Conference: Broadening Participation in an Astrosociology Curriculum

White Paper

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Abstract

Teaching courses that combine the social sciences with traditional STEM subjects can broaden participation for those who have been historically underrepresented in these fields. An undergraduate course in astrosociology fulfills a need to incorporate the human dimension into the burgeoning areas of space science and astronomy by studying the deep interrelationships between society and discoveries and opportunities in science. The one-day, online conference reported on here explored potential changes to the topic coverage and pedagogy of an existing astrosociology course to meet the needs of minority-serving institutions and to support interested faculty in promoting the adoption of a course at their institution. Eleven astrosociological course topics were discussed, ranging from science fiction to the conception of the "other." Six broad ranges of pedagogy were discussed: simulations, group-work, sustained reflection, hands-on activities, inquiry/project-based learning, and student discussions of readings. Issues related to diversity, equity, inclusion, and accessibility were covered, and methods to engage a diverse student body were brainstormed. Necessary procedural and preparatory steps for course adoption and teaching were discussed and elaborated upon, including: institutional approval, course preparation by the instructor, and novel ways in which students can be assessed.

0. Background and Purpose

The overarching goal of the NSF-supported virtual conference, "Broadening Participation in an Astrosociology Curriculum," was to gather a diverse representation of higher education faculty from various institutional types to collaborate on the examination and potential re-design of an astrosociology curriculum developed by Gerhard Sonnert at the Harvard Astronomy Department. Central to this effort was generating insights, from an equity-topic centered approach, into how to make the curriculum work at the national scale in diverse institutional environments, particularly at minority-serving institutions (MSIs). The conference goal was organized around three stakeholder-defined objectives:

(1) increasing participant awareness of the subdiscipline of astrosociology by introducing astrosociology and the astrosociology curriculum,

(2) exploring the curricular infusion of diversity, equity, inclusion, and accessibility (DEIA), and

(3) assessing faculty need/want to adopt the course successfully at their institutions.

The virtual conference was held on Friday, March 1, 2024, from 1:00 pm – 4:00 pm EST and was led by Dr. Sonnert. In organizing the conference, he invited the participation and support of various faculty, postdocs, administrative staff, evaluators, and Zoom tech personnel. There were 29 registrants, representing 20 distinct institutions. The conference was divided into three sessions of one hour each. Each session started with a general presentation of the session topic followed by small group brainstorming discussions in "breakout" rooms.

1. Session Overviews

- **Introductions & Overview**: The conference opened with a welcome address, emphasizing the importance of creating an inclusive and relevant astrosociology curriculum. Dr. Gerhard Sonnert provided an overview of the day's agenda and goals.
- **Session 1: Curriculum Overview (Led by Dr. Sonnert)**: This session presented the astrosociology curriculum, highlighting its interdisciplinary approach that combines astronomy with sociological perspectives. It focused on introducing the core topics and objectives of the curriculum, as well as discussing its student-centered pedagogy. Participants were divided into breakout groups to discuss potential topics to be added or dropped, as well as suggested readings to enrich the curriculum.
- **Session 2: Astrosociology - Infusing the Curriculum with DEIA (Led by Dr. Remy Dou)**: This session emphasized the tailoring of the astrosociology curriculum to meet the needs of students at MSIs by integrating DEIA principles in the context of culturally sustaining pedagogies.
- **Session 3: What Support will Faculty Need or Want to Successfully Adopt an Astrosociology Course? (Led by Dr. Philip Sadler):** This session focused on the different pragmatic, bureaucratic, and logistic challenges for adopting a new course that are posed in different institutional environments. Dr. Sadler offered various suggestions of how to proceed with efficiency and success. He also discussed how to evaluate students' learning in the course, i.e., their growth in "21st century skills" (National Research Council, 2011) and cognitive and meta-cognitive capabilities, because standard test formats (e.g., multiple choice exams) are incompatible with the pedagogical approach of the course.

