STEM related graduate programs.
2. By September 2024, the number of graduate degrees awarded annually to Hispanics and

other underrepresented minorities will double from the current baseline.

Depending on the program setting, it may take 2-3 years for the first two cohorts of students to reach the destination of graduation within the period of grant funding. Therefore, assessing the *rate of progress* is important in the process of degree completion. It is also critical to quality assurance of program operation for attainment of the first two objectives by the remaining students in the program pipeline.

In addition, the third objective of the original proposal is stated as:

By September 2024, the completion rate in STEM related graduate courses for all STEM graduate students (with Hispanics equitably represented) will increase by 20%.

Despite the need of tracking the completion rate, "nearly all measures of enrollment patterns are handicapped by untested assumptions about a more fundamental measure, namely students' rate of progress" (Bahr, 2009, p. 691). Hence, adequate attention must be devoted to monitoring the *rate of progress* (ROP) to fill the crucial void of research literature. In *Year 1 Evaluation Report* (Wang, 2021), an ROP indicator has been conceptualized to track the pace of student progress. Configuring the trajectory of program completion may help inclusion of more students, including these within the program pipeline, for assessing sustainable impact of PPOHA funding in five years.

Conceptual Framework for ROP Information Gathering

Similar to *freshman, sophomore, junior,* and *senior* steps at the undergraduate level, graduate students have three status standings, *GRA1 Conditionally Classified, GRA2 Fully Classified,* and *GRA3 Graduate Candidates*, in STEM programs. To date, no one has constructed the ROP index for local students before. Beyond CSUB, Bahr (2009) acknowledged that "Students' rate of progress is a fundamental concept in educational research, ... Only

recently has the literature begun to hint at its import" (p. 710).

Due to the exploratory nature, a *participatory, utilization-focused*, and *program theory-driven* approach has been adopted to support the index tracking. The *participatory* consideration hinges on involvement of key stakeholders to strengthen understanding of program features (Guijt, 2014). While the status of GRA1, GRA2, and GRA3 has been documented in the PeopleSoft system, a Co-Director of the PPOHA project clarified,

> many graduate programs were not using these in the same way ... One option would be to use one or only a few programs (biology and geology are the most likely) that have data and this could form an initial example of how we intend to track progress once we get the data for other programs cleaned.[8]

It is the *participatory* approach that ensures incorporation of perspectives from key stakeholders to enhance accuracy of the data tracking, and thus, facilitate meaningful interpretation of the evaluation outcomes.

The *utilization-focused* evaluation is built on identification of the intended users to ensure usefulness of the procedures and findings for informing program improvement (Patton, 2008). To faciitate the information unilization, a Co-Director of the PPOHA project offered clarification on data structure:

> Each line is a different student and the document has their admit term, the date they advanced to GRA2 (only for students admitted at GRA1 classification), the date they advanced to graduate candidate status (GRA3), and the term of their graduation. Students in blue that have "blanks" instead of dates have not yet been advanced to those classifications.

[8] Email of Professor Anna Jacobsen on 10/14/2021

> Using this data should also be valuable in determining how to calculate progress and a plan for what data would be valuable for analyses in other programs in future years.[9]

Feasibility of the ROP tracking also hinges on a *program theory-driven* approach to link the evaluation mechanism to institutional expectations (Donaldson, 2007). In particular, a Co-Director cited information from the program catalog to support interpretation of 344 days as an average period of student progress in a program pipeline:

> The GRA3 to graduation date information is great! (344!). That is definitely meeting program expectations and is great news. Not sure about what you are thinking regarding documenting of this as an expectation. For biology, we have this included in our catalog copy… "Acceptance as a candidate indicates that the student has completed at least 16 semester units within their approved Plan of Study and that there is a reasonable expectation that the student will complete all remaining requirements within one year."[10]

In this report, the combination of *participatory, utilization-focused,* and *program theory-driven* approaches forms a conceptual framework to guide collection of program data for the ROP index configuration.

