# Active Learning Grant Application 2025

## 1. TITLE

Enhancing Active and Experiential Learning with Low-Cost Telescopes

## 2. PURPOSE

Students enrolled in astronomy courses rarely can actively observe celestial objects. Night-time observation opportunities are scarce, and when available, more than ten students often share a single large telescope. This situation is far from ideal and runs counter to the goal of fostering an active learning environment.
By providing each student with an individually operable low-cost telescope (costing less than $100) and a smartphone adapter for digital imaging, we can introduce a novel and unprecedented active learning approach in astronomy courses. Each student can independently conduct their observation projects at a time and place of their choosing, greatly enhancing the active learning experience.

Many students are initially drawn to astronomy by the awe and beauty of celestial objects. However, even for those enrolled in undergraduate astronomy courses, opportunities to observe these celestial objects firsthand through telescopes are rare. This scarcity is particularly pronounced for astronomy majors, whose coursework involving telescopes is limited.

Traditionally, night-time observations are conducted using expensive telescopes (8 to 14 inches in size, each costing up to several thousand dollars) owned by the department. Such observation sessions require students to gather on campus at night, presenting challenges related to security and scheduling. Additionally, weather conditions and light pollution at the campus site can negatively impact these hands-on experiences. The need to register for late-night astronomy labs may further discourage students from enrolling in such courses. By loaning telescopes to individual students or small groups (less than three students), these issues can be mitigated. Each student can independently conduct course activities at their chosen location and time, aligning with the principles of active and experiential learning.

With previous support from the Office of Active Learning (PI: Inseok Song, $18,500 in summer 2024), we have purchased about 60 sets of low-cost telescopes (LCT)[1] and

[1] FirstScope ($70/telescope) sold by Celestron

smartphone adapters (Fig 1). Three faculty members (two from Physics and one from the School of Arts) started developing curriculum activities including the creation of an "Astrophotography" course that is to be cross listed between two departments (Physics & Astronomy and Photography).

With the 2025 Active Learning Grant, we aim to develop about 10 curriculum activities (selected from ~20 potential topics) with LCT. We will implement these activities in astronomy courses during AY2025 and gather classroom data through student surveys and in-depth interviews. We will publish the result as professional journal articles and share the developed curricular as Open Education Resources.

For us to collect student data to formally assess the impact of our novel active learning approach and share the result through publishing in peer-reviewed journals, we have already applied and secured the IRB approval (IRB ID = PROJECT00011071).

## 3. FORMAT

This Project falls in the "**Foundational Course Redesign**" Category

During the 2024 Fall semester, we implemented the first LCT activity as a term project in ASTR 3010, Observational Astronomy, which is a required course for upper class astrophysics majors. Responses from students were overwhelmingly positive and we collected student data from pre- and post-surveys including a handful of in-depth interviews. With 2025 Active Learning Grant, we aim to (1) fully develop N=10 LCT curriculum activities (lab sessions) that can cover a wide range of student populations (science or non-science major, lower or upper class), (2) submit a CAPA entry for the cross-listed "Astrophotography" course with the target implementation semester of 2025 Fall, (3) create entry-level First Year Odyssey course, (4) develop public outreach components, and (5) share the project result with the education community trough conference presentation and journal publications.

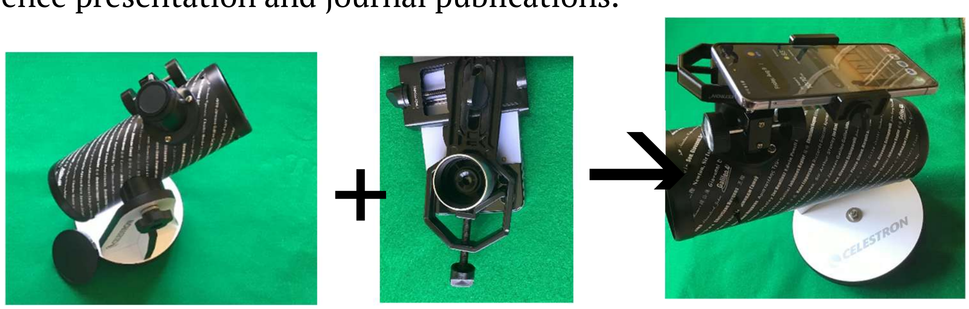


**Fig 1**: FirstScope 4 inch reflector telescope with a smartphone as a digital detector.

# Active Learning Grant Application 2025

We have already identified a set of suitable curriculum activities, each of which can be handled as a separate lab session or assigned as a term project.

