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Expanding Student and Faculty Engagement in NASA's Artemis Mission Through a Novel Mini-Grant Program at an MSI

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Dr. Richard Warren Jr., Professor at the University of Maryland Eastern Shore, a former Maryland State Teacher of the Year, and Chair of Education Executive Policy for the Moore-Miller Administration. As an award-winning scholar, his research examines the recruitment, development, and resilience of Black male educators amid systemic barriers. Through qualitative inquiry and programmatic innovation, Dr. Warren advances strategies to strengthen teacher pipelines, support educator longevity, and reimagine equitable pathways into the profession.

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Abstract

NASA–MSTAR program has selected the three-year proposal titled *"DREAM: Developing Robotic Explorations with Agrobots and Moonbots"* at the University of Maryland Eastern Shore (UMES) as one of the nine recipients of their PHASE-III awards in September 2023. The program integrates NASA's Minority University Research and Education Program (MUREP) with Space Technology Artemis Research (STAR) to expand participation of minority-serving institutions in Artemis-related research and education.

The DREAM project supports three primary objectives: (i) engaging UMES and partnering institution students in research on rover-based lunar exploration and autonomous navigation, (ii) conducting preliminary experiments in plant growth using robotic platforms in simulated lunar regolith, and (iii) fostering broad campus and community engagement through curriculum integration and innovative projects aligned with NASA's Artemis mission. These efforts are especially timely as Artemis II prepares for the first crewed lunar flyby since Apollo, and subsequent Artemis missions aim to achieve a historic lunar landing with the first woman and the first person of color on the Moon.

To advance the third objective, DREAM project has integrated a mini-grant program that funds two interdisciplinary faculty–student projects each year. The inaugural year supported projects on an extravehicular activity (EVA) smart toolset for planetary field geology, and integration of lunar soil chemistry into advanced chemistry curricula. Building on this foundation, the second year's mini-grants expand into new areas of applied research and educational innovation connected to astronaut health, safety, and K–12 STEM education.

This paper will highlight the implementation strategies, student engagement, and outcomes of the Year 2 mini-grants, while situating them within the larger ecosystem of DREAM activities at UMES that bridge engineering, agriculture, and education. The paper also reflects on the role of MSIs in preparing a diverse new generation of engineers, scientists, and educators who will contribute to NASA's Artemis program and the future of human space exploration.

1. Introduction

NASA's Artemis program represents the most ambitious human exploration initiative since Apollo, with Artemis II preparing for a crewed lunar flyby and Artemis IV targeting a historic landing at the Moon's south pole. These missions aim to establish the foundation for sustained lunar presence, expand scientific research in permanently shadowed regions, and broaden astronaut participation. Following the precedence of Artemis II crew (see Figure 1), the Artemis IV will include the first woman and the first person of color to walk on the lunar surface,

Figure 1: Artemis II Crew

reinforcing NASA's commitment to expanding representation in human spaceflight [1, 2]. As NASA prepares for these milestones, broader engagement of the new generation STEM students is being advanced through programs such as NASA- Minority University Research and Education Program Space Technology Artemis Research (MSTAR). The primary author of this paper is the PI on one of the nine Phase III awardees of the MSTAR initiative at the University of Maryland Eastern Shore (UMES), an 1890 land grant historically black institution.

The NASA MSTAR funded DREAM (Developing Robotic Explorations with AgroBots and MoonBots) project at UMES is now in its third year of implementation. The project draws inspiration from NASA's Space Technology Mission Directorate (STMD) objectives and strategic thrust areas under the overarching paradigm of *Go, Land, Live, and Explore* in alignment with the Artemis program. Interdisciplinary research efforts are underway at UMES in collaboration with University of Maryland (UMD) in addressing MoonBot exploration [3,4] and AgroBot driven plant growth trials in regolith simulants [5] by the core project team. In addition to its core experiential learning and research activities, the DREAM project includes an innovative **Mini-Grant** component that has been budgeted for each year of the project duration. This component provides a mechanism for engaging a broader segment of UMES faculty, students, and the campus community in Artemis-relevant activities through semester-long initiatives conducted during the spring term. These initiatives emphasize course integration and enrichment activities aligned with NASA mission themes. Appendix (a) presents a sample call for proposals used in the Mini-Grant solicitation.

