FLORIDA POLYTECHNIC UNIVERSITY

Faculty Instruction Projects

Grant Application Cover Page

PROPOSAL TITLE: _
Incorporation of a Virtual Materials Characterization Lab in Enhancing Student Performance in Structure and Property of Materials_____

FACULTY NAME:

NAME: _Dr. Sanna F. Siddiqui_____

EMAIL: _ssiddiqui@floridapoly.edu_____

DEPARTMENT: _Mechanical Engineering_____

ADDITIONAL FACULTY TEAM MEMBERS:

NAME: _Dr. Mary Vollaro_____

EMAIL: _mvollaro@floridapoly.edu_____

DEPARTMENT: _Mechanical Engineering_____

NAME: _____

EMAIL: _____

DEPARTMENT: _____

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In order for the project to be considered for committee review, each section must be completed in its entirety. Any missing or incomplete sections will disqualify the project from consideration for funding.

PROJECT SUMMARY / ABSTRACT: (limited to 300 words)

The proposed study will investigate how the implementation of a virtual materials characterization lab helps in enhancing student performance and success rate in EGN 3365: Structure and Property of Materials course at Florida Polytechnic University. It has been reported in literature that incorporation of a virtual materials characterization lab is beneficial to improving the student success in these courses at large universities. Given that the course is highly conceptual, it is anticipated that development of an interactive virtual lab which places the student in the role of "experimentalist," may help to bridge theory with real-world application enhancing overall student performance in this course at Florida Polytechnic University. Student performance will be evaluated through course assessments. Results will be compared with student performance in earlier semesters, which did not incorporate a virtual lab. Given the outcomes of the proposed research, it is the intent to expand this research into courses taught within the Materials/Advanced Manufacturing ME Concentration.

To achieve the proposed objectives, a manual grinder/polisher system has been requested that will be used to develop videos on metallurgical preparation process for microstructural analysis that will be featured in the virtual lab platform developed. In addition to being used to enhance the educational curriculum in Structure and Property of Materials, this manual polisher/grinder will expand the current research capabilities by supporting the current research equipment (i.e., optical microscope, scanning electron microscope etc.) in the Materials Characterization Laboratory that will be used for development of microstructural analysis videos. Research outcomes are anticipated to be disseminated in a final report/presentation and journal/conference publications.

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RESEARCH/PROJECT PLAN: (Please see attached file)

Submit this document as a separate attachment. This section must describe your project and how it addresses specific instructional or student learning problems.

This document is required to use 1 in margins and be typed in Arial 11-point font or Times New Roman 12-point font. Page numbers must be entered in the footer.

The research/project plan should be a maximum of 6 pages, including any figures, images, and/or tables.

This section must include the following sections:

- Introduction
    - Problem statement or specific research questions
    - What gap(s) is this project intending to address?
    - Description of the research context (type of class / instructional setting)
- Literature review (may be brief, approximately 3-5 sources)
- Methodology
    - What data/information will be gathered?
    - How will this be collected and validated?
    - How will this approach provide reliability?
    - How will the funding/equipment requested support this project?
- Assessment plan
    - What are the learning outcomes associated with this project? How is it related to the gap(s) that are intended to be addressed?
    - What is the desired level of achievement?
    - What is the percentage of students who will benefit from this project?
    - How frequently will assessments be conducted?
    - What methods will be used for assessment
- Timeline for the project (may include milestones or specific tasks associated with the project)
- Broader Impacts: A description of the potential impact of your project on the University community and/or the broader world.
- Works cited/references (This section does not count towards the 6-page maximum.)

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Budget

Complete the relevant budget categories below, including subtotals. Leave the rest blank. If you need to add more lines to a table, tab to add another line.

Budget Overview

Category	Subtotal	Anticipated date needed
Supplies/ Equipment	$3,999	June-July, 2021
Payment for Services	$0	
Miscellaneous	$0	

Total requested budget: $_3,999_

Supplies / Equipment

- List each item separately
- Quotes are required for all equipment over $5,000

Item	Amount	Anticipated date needed
EcoMet 30 Single Manual Grinder/Polisher	$3,999	June-July, 2021
	$	
	$	

Supplies / Equipment subtotal: $_3,999_

Provide a justification of the items listed above, including a statement of purpose and how the amount was determined .

The request of the EcoMet 30 Single Manual Grinder/Polisher is required to develop the virtual lab for the proposed research study. It will show students the process used in industry for capturing the microstructure of metal materials (i.e., grinding/polishing process). Please see provided attached quote by Buehler.

