

# The Development of a Project-Based Learning Model Based on the ASTRO-KHURU Framework to Enhance Astronomical Research Skills of Secondary School Students

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This study aimed to: 1) explore the development of a project-based learning model for astronomy integrated with the ASTRO-KHURU framework, 2) construct and validate the quality of the proposed instructional model, and 3) examine the effects of implementing the model by comparing students' post-learning abilities in planning and conducting astronomical research with the 70% benchmark, along with a qualitative analysis of their learning behaviors and research skill development.

The target group consisted of 30 upper secondary school students from Kuruprachasan School who voluntarily participated in the project "Astro Research Kick-off: Igniting Dreams, Building Young Astronomical Researchers." A purposive sampling technique was employed. The research instruments included: 1) the ASTRO-KHURU instructional model, developed from the integration of Project-Based Learning (PBL), systems thinking, and the PDCA cycle; 2) an astronomical research skills assessment; and 3) field note and reflection forms. Data were analyzed using descriptive statistics (mean and standard deviation), one-sample t-tests, and content analysis.

The findings revealed that 1) The ASTRO-KHURU Model comprises nine stages A: Activate Curiosity, S: System Thinking & Science Literacy, T: Teamwork & Topic Selection, R: Research Design, O: Observation & Operation, K: Knowledge Construction, H: Highlight & Presentation, U: Use of Feedback, and R: Reflection & Future Path—which support systems thinking, hands-on practice, and experiential learning in a structured manner, enabling full student engagement in the research process. 2) The model's appropriateness, as evaluated by experts, was at the highest level (Mean = 4.43, S.D. = 0.38). Its instructional efficiency was calculated at 78.92/82.67, exceeding the specified benchmark (75/75). 3.1) Students' post-learning astronomical research skills reached 88.37%, significantly higher than the 70% criterion at the .01 level. 3.2) The overall satisfaction level toward the learning model was high (Mean = 4.52, S.D. = 0.41), with the highest-rated aspect being "Inspiration for future learning and career in science" (Mean = 4.68). 3.3) Content analysis of students' reflections indicated that 92% could clearly articulate their cognitive development, skills gained, and aspirations for pursuing further education in space science.

These findings indicate that the ASTRO-KHURU Model is an effective and sustainable instructional approach that fosters active learning and enhances secondary students' competencies in astronomical research.

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