All UMES faculty are invited to form interdisciplinary teams with two selected students and submit proposals to the project collaborator at UMD, who serves as the external evaluator. Proposal submissions occur toward the end of the fall semester. Two proposals are selected, and the UMES PI and Co-PI are notified. Faculty leads are informed during the winter session in January and begin project activities at the start of the spring semester.

The Mini-Grant program is structured to support interdisciplinary faculty–student teams across campus with modest financial support, while maintaining a clear and intentional connection to Artemis mission themes. Faculty proposals outline project objectives, methodologies, student roles, anticipated outcomes, and the specific Artemis-aligned content to be embedded in coursework or design activities. Selected teams receive project funds and are required to submit mid-semester and final presentation slide decks, along with a comprehensive written report. Two online presentations—conducted at mid-semester and at the conclusion of the spring term—are organized by the PI. These sessions include participation from the NASA activity manager, Space Grant representatives, project collaborators, and Co-Is, providing opportunities for feedback and engagement. Final reports are submitted at the beginning of the summer term.

Successful implementation of the Mini-Grant program during the inaugural year of the DREAM project has been reported previously [6]. The Mini-Grant framework supports short-term, high-impact exploratory projects that engage students in creative inquiry directly connected to NASA's Artemis missions. Prior work has demonstrated that such approaches significantly broaden participation and enhance STEM engagement at minority-serving institutions [7], [8].

This paper presents the **Year-2** implementation of the Mini-Grant program and includes descriptions of the two selected projects, their methodologies, results, reflections, and documented student outcomes. Emphasis on interdisciplinary participation aligns closely with the mission of the ASEE's MIND Division to broaden access, support underrepresented learners, and strengthen pathways into STEM careers and teaching. The first project focused on biomedical engineering, examining medical readiness for lunar operations through the development of customizable 3D-printed casts using portable scanning and generative modeling techniques. The second project centered on teacher preparation, aiming to build capacity among future K–12 educators—particularly Black and Brown male teacher candidates—to design and implement Artemis-related lessons using a collaborative lesson-study model.

3. Project 1: Developing Customized 3D-Printed Medical Casts for Artemis Astronauts

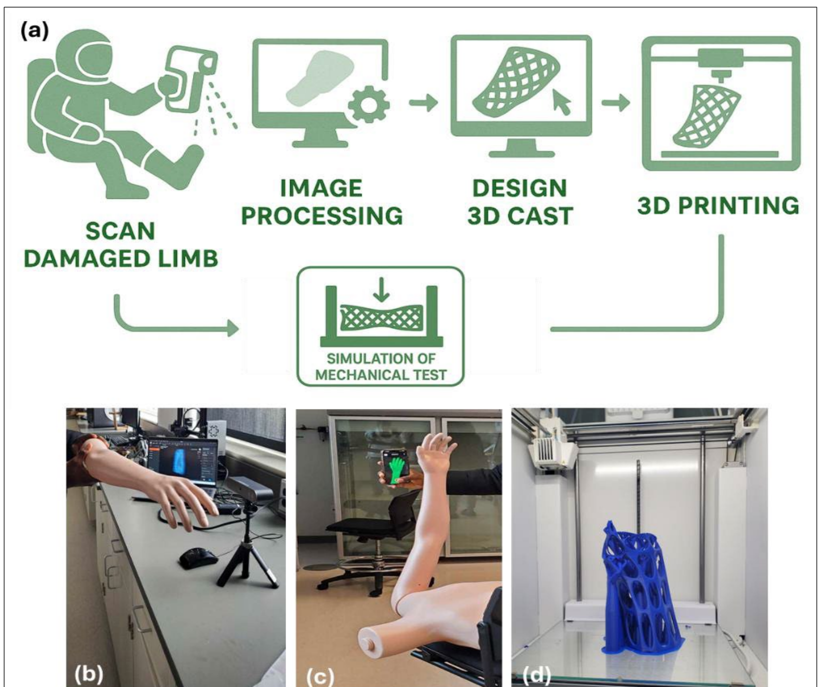

Figure 2: Workflow for personalized medical cast fabrication for Artemis missions, including limb scanning, image processing, cast design, additive manufacturing, and mechanical evaluation.