Empirical Findings from the ROP Index Tracking

In AY 2020-2021, empirical data are gathered from 57 biology students across GRA1, GRA2, and GRA3 stages of the program pipeline (Table 5). For students admitted at GRA1, it is stipulated in the university catalog that "The transition to Classified Status must be accomplished within one semester after acceptance as a Conditionally Classified Graduate Student. Students that do not meet this requirement will not be permitted to remain enrolled in the program."[11]

[9] Email of Professor Anna Jacobsen on 10/21/2021
[10] Email of Professor Anna Jacobsen on 10/22/2021
[11] https://www.csub.edu/catalog/2021-2022-biology-graduate-program

Thus, these students are expected to advance to GRA2 in the second semester and apply for GRA3 entry in the third semester. Under this arrangement, students in the program pipeline progress to GRA3 in one year, regardless of their admission status at GRA1 or GRA2. Based on the program setting, two important timelines are identified as expectations for all students:

- Period 1 from the active date of program admission to GRA3 lasts one year;
- Period 2 from GRA3 to graduation lasts another year. (Ibid. 8)

Tracking student progress also fits a common goal of Titles III, V, and VII grants on strengthening *persistence* of low-income and minority students in higher education (U.S. Department of Education, 2020). As Bahr (2009) observed, "If persistence and rate of progress are correlated positively, the explanatory value of persistence increases" (p. 694). This anticipated connection has made the *rate of progress* a more preferred indicator than the *course completion patterns* in formative assessment. Accordingly, the *rate of progress* for each student is defined as

$$rate\ of\ progress = \frac{Expected\ Time\ Period_{ps}}{Actual\ Time\ Period_{ips}}$$

where subscripts are designated with i for individuals, p for programs (e.g., Math, Science, Engineering), and s for transition periods.

The *actual time period* in the denominator can be averaged at the program level to represent the overall pace of student progress. Delimiting the pilot data in biology, the *expected time period* in the numerator has been set as one year (or 365 days) for period 1 or 2 (Ibid. 11). When the ROP ratio is strictly larger than 1, it indicates a faster rate of progress across the program pipeline. If the ROP ratio is strictly less than 1, students have taken longer than the expected time to complete each stage, which corresponds to a slower pace of progress.

The ROP computing conforms to professional practice in program evaluation. For

instance, Millett and Nettles (2009) testified that "We constructed our rate of progress measure by grouping individuals by their fields of study and reported stages of progress" (p. 68). They also defined ROP as a ratio of dividing a field- and stage-specific median value by the time each individual reported being in the program (see Millett & Nettles, 2009). Based on the *program theory-driven* approach, the benchmark has been improved from a *median value* in Millett and Nettles' (2009) approach – The use of the *expected time period* in the program catalog (Ibid. 11) in this report has avoided empirical result variation from the *median value* configuration.

Table 5: Rate of Progress for Graduate Students in the Biology Program Pipeline

Period	Pipeline Stage	N	Average Number of Days	Rate of Progress
1	GRA1 → GRA3	18	427	0.85
	GRA2 → GRA3	12	331	1.10
2	GRA3 → Graduation	27	344	1.06

Results in Table 5 indicated that the majority of graduate students (i.e., N=39 in last two rows) progressed ahead of schedule in pipelines *GRA2→GRA3* and *GRA3→Graduation*. The pipeline of *GRA3→Graduation* represents a common pathway, regardless of student entry status at GRA1 or GRA2. Despite the lower rate of progress during *GRA1→GRA3* (i.e., ROP=0.85 in the first row) in Period 1, the subsequent ROP value for Period 2 is still larger than 1 to suggest acceleration of student advancement toward graduation.

In summary, it was indicated in the original grant proposal that "Data about graduate students is inadequate. Graduate students are not tracked at all and there is no system in place to collect and analyze graduate student data" (p. 16). That issue has been fixed with the PPOHA grant funding. The use of catalog information has effectively supported the *program theory-driven* approach that can be adapted to various program structures. Unlike the two-year program in biology, other graduate programs (e.g., psychology) may last three years. The *participatory* consideration of program features also supports *utilization* of the formative evaluation for

program improvement. Altogether, the indicator monitoring has benefited from the collective merit of *participatory, utilization-focused*, and *program theory-driven* approaches to assessing the student progress toward degree completion. In terms of the broad impact, the ROP tracking in Table 5 not only confirms satisfactory progress of most biology students across the program pipelines, but also establishes an effective mechanism for expanding the index tracking in other STEM programs next year.

III. Summary of Impact Stories from Faculty Reports

In the last annual report (Wang, 2011), a model of *Context, Input, Process*, and *Product* (CIPP) was employed to enhance coherence of program evaluation. It was echoed by Finbarr Sloane (2008), a director of NSF, that "We change the basic research question from *what works* to *what works for whom* and *in what contexts*" (p. 43). In this section, impact stories are gathered from faculty annual reports to elaborate outcomes of program offering under the CIPP paradigm.