- **Closure Discussion:** The final session summarized the day's discussions and outlined next steps. Participants shared their key takeaways and planned for the implementation of suggested changes to the curriculum.
- **Evaluation Survey:** The conference concluded with an evaluation survey, allowing participants to provide feedback on the sessions and the overall conference experience.

2. Astrosociology Curriculum Overview

What is astrosociology?

Astrosociology can been defined as "the study of social, cultural, and behavioral patterns related to outer space" (Pass, Hearsey & Caroti, 2010, p. 1), or, even more briefly—the study of the interrelationship of humanity and the cosmos. Spurred by new modes in which humans interact and are about to interact with the cosmos, astrosociology is an emerging sub-field, the latest to differentiate out of astronomy.

History of the curriculum

The course ASTRON 5 Astrosociology was designed as an offering of the astronomy department to undergraduates of all concentrations (majors) and introduced in the fall semester of 2017. Since then, the course has become highly popular. The last few semesters, about 150 prospective students entered the lottery for the 25 seats in the course (the size of the course is capped because of its particular pedagogy, outlined below). The course has received exceptionally high ratings from participating students in the course evaluations.

3. Session 1: Introduction to astrosociology and the astrosociology curriculum

The course on astrosociology is designed to appeal to two target audiences among the undergraduate population: First, it behooves all future professionals in space-related fields (astronomers, engineers, as well as those in sales and human resources) to develop a sense of the wider non-technical issues connected with their work and to become accustomed to thinking critically about them. The course encourages these students to develop a critical perspective on their intended work and careers, a perspective that looks beyond purely scientific research and technical skills. By making astrosociology part of the astronomy curriculum, this broader student outlook is encouraged and strengthened.

Second, decisions and occurrences in the astrosociological realm affect not only specialists in the field, but the whole citizenry or even humankind and are therefore of universal interest. Moreover, in the broadest—and a liberal arts education sense—the course provides a vehicle for all students to learn to think critically about things that are outside their normal life-world and thereby also to learn more about themselves (in the sense of discovering and explicitly addressing unquestioned assumptions they hold).

The curriculum is innovative in both content and pedagogy. It is highly interdisciplinary, exploring the social dimensions of space exploration and astronomy.

A. Curricular Contents of the Course

The topics cover the gamut of modes of human interaction with the cosmos, from the beginnings of humanity to speculative future events such as detection of extraterrestrial intelligences or even contact. The following is a brief description of the units of the astrosociology course, their purpose, and main learning goals.

I. Astrosociology: Definition and Context

Students are introduced to a brief history of astrosociology and its current status as an evolving interdisciplinary field, spanning science, social science, and the humanities. The unit motivates students to reflect on the following questions: What is science? How is science different from, and similar to, the humanities? Why do we do science?

II. Astronomy Past and Present

This unit presents a broad history of astronomy from a sociological perspective. It considers the role the sky has played for human cultures and societies since the beginning. Emphasis is placed on Durkheim's distinction between the sacred and the profane and the dual function of astronomy as integrating both practical (time measurement, navigation) and sacred (sky as heaven and home of gods in many cultures; origin myths and explanations of day/night and the seasons) elements. Of particular interest is how sometimes the realms of the sacred and the profane collide in modern astronomy (e.g., when a telescope is to be built on land considered sacred by indigenous people, such as the Thirty-Meter-Telescope on Mauna Kea, Hawaii). The course examines the power of basic assumptions, a worldview, or axioms on which scientists base their theories. How would a "flat-earther" interpret Eratosthenes' famous measurement? How did Ptolemy try to protect the axiom of uniform circular motion in the face of astronomical observations (epicycles, equant, eccentric)? How did the heliocentric model come about? Virtually all students "know" that the Earth spins on its axis and orbits around the sun, but surprisingly few students are able to come up with scientific evidence for either fact. This should foster insights into the determinants of culturally self-evident knowledge and might inspire some modesty toward ancient ("wrong") astronomical systems (Ptolemy was not an idiot!).

