Pedagogical Framework for the Human Mission to Mars Course

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1. Overview and Pedagogical Philosophy

The Human Mission to Mars course is an interdisciplinary exploration of one of humanity's most ambitious undertakings — sending humans to Mars and sustaining life there. Designed within the flipped-classroom format, this course empowers students to engage actively with scientific, engineering, social, and ethical challenges while cultivating what historian author Dr. Yuval Noah Harari calls "the Four C's:" Collaboration, Communication, Critical Thinking, and Creativity[†]. Instead of relying on traditional lectures, students come to class prepared to discuss and apply concepts they have explored through readings, videos, and multimedia content. Class time is devoted to solving problems collaboratively, engaging in inquiry-based discussions, and developing project-based outputs.

2. Learning Framework: The Four C's

A. Collaboration

Collaboration is central to the structure of this course. Each student belongs to a small interdisciplinary team that works together on a series of projects addressing key challenges of Mars exploration—such as propulsion, life-support systems, human adaptation, and the ethics of colonization. Each project designates a rotating team leader, ensuring that all students experience leadership responsibilities and group coordination. Through this structure, students learn how to manage distributed responsibilities, integrate diverse disciplinary perspectives, and produce unified deliverables. Collaborative assessment emphasizes team process as much as product.

B. Communication

Students refine their scientific and technical communication skills through multiple modalities: written communication in three short research-based papers summarizing group findings; oral communication through end-of-semester team presentations functioning as the course's final examination; and interpersonal communication within teams, as each group must articulate ideas, negotiate viewpoints, and convey progress

[†] Harari, Y. N. 2018, "21 Lessons for the 21st Century," Random House, New York, p. 252

effectively. These experiences simulate real-world scientific collaboration, where clear communication across disciplines determines the success of complex missions.

C. Critical Thinking

The course design systematically guides students through the scientific method and the process of hypothesis-driven inquiry. Each module presents students with open-ended questions rather than closed factual problems—for example, 'How can we design a self-sustaining habitat on Mars using *in situ* resources?' or 'How will prolonged spaceflight affect human psychology and biology?' Students must gather evidence from multiple disciplines, evaluate competing models, assess uncertainty, and justify their conclusions based on empirical and theoretical reasoning. Quizzes and class discussions reinforce comprehension and analytical reasoning, while project work allows deeper critical synthesis.

D. Creativity

Creativity is cultivated not as an abstract ideal but as a practical necessity. Students are challenged to design original, plausible solutions to unprecedented problems—engineering systems, life-support strategies, psychological interventions, and ethical frameworks for Martian habitation. By embracing failure as a natural part of creative inquiry, students learn to iterate, reframe, and improve their ideas. This aligns with one of the course's learning outcomes: to 'explore the process of scientific inquiry and creativity (including failures) to address a problem or challenge.'

3. Course Design and Assessment Integration

Component	Purpose	Skills Reinforced
In-class Quizzes (35%)	Assess comprehension of pre-class materials and conceptual readiness.	Critical Thinking
Three Short Papers (40%)	Encourage synthesis of project results, structured reasoning, and written clarity.	Communication, Critical Thinking
Oral Group Presentations (20%)	Demonstrate collaborative integration of knowledge and persuasive communication.	Collaboration, Communication, Creativity
Attendance and Engagement (5%)	Encourage presence, preparation, and peer accountability.	Collaboration

4. Interdisciplinary and Integrative Learning

The course structure exemplifies integrative learning, blending natural sciences, engineering, psychology, architecture, and ethics. Each module—taught by a faculty specialist—builds on the previous one to create a holistic understanding of Mars missions: scientific foundations (planetary exploration and propulsion); human adaptation (biological and psychological); engineering design (habitat construction and life-support systems); and societal and ethical implications (AI integration, discovery of extraterrestrial life). This progression reinforces the idea that real-world challenges demand multidimensional thinking and cooperative expertise.

5. Experiential Learning and Student Empowerment

By rotating leadership roles, designing solutions, and presenting findings, students take ownership of their learning process. The flipped model transforms instructors into facilitators, guiding inquiry rather than delivering information. The course embodies active learning—students not only consume knowledge but produce it. This pedagogical model mirrors the environments of research teams and space agencies, where success depends on curiosity, adaptability, and mutual trust.

6. Alignment with Institutional Goals

As part of the FAU General Education Curriculum in the Natural Science area, Human Mission to Mars fulfills key objectives: demonstrating scientific reasoning and ethical research practice; engaging students in evidence-based problem solving; and cultivating interdisciplinary literacy and societal responsibility. By merging scientific rigor with creative exploration, this course exemplifies the university's commitment to preparing students for complex, global challenges that extend beyond disciplinary boundaries.

7. Summary

The Human Mission to Mars course at Florida Atlantic University operates as a living laboratory for the Four C's. Through its flipped design, project-based structure, and interdisciplinary focus, it offers students not only knowledge about Mars exploration but also the skills essential for leadership in the 21st century: to think critically, create boldly, communicate effectively, and collaborate meaningfully.