This Year-2 mini-grant project examined how portable 3D scanning, mesh processing, and additive manufacturing could be used to produce casts for astronauts on demand.

The project was led by an engineering faculty member and engaged two undergraduate students exemplifying the Mini-Grant program's goal of hands-on learning aligned with NASA mission priorities.

Extended surface operations planned for Artemis III and beyond, particularly in the Moon's south-polar region, will expose astronauts to uneven terrain, reduced gravity, and limited access to immediate medical care. Musculoskeletal injuries such as fractures or severe sprains represent a credible operational risk in this environment. Conventional medical casts are typically bulky, non-customized, and poorly suited for spaceflight logistics. This Mini-Grant project explored the feasibility of on-demand fabrication of personalized, lightweight, and ventilated medical casts using portable 3D scanning and additive manufacturing technologies, directly supporting Artemis goals related to crew safety, sustainability, and operational autonomy [9]. The student team developed and validated an end-to-end workflow for customized cast fabrication (Fig. 2).

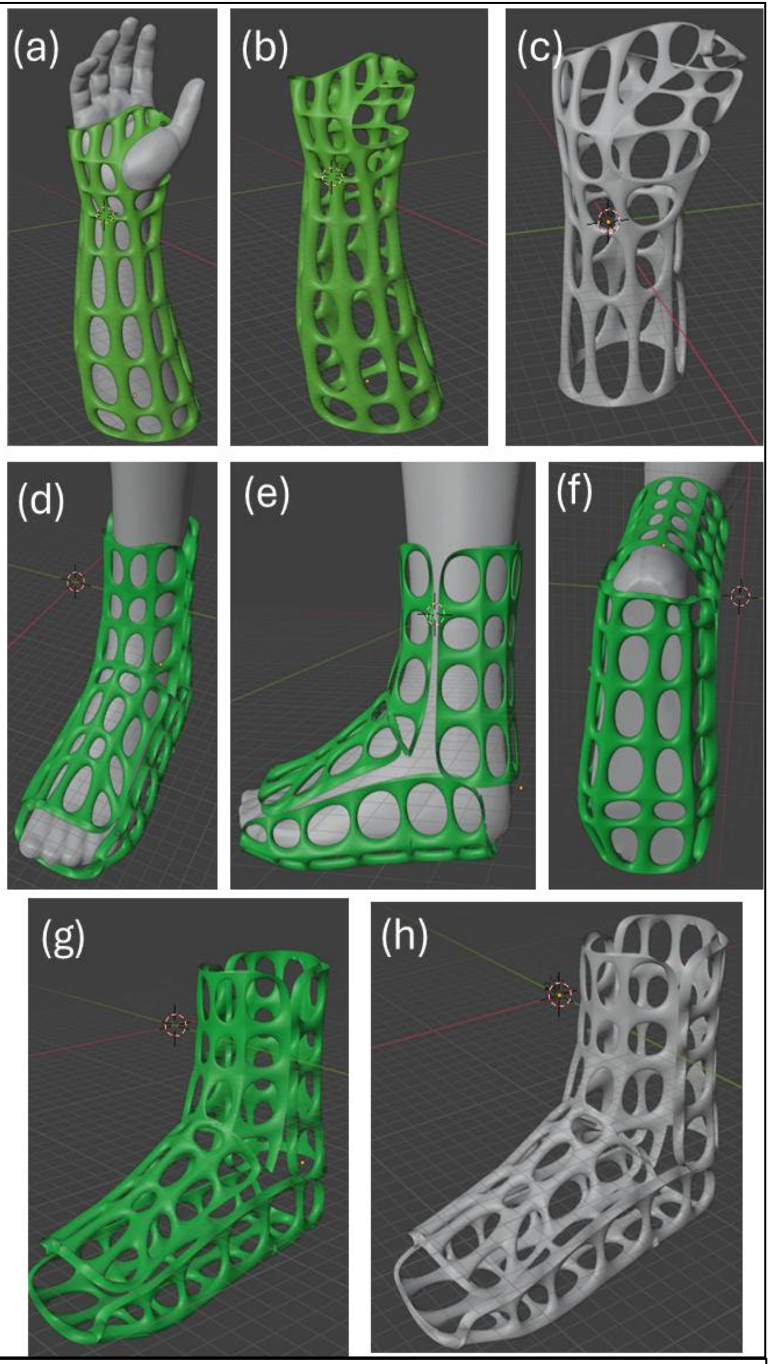

Figure 3: Porous medical cast designs generated in Blender for forearm and ankle applications, illustrating anatomically conforming lattice structures prior to fabrication.

The process began with 3D scanning of mannequin limbs representative of astronaut extremities using both a commercial handheld scanner and a smartphone-based scanning application. This dual-approach demonstrated that anatomically accurate digital models can be generated using either dedicated hardware or readily available mobile devices—an important consideration for spaceflight and other remote or resource-constrained settings. The scanned data were subsequently processed using open-source and commercial software to remove noise, fill gaps, and generate watertight meshes suitable for design and fabrication.