Similarities and differences between astrology and astronomy are discussed. During the repeated instances of teaching the course, it turned out that more students than expected have been

interested in horoscopes. An exercise demonstrates the limited predictive power of horoscopes. Finally, the science-internal and societal factors that shape the development of a discipline are explored. The concrete example is how scientific advances (spectroscopy) and technological developments (photography) can influence how astronomy is done (transition to astrophysics) and by whom (entry of women into the field).

III. Ontology and Epistemology

In a field such as astrosociology that is dealing with "weird" issues and phenomena (UFOs/UAPs, aliens, etc.), conspiracy theories and fringe theories abound. This brings home the necessity of addressing some fundamental questions about how to address such issues in a reasonable way. Students should reflect upon questions such as: What is truth? What is reality? Major truth theories are discussed, as well as their relationships to science. The "black swan" theory of unexpected, high-impact events is introduced. The "Tricky Tracks" exercise (National Academies of Sciences, 1998, pp. 87-89) has been found useful for making students aware of their epistemological assumptions.

IV. UFOs

UFOs—or, in more recent parlance, UAPs (Unidentified Anomalous Phenomena)—are a core topic for astrosociology, and public interest in UFOs/UAPs has, if anything, even increased recently. Students should reflect upon science and pseudo-science, on how to tell these two apart, and on how to make decisions based on woefully incomplete information. This unit supports students' critical thinking about conspiracy theories and the soil in which they grow (e.g., secrecy).

V. Science Fiction

In this unit, we observe the influence of science upon science fiction—and vice versa. Science fiction is viewed as a cultural critique, commentary, or as a thought experiment. For

instance, in the guise of Afrofuturism, science fiction provides a canvas for radically questioning deep-seated concepts of racism and perhaps even the idea of race itself. The class also watches a classic silent movie adaption of Jules Verne's *From the Earth to the Moon* (1865).

VI. Conceptions of the "Other"

The concept of the alien, central to astrosociology, is rooted in a rich sociological tradition of studying the stranger or the "other" in the context of group formation (in-group/outgroup dynamics, historical examples, such as colonialism, group reactions toward threats). Students are invited to reflect on their own reactions and attitudes toward "others" of various kinds and on situations in which they themselves were the "other."

VII. Space Exploration

The recent advances in space exploration hold great interest for students, particularly for those who are planning careers in this sector. The course covers some basics of space law and space treaties, the national and international institutions of space policy making, as well as the history of the space race of the 1950s and 1960s and its relation to the Cold War. Other topics include planetary defense (against asteroid impact) and planetary protection (against microorganisms), asteroid mining, potential Moon and Mars settlements, and the present and future state of the space economy. Ethical aspects of space exploration and problems of "colonization" (a concept that is highly contentious in view of terrestrial precedents) are also discussed. A more speculative aspect of space exploration is whether extraterrestrial intelligence exists or whether humanity is alone. The classic Drake Equation and the Fermi Paradox are discussed, as well as the various methods of discovering exoplanets. Students are challenged to develop their own thinking about the probability of extraterrestrial intelligence by estimating parameters of their personal Drake Equation.

VIII. Extraterrestrial life and civilization

To better understand the concept of extraterrestrial intelligence, students are invited to ponder two fundamental questions. What is life? And what is a civilization? Terrestrial examples of life in unexpected and extreme environments are examined. By asking themselves what elements they think are necessary to speak of a civilization, students should become aware to what extent their definition is conditioned by their experiences and knowledge of humanity and should reflect upon the extent to which they are prepared to relax those presuppositions.

IX. Problems of Communication

The difficulty of communication is often underestimated. This can be illustrated by difficulties in communicating within our own species, especially over long ranges of time. The questions here are: How *could* we communicate with extraterrestrial civilizations? And relatedly: *Should* we attempt to communicate with extraterrestrial civilizations in the first place?

