SECTION V. SABBATICAL LEAVE APPLICATION

Kitran Colwell

Name (Open Print Preview to have your name populate throughout the form)

1/18/23

Date

Diablo Valley College, Pleasant Hill Campus

College

Fall 2023

Sabbatical leave period requested

Physics

Teaching field(s)

7

Years of service in CCCCD

Have you had previous Sabbaticals? If "yes" give time period(s) and activity (activities).

No

Indicate type of Sabbatical program (see United Faculty Agreement, Section 12.5.6) If program can be categorized by more than one type, check where applicable.

☐ Institutional study (complete Form A)
☐ Travel (complete Form B
☒ Professional Study and/or Creative Study (complete Form C)

GENERAL SUMMARY OF SABBATICAL PROGRAM

(GIVE A 100-WORD MAXIMUM STATEMENT)

Many students in STEM classes who make heavy use of higher mathematics (such as physics, chemistry, and engineering) have historically had difficulties in applying the topics presented in their mathematics courses to the contextualized environments of science. The causes are varied: the sheer breadth of material covered in MATH courses, the emphasis on practical skillbuilding over applications due to time constraints, the relative ineffectiveness of online learning for many high school students during the pandemic, differences in notation and "style" for how the mathematics is presented, etc.

This project will create an extensive set of resources to be deployed in physics classes for instructors to diagnose deficiencies in math skillsets, remediate those skills, and provide appropriately contextualized examples of those mathematical tools used in physics. These resources are intended ot be used in the physics for scientists and engineers sequence: PHYS-129, PHYS-130, PHYS-230, and PHYS-231.

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VALUE TO EDUCATIONAL PROGRAM

(The Sabbatical Leave Committee will utilize this information as the basis for scoring Rubrics 1, 2, 3 and 4)

Describe how the proposed sabbatical will benefit the educational program. In particular:

1. *How will it benefit students, programs, or staff/colleagues?*

DVC students who take our PHYS129/130/230/231 classes (hosting about 900 students in the 2022 calendar year, serving as prerequisites for 5 other major non-PHYS courses and 12 degrees/certificates, so this is a cohort of central importance) are generally planning to transfer to a university to persue a degree in physical science or engineering. Experts in these fields typically require nearly effortless familiarity with mathematical techniques, but students often only have a procedural knowledge of the mathematics they've obtained from their MATH courses, and any missing or underdeveloped skills are hard to regain, since most students have already passed the course in question and cannot repeat it. An opportunity to practice remedial mathematics skillsets outside of the MATH classroom (but not at the expense of the introduction and discussion of physics principles) will much better prepare them for practical applications they will need to understand.

In the Fall 2022 semester, I met with five instructors in the mathematics department to gain a general impression of how their students were performing, particularly regarding the skillsets most desired in physics classes. Their responses universally expressed concern and disappointment that additional time could not be given to more practical applications. Part of this is the enormous scope of most MATH class curricula, and part is the continual remediation that many students required for topics from prerequisite classes (an ever-present continuing feature, evidenced by low performance for 4th and 8th graders on NAEP national levels and mountains of anecdotal data). This project may help to reduce this pedagogical load on the MATH department, provide students with a greater realization of the interconnectedness in these topics across STEM curricula, and assist our own program in maintaining standards of mathematical rigor and difficulty across our courses.

Additionally, these resources will allow our instructors to measure and improve students' mathematical understanding with very little additional overhead in time or effort, helping to maintain department academic standards. Easy-to-administer diagnostic quizzes will allow instructors to quickly note who needs practice in which mathematical areas; an easy-to-import Canvas shell can be assigned to these students with additional quizzes to test for mastery. Both perfunctory drills and contextualized problems will be used to link the standard presentation in a mathematics class with how these tools are used in a physics class. This should help instructors accommodate a larger range of existing mathematical abilities in a fairly standardized and easy-to-implement way.