Using Blender, students designed porous, anatomically conforming cast geometries by wrapping simplified lattice structures around the scanned limb models (Figure 3).

Adjustable pore size, strand thickness, and overall cast thickness were incorporated to balance structural support, ventilation, weight reduction, and wearer comfort. The resulting designs were exported as STL files and fabricated using fused deposition modeling (FDM) 3D printing with common thermoplastic materials, including PolyLactic Acid (PLA) and Acrylonitrile Butadiene Styrene (ABS), at varying infill densities. These fabrication trials allowed students to explore trade-offs among print speed, material usage, mechanical integrity, and ergonomics (Figure 4).

Preliminary evaluation of the printed casts demonstrated good anatomical fit on mannequin and human limbs with comparable dimensions, as well as high perceived comfort and wearability. To further assess structural performance, the team conducted finite-element simulations using

Figure 4 :3D-printed porous medical casts fabricated using PLA and ABS at different infill densities and evaluated for fit and wearability on mannequin and human limbs.

ABAQUS to examine cast behavior under axial and radial loading conditions representative of light to moderate limb stabilization scenarios (Fig.5). The simulations showed that the cast designs remained within acceptable elastic deformation limits under moderate loads, while also identifying stress concentrations associated with the onset of plastic deformation. These results provided valuable insight into design safety margins and informed future optimization of pore geometry and material selection.