Enhancement of Program Effectiveness in Year 2 Operation

With federal resource *input* from PPOHA, positive changes in the CSUB *context* are indicated by the attainment of project milestones in Section I. The ROP index has been tracked in Section II across GRA1, GRA2, and GRA3 toward program completion to reconfirm satisfactory student *progress* in Year 2. Because student learning is inseparable from faculty commitment to quality *teaching, research*, and *mentorship*, impact stories are examined in this section to illustrate the *products* of PPOHA grant investment.

In assessing the program effectiveness, a nursing professor reported that "We elected to do more academically, [the PPOHA grant] also propelled us out of our norm within our culture and be successful." More specifically, the program support has expanded her horizon beyond regular teaching on three fronts:

- Enhance research culture mindsets for mentees in regular communications;
- Share practical experiences of nursing and healthcare with other colleagues beyond the department boundary;
- Increase research vitality to support student research competitions and the Grad Slam activities.

The enhancement of research culture was resonated by a biology professor. She testified, "The title VB faculty fellows have been dedicated to principles of graduate culture throughout the whole year." She also indicated creative ways to engage students in the STEM learning process, including regular online meetings, in-person lab activities, and equipment maintenance during COVID-19. Across the school, the program supported faculty partnerships to expand opportunities for inter-disciplinary research, which also facilitated growth of junior faculty in STEM education.

Another biology professor offered a contrast against his regular performance – "I have always had lab meetings with my students, but [without the grant support] never this regularly, and I never discussed additional topics (outside of research) with them." With support from the PPOHA program, he figured out more topics that were important for students to learn, and thus, strengthened the mentor-mentee relationship along with student progress.

The student-centered practice was also reflected in responses of a geology professor. He worked with graduate students to digest relevant scientific papers, review proposed research, and discuss preliminary results. The following benefits have been elaborated by him on student mentorship:

> This program helped to improve my graduate student mentoring in that it required regularly scheduled meetings and documentation of meeting activities. These regular meetings proved to be beneficial in helping me keep track of the progress made by the students as well as helping to elucidate the areas where I could provide useful feedback

and guidance on their research activities.

A psychology professor further reported his success of collaborating with mentees to make a research presentation at the 2021 American Psychological Association Convention. The enhancement of scholarly creativity was inseparable from program support – "The program provided structure and financial resources for the student to conduct this research. … The program has also provided exposure to different types of research which allows for more creativity in the research process."

In summary, the *product* component of CIPP is delineated by in-depth account of STEM faculty in lab enhancement, scholarly inquiry, partnership development, and horizon expansion across *teaching*, *research*, and *mentorship* domains. The description of PPOHA grant support also reflects enrichment of learning opportunities for students, as well as strengthening the GSG culture establishment in the campus community.

Information Extraction from Text Analytics

The quotes from these authentic stories, albeit their linkage to the tradition of qualitative investigation (see Tie, Birks, & Francis, 2019), are inevitably delimited to inductive reasoning. To achieve a goal of result summary, natural language processing (NLP) is applied in this section to transform unstructured text into normalized data suitable for analysis by machine learning algorithms. To reduce sparsity of the term matrix, keywords are stemmed by NLP for all figures. The method is preferable because "Today's natural language processing systems can analyze unlimited amounts of text-based data without fatigue and in a consistent, unbiased manner."[12]

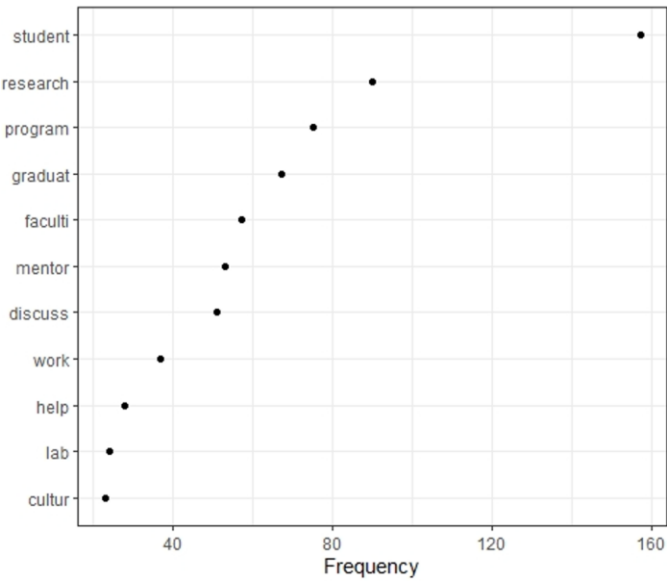
The NLP-based information synthesis is spearheaded by an R package, Quantitative Analysis of Text Data (quanteda). According to Benoit et al. (2018),