X. SETI/METI: Listening for and Messaging Extraterrestrials

This unit chronicles the search for signals from extraterrestrial civilizations—from radio transmissions and spectroscopic signatures to physical objects and to the plan of sending a fleet of tiny starships to a planet orbiting Proxima Centaury (Project Breakthrough Starshot). What are the main technological challenges for such attempts? Past attempts at messaging into outer space, such as the Pioneer Plaques and the Golden Record, are critically evaluated.

XI. Sociological Implications of Detection and/or Contact

What is the range of possible scenarios of detection and/or contact and their short-term and long-term effects? What are their likelihoods? Students imagine scenarios from catastrophe to deliverance, and anywhere in between. What are more specific impacts on the world's religions, culture, and economy? What are the ethics of detection (when and how to tell)? Can lessons be

drawn from terrestrial analogs of cultural encounters (ranging from genocide and colonialism to mutually beneficial exchange)?

XII. Additional topics suggested by conference participants

During the breakout room discussions, multiple suggestions of additional topics were made. Among them were to integrate health and health research integration (e.g., in considering hearing loss and multiple other health issues brought on by humans' exposure to microgravity and cosmic radiation). Another suggestion was to discuss the psychological and social challenges posed by a long confinement to small, isolated spaces, such as spaceships or space colonies. Furthermore, it was suggested to explore the published data archives on exoplanets, the challenges of dealing with space junk, and to engage in case studies of commercial space enterprises.

Furthermore, it was emphasized that the curriculum should be adaptable to cater to different student populations and their interests, thus allowing for varied opportunities in course content. There was a call for including more content on the history of underrepresentation, particularly of women, within the curriculum. Participants also suggested that the curriculum could be enriched by adding philosophical discussions, such as addressing biases in scientific research and the ethical aspects of space exploration.

B. Pedagogy

The course is based on a theory of teaching and learning that goes beyond the traditional lecture model. That traditional model characterizes education as the transmission of knowledge from the instructor to the students. One precondition of this model is that a standardized canon of subject knowledge exists that needs to be absorbed by the students during a course. In an introductory astronomy course, such subjects would typically include the solar system, orbits and

gravity, stars, galaxies, the Big Bang, and space exploration. By contrast, astrosociology is a new field in which such a canon of established knowledge does not exist. This presents the opportunity for the course to emphasize alternative pedagogies that include inquiry-based and active learning approaches and center on the student learners, affording them the greatest latitude to follow their own interests.

I. Simulations

Simulations are at the heart of the pedagogy in this course. All simulations are done by student groups, which helps students practice constructive teamwork. The topic of astrosociology is particularly suited to invite students to enter, make sense of, and make decisions in, highly unusual, speculative, and ambivalent scenarios. For instance, there is a lengthy simulation of a spaceship coming to Earth, in which students have to assume the roles of various decision-makers with different interests. Another simulation asks students to replay terrestrial evolution in the absence of the emergence of humanity. This simulation is intended to get students to think about the extent to which evolution is driven by random events with outsized effects on its future trajectory—and the extent to which evolution converges on a basic trajectory, regardless of random jitter. In the Mars Colonists Selection Committee exercise, students are asked to consider potential technical and social problems and emergencies that might arise in a Mars settlement and to evaluate needed and desirable personal characteristics and skill sets as well as group composition issues.

II. Group work and collective learning

Most student exercises involve small groups of students who work together on tasks and then interact with the whole group. In addition, one or two formal debates are held. These activities

give students the opportunity for social interactions. Afterwards, de-briefings make students aware of social dynamics that occur during the exercises.

III. Sustained reflection

In one assignment, students are required to take the role of a freshly arrived alien sociologist and, for one week, to keep a research journal of human behavior in order to make sense of it. This exercise is designed for student to become aware of some of their implicitly held foundational cultural knowledge

IV. Hands-on activities

Building simple quadrants from protractors and straws and measuring the position of the sun is a hand-on experience that provides students a sensorimotor connection to astronomy and fosters respect for the tradition of celestial measurement and navigation and for professional astronomical instruments.