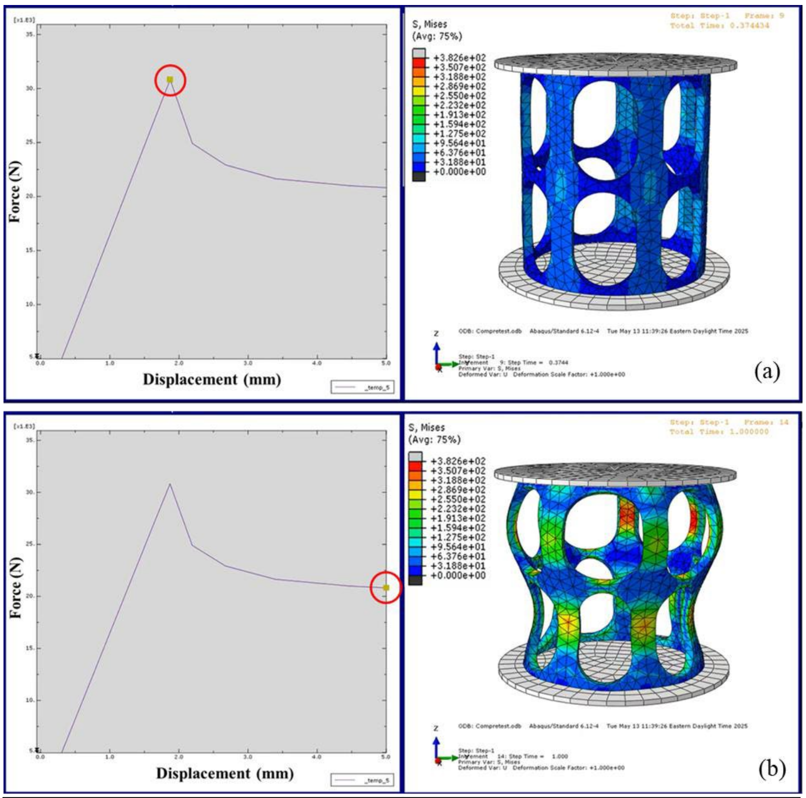

Figure 5: Mechanical loading of the cast in the axial direction simulated using ABAQUS: (a) elastic deformation phase, and (b) plastic deformation phase.

From an educational perspective, this Mini-Grant project provided a high-impact experiential learning opportunity for undergraduate students at an HBCU, integrating biomedical engineering, mechanical design, additive manufacturing, and computational simulation within an authentic NASA mission context. Students gained practical experience with emerging technologies relevant to aerospace and healthcare applications, developed project management and technical communication skills through mid-semester and final presentations, and interacted directly with NASA and Space Grant stakeholders during scheduled project reviews.

Overall, this Year-2 Mini-Grant project illustrates how modest, semester-scale funding can catalyze Artemis-aligned technical innovation while simultaneously broadening participation in STEM research. The project advanced early-stage concepts for personalized medical devices suitable for space missions and reinforced the DREAM program's broader objectives of workforce development, interdisciplinary collaboration, and inclusive engagement in NASA-relevant research. Lessons learned from this effort inform future endeavors and demonstrate a scalable model for embedding space-focused research experiences into undergraduate engineering education at minority-serving institutions.

4. Project 2: LIFT — Launching Innovation for Future Teachers

The second Year-2 Mini-Grant project supported under the NASA-MSTAR DREAM initiative was the LIFT (**L**aunching **I**nnovation for **F**uture **T**eachers) project, which focused on strengthening the preparation of future K–12 educators through the development and classroom implementation of an Artemis-themed STEM curriculum. The project was led by two teacher candidates from the University of Maryland Eastern Shore (UMES) 'Men of Color in Education' program under faculty mentorship (Fig. 6) and exemplifies the Mini-Grant program's emphasis on interdisciplinary engagement, culturally responsive pedagogy, and broadening participation in STEM education.

Figure 6: Lead Faculty Dr. Warren(center) with Students (Teacher Candidates) Oscar Garcia and Quinton Smith.

The primary deliverable of the LIFT project was a comprehensive Artemis Mission STEM Unit Plan designed for grades 2–3, consisting of a sequenced set of 16 standards-aligned lessons integrating science, engineering, and leadership development (Fig. 7). The curriculum was explicitly aligned with the Next Generation Science Standards (NGSS) and Maryland Science Standards, and incorporated inquiry-based learning, hands-on experimentation, and accommodations for diverse learners. Core STEM content included lunar science, rocket propulsion, astronaut training, space stations, and rover exploration, all contextualized through NASA's Artemis mission objectives of returning humans to the Moon and preparing for future deep-space exploration [1, 2].

