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P24 - Thai Heritage and ASEAN Astronomy Learning Ecosystem: An Integrated Astronomy Education Framework through Mission-Based, Jigsaw, Game-Based, and Active Learning

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Astronomy education provides a unique opportunity to integrate scientific inquiry with cultural heritage and interdisciplinary learning. However, astronomy instruction in many schools remains largely lecture-based, limiting students' opportunities to engage in authentic scientific investigations and connect astronomical concepts with local contexts. Thailand and ASEAN countries possess rich astronomical heritage embedded in temples, archaeological sites, traditional calendars, architectural alignments, and indigenous knowledge. Despite their educational value, these resources are rarely incorporated into formal astronomy education. To address this challenge, Buddhajak Wittaya School developed the Thai Heritage and ASEAN Astronomy Learning Ecosystem, an educational framework integrating classroom instruction, extracurricular learning, heritage-based field experiences, and community outreach through Mission-Based Learning, Jigsaw Learning, Game-Based Learning, and Active Learning.

The framework was designed to (1) integrate astronomy with science, history, culture, mathematics, geography, and local wisdom; (2) promote inquiry, collaboration, and problem-solving; (3) enhance astronomy achievement and twenty-first-century competencies; and (4) strengthen astronomy communication and community engagement.

The learning ecosystem consisted of five interconnected components: Classroom Astronomy, Astronomy Club, Thai Heritage and ASEAN Astronomy Camp, Heritage Field Study, and Community Astronomy Outreach. The Thai Heritage and ASEAN Astronomy Camp served as the central learning experience through five mission-based learning activities, where students worked collaboratively in expert teams using Jigsaw Learning to solve authentic astronomical challenges through inquiry, evidence collection, collaborative investigation, and scientific communication.

The five missions consisted of Mission 1: Decoding the Solar Temple, in which students investigated the astronomical orientation of Buddhist temples by measuring solar shadows, determining cardinal directions, constructing simple sundials, and interpreting how ancient civilizations applied solar observations in sacred architecture; Mission 2: The Lost Lunar Calendar, where students reconstructed the traditional Thai lunar calendar from historical evidence while exploring lunar phases, Buddhist festivals, agricultural traditions, and indigenous astronomical knowledge; Mission 3: ASEAN Sky Explorer, in which students compared constellations, celestial navigation, and indigenous astronomical knowledge across ASEAN civilizations to understand astronomy as a shared cultural heritage; Mission 4: Solar Tracker, where students investigated the apparent motion of the Sun through direct observations and field measurements to explain Earth's rotation, seasonal changes, solar altitude, and sunrise–sunset positions; and Mission 5: Stargazer Navigator, in which students interpreted star maps, identified constellations, observed celestial objects through telescopes, and applied celestial navigation techniques to determine directions and explain astronomical phenomena. Each mission incorporated Game-Based Learning through puzzles, astronomy detective tasks, escape challenges, collaborative investigations, and reflective discussions to promote active participation, critical thinking, conceptual understanding, and interdisciplinary learning.

A total of 430 participants, including 80 upper-secondary students from Buddhajak Wittaya School and 350 primary school students from ten partner schools in Bangkok, participated in the program. Students' mean achievement scores increased significantly from 9.18 ± 2.31 before participation to 16.74 ± 1.94 after the program, representing a 70.1% improvement ($p < .001$). Reflective journals and semi-structured interviews revealed increased scientific curiosity, stronger appreciation of Thai and ASEAN astronomical heritage, improved teamwork, enhanced science communication skills, and greater confidence in applying astronomy to authentic cultural contexts.

The findings demonstrate that integrating Mission-Based Learning, Jigsaw Learning, Game-Based Learning, and Active Learning within a heritage-based astronomy learning ecosystem effectively promotes conceptual understanding, interdisciplinary thinking, scientific inquiry, and public engagement. The framework also establishes sustainable partnerships among schools, temples, and local communities while preserving and

communicating Thailand's and ASEAN's astronomical heritage. This model offers a scalable and transferable approach for Astronomy Education, Interdisciplinary Astronomy, and Communicating Astronomy with the Public throughout Southeast Asia.

Keywords: Astronomy Education; Interdisciplinary Astronomy; Astronomical Heritage; Mission-Based Learning; Jigsaw Learning; Game-Based Learning; Active Learning; Community Outreach; Thailand; ASEAN.

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