[12] https://www.linguamatics.com/what-text-mining-text-analytics-and-natural-language-processing

> quanteda is an R package providing a comprehensive workflow and toolkit for natural language processing tasks ... Using C++ and multithreading extensively, quanteda is also considerably faster and more efficient than other R and Python packages in processing large textual data. (p. 774)

In the past five years, the R package application has been widely adopted in large-scale assessment projects of the federal government (Caro & Biecek, 2017; Matta, Rutkowski, Rutkowski, & Liaw, 2018). In preparing this report, R scripts are developed to highlight overall features of the impact stories through text analytics.

Figure 1: Frequently-Used Keywords in Impact Stories



After NLP's tokenization, stopping-word/punctuation cleaning, and dictionary stemming (see Sarkar, 2019), the most frequently-used words are plotted in Figure 1 to show the story focus on student preparation. Across the impact stories, "student" was repeated almost 160 times. Other keywords are stemmed in Figure 1 to reflect features of STEM learning, such as *faculty mentorship/discussion*, *program help*, *lab work*, and *graduate research culture*.

Beyond identification of the top-impact expressions, a word cloud plot is constructed in

Figure 2 to include other terms from the impact stories. The plot shows keywords, such as "student", "graduate program", and "mentor[ing]", at the center with relatively larger fonts, which confirms the term highlight in Figure 1. The font size difference also sharpens the story focus on PPOHA grant support in STEM education for graduate students at CSUB.

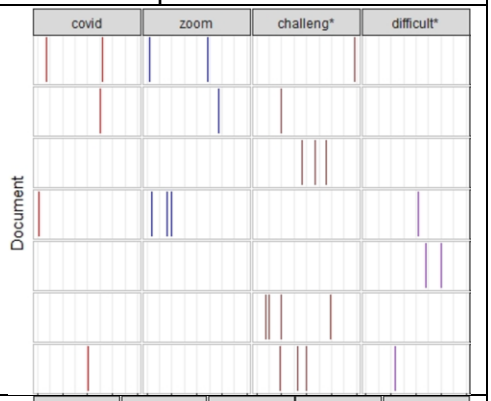
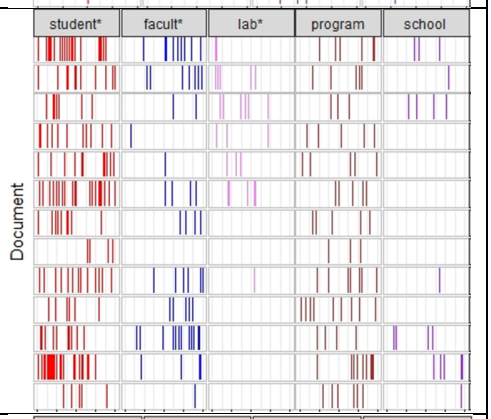
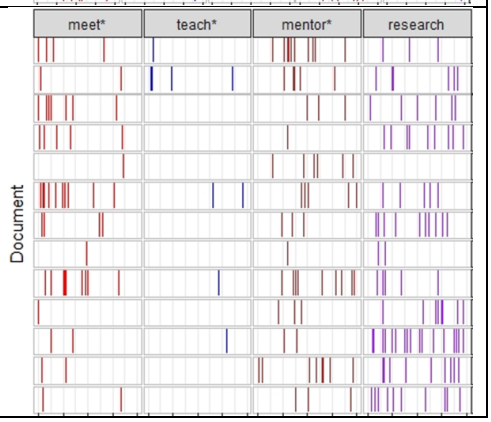
Figure 2: Word Cloud Plot of Stemmed Keywords

Figure 3: Appearance of Positive Words in Impact Stories

Variation of the story features is reflected by a lexical dispersion plot in Figure 3. With

no exception, positive words, such as *good*, *great*, *successful*, *helpful*, *supportive*, and *enjoying*, are stemmed from the text extraction. In particular, "help*" and "support*" are functioning terms that appear more often than "good", "great", "success*", and "enjoy*" for feeling description. Thus, these stories demonstrate more emphases on grant activities than sentiment expressions.

