

a. Program Learning Outcomes

The Liberal Arts and Sciences (LAS) program learning outcomes have been changed. Please refer to the section on the LAS degrees for more information on the review process.

The program learning outcomes for Liberal Arts and Sciences that are applicable to the Astronomy sequences (AST 111, 112, & 113) are:

Outcome I – Critical Thinking/Problem Solving

Students should have the ability to think logically and problem solve using analysis, synthesis and evaluation.

Outcome II – Global Awareness

Students should recognize and articulate an understanding of the increasing interdependence of world cultures and their consequences.

Outcome III – Group Participation/Social Interaction

Students should learn to achieve group goals in a variety of social contexts.

Outcome IV – Professional Effectiveness

Students should demonstrate responsibility and accountability in accomplishing goals.

Outcome V – Communication

Students should be able to communicate effectively in a variety of ways with varied audiences.

b. End-of-sequence learning outcomes for Astronomy

In order to complete the sequence successfully the student should be able to do:

- Describe the major patterns and movements of the Sun, Moon, Planets and stars.
- Discuss the formation of the solar system and describe the major physical characteristics of each planet.
- Describe the minor bodies of the solar system (moons, asteroids, comets and meteoroids).
- Discuss the physical characteristics of the stars and the Sun (mass, temperature, radius, luminosity) and the relationships among these variables.
- Discuss the stages of evolution for stars of various masses and describe the properties of stellar remnants (white dwarfs, neutron stars and black holes).
- Discuss the properties of galaxies including the Milky Way.
- Discuss the history and possible futures of the universe.
- Discuss the history of astronomy including historical beliefs and major contributions to the field of astronomy.
- Discuss the night sky, how it appears from earth, and how constellations and coordinate systems are used to locate objects in the sky.
- Discuss the nature of gravity and electromagnetic radiation (including visible light).

- Describe the major types of telescopes and discuss how astronomers use them along with various detecting instruments to study celestial objects.

The study of any branch of mathematical sciences, including astronomy, should help students to develop certain skills, including problem solving and critical thinking. Some of the competencies students who finish the three-quarter astronomy sequence should be able to demonstrate include the following:

- The ability to grasp very large and very small numbers, to display these numbers in proper scientific format, and to manipulate them with the aid of a scientific calculator.
- The ability to solve for unknown quantities, given the values of other related quantities and the relationships between them
- The ability to analyze scientific data, both measurements and descriptions, and arrive at valid conclusions.
- The ability to think critically about scientific evidence presented to them and to make decisions based on that evidence.

III. Assessment Method(s): A measurable indicator of success in attaining the stated learning outcome(s). The methodology should be both reliable and valid. Please describe in detail.

- a. **Formative Assessment Method(s) and Description:** a measurable indicator of student in-progress success in attaining the stated learning outcome(s).

Students in the astronomy sequence complete an individual project as part of each course. The emphasis changes as students progress throughout the sequence: basic astronomy, the solar system, constellations. Students make an individual choice for their project; in AST 112, the student chooses a solar system; and in AST 113, the student chooses a constellation or other appropriate project. The projects require observation, research or problem analysis as well as writing a four-page paper with a bibliography.

Students in AST 113 also complete a multiple-choice test to assess their general knowledge of the astronomy sequence learning outcomes. The test consists of 150 questions derived from the astronomy test bank used by the department and measures astronomy vocabulary and thinking. The test is administered during lab class the last week of the quarter. Participation in testing is optional for the student; those that complete the test receive extra credit.

- b. **Summative Assessment Method(s) and Description:** a measurable indicator of end-of-program success in attaining the stated program learning outcome(s).

Not applicable to end-of-sequence assessment.

Refer to the report at the beginning of the Liberal Arts and Sciences for information on summative assessment of the program learning outcomes for Liberal Arts and Sciences.

IV. Results: A description of the actual results of overall student performance gathered from the assessment(s). (see III.a.)

The individual class projects that are done in AST 111-112-113 show evidence of thinking skills.