There is also potential for synthesis with similar (but not quite the same) efforts in STEM departments: Ellen Beaulieu of Chemistry has constructed two INTD courses (080/081NC) designed for algebra skill review for STEM courses. While her focus is on contextualization in the field of chemistry, and only at the algebra (non-trigonometry) level, this sabbatical could expand on those ideas and present curriculum for a physics-focused version of the course. Lindsey Lang of Mathematics is producing a math review course (MATH003NC) to be entirely online via Canvas and Knewton Alta (an activity-based learning platform) for math remediation. This model (a Canvas shell plugin that is easily adopted) provided some inspiration for one of the objectives of this sabbatical project. The ability of this project to be extended and shared in future collaborations, courses, or sabbatical projects is an attractive feature.

2. *How will it enhance and/or improve your background and professional competence?*

Though my PhD is in Physics, I did have a double major with mathematics as an undergraduate, and spent six years working as a tutor in physics and math. This has given me a broader perspective on how students interact with mathematics both in and outside their classrooms. This project will expand on that perspective by including the common practices of DVC's Mathematics department and requiring me to develop fairly unique contextualized physics problems that stress or require very particular sets of mathematical tools. This should improve my ability to recognize common patterns of mistakes students make in mathematics applied to physics problems, and prepare me (and the subdepartment) with a more precise corrective tool for those patterns. Being able to identify student weaknesses early on with diagnostic quizzes will enable more effective teaching with greater efficiency in how classtime is spent.

3. *How will it relate to your ongoing professional assignment?*

These resources (Introductory Canvas modules, perfunctory and contextualized worksheets, and diagnostic and summative quizzes) will be used by all of my students in the physics for engineers sequence. The project will also strengthen our subdepartment ties with mathematics faculty (many of them are interested in seeing the final project when completed, and may use some of the resources in their own classes), and guide future curricular discussions in our department/division and the mathematics department (I currently serve as the Curriculum Committee representative for the Physical Sciences division, and so am aware of places we might work together). I hope that it also makes me a better personal resource for newly hired faculty in our subdepartment, who often need pointers on what the expected levels of mathematical difficulty in their courses should be. I'd like to be able to give better advice on that topic after this project is complete.

4. *How are the breadth and depth of the project appropriate for the sabbatical leave rather than the regular teaching year?*

The creation of these resources will require time and effort that would conflict with a full teaching load. Despite hearing anecdotal stories from physics faculty for years lamenting students' mathematical skills, a full investigation and production of teaching, practice, and assessment curricula to mitigate these concerns would simply take too much to complete during (or even before) a standard semester's worth of classes.

Informal interviews with the mathematics department faculty have already taken nearly ten hours to complete (these are obviously not included in the sabbatical effort computation), and this was only to get a rough baseline for perceived student abilities. Development and implementation of the necessary course and "Canvas plugin" materials will take substantially longer.

The project proposal consists of 16 "Modules" (designed to be roughly once-a-week inclusions for a course, though instructors may opt to select only specific content) covering the necessary skillsets from Pre-Algebra through Beginning Calculus. Each module will consist of 5 documents (a diagnostic quiz, an introduction/review, two worksheets, and a summative quiz), with an estimated 380 total pages (or equivalent) produced.

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PROPOSED OBJECTIVES AND EVIDENCE OF COMPLETION

(The Sabbatical Leave Committee will utilize this information as the basis for scoring Rubrics 5 and 6). Note that Rubric 6 regarding the "Proposed Evidence of Completion" is weighted twice that of all other rubrics.

Identify specific objectives and describe in detail the evidence that will accompany your report, which indicates that you have met each objective. The product of your approved sabbatical leave program will be subject to review by the Sabbatical Leave Committee at the time of making your final report. Examples follow:

Institutional study

Objective: *9 units of graduate level history courses as indicated on Form A will be taken at ... University.*

Evidence: *(Here you would describe the transcripts, class notes, exams, class projects, etc., you would submit as evidence of completing these units.)*