LCT + Smartphone Curricular activities

**Preparatory activities**

1. Introduction to the telescope + smartphone
2. Collimation of telescope mirrors
3. Tutorial on the camera operation (ISO, exposure, repeat, etc.)
4. Image data analysis (preprocessing + stacking)
5. Image enhancement tutorial (photoshop etc.) for astrophotography

**Observation projects**

6. Measure the field of view (of the telescope + smartphone)
7. Astrophotography → imaging a bright galaxy, nebular, or cluster
8. Phase & libration of the Moon → create a short video or animated photo
9. Phase of Venus & phase-size dependency
10. Imaging Uranus over multiple nights → estimate its "circular" speed and derive its distance using the Kepler's 3$^{rd}$ Law.
11. Mapping the light pollution in your area
12. Color-scale of your camera: measure the relationship between RGB color and temperature of several types of stars
13. Asteroid observation: (1) observe a known asteroid and recover its orbit or (2) blind hunting for new asteroids
14. Any opportunistic objects such as comets
15. Observe Galilean Moons → create an animated movie showing the movements of moons → and measure their positions → fit their orbits using measured positions calculate distances from the central object (e.g., Jupiter)
16. Obtain the telescope deep imaging limit → how deep one can go with the LCT+smartphone setup? Related to the light pollution mapping.
17. Color-Magnitude diagram of bright, nearby clusters (Pleiades, Hyades, Beehive, etc.) → take images → perform aperture photometry → create the diagram
18. Observations of short-period variables (Cepheids, Eclipsing Binaries, etc.) → perform aperture photometry → recover known periods.
19. Standard transformation of your smartphone camera so that reduced data (brightness and color) can be used for professional astronomy research.

Topics listed under the preparatory category can be assigned to any level of students.

Topics in the Observation Project category are getting more difficult (i.e., suitable for upper class students) with increasing numbers.

For each topic listed above, we will create a lab manual.

Some of the images obtained through 2024 Fall ASTR 3010 course term projects are shown below.

Moon, with 20mm eyepiece, 1/30 sec

Double Cluster, with 15mm eyepiece

Saturn+Titan, 4mm eyepiece


Pleiades

Messier 25, with 20mm eyepiece

Jupiter + 3 Jovian Moons, 4mm eyepiece

With Prof. Marni Shindelman at the Lamar Dodd School of Arts, we have begun the effort of creating a new course which is titled tentatively as “Astrophotography” which will be cross-listed and offered between two departments. Class activities for this course are mostly from topic #1 through #9.

We will also create a First Odyssey Seminar course with only one observation project assigned.

Through the service leaning course PHYS 4910S/6910S, we plan to develop public outreach components for Athens area local schools. Community wide collaborative project of creating our own light pollution map can be a suitable project.

## 4. IMPACT

Affected courses by our project (and their latest annual enrollments) are:

- ASTR 1010 (180): Astronomy of the Solar System
- ASTR 1110/H (50): Introduction to Astronomy (Honors)
- ASTR 1010L/1020L (50): Introduction to Astronomy Lab
- ASTR 1110L/2030L (20): Introduction to Astronomy Lab
- ASTR 3010 (20 over 2 years): Observational Astronomy
- FYOS 1000 (12): Introduction to Astrophotography
- PHYS 4910S/6910S (?): Communicating Physical Science Topics to Diverse Audiences: Service-Learning Through Science Shows
- To-be-created Cross-listed course: Astrophotography

For ASTR 1010 students, we cannot implement a class-wide LCT activity. Instead, we will assign an observation project as a side project or bonus credit work. For other courses, we can implement class-wide LCT activities. All in all, we expect to impact >300 students per year by providing a new, novel active learning environment in astronomy.

We will disseminate the result of the project in two main ways: (1) as published journal papers and (2) share the fully developed curricula as open education resources (OERs). Therefore, the board impact of the project goes beyond the boundary of UGA. Schools in the underprivileged communities can replicate the effective, active learning initiatives from our shared OERs by following the guideline provided in the shared OERs.