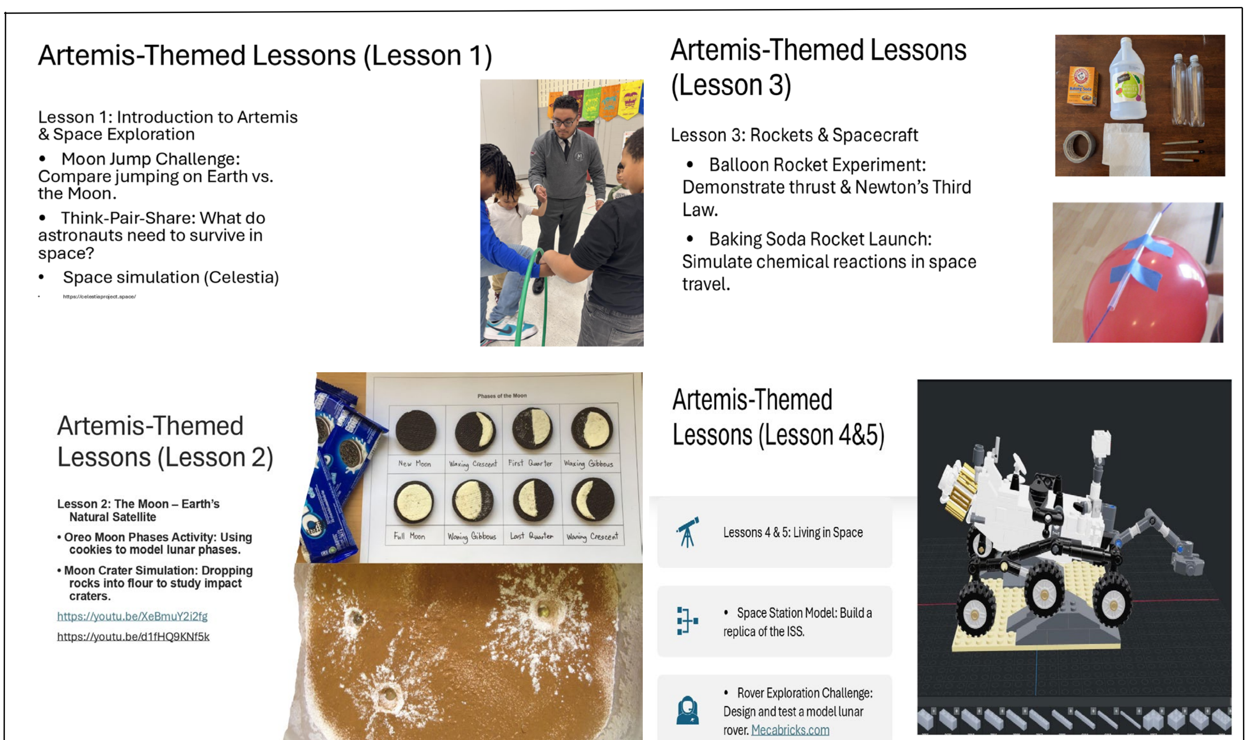

Figure 7: Few Representative Samples of Artemis Related Lesson Plans

A distinguishing feature of the LIFT curriculum was the intentional integration of leadership development and social-emotional learning (SEL) alongside technical STEM concepts. Supplemental lesson modules addressed confidence building, goal setting, perseverance, and reflection using age-appropriate activities embedded within space-themed instruction. These components were designed to support early STEM identity formation while reinforcing culturally responsive teaching practices shown to be particularly effective in engaging students from underrepresented backgrounds [10].

The project employed a lesson-study–informed implementation model, in which teacher candidates served as both curriculum developers and classroom facilitators. Iterative cycles of lesson planning, classroom delivery, reflection, and refinement were used to improve instructional quality and student engagement (Figure 8). Classroom activities included experiential demonstrations such as the “Moon Jump” gravity simulation, Oreo-based lunar phase modeling, balloon rockets to illustrate thrust, and collaborative design challenges related to space stations and astronaut equipment. These activities emphasized inquiry, teamwork, and communication, aligning with NGSS science and engineering practices as well as leadership skill development [11].

Documented outcomes from the final project report indicate that the LIFT project successfully engaged elementary students in foundational STEM concepts while simultaneously supporting the professional growth of the participating teacher candidates. Reflections highlighted increased confidence in teaching STEM content, improved classroom facilitation skills, and heightened awareness of culturally responsive instructional strategies. Importantly, the presence of relatable role models—particularly Black male educators—in the classroom was identified as a meaningful factor in promoting student interest, participation, and positive STEM self-concepts, consistent with prior research on representation in STEM education [12].