Figure 4: Extraction of Story Keywords from the CIPP Perspective

Perspective	Lexical Dispersion Plot
Project Context	
Input Unit	
Service Process	

It should be noted that the impact stories as a **product** were derived from a difficult period of COVID-19 when most STEM faculty were challenged in a new territory of zoom instruction. Perspectives from this **context** were indicated by keywords, "covid", "zoom", "challeng*", and "difficult*", in Figure 4. In addition, the story **input** were beared on stemmed terms of "student*", "facult*", "lab*", "program", and "school", the core entities of higher education. Figure 4 also contained a lexical dispersion plot of story keywords from the perspective of service **process**. Apparently, specialized terms of "research" and "mentor[ing]" are more frequently cited in the impact stories than general terms of "meet[ing]" and "teach[ing]". At a teaching-focused institution like CSUB, the PPOHA impact stories seem to have promoted the merit of STEM inquiry capacity in research and mentorship for student professional growth.

In summary, the text data aggregation reveals positive contributions of the PPOHA grant across the components of CIPP model. While Figure 3 indicates sustainable *products* from the impact stories, plots in Figure 4 shed more light on the *context*, *input*, and *process* components to continue the improvement. R scripts are provided in Appendix 1 to facilitate the result replication.

IV. Network of Faculty Support in CSUB Capacity Building

Besides the three objectives addressed in last section, the fourth objective of the PPOHA grant proposal is on partnership building. One of the Project Co-Directors testified,

> Faculty-to-faculty mentoring and connections are really important, … our Title Vb fellows are working together (which is great) and it also shows that the "reach" that we have through the grant extends to a much broader network of faculty on campus.[13]

[13] Email of Professor Anna Jacobsen on 9/23/2021

Following an axiom that the whole could be larger than the sum of its parts, the PPOHA grant has supported creation of *accessible, integrated,* and *wrap-around* services for the GSG culture development. As a result, the Graduate Research Center has been elevated as a hub for collaborative research, and "Faculty and students will be encouraged and supported to develop learning/research projects with community involvement in all phases."[14] In particular, STEM faculty are coordinated to develop common core learning outcomes for the graduate grogram (Ibid. 13). As a direct outcome of the institutional capacity building, faculty networks have been expanded to strengthen the collaboration of research and teaching since the beginning of grant funding. The partnership development is also aligned with Goal 2 of the grant proposal because "Nearly all faculty teach both graduate and undergraduate programs".[15]

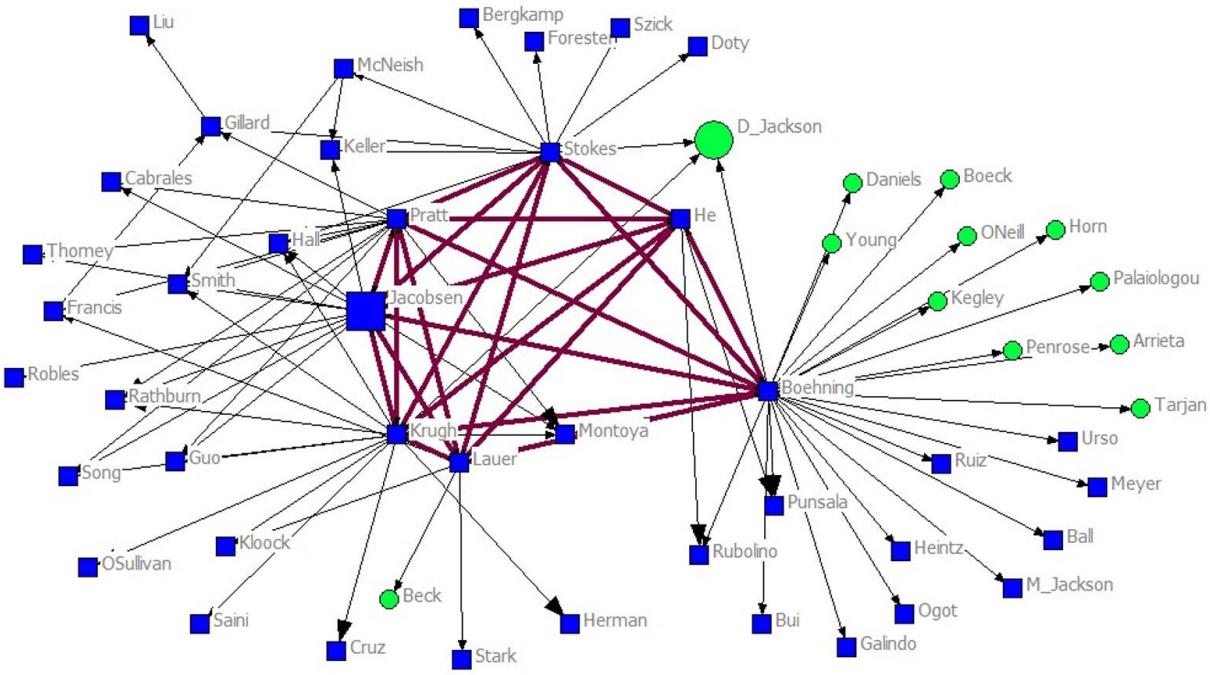
Built on the *participatory* principle for formative evaluation (Guijt, 2014), the evaluator cooperated with a Co-Director of the PPOHA project to develop a Faculty Collaboration Survey (Appendix 2). An initial version of the instrument was delimited to faculty partnerships in *teaching* and *research*. In consideration of the network impact on student progress, the Co-Director added another important domain on student *mentorship* to expand the information gathering. In Fall 2021, the partnership data were collected from 11 STEM faculty members who reported 118 partnership connections with 50 other colleagues, 12 in non-STEM departments and 38 in STEM departments.