Travel

Objective: *Travel to archeological zones in Central America.*

Evidence: *(Here you would describe exactly what you plan to submit to document your sabbatical leave travel. You should specify the kinds of things you will present, like journals, artifacts, and slides, and you should give the committee an idea of the extent of the evidence by specifying the minimum number of slides, pages in a journal, number of museums, etc. If you so state, you must provide tangible evidence in your final sabbatical leave report that you have, in fact, written the minimum number of pages you proposed, visited the minimum number of archaeological zones you proposed, etc.*

Professional study and/or creative study

Objective: *Compose a musical score or write a textbook.*

Evidence: *(Here you would clearly indicate the scope of the project, including the minimum number of pages you plan to write, approximate length, an outline of the contents, description of the complexity, etc.)*

The Committee will rely on the information you provide in the evidence section to determine if you have met the contractual obligation of the leave.

1) Objective: Generate Procedural Worksheets

Evidence: 16 worksheets with "procedural/perfunctory/rote/drill" (I haven't decided on what terminology works best) practice problems.

There will be at least 30 problems per worksheet, divided into 3 10-question difficulty classes (ABC) so that students may find their level of preparedness and instructors can assign sets relative to where the student is in thier PHYS (and MATH) sequence.

Class A problems should be used for students who are struggling to remember basic facts and procedures in the topic, and may need to practice much more introductory material. It is likely that these students are earlier in their PHYS/MATH sequence, but occasionally more experienced students will need these due to the distance in time from when the material was last used/examined. These problems are fairly straightforward and test basic understanding.

Class B problems may involve more than one step and link more than one concept. They may involve more sophistocated or nuanced thinking, or best utilize a lesser-known method for solution. These problems are for students who performed well in these topics (A/B grades), but might just need refreshers due to time.

Class C problems may involve multi-level thinking or the combination of many previous notions. They may examine edge cases in the range of validity of a method or theorem, or clever insight, or require additional analysis. These are meant for students who did very well in their previous courses and have retained most of the knowledge, but might have become complacent, or simply wish to push their limits. These are NOT meant to be incredibly difficult challenge/competition-level problems that very few students could reasonably complete.

Worksheets will be formatted in BOTH Multiple Choice (MC) style (for easy administration/grading, with appropriately curated distractor options) and Free Response (FR) style (for more detailed solution showcasing).

For all problems where the distinction is possible or relevant, BOTH a symbolic version and a numerical version will be developed.

BOTH answer keys (with only "answers" but no solutions) and fully worked solution manuals will be created. These are for the instructor to use and disseminate to students if desired (for use in exam preparation, for example). Worksheets and keys will be distributed in PDF format (the natural output of a LaTeX rendering).

The worksheets will cover the following topics; once the project has begun, it is possible that the ordering or particular divisions might be altered, but the total number of worksheets and problems will be maintained:

i) Arithmetic - How to use a scientific calculator (modes, order of operation, scientific notation), rules of significant digits, valid operations with fractions/roots, real number properties

ii) Word Problems and Problem Solving Strategies - How to identify explicit/implicit given and wanted information, translate into symbolic expressions/variables, use dimensional analysis

iii) Exponents and Radicals - Rules, simplifying, solving equations

iv) Linear Functions - Various forms, graphing, dependent vs. independent variables

v) Polynomial Functions - Division, roots, end behavior, solving, graphing

vi) Rational Functions - Ratios and proportions (unit conversions), percentages, domains, end/asymptotic behavior, solving, graphing

vii) Logarithmic and Exponential Functions - Rules, solving, graphing

viii) Functions in General - domains, roots, end/asymptotic behavior, parameters vs. variables

ix) Systems of Linear Equations - solution techniques (numerical and symbolic)

x) Nonlinear Systems and Inequalities - solution techniques, numbers and types of solutions (solution set/loci)

xi) Geometry - axioms and theorems about parallel lines, angles, circles, polygons (triangles later), area and volume

xii) Trigonometric Functions - identities, rad vs deg, solving, graphing

xiii) Triangles (Right and Oblique) - law of sines/cosines, vector analysis, SOHCAHTOA

xiv) Complex Numbers and Polar Coordinates - rules, main theorems, unit vectors

xv) Differential Calculus - limits and derivatives, optimization, rates

xvi) Integral Calculus - main techniques, use in physics

2) Objective: Generate Contextualized Worksheets

Evidence: 16 additional worksheets with problems from physics that specifically showcase mathematical techniques from that topic in an applied setting, as would be needed in a physics class.