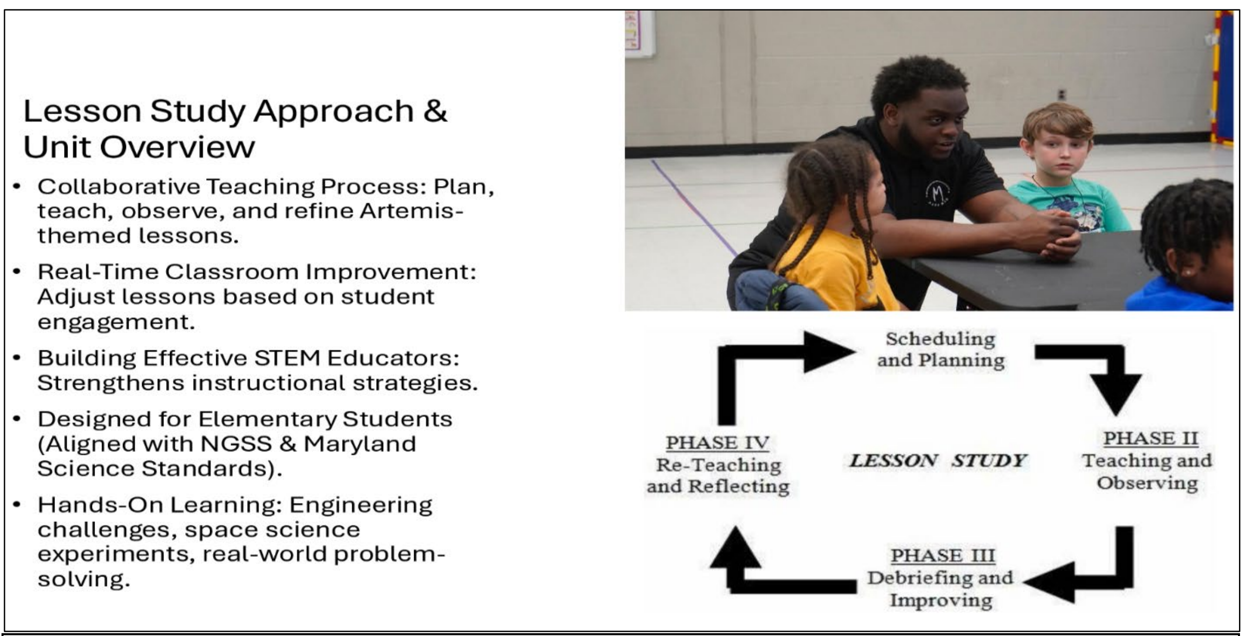

Figure 8: Teacher-candidate-led classroom implementation- Iterative cycles of lesson planning, classroom delivery, reflection, and refinement.

Overall, the LIFT Mini-Grant project demonstrates how modest, semester-scale investments can yield high-impact outcomes in teacher preparation and STEM engagement at a minority-serving institution. By coupling NASA Artemis mission content with leadership development and inquiry-based pedagogy, the project advanced the DREAM initiative's broader goals of workforce development, inclusive participation, and early-pipeline STEM engagement. The curriculum products developed through LIFT are readily adaptable for broader dissemination through professional development workshops, extension programming, and future outreach.

Figure 9: Screen Shot of Participants during the Mini Grant Mid-Semester Online Presentation on March 14th

5. Results

Both projects produced substantive student learning outcomes. Engineering students gained proficiency in scanning technologies, mesh cleaning, generative design, additive manufacturing, and finite-element simulation. The progression captured in early and final presentations illustrates a clear trajectory from conceptual exploration to functional prototype development.

The pre-service teacher candidates developed confidence integrating NASA mission content into inquiry-based instruction. Final presentation showed richer discussion prompts, more polished instructional materials, and examples of classroom engagement. Candidates expressed increased interest in STEM teaching careers and improved understanding of how space-science concepts can be adapted for diverse learners.