V. Inquiry-based and project-based learning

The course has no final in-class exam; rather, a large part of the course credit is based on a final project. In this form of authentic assessment, students examine a topic of their own choosing in depth. Whereas students in the humanities and social sciences typically are already experts in producing a 10-12-page research paper on their own, students in the natural sciences are less accustomed to the process. Therefore, a series of deadlines or milestones are implemented during the course of the semester (e.g., choice of a topic, a brief prospectus, a literature list), which helps scaffold the process, counteracts procrastination, and allows for the early detection of problems. In the very few problematic cases, we have added intermediate milestones. The scaffolding system that is in place is highly efficient in making the successful completion of the task possible for all students (regardless of backgrounds and potential learning challenges).

VI. Student discussion of readings

Another element of student-centered pedagogy is fostering students' responsibility for discussing the course readings. Each unit has readings, which are divided into required readings and optional readings. For each unit, a small group of students are designated "discussion leaders" who briefly introduce the readings and then lead the class discussion about them. Ahead of the discussion, all students are required to post a comment or question about the readings on Canvas (a course website). These posts help the discussion leaders to structure the discussion; leaders can pose a student question to the class or call on that student to elaborate. The intention of the student-led, rather than instructor-led, discussions is to get students to value each other as essential partners and resources in their own learning and to impress upon them that they should not reflexively "tune out" when another student speaks.

VII. Additional suggestions by conference participants

It was emphasized that encouraging different student roles and responsibilities in discussions and projects could enhance engagement and learning. Offering alternatives to traditional readings, such as special projects, was encouraged to provide varied learning pathways and cater to different learning styles.

4. Session 2: Infusing the Curriculum with Diversity, Equity, Inclusion, and Accessibility (DEIA)

The focal point of Session 2, led by Dr. Remy Dou, was the adaptation of the astrosociology curriculum so that it would be more inclusive and relevant to students from various groups who often face marginalization in undergraduate STEM contexts. The session was divided into two halves: a presentation on Culturally Sustaining Pedagogies followed by an interactive

brainstorming discussion. Dr. Dou began with a comprehensive presentation outlining "Culturally Sustaining Pedagogies" as a framework for incorporating the diverse experiences and characteristics of various student groups, including first-generation college students, Black, Latino, Indigenous, or other racialized groups in STEM, female and non-binary students, LGBTQ+ students, students with disabilities, recent immigrants, socioeconomically disadvantaged students, community college students, and linguistically and culturally diverse students.

By integrating the principles of Culturally Sustaining Pedagogies and addressing the specific needs of marginalized student groups, revisions of the astrosociology curriculum should aim to not only broaden participation in this emerging field but also contribute to a more inclusive and equitable STEM education landscape. Dr. Dou introduced these principles as articulated by Alim, Paris, and Wong (2017):

1. **Culture is Complex:** Recognizing that culture is multifaceted and dynamically influences students' identities. This principle encourages educators to appreciate and incorporate the rich cultural backgrounds that students bring to the classroom.
2. **Decentering the White Gaze:** Challenging Eurocentric perspectives and affirming diverse cultural viewpoints. This involves re-evaluating curriculum content to ensure that it reflects a variety of cultural perspectives and experiences.
3. **Critically Reflective:** Encouraging both students and educators to reflect on their own assumptions and biases. This critical reflection helps to foster an inclusive environment where all students feel valued and understood.
4. **Desire-based Approaches:** Focusing on students' strengths and aspirations rather than their deficits. This approach shifts the narrative from what students lack to what they bring and can achieve.

5. **Pluralistic:** Embracing multiple ways of knowing and understanding the world. This principle supports the inclusion of diverse epistemologies and methodologies in the curriculum.
6. **Sustaining Lives:** Ensuring that educational practices support and sustain students' cultural and linguistic backgrounds. This involves creating learning environments that affirm and celebrate students' identities.

