Affordable Learning Georgia Affordable Materials Grants  
Transformation Grants Final Report

# General Information

Date: **May 3, 2024 – May 16, 2025**

Grant Round: **Round 25**

Grant Number: **711**

Institution Name(s): **University of Georgia**

Project Lead: **Inseok Song**

Team Members (Name, Title, Department, Institutions if different, and email address for each):

**Nandana Weliweriya, Lecturer, Department of Physics and Astronomy**

**Cassandra Hall, Assistant Professor, Department of Physics and Astronomy**

**Loris Magnani, Emeritus Professor, Department of Physics and Astronomy**

**Nicolas Young, Assistant Professor, Department of Physics and Astronomy**

Course Name(s) and Course Numbers: **ASTR 1010, 1110, 1110-H, 1010/1020L, 1110/2030L, 1420, 1420E**

Semester Project Began: **Summer 2024**

Final Semester of Implementation: **2025 Fall (Planned)**

Total Number of Students Affected During Project: **TBD (about 200 students will be affected in CY25-26)**

# Narrative

* 1. *Describe the key outcomes, whether positive, negative, or interesting, of your project. Include:*
* In this project, our goal was to develop a set of scientifically accurate, immersive, engaging, and visually stunning modular 3D astronomical simulations. These simulations are designed for classroom use to enhance students’ understanding of fundamental 3D astrophysical concepts. Our efforts primarily focus on creating high-quality Open Educational Resources (OERs), addressing the current gap in the OpenStax Astronomy textbook (Astronomy, ISBN-13: 978-1-951693-50-3).
* Integrating 3D simulations into the course requires revising lesson plans to incorporate active learning activities for students. This shift has fundamentally transformed traditional, lecture-centered instruction into a modern, student-centered, active learning approach.
* *Transformative impacts on your students and their performance* 🡪 To be measured during the upcoming Fall semester.
  1. *Describe lessons learned, including any things you would do differently next time.*

A key step in our project was the development of six high-priority 3D simulations using *Unity*. The model development was led by undergraduate students, partially funded by the grant. Initially, eight students participated in the project: however, by the time of this final report, only three remained active. Retaining experienced student programmers has been a significant challenge, as some transferred to other USG schools, shifted their research focus to different disciplines, or phased out due to demanding coursework and other obligations.

Another challenge has been the uncertainty surrounding ever-changing teaching assignments. In our department, three astronomy faculty members have retired over the past two years, leading to a major realignment of teaching responsibilities. As a result, the actual classroom implementation of the 3D models could not proceed as originally planned, primarily due to two factors: (1) delays in 3D model development and (2) changes in teaching assignments.

Despite these challenges, four major 3D astronomical models have been successfully developed and are ready for use in upcoming semesters. We plan to incorporate them into the 2025 Summer ASTR 1420E course and the ASTR 1010, 1110, and lab courses in Fall 2025. However, as of this report, the academic year 2025-2026 teaching schedule has not been finalized in my department, meaning future in-classroom implementation may still be subject to change.

* 1. *Describe any materials you created or revised/remixed that will be shared with the public. Include the* [*open license your materials will be shared under*](https://creativecommons.org/share-your-work/)*—for most materials, this will be an Attribution 4.0 License (CC BY) as required in the Grants Request for Proposals.*

In 2024 summer, five students (including three high school students) started the development of 3-D astronomical models for selected high priority topics listed below. At the end of the 2025 Spring semester, only two active undergraduate programmers remain in the project. These students developed:

* Solar rotation and activity cycle model: It is fully developed and ready to be used in a classroom.
* Binary orbital motions and orbital elements model: A 3-D model controllable by a user using a mouse or VR hand controllers has been fully developed with *Unity*. This model can enhance the students’ understanding of orbital motion of a binary, including orbits of exoplanets. By changing any one of six orbital elements interactively, students can grasp the principles of determination of orbits intuitively.
* Eclipses model: All core components were fully developed. The final model with a user-interface is being developed, and it should be fully developed by the end of the 2025 summer semester.
* Virtual Night Sky model: The model was almost fully developed and only needs final refinement. This model is an enabling module, with only minor changes in configurations, which can be used to describe other astronomical phenomena seen/projected on the celestial sphere. For examples, two other key topics (“Origin of seasonal constellations” and “Astronomical Time and Calendar”) are easily covered by this model as well. In addition, with slight modifications, the same model can describe “Retrograde motions of Inner Planets”, “Atmospheric Effect”, “Light pollution”, etc.