## 5. TEAM MEMBERS

*Each change grant team must assign two faculty members as Active Learning Change Grant Facilitators who will lead and oversee the project. At least one of the two facilitators must have finished ALSI before applying for the grant. In addition to the two required facilitators, teams may include any additional team members. These members could be instructors who will help with the redesign (e.g., other ALSI alumni), instructors who will be teaching the redesigned courses, any instructor-adjacent roles (e.g., lab managers), and department leader(s).*

### TEAM FACILITATOR #1 (REQUIRED)

- **Full Name:** Inseok Song
- **Professional Title**: Associate Professor of Astronomy
- **ALSI Alumnus?** No
- **UGA Email:** song@uga.edu
- **Other Relevant Experiences:** Active astronomer with ~150 peer-reviewed publications. Leading a STEM education enhance project (STEMin3d.net) by using immersive technologies and the leader of the AY24-25 Faculty Learning Community (“Faculties for Immersive Technologies”).

### TEAM FACILITATOR #2 (REQUIRED)

- **Full Name:** Nandana Weliweriya
- **Professional Title:** Lecturer

# Active Learning Grant Application 2025

- **ALSI Alumnus?** Yes (2021)
- **UGA Email:** nandanaw@uga.edu
- **Other Relevant Experiences:** Specializing in physics education research and undergraduate curriculum development, particularly in active learning and engagement, his research focuses on exploring students' problem-solving processes and strategies. He is especially interested in using his findings to shape and improve instructional methods.

OTHER TEAM MEMBERS (OPTIONAL)

- **Full Name**: Cassandra Hall
- **Professional Title:** Assistant Professor
- **UGA Email:** cassandra.hall@uga.edu
- Theoretical astrophysicist with extensive experience in inclusive education, particularly as the physics coordinator for an equal access to higher education program.

- **Full Name**: Marni Shindelman
- **Professional Title:** Associate Professor of Photography
- **UGA Email:** marni@uga.edu
- Expert in photographs and immersive videos and regularly teach photography courses.

## 6. BUDGET

*Applications for Change Grants will be evaluated based on the inclusion of a clear and comprehensive $15,000 budget that covers the redesign planning, implementation, and assessment. Plans that also include a financial commitment from the participating program to ensure sustainability will be preferred but not required*

| Category | Details | $ |
|---|---|---|
| **Supplemental Salaries for Facilitators** | Summer Salary for facilitator #1 | 4,000 |
| **Supplemental Salaries for Facilitators** | Summer Salary for facilitator #2 | 4,000 |
| **Outreach Expenses** | Graduate student support | 4,000 |
| **Operational Expenses** | Procure additional equipment | 3,000 |
| **TOTAL** | | **15,000** |
| **Anticipated Matching Funds by College** | | **unknown** |

# Active Learning Grant Application 2025

## 7. ASSESSMENT PLAN - REQUIRED COMPONENTS

*Change Grant applications must include an assessment plan to measure the impact on students' learning and success. The assessment plan should include clearly stated outcomes, measures, and a timeline for data collection (see prompts below). Applications must include an evidence-based assessment plan that includes student disciplinary knowledge indicators.*

| | |
|---|---|
| **Learning Outcomes**<br>*In what ways do you expect to see improvement in students' learning? Identify at least one learning outcome describing skills, knowledge, or competencies expected of students in this discipline that your Change Grant efforts will target. Consider using an existing course learning outcome (CLO) or program-level learning outcome (PLO) if appropriate. If identifying a PLO, explain how the course(s) redesigned through the Change Grant are critical points in the curriculum where the PLO is addressed.* | *In completing this course, connected to the topics covered in this class, Students will demonstrate,*<br>• ***Understanding and Utilizing Telescopes and Smartphones for Astrophotography:*** *proficiency in operating a telescope and smartphone for astrophotography, including proper collimation of the telescope mirrors and camera settings (ISO, exposure, etc.).*<br>• ***Data Collection and Image Processing:*** *develop skills in preprocessing and stacking astronomical image data to enhance the quality of images for analysis and demonstrate the ability to optimize data for scientific purposes.*<br>• ***Application of Observational Techniques to Celestial Phenomena:*** *Students will design and conduct observation projects such as imaging a galaxy, nebula, or cluster, and use their data to draw conclusions about astronomical objects. Students will analyze the phase and libration of the Moon, the phase of Venus, and perform astrometric measurements of Galilean moons, fitting their orbits and calculating orbital periods and sizes.*<br>• ***Astrophysical Observations and Analysis of Variables:*** *Students will analyze the color-scale relationship between RGB color data from smartphone cameras and the temperature of stars, gaining insight into stellar classification.*<br>• ***Synthesis of Observational Data into Scientific Context:*** *Students will synthesize observational data into scientifically meaningful outputs, such as creating animated movies of the Galilean moons and measuring their positions for further analysis. Students will be able to justify and explain their thinking and approach to solve a problem in either written or oral form.*<br><br>**Connection to Course Learning Outcomes (CLOs) and Program-Level Learning Outcomes (PLOs):**<br><br>**CLOs:** These outcomes align with the course learning objectives, particularly in teaching students how to use modern technology for astrophysical observations and process the resulting data scientifically. Students will develop technical, analytical, and observational skills essential for advanced studies in physics and astronomy.<br><br>**PLOs:** These activities target key program-level outcomes in physical sciences and engineering, where students are expected to:<br>1. Demonstrate proficiency in using experimental equipment and techniques for data collection and analysis. |