Dr. Dou emphasized that faculty looking to adapt the curriculum should draw on their expertise and experiences with their own student populations to propose relevant ideas. He positioned this as aligning with the goals of the curriculum, which include fostering an understanding of, and questioning, assumptions, as well as developing a skilled mindset for dealing with extraordinary phenomena in a reasonable manner.

The second half of Session 2 involved an interactive brainstorming session where participants discussed various aspects of adapting the astrosociology curriculum. Using a Jamboard and Zoom breakout rooms, several key points emerged from these discussions:

- **Improving Critical Thinking:** The course should prioritize enhancing students' ways of thinking over merely delivering content. This involves exploring strange phenomena to encourage questioning of assumptions and developing a mindset for dealing with the extraordinary. Participants highlighted the importance of fostering critical thinking skills that enable students to navigate and understand complex, and often extraordinary, phenomena. This focus on critical thinking helps students not only in their academic pursuits but also in their personal and professional lives, equipping them to handle a wide range of challenges.

- **Interdisciplinary Integration:** Participants discussed the potential challenges of integrating sociology and astronomy. Suggestions included adopting interdisciplinary approaches that make these subjects accessible and relevant to all students. The integration of sociology and astronomy presents unique challenges and opportunities. While some participants expressed concerns about the difficulty for astronomers to grasp sociological concepts and vice versa, the consensus was that an interdisciplinary approach could enrich the curriculum. This could involve collaborative teaching methods, interdisciplinary projects, and an emphasis on the interconnectedness of these fields.
- **Creating Equal Opportunities:** Participants' comments emphasized the importance of equity in education, ensuring that all students, regardless of background, have equal opportunities in space-related fields. This includes addressing systemic barriers and making resources accessible to all. There was a focus on making space-related education accessible to a broad range of students, including ROTC students, veterans, and those from historically underrepresented groups. This includes addressing any potential assumptions about their capabilities and ensuring that opportunities are truly available to everyone. In particular, it was suggested that the curriculum should not shy away from including military applications and history, especially to attract and engage ROTC students and veterans. This suggests a need for pedagogical approaches that respect and integrate the experiences and interests of students with military backgrounds. The concept of equity should be extended to discussions about how resources should be allocated fairly in outer space, reflecting broader societal debates about fairness and justice. This could inform pedagogical approaches that include discussions about ethics and equity in science and technology.

- **Inclusive Topics:** The curriculum should include diverse and relevant topics such as gender, economic inequality, Afrofuturism in science fiction, genetic diversity, ableism, and drawing from indigenous knowledge. Including a wide range of topics ensures that the curriculum resonates with students' diverse experiences and interests. Participants suggested incorporating themes such as Afrofuturism to explore speculative futures through a culturally rich lens, using indigenous knowledge to provide alternative perspectives on land, space, and the cosmos. There should be an emphasis on understanding and respecting diverse cultural perspectives, particularly when addressing topics that intersect with indigenous worldviews, such as the Mauna Kea telescope controversy. Educators are encouraged to integrate these perspectives thoughtfully into the curriculum.
- **Communication and Contact:** Exploring anti-colonial approaches to the existence of extraterrestrials and considering communication from philosophical and linguistic perspectives. Addressing the possibility of extraterrestrial life through anti-colonial approaches helps challenge traditional narratives and promotes a more inclusive understanding of space exploration. Discussions also emphasized the importance of considering philosophical and linguistic aspects of communication, which are crucial for understanding potential contact with extraterrestrial civilizations.
- **Developmental Pedagogies:** Using developmental frameworks, such as those proposed by Piaget, to guide and score student learning. Applying developmental pedagogical frameworks ensures that the curriculum is tailored to students' cognitive and developmental stages. This approach can help in designing assessments and learning activities that are appropriate for different age groups and learning levels.