There will be at least 15 problems per worksheet, divided into 3 5-question difficulty groups (as in Objective 1). Both MC and FR formatting, with answer and solution keys, in symbolic and numerical versions will be provided, with the same 16 topics as mentioned in Objective 1.

3) Objective: Generate a Sequence of Canvas Modules

Evidence: 16 Canvas modules that can be imported easily into other instructors' course sites. These will consist of a short (one or two "pages" in Canvas) review of the relevant material with links to resources for greater detail and at least one perfuntory and one contextualized worked example. The worksheets mentioned in Objectives 1 and 2 will be included, as well as the diagnostic and summative quizzes mentioned in Objectives 4 and 5.

4) Objective: Generate Diagnostic Quizzes

Evidence: 16 Canvas quizzes will be generated (to be included in the modules above) with at least 10 questions (MC only) each to assess student competancy with each topic. The difficulties will be varied so that an approximation of how much review is necessary can be made. In light of AB-705, students may not be "placed" into non-transfer math or english classes, and this has had a chilling effect on the use of "placement tests" to determine student abilities in these subjects (the idea being that the students' grades in prerequisite classes should do this). However, the utility of "placement tests" as a diagnostic tool (or even as a means of actually placing students in other fields; I believe the Chemistry department actively employs such a test to determine where in the sequence new students should enroll) is incredibly useful to instructors to gauge student readiness.

5) Objective: Generate Summative Quizzes

Evidence: 16 Canvas quizzes will be generated, much like the diagnostic quizzes, but with the intent to measure student growth in each particular topic after review. These will be of use to the instructor to assess student completion of the material, to the student for a sense of mastery, and to the program as a measure of how effective this project is.

All materials developed will be shared on the Physics Faculty Commons Canvas site for use at the subdepartment faculty's discretion, and shared with any faculty in other departments (mathematics, chemistry, engineering, etc.) who express or have expressed interest. Our program lead has given permission for these resources to be "recommended" or "suggested" officially by the Physics subdepartment.

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INSTITUTIONAL STUDY
Form A

Name of Institution	*Place of Institution*

Period of Attendance	**UNDERGRADUATE LEVEL**	**GRADUATE LEVEL**
	☐ Semester units to be attempted* ☐ Quarter Units to be attempted **(Minimum 12 semester units)* **(Minimum 18 quarter units)* **Neither continuing education units (CEUs) nor courses taken from unaccredited institutions will be considered as Institutional Study. Please see Professional Study Form C.*	☐ Semester units to be attempted* ☐ Quarter units to be attempted **(Minimum 9 semester units)* **(Minimum 13.5 quarter units)* **Neither continuing education units (CEUs) nor courses taken from unaccredited institutions will be considered as Institutional Study. Please see Professional Study Form C.*

Accepted for Admission:

☐ Yes ☐ No ☐ Other

If "Yes," attach evidence of admission.
If "Other," explain:

List courses and unit value from the institution's catalogue. In case your choice of courses is not available, please indicate substitutions. (The Sabbatical Leave Committee will utilize this information as the basis for scoring Rubric 7. Be sure that the scope of your studies is clearly defined.)

** A full load is considered to be 12 semester units of undergraduate work or 18 undergraduate quarter units, or 9 semester units of graduate work or 13.5 quarter units at an accredited college/university.*

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TRAVEL
Form B

Plan: Itinerary *(The Sabbatical Leave Committee will utilize this information as the basis for scoring Rubric 7. Be sure that the purpose, duration, and schedule of your travel are clearly delineated.)*

Place	Duration of Visit	Purpose

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PROFESSIONAL STUDY AND/OR CREATIVE STUDY

Form C

(The Sabbatical Leave Committee will utilize this information as the basis for scoring Rubric 7. Units completed at any unaccredited and/or international institutions will not be considered. Be sure the kind and scope of your study methods, resources, and activities are clearly delineated. Include an estimate of the time that will be spent engaged in various activities.)

