Affordable Learning Georgia Affordable Materials Grants  
Transformation Grants Final Report

*(or Textbook Transformation Grants, if R17 or earlier)*

# General Information

**Date:**

05/10/2024

**Grant Round:**

22

**Grant Number:**

640

**Institution Name(s):**

Georgia Southern University

**Project Lead:**

Jinki Kim

**Team Members:**

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**Course Name(s) and Course Numbers:**

Autonomous Vehicle and Robot Sensors, MENG 5090(G)

Introduction to Programmable Logic Controller, MENG 3553(G)

**Semester Project Began:**

Fall 2022

**Final Semester of Implementation:**

Spring 2024

**Total Number of Students Affected During Project:**

23

# Narrative

The courses enhanced through this project, MENG 5335(G), Introduction to Programmable Logic Controller (PLC) and MENG 5090(G), Autonomous Vehicle and Robot Sensors, are senior/graduate level courses in the department of mechanical engineering, which are centered around laboratory experiments. Through this project, the research team developed and offered online lab manuals for these courses. The developed learning resources are comprised of written instructions, examples such as ladder logic/diagram, wiring diagrams, LIDAR sensor development, and exercises problems for assignment submissions.

The developed Open Educational Resources (OER) is beneficial for students with diverse pedagogical needs and allows instructors to interact more during the laboratory hours. A pdf format was adapted for all the written portions of the material, and it meets Affordable Learning Georgia (ALG) copyright requirements, Attribution 4.0 (CC BY). Currently the course material is provided to students through Folio, an online learning management system adopted at Georgia Southern University. However, the resource will be provided to open repositories, such as ALG and GALILEO Open Learning Materials [website](https://oer.galileo.usg.edu/)s and Digital Commons @ Georgia Southern

As part of ongoing assessment, the Folio system can track website usage data, which will be utilized to inform revisions of the materials. A comprehensive guide detailing the installation of PLC software and covering laboratory topics in the course has been created and shared with a teaching assistant. For each topic, a full set of labs, along with their respective solutions, has been developed. Although Dr. Choi is the sole instructor for the course in every semester except for the summer semesters, all materials and solutions will be shared via Google Drive for future instructors and teaching assistants. At the end of each semester, discussions will be held regarding the challenges and intricacies of the laboratory course, and adjustments to the difficulty levels of the lab problems will be made to better suit student needs.

The utilization of resources in MENG 5335(G) proved highly successful for instructors, teaching assistants, and students alike. Students had access to numerous examples, some of which were thoroughly explained. When examples are included in online materials, students can ask questions during lab hours, enabling them to learn and grasp the concepts more effectively. For instance, detailed wiring diagrams allow students to actively compare hardware setups with instructional diagrams to successfully construct circuits. Previously, instructors often had to repeatedly explain this concept and go over details at each station. Now, instructors can introduce the concept and direct students to additional examples, which students can review at their own pace, as many times as necessary. Consequently, instructors were able to dedicate more in-class time to assisting students in understanding the practical application of concepts and debugging their programs.

Several challenges arose during the development of the materials, particularly concerning the number of participants. Having more students across multiple sessions would provide increased opportunities to gather data for making improvements. Additionally, students could engage in laboratory work outside of scheduled class times in the absence of a lab session. In addition, although the course materials were newly developed for MENG 5090(G), the course could not be offered due to other circumstances within the department.

# Quotes

Student A:

“OER gave us the opportunity to apply what we learn in class to a real-world application.”

Student B:

“OER is more effective than software simulation because all connectors can be seen and worked with while setting up the ladder diagrams and navigation all components.”

Student C:

“It is much more effective with OER compared to traditional simulation.”

# Quantitative and Qualitative Measures

## Uniform Measurements Questions

*The following are uniform questions asked to all grant teams. Please answer these to the best of your knowledge.*

**Student Opinion of Materials**

**Was the overall student opinion about the materials used in the course positive, neutral, or negative?**

Total number of students affected in this project: \_\_\_\_23\_\_\_\_\_\_

* Positive: \_\_\_95\_\_\_\_ % of \_\_\_22\_\_\_\_\_ number of respondents
* Neutral: \_\_\_5\_\_\_\_ % of \_\_\_1\_\_\_\_\_ number of respondents
* Negative: \_\_\_0\_\_\_\_ % of \_\_\_\_0\_\_\_\_ number of respondents

**Student Learning Outcomes and Grades**

**Was the overall comparative impact on student performance in terms of learning outcomes and grades in the semester(s) of implementation over previous semesters positive, neutral, or negative?**

*Student outcomes should be described in detail in Section 3b.*

Choose One:

* \_\_x\_ Positive: Higher performance outcomes measured over previous semester(s)
* \_\_\_ Neutral: Same performance outcomes over previous semester(s)
* \_\_\_ Negative: Lower performance outcomes over previous semester(s)

**Student Drop/Fail/Withdraw (DFW) Rates**

**Was the overall comparative impact on Drop/Fail/Withdraw (DFW) rates in the semester(s) of implementation over previous semesters positive, neutral, or negative?**

*Depending on what you and your institution can measure, this may also be known as a drop/failure rate or a withdraw/failure rate.*

\_\_\_0\_\_\_\_% of students, out of a total \_\_\_23\_\_\_\_ students affected, dropped/failed/withdrew from the course in the final semester of implementation.