| | |
|---|---|
| | 2. Apply mathematical and scientific principles to solve real-world problems in physics and astronomy.<br>3. Develop communication skills in presenting scientific data and interpreting results for both scientific and public audiences.<br><br>This Change Grant effort enhances the curriculum by providing hands-on learning opportunities that contribute to these competencies, preparing students for more advanced studies in astrophysics. |
| **Specific Measurements**<br>*Describe the assignment, exam, survey, project, etc., to assess whether students have achieved the learning outcome. Consider a pre/post design to capture the impact of the course redesign. Please describe the specific data that will be collected and how it will be analyzed over time.* | **1.) Pre-Course Survey (Baseline Knowledge Assessment)**: to measure students' baseline knowledge and skills in astrophysics, telescopic observation, and image processing before engaging in the redesigned curriculum.<br><br>The survey consists of: Multiple-choice questions, Likert scale questions (on confidence and previous experience), and short-answer questions.<br>The survey will include questions on: Basic understanding of telescope operations and astrophotography. Familiarity with concepts like field of view, image stacking, and data analysis. Knowledge of Kepler's Laws and stellar classification (RGB color-temperature relationships). Previous experience with light pollution mapping and observational techniques.<br>**Analyze pre-course responses** to determine areas of strength and areas that need improvement. Compare results by student demographics (e.g., prior experience in physics) to identify baseline trends.<br><br>**2.) Formative Assessments (Lab Sessions/Assignments):** to provide continuous feedback on student progress throughout the course. These assessments are linked directly to the hands-on activities that align with the learning outcomes.<br><br>Lab Reports: Students will submit reports for each observational activity, such as measuring the field of view, conducting astrophotography, and analyzing the Galilean moons' movement. Each report will focus on the application of scientific methods, data collection, image processing, and analysis.<br>Peer-Reviewed Presentations: Students' progress will be tracked over time to identify areas needing improvement and to measure their competency in astrophysical concepts. Halfway through the course, students will present their findings from a specific observational project to their peers. Presentations will assess both technical understanding and the ability to communicate scientific findings.<br>Analysis: Rubric-based evaluation will be used to assess students' ability to apply the scientific method, conduct precise measurements, analyze data, and interpret results.<br><br>3.) **Mid-Course Exam (Assessment of Technical Skills and Conceptual Understanding):** to assess students' grasp of the theoretical concepts and practical skills introduced during the first half of the course. |

| | |
|---|---|
| | **4.) Final Project (Astrophotography and Data Analysis):** to provide a comprehensive assessment of students' ability to apply all the skills and knowledge they've learned throughout the course, culminating in a final observational project.<br><br>The final project report will be graded based on: Technical execution (e.g., quality of images, accuracy of measurements). Data analysis (e.g., correctness of calculations, use of scientific principles). Discussion to potential sources of errors and uncertainties.<br>The final presentation will be graded based on: Communication (e.g., clarity of report, presentation quality).<br><br>**5.) Post-Course Survey (Evaluation of Learning Outcomes): t**o assess the overall impact of the course redesign on students' knowledge, skills, and competencies, and gather feedback on the redesigned curriculum.<br><br>The survey will include questions on: Likert scale responses (for confidence and skill levels), open-ended feedback.<br><br>**Overall Data Analysis Plan:** Pre/Post Comparison: The pre- and post-course surveys will provide a clear picture of student growth in knowledge, technical skills, and confidence. Statistical analysis (e.g., paired t-tests) will be used to compare pre- and post-survey results, identifying areas of significant improvement. |