The astronomy test recently used for assessment in AST 113 has been administered over the past four years. The results are based on small sample sizes between 6-15 students. The average test score are very consistent with an average around 73%. The instructors observed that these test results are consistent with the course grades that were assigned.

A number of students continue on to four-year colleges for further study in Astronomy after completing the AST sequence. Some students pursue additional course work in science at four-year schools after completing the AST sequence. The AST sequence also attracts students interested in becoming science educators, particularly at the elementary education level.

One of the instructors has introduced a short pre-test assessment tool identifying common myths and misconceptions about astronomy and the universe. This pre-test data will allow for growth in learning to be tracked when compared to post--test assessment scores.

V. Analysis/Actions: From analysis of your summative assessment results, do you plan to or have you made any adjustments to your program learning outcomes, methodologies, curriculum, etc.? If yes, describe. If no, explain.

The new test developed for AST 113 will be administered again next year in order to increase the sample size and allow analysis of results from year to year.

It has been observed that students transferred in to the program from other institutions do less well on the assessment test than students who have taken the entire sequence of AST 111, 112, and 113 at Sinclair.

Anecdotal evidence suggests that through the AST sequence students become more aware of the astronomy in their daily lives. Planetarium visits seem to build interest for astronomy through hands on experience with this science.

VI. General Education: Are you using any tool(s) to assess any of the three primary general education outcomes* (communication, thinking, values/citizenship)? If so, describe.

- a. Where within the major do you assess written communication? Describe the assessment method(s) used. Describe assessment results if available.

Individual projects completed in all three courses of the AST sequence require students to write a four-page paper. That paper includes all the expectations appropriate for a college level research paper including a bibliography. Some students in AST 111 choose the creative writing option to meet the assignment requirement. All students must respond in writing to several short-answer questions on each exam. Students with severe writing difficulties are appropriately counseled and have difficulty succeeding in this course. Throughout the AST sequence, students are reminded of proper techniques for citing sources and creating a bibliography. No general education checklist or rubric is currently utilized when assessing student work.

- b. Where within the major do you assess oral communication? Describe the assessment method(s) used. Describe assessment results if available.

Oral communication skills are used during class discussions and through examination of controversial issues. Students also communicate when they work together as lab partners or when working together in groups. Lab-based activities are a portion of each AST course. This learning method encourages student interaction, discussion and dialog. No effort is currently made to offer formative feedback to students in a systematic way with respect to their oral communication skills.

- c. Where within the major do you assess thinking? Thinking might include inventing new problems, seeing relationships and/or implications, respecting other approaches, demonstrating clarity and/or integrity, or recognizing assumptions. Describe the assessment method(s) used. Describe assessment results if available.

Thinking skills are required in astronomy for conceptualizing distance and space and "time travel." Thinking is also required for students to understand the properties in astronomy of sizes, speed and time frames. Students must also use thinking skills to distinguish scientific fact and recognize assumptions. The essay questions used on course tests illuminate thinking as well as writing skills.

- d. Where within the major do you assess values/citizenship/community? These activities might include behaviors, perspective, awareness, responsibility, teamwork, ethical/professional standards, service learning or community participation. Describe the assessment method(s) used. Describe assessment results if available.

Global values and environmental issues are addressed in AST courses. Students acquire knowledge of historical and cultural differences in views of astronomy, especially in naming practices used commonly throughout Western civilization and the Northern hemisphere.

Students learn to see the Earth as a single planet with a common global environment. Discussions on how people effect this environment includes

various topics such as pollution, overpopulation, the clearing of land for farming and building and light pollution which makes it harder for today's students to see the night sky.

e. Computer and information literacy:

Basic computer skills are required for all students completing the AST program. Computer use is required in numerous AST classes. Papers are to be completed on a word processor; many lab activities require the use of computerized lab equipment or scientific calculators. Information literacy skills are utilized to access information, analyze the information for its usefulness and interpret findings.