- **Socioemotional Support:** Building a supportive community that values the socioemotional well-being of students, ensuring they feel included and respected. Socioemotional support is vital for creating an inclusive learning environment. Participants emphasized the need for community-building activities, mentoring programs, and other support mechanisms that help students feel valued and connected.
- **Perspective Taking:** The challenge of integrating indigenous worldviews with the worldview of science was emphasized. One pedagogical device would be to intentionally reverse roles to encourage students to take, and learn about, each other's perspectives. For instance, in the case of the Thirty Meter Telescope, to have indigenous students argue the pros and white students argue the cons.
- **Diverse Learning Needs:** Acknowledgment of the varying levels of mathematics mastery among students, regardless of their educational background. This highlights the need for differentiated instruction and support, such as mathematics labs or additional tutoring. This approach aims to include rather than exclude students who may struggle with more advanced mathematical concepts.

The key outcomes of this session included practical pedagogical strategies to engage a diverse student body. Moving forward, the insights and suggestions will inform the revision and enhancement of the astrosociology curriculum, ensuring it is inclusive, relevant, and accessible to students at minority-serving institutions. This collaborative effort marks a significant step towards broadening participation in astrosociology and fostering an interdisciplinary and socially responsive educational environment. The continued engagement and contributions of faculty from diverse backgrounds will be crucial in achieving these goals and ensuring the curriculum remains

dynamic and impactful. The implementation of these ideas will involve ongoing collaboration, iterative feedback, and a commitment to educational equity and excellence.

5. Session 3: What support will faculty need or want to successfully adopt an astrosociology course?

Dr. Philip Sadler discussed several procedural and administrative steps that are necessary to get an astrosociology course approved in an institution of higher education. While the specifics can vary, the basics are similar, as the proposal moves up from the department to divisional or school or even institutional levels. Furthermore, an astrosociology course, owing to its uniqueness and interdisciplinarity, poses particular challenges to the instructor in terms of preparation and support.

- **Getting approval**

The following are useful general tips for getting a new course approved (as adapted from https://www.student.com/blog/how-to-get-college-course-approved/):

  - *Show the demand for the course:* Be ready to present evidence of student interest. Acquiring the number of students who want to take an astrosociology course may be a challenge. You may also want to send out a survey to students. Students may appreciate the unusual opportunity to take a course in a "hard science" department that foregrounds the social implications of that science.
  - *Explain the goal of the course (selling the course to the administration):* The administration will need to know the purpose and goal of a new course you want to implement. Explain the unique benefits that the astrosociology course will give students and the growing demand for the skills that the course will teach.

- *Present how the course will fill a department need and university's mission:* Presenting specifics about the astrosociology curriculum will show both how it fits and its uniqueness. Specify the credit hours and course name. Use a sample syllabus, schedule, and other details provided here.
- *Clearly state the learning outcomes of the course:* The department chair will need to know what it is that the students should be able to do at the end of a course that they could not do at the beginning. The outcomes should be student-centered rather than instructor-centered and they should be measurable. Fundamentally, the astrosociology course is not about science facts or skills, but about furthering students' critical thinking and supporting their cognitive growth. This poses specific issues of assessment (discussed below).
- *Show that you have done your homework:* Each university's course approval requirements are different. Do not forget to check out your university web page for course approval requirements and deadlines.

- **Preparation**

There are many tips for instructors how to prepare for teaching a new course (e.g., https://www.facultyfocus.com/articles/course-design-ideas/planning-a-course-youve-never-taught-before/). However, the situation of preparing to teach an astrosociology course is somewhat different and unique. Two useful tips—gathering and reviewing previous course syllabi and resources, plus talking to people who have taught the course previously—are widely applicable for standard courses (e.g., Introduction to Astronomy) where there exists a wealth of courses, textbooks, and plenty of colleagues who have taught the course before. In astrosociology, there is basically just one instance of the course, one syllabus, and one experienced instructor. Hence, a

major incentive for this conference was to introduce the syllabus, resources, and offer support for teaching it to interested instructors. What is more, owing to its extreme interdisciplinarity, preparation and support are needed to a particularly high degree because few instructors will be equally familiar with all diverse elements of the course, ranging from the history of astronomy to science fiction and epistemology. Co-teaching, if possible, is an excellent way to teach this curriculum while drawing on the skills and knowledge from different disciplinary backgrounds.