Payments for Services

- Includes vendors and services. Signed contracts may be required and may need to be reviewed by procurement
- Payment to students or faculty is not allowable

Service	Amount	Anticipated Date	Additional Info (optional)
	$0		
	$		

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Payments for Services subtotal: $__0_____

Provide a justification of the items listed above.

No payment for services is requested.

Miscellaneous

Expense	Amount	Anticipated Dates
	$0	
	$	

Miscellaneous subtotal: $_0_____

Provide a justification of the items listed above.

No payment for services is requested.

Signature of all applicants below certifies the statements in the application are true, complete, and accurate to the best of her/his/their knowledge. All faculty applicants agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if a grant is awarded as a result of this application.

a) Faculty Applicants

Sanna Siddiqui Date 4/15/2021

Mary B. Vallaro Date 4/15/21

b) Department Chair or Division Director Signature

Mary B. Vallaro Date 4/15/21

Incorporation of a Virtual Materials Characterization Lab in Enhancing Student Performance in Structure and Property of Materials

Principal Investigator (PI): Dr. Sanna F. Siddiqui
Co-Principal Investigator (Co-PI): Dr. Mary B. Vollaro

Introduction

The "processing-structure-properties" of a class of materials directly enhances its mechanical performance, governing the real-world application in which it is used. Given the critical importance of material selection for intended engineering design, the implementation of a virtual materials characterization laboratory in reinforcing difficult concepts in the core mechanical engineering (ME) course of EGN 3365: Structure and Property of Materials, is intended to enhance success rate/performance metric standards for this course at Florida Polytechnic University. Given that the course is highly conceptual, the introduction of an enhanced, interactive, virtual lab that bridges theory with applied knowledge supports the core project-based learning educational environment central to Florida Poly. It further prepares graduates to have the necessary skillsets sought by industry employers and graduate school. The proposed study aims to address the following research questions, providing answers to these current knowledge gaps.

- Problem Statement/Research Questions:

  Does incorporation of an *interactive virtual materials characterization lab* enhance overall student performance through evaluation of course assessments, as compared with primarily lecture format of the course at Florida Polytechnic University?

- What gap(s) is this project intending to address?

  The primary knowledge gap that this project attends to address is regarding whether there is an improvement in overall student performance/success rate in Structure and Property of Materials course at Florida Polytechnic University, with the incorporation of a virtual materials characterization lab that bridges theory with application.

- Description of the research context (type of class / instructional setting)

  The incorporation of a virtual materials characterization laboratory will be explored in the fundamental core course of EGN 3365: Structure and Property of Materials in the Mechanical Engineering Department. Given the outcomes of the proposed research, it is the intent to expand this research into courses taught within the Materials/Advanced Manufacturing ME Concentration.

Literature Review

Current literature studies have shown the effectiveness of incorporating a virtual materials lab in enhancing student learning and overall performance. Hashemi and authors developed a virtual platform that incorporated video clips of metallurgical preparation process for microstructural analysis, and found that the virtual simulation was as effective as lecture and pre-lab at a large university, such as Texas Tech [1]. A review article by Jong and co-authors, has explored the benefits of virtual labs across multiple disciplines, highlighting the benefits of virtual lab environment to include "student involvement in assessing experiment outcome, conducting multiple experiments in short time period, and providing online adaptive guidance" [2], which was

supported by another study analyzing student performance [5]. Further studies by Brophy and authors found that students were able to identify the mechanisms at the atomic level governing plastic deformation response of an unknown material, after exposure to the virtual lab simulation environment [3]. Other studies have further emulated the benefits of virtual lab incorporation with explanatory 2D/3D animations [4]. A summary of these key studies reveals the benefits of incorporating a virtual lab for enhanced understanding of fundamental concepts presented within STEM disciplines. Nevertheless, most studies in the area of virtual materials characterization lab were performed at larger universities.

Methodology

- What data/information will be gathered?

This piece of equipment is used to prepare samples for analysis in the optical microscope. To perform microstructural analysis, samples must be sectioned, mounted in Bakelite or epoxy, and then polished to achieve a very flat, scratch free surface required by the optical microscope, which has a wide field of view but a very short focal length. Looking to explain the 'property, processing, microstructure' relationship in both new and 'old' materials, the optical microscope provides physical evidence of microstructural features such as grains and grain size in metal, morphology in composites and crystallinity in polymeric materials, to cite common applications. The photomicrographs are analyzed to ASTM standards, compared to results in literature or generate completely new information. Research are obvious benefactors for quality sample prep, but undergrad students and instructors can use this equipment to prepare samples for in-class activities such as worksheets and real-world applications. Just to note, a poorly prepared sample, (done without this equipment) will yield poor results with samples that are out of focus and blurry in the field of view, or with scratches and surface anomalies that will distract from conclusive and/or publishable results.