All these models were developed in *Unity*, all source files are released to the public. However, because the total file size is several giga bytes (3.6 GB), we created a GitHub repository ([STEMin3D/Astro-3D](https://github.com/STEMin3D/STEMin3D)) and all source files and final rendered models can be easily downloaded from this repository.

These shared *Unity* package files can be used by any other educators to further refine the models or create new topics. They are released under Attribution 4.0 License (CC BY).

Several screenshots of the developed 3-D models in action are shown below.

A black sky with stars and constellations

AI-generated content may be incorrect.

Screenshot of the virtual night sky simulation. This model is currently rendered on a PC screen, however, it will also be rendered as a VR model and 2-D WebGL model as well.

A planet earth and the sun

AI-generated content may be incorrect.

Eclipse model with multiple, selectable, camera views.

This model has been developed by the 2nd year UGA astrophysics student, Aiza Ahmad. She will finish the development of the model by adding a real-time user-interface with which a student can change various parameters such as the sizes of Sun/Earth/Moon, sizes of their orbits, inclinations of two orbital planes. Such a real-time playability allows students can explore the effect of such parameters in the resultant eclipse frequencies.

A screenshot of a computer

AI-generated content may be incorrect.

Model of solar rotation and activity cycle. By changing the rotation speed of the camera around the Sun, students can empirically determine the rotational period of the Sun. Also, students can experience the differential rotation phenomenon.

# Quotes

The actual in-classroom implementation has been delayed to 2025 Summer semester (1420E, Life in the Universe). Therefore, no student quotes are available currently.

# Quantitative and Qualitative Measures

Because the in-classroom implementation has been delayed from 2025 Spring semester to 2025 Fall, no student data has been collected. The major student data collection will be done in the 2025 Fall semester when ASTR 1010, 1110/1110H, and 1010/1020L, 1110L/2030L are offered to students.

## 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: \_\_\_\_\_\_\_\_\_\_

* Positive: \_\_\_\_\_\_\_ % of \_\_\_\_\_\_\_\_ number of respondents
* Neutral: \_\_\_\_\_\_\_ % of \_\_\_\_\_\_\_\_ number of respondents
* Negative: \_\_\_\_\_\_\_ % of \_\_\_\_\_\_\_\_ 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:

* \_\_\_ 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.*

\_\_\_\_\_\_\_% of students, out of a total \_\_\_\_\_\_\_ 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)
* \_\_\_ 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

*In this section, summarize the supporting impact data that you are submitting, including all quantitative and qualitative measures of impact on student success and experience. Include all measures as described in your proposal, along with any measures developed after the proposal submission.*

*[When submitting your final report, as noted above, you will also need to provide the separate file (or .zip with multiple files) of supporting data on the impact of your Textbook Transformation, such as surveys, analyzed data collected, etc.]*

* *Include measures such as:*
  + *Drop, fail, withdraw (DFW) delta rates*
  + *Course retention and completion rates*
  + *Average GPA*
  + *Pre-and post-transformation DFW comparison*
  + *Student success in learning objectives*
  + *Surveys, interviews, and other qualitative measures*
* *Indicate any co-factors that might have influenced the outcomes.*

# Sustainability Plan

The Department of Physics and Astronomy at UGA is fully committed to enhancing STEM education and fostering an active learning environment. The department greatly values the adoption of Open Educational Resources (OERs), including the no-cost textbook, and will continue using the OpenStax textbook in most introductory astronomy courses (ASTR 1010, 1020, 1110/110H, 1420) for the foreseeable future.

# Future Affordable Materials Plans

With the support of the ALG R25 grant, we have successfully developed most of the high-priority models. However, approximately 20 additional topics remain for which we plan to create 3D models. Over the next several semesters, we will continue developing models for the remaining topics of the Astro-3D project ([astro-3d\_content](https://stemin3d.net/astro-3d_content)). Our 3D astronomical models will significantly expand the pool of Open Educational Resources (OERs) alongside the OpenStax textbook, reinforcing the long-term adoption of this free educational resource.

# Future Scholarship Plans

# We have secured an IRB approval to collect student data for this project already. During the Fall 2025 semester, we will collect classroom data. A graduate student will take a lead in analyzing the data and publish the result in a peer-reviewed journal (e.g., American Journal of Physics Teachers).

# Description of Photograph (optional)

*N/A*