The mini-grant model successfully advanced Artemis-aligned engagement across engineering and teacher preparation. The biomedical engineering project demonstrated meaningful student gains in advanced technical competencies, while the LIFT project exemplified reflective pedagogy and STEM-teaching capacity building. Together, the projects highlight how MSIs can broaden participation in both STEM fields and STEM education, directly aligning with MIND Division goals of representation, equity, and empowerment for underrepresented learners.

Figure 10: Screen Shot of Participants during the Mini Grant Mid-Semester Online Presentation on May 19th

6. Acknowledgement

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Appendix(a)

DREAM Project Mini-Grant Proposal Guidelines

Overview

The DREAM Project Mini-Grant competition invites faculty members from both STEM and non-STEM disciplines. The goal is to incorporate Artemis project-related content into courses or to devise innovative enrichment initiatives.

Funding

- Each mini-grant provides a budget of $8,500.
- This includes a $2,500 stipend/student, for two student assistants, and a $3,500 summer compensation for the faculty lead. Part of the $3,500 can also be used towards faculty release time/ or professional travel to conferences
- Every spring, two mini-grants will be awarded, centering on themes related to NASA's Artemis Program.
- The lead faculty for each mini-grant must submit a report detailing their activities, outcomes, and impact to the project team by June 1st (2024 for year 1 of the project).

Proposal Requirements

- The proposal should not exceed 7 pages, excluding references.
- Formatting should adhere to the following: Font:Times Roman (11), Margins- 1 inch on all sides, Spacing- 1.5 lines.
- Proposals that have pre-identified student participants will be given preference.

Proposal Components

A. **Introduction**: Background and relevance of the proposal related to the Artemis project.
B. **Eligibility**: Specify the discipline (STEM or non-STEM) from which the applying faculty originates.
C. **Thematic Element and Objectives**: Explain how your proposal aligns with NASA's Artemis Program themes. Succinctly outline what you aim to achieve with the proposed project.
D. **Student Participation**: Provide details of the student participants if already identified. This is preferred but not mandatory. Describe the proposed scientific merit and broader outcomes from the project.
E. **Timeline and Activity Report Plan**: Include a timeline of the project activities, and explain how you plan to document and report activities, outcomes, and their impacts by June 1st.
F. **Budget Outline**: Detail how the $8,500 will be utilized: $2,500 stipend distribution for two student assistants; and $3,500 summer compensation for the faculty lead.

Criteria for Evaluation

Relevance (30%): How well does the proposal align with NASA's Artemis Program themes? The Artemis Program has specific goals and themes. Is the proposal relevant to these objectives and likely to contribute meaningfully to inform and engage students with the Artemis program?
Innovation (20%): To what extent is the proposal original and unique? Did the proposal demonstrate a unique approach, using advanced technology, or presenting a unique perspective aligned to the Artemis program?
Student Involvement and Impact (25%): Preference will be given to those who have identified student participants and potential positive impacts on students' learning. The proposed activities must involve students and incorporate the students' learning outcomes, hands-on experiences, and how the project can influence potential career pathways.
Budget, Timeline, and Feasibility (25%): The practicality of successfully implementing the proposed project within the given budget and timeframe. The proposer must provide a clear roadmap for the project, detailing the plan to overcome potential challenges, the resources to be used, and how the project will stay within the timeframe and meaningfully utilize the funds.

Submission: Proposals should be emailed to **Dr. Mary Bowden** at maryb@ssl.umd.edu , with a CC to **Dr. Madhumi Mitra** at mmitra@umes.edu. The submission deadline is December 2, 2024.

Notification and Further Steps:
Two proposals will be chosen for funding, and the lead faculty will be informed by the first week of January 2025.
The faculty leads must identify the two students receiving the $2,500 stipend by January 20, 2025.

Applicants should ensure that their proposals comprehensively address each component. The DREAM project team looks forward to receiving your innovative proposals and supporting educational advancements related to the Artemis Program.