- **Assessment**

Assessment is another demanding issue for the astrosociology course because the typical assessments that occur in college-level courses are not available in the astrosociology course. Typically, midterm and final exams ask the students to demonstrate mastery of the material they have learned in the course. In an Introduction to Astronomy exam, students might be asked to calculate orbits, to recall facts about galaxies, stars, and planets. The astrosociology course is explicitly designed not to teach the students a canon of facts and procedures, but to help advance what have been called 21st century skills. These include (National Research Council, 2011):

  - Cognitive skills: nonroutine problem solving, critical thinking, systems thinking.
  - Interpersonal skills: complex communication, social skills, teamwork, cultural sensitivity, dealing with diversity.
  - Intrapersonal skills: self-management, time management, self-development, self-regulation, adaptability, executive functioning .

The following figure from Levi & Murnane (2004) illustrates the increasing importance of these advanced skills in the economy.

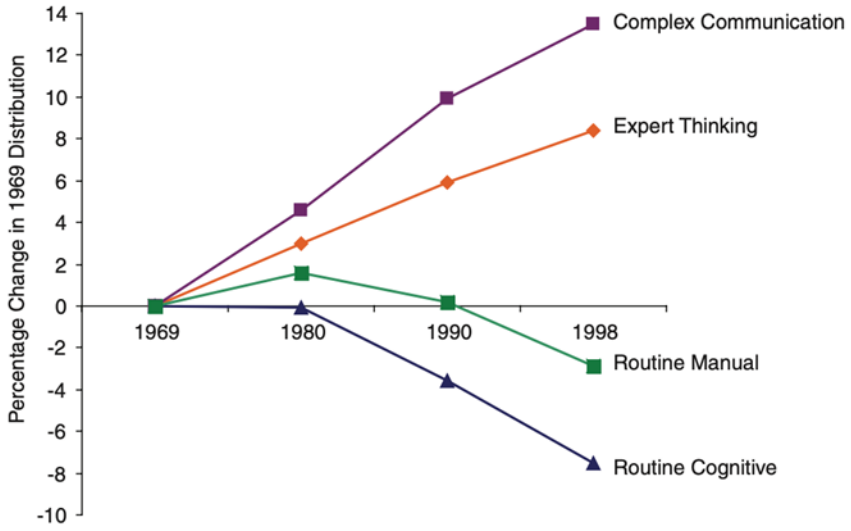

FIGURE 1-5 Economy-wide measures of routine and nonroutine task input: 1969-1998 (1969 = 0).

There are a variety of critical thinking tests, such as Watson-Glaser Critical Thinking Appraisal (WGCTA), the Cornell Critical Thinking Test (CCTT), the California Critical Thinking Skills Test (CCTST), the California Critical Thinking Disposition Inventory (CCTDI), and the LRJA Lectical Reflective Judgment Assessment (LRJA) (Dawson-Tunik, 2006), the latter being the preferred choice of the Harvard astrosociology instructor (see discussion of critical thinking tests in National Research Council, 2011).

- **Additional suggestions by participants**

In the breakout rooms, participants emphasized that different institutions will want to focus on different contents, pedagogies, and assessment strategies, depending on local challenges and resources (e.g., collaborating with local observatories or museums). The interdisciplinary nature of the course will require providing professional development for the instructors. It was noted as a particular challenge for this course to recognize and integrate skills such as mobility, sustainability, problem-solving, and communication, which are often undervalued as "soft" skills but are essential for student success in this course, and that this should be emphasized in course

proposals to administrators. It was further pointed out that designing assignments and activities, such as interviewing students and writing reports, can be a barrier if not well-integrated into the curriculum. These practical activities are crucial for deepening student understanding but require careful planning and resources. In terms of assessment, one proposal was pre-post student self-assessments to compare their expectations of what they will learn in the course at the beginning of the semester to what they think they actually gained at the end of the course.

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