Choose One:

* \_\_\_ Positive: This is a lower percentage of students with D/F/W than previous semester(s)
* \_\_x\_ Neutral: This is the same percentage of students with D/F/W than previous semester(s)
* \_\_\_ Negative: This is a higher percentage of students with D/F/W than previous semester(s)

## Measures Narrative

The delta rates for Drop, Fail, and Withdraw (DFW) remain relatively unchanged compared to the previous semester (Fall 2023), which did not incorporate OER.

Retention and completion rates for the course also show no significant deviation from the previous semester. Students enrolled in the PLC course are highly motivated due to the practical relevance of PLC knowledge in their prospective careers. Many mechanical engineering graduates encounter PLCs in factory automation, making proficiency in both hardware and software highly advantageous.

For the Fall semester of 2023, the average GPA for undergraduate students was 3.83, and for graduate students, it was 3.92. In the Spring semester of 2024, the average GPA for undergraduate students decreased slightly to 3.75, while the average GPA for graduate students remained relatively stable at 3.84.

For our learning objectives, we've identified three associated outcomes:

1. Comprehend the process and contemporary tools of data acquisition using PLC as a platform.
2. Analyze, interpret, and report experimental data effectively.
3. Apply analog signal processing and digital circuits within industrial systems.

The first two objectives are attainable by diligently following the Open Educational Resources (OER) during laboratory sessions. Not only do all students successfully complete these labs, but they also gain a deep understanding of the content through hands-on experiences facilitated by the OER. Achieving the third objective entails a combination of traditional lectures and practical work in the laboratory.

This course will run each semester (Spring and Fall), with enrollment comprising both graduate and undergraduate students, totaling 24. We plan to extend the enrollment capacity to accommodate up to 30 students.

# Sustainability Plan

MENG 5335(G) is offered every Fall and Spring Semester and MENG 5090(G) is planned to be offered every Fall Semester. Both courses serve as a technical elective course for senior and graduate students. The OERs are predominantly utilized during the final four weeks of each semester for the laboratory component.

Currently, we have one instructor who can accommodate 24 students per semester, but we aim to increase enrollment to 30 students. To accommodate this expansion, multiple sections will be introduced. Prior to the semester start, instructors will undergo a simple workshop to familiarize themselves with OER and the hardware laboratory classes. At the semester's end, students will be provided with a questionnaire to gather feedback on the strengths and weaknesses of the OER contents, enabling adjustments to optimize pedagogical effectiveness.

To ensure the sustainability of the course, continuous assessment will occur at the end of each academic year. This assessment will encompass student performance and retention evaluations. For graduate students, special topics will be introduced as open-ended projects, with several topics developed to maximize the application of the OER.

# Future Affordable Materials Plans

This project allowed the research team to develop OERs for two mechanical engineering courses. The enhanced and expanded OER was tailored to the specific course learning outcomes while still being relevant as a general engineering resource for use in similar courses and as a long-term reference in follow-up courses.

The OER for MENG 5335 is specifically designed for the micro 800 series family PLC, particularly the 820 model, with minor adjustments. Its flexibility extends to other auxiliary PLC hardware, allowing for potential expansion of intermediate-level laboratory course content. Furthermore, segments of this OER can be integrated into the Introduction to Mechatronics course, enriching students’ comprehension of industrial applications within Mechatronics. Additionally, the OER PLC material can be introduced in seminars for graduate students within the Mechanical Engineering and Electrical Engineering departments. Notably, graduate students in Electrical Engineering can enroll in the course, and we have consistently welcomed students from various other departments.

Feedback from the MENG 5335 questionnaire indicates that students highly appreciate the format of the OER laboratory course. As a result, we plan to gradually augment both the content and enrollments of the course.

# Future Scholarship Plans

This work was presented and published at the American Society for Mechanical Engineering International Mechanical Engineering Congress and Exposition in October 2023:

**Kim, Jinki, Junghun Choi**, and Jongyeop Kim. "Introducing Machine Learning in Undergraduate Mechanical Engineering Mechatronics Classes." vol. 87653, p. V008T09A019. American Society of Mechanical Engineers, 2023

An extension of this paper will be submitted for publication in the Journal of Higher Education Theory and Practice.

# Description of Photograph (optional)

*This is where a team can list the names of the people shown in this separately uploaded photograph, along with their roles, if applicable.*