On average, each respondent identified 2.31 partnership connections in *teaching, research,* and *mentorship*. In Year 2 of the grant operation, the network emerged in two clusters. The structure for one cluster is grounded on the partnership data from 10 respondents with 112 links (Figure 5). STEM and non-STEM faculty members are differentiated by blue and green

[14] Page 18 of the grant proposal
[15] Page 10 of the PPOHA grant proposal

nodes, respectively. Professional leadership in the partnership building is illustrated by larger nodes for more connections to both Co-Directors of the projects (see "Jacobsen" and "D_Jackson" in Figure 5). The network is also well-established with only 16 nodes as "leaf nodes" for no further connections. The rest 35 faculty members are displayed as the majority of the nodes with multiple connections in the network.

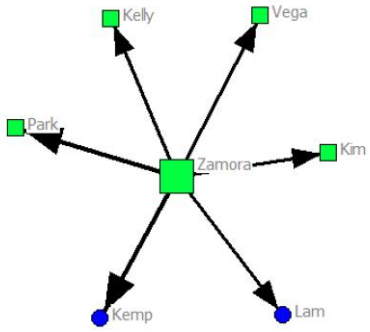
Figure 5: Network Structure for Cluster 1



Reciprocal links are indicated by brown color to highlight the mutual connections that are confirmed by both partners. Because "reciprocation rate is inversely related to the barrier level" (Singhal, Subbian, Srivastava, Kolda, & Pinar, 2013, p. 1), extensive mutual links in Figure 5 show less network barrier among STEM faculty members.

The network structure for Cluster 2 is based on survey responses from a faculty member in psychology who identified six partners (Figure 6), two in mathematics (see blue nodes) and four in psychology (see green nodes). However, none of the nodes are connected to a broad network in Figure 5.

Figure 6: Network Structure for Cluster 2



Through the *participatory* approach, the network findings have been reviewed by Co-Directors of the PPOHA project. One of them responded, "The disconnection of Rich [Zamora in Figure 6] is likely due to him being the only representative (so far) from a program within SSE [School of Social Sciences and Education]. All of the other participants are in NSME [School of Natural Sciences, Mathematics, and Engineering] and the network for that school is therefore more developed."[16] The developing feature is also illustrated by no reciprocal links in Figure 6, despite its inclusion of STEM professors in mathematics.

Thickness of the connection lines is used to differentiate partnerships in *teaching*, *research*, and *mentorship* domains. In Figure 5, all links to non-STEM faculty are confined in a single domain with the same thickness while some STEM faculty demonstrated stronger links with thicker lines. In contrast, the line thickness in Figure 6 is not strictly divided by the color of departments. In part, the pattern seems to reflect the fact that the GSC support platform for partnership building serves the entire campus community, regardless of the faculty department affiliation.