## 7. ASSESSMENT PLAN - OPTIONAL COMPONENTS

*In addition to student disciplinary knowledge indicators, other impact data, such as student perspectives on the active learning approaches used in these course(s), instructor peer observations, and/or instructor self-reflections, will be especially welcome.*

| | |
|---|---|
| **Student Perspectives**<br>*In addition to indicators of students' disciplinary knowledge, change grant teams may also wish to collect students' perceptions of the active learning course redesign. To do so, teams could use course evaluations, gather supplementary reflections, and/or work with the Center for Teaching and Learning to build team capacity to conduct Mid-Semester Formative Evaluations for these classes* | In addition to measuring students' disciplinary knowledge, it is equally important to gather insights into their perceptions of the redesigned active learning course. Understanding how students experience the course, including the active learning components and the integration of technology, provides valuable feedback for improving course design and teaching strategies.<br><br>**1.) Course Evaluations:** We will conduct both Mid semester formative evaluations and End-of-semester course evaluations to assess students' overall satisfaction with the course redesign, particularly with regard to active learning activities. Specifically, Mid-Semester Formative Evaluations will help us gather feedback from students halfway through the course to identify issues early on and make adjustments if necessary.<br><br>**2.) Focus Groups or think-a-loud Interviews**: to gain deeper |

| | |
|---|---|
| *(more information here).* | insights into students' experiences, particularly for areas that require further exploration (e.g., challenges with specific active learning components), we'll conduct small focus groups or individual interviews with a sample of students throughout the course.<br><br>**We already have the IRB approval for conducting pre/post surveys and focus group or think-a-loud interviews.** |
| **Instructor Peer Observations**<br>*In addition to gathering student data, change grant teams may also wish to collect instructor data through observations of peers. To learn how to conduct peer feedback, the SEER Center on campus has options for training for individual instructors and entire teams (more information here).* | In addition to gathering student data, it is equally important to collect feedback from peers in order to gain insights into the effectiveness of the course redesign from an instructor's perspective. To ensure that peer observations are effective, instructors can seek out support from the **SEER Center and engineering EETI group** on campus, which offers training for both individual instructors and entire teams. |
| **Instructor Self-Reflection Components**<br>*Instructors can also provide reflections on the redesign process, including any adjustments made over time to the class as a result of the data collected and analyzed.* | Instructor self-reflection is a critical part of the course redesign process and it is an important part of the annual evaluations in the physics department. Instructor self-reflection will focus on the following key areas: (1) Reflection on Learning Outcomes and Adjustments, Reflection on Student Engagement and Learning, (2) Reflection on Technology Integration, (3) Reflection on Active Learning Strategies, (4) Reflection on Student Feedback and Course Evaluations, and (5) Reflection on the Redesign Process. |

# Active Learning Grant Application 2025

| 8. TIMELINE | |
|---|---|
| *Change grant applications should include a proposed project timeline that aligns with the Active Learning Change Grant implementation schedule provided below. Please check each step to ensure you agree to make progress in the timeline given.* | |
| Year One (Fall) | 1. Finish creating lab manuals for topics #1-#10 (on page 3)<br>2. Finish the setting and preparation of the cross-listed "Astrophotography" course<br>3. Publish a paper from the ASTR 3010 trial project in a peer-reviewed journal (e.g., American Association of Physics Teachers)<br>4. Provide the first FYOS 1001 on "Astrophotography"<br>5. Publish selected (N~3) ASTR 3010 term project reports into an individual undergraduate research paper (e.g., American Journal of Undergraduate Research) |
| Year One (Spring) | 6. Restructure all astronomy labs with LCT curricular topics<br>7. Finish lab manuals for the remaining topics (#11-#19)<br>8. Offer the cross-listed "Astrophotography" course<br>9. Gather student/classroom data |
| Year Two (Fall) Through Year Five (Spring) | 10. Revision of lab manuals from year 1 implementation<br>11. Arrange topics into a hierarchical course system targeting different student populations (e.g., intro-level course for non-science major, intro-level science course, upper-level science course, service-learning outreach course, etc.)<br>12. Publish project result in peer-reviewed journal papers (in yr2)<br>13. Share the developed lab manuals and other resources as OERs<br>14. Offer redesigned, active learning oriented, LCT curricular courses (all ASTR courses, FYOS 1001, and Cross-listed course) regularly. |