- How will this be collected and validated?

Sample preparation will follow standards set forth in the American Society of Metals (ASM) handbooks and/or literature. Sample preparation is as much an art as it is a science, thus training and experience in investigators is valued. Validation will be research-grade and publishable photographs form the optical microscope.

- How will this approach provide reliability?

Sample preparation process can be compared to 'standard operating procedures' (SOPs) for each sample type. Once the investigator establishes the 'best' process, repeatability is achievable with this equipment versus hand polishing or equipment that is not designed specificity for sample preparation. The equipment in this proposal is the industry standard for both research and production environments. This equipment offers flexibility to accommodate a wide range of materials quality surface finishes, and sample configurations (versus only 1-inch diameter Bakelite mounts).

- How will the funding/equipment requested support this project?

Simply stated, it will allow us to use our optical microscope to its full capability on a wide range of materials. Currently, this is not possible.

Assessment Plan

- What are the learning outcomes associated with this project? How is it related to the gap(s) that are intended to be addressed?

With respect to learning outcomes, the high-quality sample preparation will directly impact our ability to 1) analyze our research samples in the optical microscope and 2) create samples to support class activities and laboratory for undergraduates (i.e., EGN 3365 Structure and Properties of Materials, EIN 3390 Manufacturing Processes and future elective courses.)

- What is the desired level of achievement?

With development of standard procedures and investigator skill, samples for high quality for analysis will be prepared in a routine and consistent manner. The photomicrographs that are publishable in research journals and/or conference presentations will be the 'check' of achievement. For class assessments, a comparison between student performance with and without the included virtual lab will be performed.

- What is the percentage of students who will benefit from this project?

At a minimum, 75 students will benefit per academic year, with the primary dependency being on the enrollment of EGN 3365 and the in-class activities to be developed and presented in this course. Others will be students who may participate in research activities, learning laboratory protocol and acquiring skills in sample preparation.

- How frequently will assessments be conducted?

Student class activities incorporating activities from the virtual materials lab will be performed weekly through assessments given during the semester (i.e., quizzes, homework, exams and final project). Assessments are 'built in', noting each time a sample is polished, the quality of the photomicrograph will automatically validate the polishing process using this equipment.

- What methods will be used for assessment?

For students, the class activities, which are developed using this equipment, are expected improve mastery of course topics with the completion of custom worksheets and lab reports. It allows instructors to plan the activities to the specific needs of the students and course content. For researchers, positive reviews on papers/presentations will validate the sample preparation process (using this equipment) with the resulting high-quality photomicrographs.

Timeline for Project

The proposed educational research study will span 1 year, which will comprise of the following: a.) May-Aug. 2021 (acquisition of equipment/supplies and preparation of virtual lab worksheets), b.) Sept. –Dec. 2021 (virtual lab video design and development), and c.) Jan. –April 2022 (implementation within course, analysis of data, and dissemination of results).

- Phase 1 from May-Aug. 2021 will comprise of acquisition of a manual polisher/grinder with associated platen kits, and metal rod-stock for the metallurgical

preparation/analysis of microstructure of metal specimens. Phase 1 will also be comprised of in-class virtual lab worksheet developments.

- Phase 2 from Sept.- Dec. 2021 will involve virtual lab video developments of each stage of the metallurgical microstructural preparation process (i.e., grinding, polishing and etching, and characterization with optical and/or scanning electron microscope in the Materials Characterization Lab). The completion of Phase 2 will incorporate a virtual lab video that incorporates demonstrations by the instructor of each phase of the metallurgical process followed by "decision making" sections which places the student in the role of "experimentalist," in identifying the correct approach to each process. The output virtual lab is anticipated provide an interactive student-centered learning environment that allows students to identify "what if" scenarios, not necessarily feasible in a physical lab environment.

- Phase 3 from Jan. –April 2022 will encompass implementation of developed virtual lab and virtual lab worksheets within the curriculum for Structure and Property of Materials. Students understanding of experimental conditions simulated in the virtual lab will be tested through course assessments Comparison in performance between Exam grades/Projects (i.e., final report on the "processing-property-microstructure," of material for a selected real-world application), with and without applied virtual lab will be used to assess performance across semesters. Findings will be disseminated in a final report/presentation, and submitted for conference/journal publication in American Society of Engineering Education (ASEE) outlets.