To quantify the network development, Laramore (2020) recommended *network density* as a summary index to measure node connectivity. By definition, network density is configured as

[16] Email of Professor Anna Jacobsen on 9/23/2021

a ratio between the number of links and the maximum number of possible links. The density for Cluster 2 is 0.143, larger than 0.046 for Cluster 1. These small values suggest great potential for PPOHA faculty to expand their possible connections. Usefulness of the network analyses is targeted by the spirit of *utilization-focused* approach to inform project improvement with well-rounded evaluation findings.

Conclusion

Both quantitative and qualitative methods have been adopted in this report to support accountability justification and program improvement. Results in Section I are aligned with the milestone fulfillment for Year 2 operation. Examination of the outcome-based accountability is further expanded in Sections II to monitor student progress across multiple stages of the program pipeline. As a result, the investigation is not confined on *how much* has been done in Tables 1 and 2, but also extended to *how well* the PPOHA project performed in workshop offering (see Tables 3 & 4) and student tracking (Table 5). In addition, impact stories are summarized in Section III to provide in-depth description of profound outcomes from faculty reports. The qualitative inquiry is augmented by text analytics to portray an overall picture from the information extraction (Figures 1-4). Social network analyses are conducted to investigate the strength and pattern of faculty partnership development in response to the STEM teaching, research, and mentorship demands (Figures 5 & 6). Triangulation of the evaluation findings consistently indicates satisfactory performance of the PPOHA grant operation toward achieving its dual goals, (1) enhance and create additional capacity for the CSUB STEM graduate programs, and (2) develop a university-wide culture to encourage, support, engage, and prepare students for graduate education.

While this annual report is composed under a clear time constraint to cover grant

activities within 12 months, Year 2 operations are naturally connected to the ongoing progress across the adjacent years. As Tom Angelo (1999), former director of the National Assessment Forum, asserted, "Though accountability matters, learning still matters most" (¶. 1). The momentum of continuous improvement started with the first annual evaluation report (Wang, 2021) that included three recommendations:

- Expand video presentations in the GSC workshops.
- Switch the focus of *high school student outreach* to innovative graduate student supports that meet the PPOHA funding requirements.
- Study effective measures of GI 2025 and borrow tools, ideas, and resources to help achieve its designated goals of expanding and strengthening STEM graduate programs at CSUB.

All recommendations have been adopted by the PPOHA team in Year 2. More specifically, workshops are recorded and links are posted on the GSC website.[17] Meanwhile, the focus of grant activities has been switched from high school student outreach to innovative graduate student supports, such as the offering of Grad Slam and implementation of *Graduate Student-faculty Collaborative Research Program*,[18] to expand learning opportunities in STEM inquiry.

In reference to Graduate Initiative 2025 (GI 2025), CSUB completed a team project, *Student Success Summit: Closing the Equity Gaps*, in Academic Year 2020-2021.[19] In a similar undertaking, the CSUB PPOHA team held 10 meetings to accommodate *Graduate Studies Summit* (GSS), including five GSS committee meetings, three GSS production team meetings,

[17] https://www.csub.edu/graduatestudentcenter/events-workshops
[18] file:///C:/Users/jwang/AppData/Local/Temp/Spring%202021%20Newsletter_0.pdf
[19] "GI 2025 Update re: AY 2020-21", CSUB campus-wide email distribution on 2/3/2022

one GSS planning meeting, and one meeting for student recruitment. Thus, the project has borrowed effective measures of GI 2025 to strengthen student engagement this year.

As the PPOHA project enters its third year of operation, CSUB President announced that "Latinx students are making their mark at CSU Bakersfield, … CSU Bakersfield has access to essential support that is delivered via a number of programs tailored to the unique, nuanced experiences of our Latinx students" (Zelezny, 2022, p. 3). To monitor the support for student progress toward STEM program completion, an indicator on the *Rate of Progress* has been conceptualized in Year 1 report (Wang, 2021) and piloted successfully for Biology students this year (see Table 5). **The first recommendation is for the PPOHA project to expand the mechanism of progress tracking to more STEM programs**. Fulfillment of this recommendation is not confined with a simple replication of the existing practice in Biology. On the contrary, creative explorations are needed in the data monitoring to match programs of graduate studies with different time expectations for degree completion.