(Numbering from Pages V-4 through V-6)

Time Estimates of Objectives:

1) Procedural Worksheets - Initial descisions about specificity of topics to be included should take less than a week. Existing CORs for MATH classes (including math skill review courses like MATH003NC and INTD080/081NC) will be examined for content desired by STEM faculty.

Curation/creation of specific procedural problems of each difficulty level for each topic, with solutions/answers, in both MC and FR format, symbolic and numerical, with metadata (distractor choices, justification for problem, sources) [30x16=480 at least in total] should be completed at a rate of about one worksheet per day, or about 3.5 weeks total (workdays). At about 3 problems/questions per page, this amounts to 160 pages of material. This includes space for student solutions (which is filled in in the solution manuals).

2) Contextualized Worksheets - Though the goal is for fewer of these types of problem (15x16=240), they require considerably more effort to create, as they must be made to be extremely specific in the math skills required. Hence, with the same variability as described above, it will also likely take about one day to create each of the 16 worksheets, for another 3.5 weeks total. Another 80 pages.

3) Canvas Modules - The introductory/review "page(s)" will likely take a couple hours for each of the 16 topics; the assembly of the introduction, worksheets, diagnostic and summative quizzes into each module might take one day total. Thus, this portion of the Canvas Objective should take about one week total to complete. ~32 pages.

4) Diagnostic Quizzes - Typesetting in Canvas is more time-consuming than in LaTeX, so generating these quizzes will take more time than the equivalent writing of worksheet problems. 10 problems each (MC only, with solutions/metadata, varied in difficulty) will again likely take one day per topic, or about 3.5 weeks. If they are exported into a PDF format to be printed, this should be about 54 pages (160 problems).

5) Summative Quizzes - Very similar to the Diagnostic Quizzes in scope and content. About 3.5 weeks, 54 pages (160 problems).

Total estimated time: 16 weeks

Total estimated "pages": 380

DVC
DIABLO VALLEY COLLEGE

Dear Sabbatical Leave Committee Members,

I'm writing this letter in support of Dr. Kit Colwell's proposed Fall 2023 sabbatical project. I have reviewed a draft of the sabbatical leave application and have heard Kit report on his initial discussions with the Math department as he researched his proposal.

Having taught almost exclusively in the calculus-based Physics sequence (129, 130, 230, and 231) at DVC since 2016, I can confirm that math preparation is a common challenge for our students. Students, even at the beginning of this course sequence, have to be able to apply math skills spanning years of math pre-requisites, including Pre-Algebra, Geometry, Algebra, Trigonometry, and Calculus 1. The problem-solving skill and the "feel" for mathematics developed in this chain of pre-requisites are used on a daily basis in our courses. For students that put in the required time and effort, a deficit in math skills is by far the most common cause of a non-passing (C or higher) grade.

Sometimes a deficit in math preparation comes from a simple break in a student's educational timeline (such as for students returning from military service, students taking a break from school to spend time in the workforce, or students taking a break for family obligations). Sometimes it's a result of a student barely passing one or more math courses without actually mastering key math skills that are needed in physics classes.

Regardless of the reason for the deficit, such students have no real recourse or resources to help them move forward. Students have no option to re-take a math course if they have technically passed it. Asking students to self-study from a textbook or youtube videos without any sort of guidance is not a great solution, either. It's also not ideal for each Physics professor to attempt to cook up personalized interventions for several such students on-the-fly during a semester (office hours alone are certainly not sufficient).

I have often wished for a ready-made set of resources to support these students in a robust way. Dr. Colwell describes an extensive set of diagnostic assessments, guided worksheets with detailed solutions available, and summative assessments covering a wide range of math topics/skills that I believe would fill that role. I am eager to have them available for use in my future classes.

-Evan Large
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