Broader Impacts

Structure and Property of Materials is a required 3.0 credit hour course in the ABET-accredited Mechanical Engineering curriculum. Its concepts are tested on the Fundamentals of Engineering Licensing Exam. It has been reported that virtual labs central to material characterization enhance student performance at larger universities, nevertheless its role in enhancing student performance at Florida Polytechnic University has not yet been explored. Given the necessity of graduates from the ME program having a core understanding of "processing-structure-on resulting properties, ensuring the success rate in this course is necessary, in addition to contributing to university's performance metric standards. The proposed research study will expose students to an interactive virtual laboratory that will give them real-world perspective/skill-set of microstructural analysis and its implication in affecting performance, supporting the "project-based," learning environment central to Florida Polytechnic University, while at the same preparing our graduates for future careers in industry. Virtual lab based studies will expose students to application of taught concepts without the necessity of in-person use of sensitive lab-based equipment that comprises our Materials Characterization Lab. At the same time, it is anticipated that the proposed study will inspire our students to engage in undergraduate research opportunities with faculty in the ME Department.

Works Cited/References

[1] Hashemi, J., Austin-Stalcup, K.A., Anderson, E.E., and Chandrashekar, N., (2005). "Elements of a Realistic Virtual Laboratory Experience in Materials Science: Development and Evaluation," Int. J. Engage Ed., Vol. 21, No. 3, pp. 534-545.

[2] Jong, T.D., Linn, M.C., and Zachaniam, C., (2013). "Review-Physical and Virtual Laboratories in Science and Engineering Education," Science, Vol. 30, pp. 305-308.

[3] Bnophy, S.P., Magana, A.J., and Strachacan, A., (2013). "Lectures and Simulation Laboratories to Improve Learners' Conceptual Understanding," Advances in Engineering Education, pp. 1-27.

[4] Grodotzki, J., Ortelt, T.R., and Tekkaya, E. (2018). "Remote and Virtual labs for Engineering Education 4.0," Procedia Manufacturing, Vol. 26, pp. 1349-1360.

[5] Radhamani, R., Sasidharakurup, H., Sujatha, G., Noir, B. Chutan, K., and Diwakar, S. (2014). "Virtual Labs Improve Student's Performance in a Classroom," LNICST, pp. 138-146.

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Sales Quotation

CUSTOMER CONTACT: SANNA SIDDIQUI
PHONE NUMBER: 863-874-8564
EMAIL: ssiddiqui@floridapoly.edu

Quote No. SQ-092699

Sales Engineer

VICTORIA LUNKES
PHONE NUMBER: 847-295-4662
EMAIL: VictoriaL.Sales@Buehler.com

Sell To:

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4700 RESEARCH WAY
LAKELAND, FL 33805
USA

Quote Date	Customer No.
8/28/2020	C024012
Currency	**Terms**
USD	Net 30
Status	**Quote Expires**
Open	10/27/2020

Your Reference
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Shipping Method
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This quotation may be accepted to form a binding contract upon any one of the following options:
-Signature below and payment to Buehler for the items listed in this quote prior to the expiration date.
-Issuance of a purchase order to Buehler referencing this quote and the Buehler terms and conditions herein prior to the expiration date above.

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Minimum order $300 applies. Orders below this amount are subject to a $50 surcharge. No minimum order requirement for orders place via our e-shop. Shipping Charges added at the time of shipment.

Line No.	Item No \ Desc	QTY	U/M	Unit Price	Discount	Net Price	Total
1	4910070 EcoMet 30 Single Manual	1	Each	4,371.00	8.51064%	3,999.00	3,999.00

EcoMet30 Manual Grinder Polisher with a single platen provides

- Easy remove platen allowing frequent deep cleaning (platen sold separately)
- Ergonomic flat working surface providing better control and more comfort during manual grinding
- Durable metal casting providing added durability and stability
- Flexible option to use 8in[203mm], 10in[254mm] or 12in[305mm] platens
- Adjustable rotation from 50-500rpm

Installation Requirements:

- Power 115-230 VAC, 50-60Hz
- Requires water supply and drain
- Air-N/A

Includes:

- Power cord
- Operating Instructions
- Bowl Liner

Does not include

- Requires one platen kit containing the platen, splash ring and cover
- Additional bowl liners

2	WARRANTY Standard Warranty	1	Each				

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Quote No. SQ-092699

Line No.	Item No \ Desc	QTY	U/M	Unit Price	Discount	Net Price	Total

Buehler standard warranty, covering all new serialized equipment for 18 months from the date of delivery to the common carrier. Equipment will conform to specifications and be free from defects in material and workmanship. Includes technical support, replacement parts and repair labor.

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Subtotal:	$3,999.00
Total Sales Tax	$0.00
Invoice Discount: $372.00	Total (USD): $3,999.00