President Zelezny's (2022) afore-quoted announcement referred to campus-wide support for Latinx students. Besides the PPOHA grant under Title Vb, a new federal grant has been awarded to CSUB under Title III for Hispanic and low-income students to pursue a STEM degree.[20] The grant funds various workshops, dual admissions, network engagements, program success conferences, and STEM internships to develop equitable on-ramps to STEM pathways. Accordingly, **the second recommendation is on enhancement of the program collaboration between this PPOHA project and the Title III grant to support development of STEM careers for Latinx students**. Merit of the partnership creation has been well-recognized by agencies of the federal government.[21]

[20] https://www2.ed.gov/programs/hsistem/2021hsistemfundedabstracts508compliant.pdf
[21] https://www.govinfo.gov/content/pkg/CHRG-110hhrg35464/html/CHRG-110hhrg35464.htm

Equally important, both projects require a strong evaluation component. Hence, data collection techniques play an important role in addressing the result-based accountability. Based on the PPOHA project practice in Year 2, survey data are gathered on two platforms, *Qualtrics* and *SurveyMonkey*, with different indicators for result reporting. Consequently, Tables 3 and 4 show separate outcome configurations, one on *usefulness* and the other on *promoter* status. **The third recommendation is for the PPOHA project to choose a common data collection platform for the overall result aggregation**. The aggregation needs have been demonstrated by Year 2 data with a response count of 5 or less for five workshops (see Table 3 & 4).

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Appendix 1:

R Scripts for Information Extraction

```
install.packages(c("ggplot2", "quanteda"))
library(readtext)
Vb <- readtext("D:/USB DISK/Debra&Ann/Text/*",
               docvarsfrom = "filenames")
library(quanteda)
library(ggplot2)
ggplot(Vb,aes(length1, fill=doc_id))+theme_bw()+geom_histogram(binwidth=20) +
labs(y="text count", x="length", title="Distribution of Text Lengths with Program Stories")
Vbt<-tokens(corpus(Vb), what="word", remove_numbers=T, remove_punct=T,
remove_symbols=T, split_hyphens=T)
Vbt<-tokens_tolower(Vbt)
Vbt <- tokens_select(Vbt, pattern = stopwords('en'), selection = 'remove')
Vbt <- tokens_wordstem(Vbt)
install.packages("quanteda.textplots")
library(quanteda.textplots)
#What works for whom in which context
library(ggplot2)
theme_set(theme_bw())
tplot <- textplot_xray(kwic(Vbt, pattern=c("good", "great", "success*", "help*", "support*",
"enjoy*")))
tplot + aes(color = keyword) + scale_color_manual (values = c("red", "blue", "violet", "brown",
"purple", "black")) + theme(legend.position = "none")
library(ggplot2)
theme_set(theme_bw())
tplot <- textplot_xray(kwic(Vbt, pattern=c("meet*", "teach*", "mentor*", "research")))
tplot + aes(color = keyword) + scale_color_manual (values = c("red", "blue", "brown",
"purple")) + theme(legend.position = "none")
library(ggplot2)
theme_set(theme_bw())
tplot <- textplot_xray(kwic(Vbt, pattern=c("mentee*", "student*", "graduate", "facult*", "lab*",
"program", "department", "school")))
tplot + aes(color = keyword) + scale_color_manual (values = c("red", "blue", "violet", "brown",
"purple","green","black", "yellow")) + theme(legend.position = "none")
library(ggplot2)
theme_set(theme_bw())
tplot <- textplot_xray(kwic(Vbt, pattern=c("covid", "pandemic", "zoom", "challeng*",
"difficult*", "distance")))
tplot + aes(color = keyword) + scale_color_manual (values = c("red", "blue", "brown", "purple",
"black")) + theme(legend.position = "none")
textplot_wordcloud(Vbdfm, color=c("blue","purple", "brown", "red", "green"))
```

Appendix 2:

Faculty Collaboration Survey

Name _____ Department _____

1. **Collaboration within your department.** Please indicate whether collaborated with your departmental colleagues in teaching, research, or mentoring during Academic Year 2020-2021.

- Mark **X** in the teaching and research columns if you had the collaboration
- Mark **X*** if the collaboration was related to Title Vb activities
- Otherwise, leave it blank

Faculty Name	**Teaching**	**Research**	**Mentoring**

[the first column list faculty names within the same department with whom you have collaborated; add additional rows as necessary]

2. **Collaboration across STEM-associated departments**. Please indicate whether collaborated with colleagues from STEM-associated departments other than your own in teaching, research, or mentoring during Academic Year 2020-2021.

- Mark X in the teaching and research columns if you had the collaboration
- Mark X* if the collaboration was related to Title Vb activities
- Otherwise, leave it blank

Faculty Name	**Teaching**	**Research**	**Mentoring**

Thank you!