

Step Into Space: Designing a Giant Snakes and Ladders Game for Inclusive Astronomy Outreach



**Conference on Non-Digital Game-Based Learning in
Physics and STEM Disciplines**



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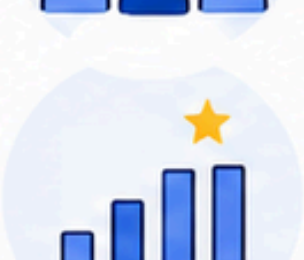


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Background: Why Astronomy Outreach?

-  1 Astronomy is a gateway to STEM curiosity.
-  2 Core astronomy ideas are abstract, spatial, and often misunderstood.
-  3 Common misconceptions occur around day–night, Moon phases, seasons, and the Earth–Sun–Moon system.
-  4 Outreach provides accessible, hands-on, and informal learning experiences.
-  5 In Indonesia, only 34% of students reached Level 2 or higher in science in PISA 2022.



Source: OECD PISA 2022; astronomy education literature.



Why Non-Digital Game-Based Learning?

-  1. Supports face-to-face interaction
-  2. Encourages collaboration and communication
-  3. Promotes hands-on and embodied learning
-  4. Does not require internet, gadgets, or electricity
-  5. Suitable for schools with limited digital infrastructure
-  6. Easy to reproduce and facilitate in outreach settings



Sources: Sousa et al. (2023); Nautiyal et al. (2024); UNESCO GEM Report (2023).



Previous Studies on Snakes and Ladders Games



Study 1

Science Learning Outcomes

- ★ Snake ladder media improved science cognitive achievement
- ★ Average score increased from 60 to 72
- ★ N-gain = 0.30 (moderate)

(Amin, Sulistyorini & Sugianto, 2020)



Study 2

Mathematics Learning Outcomes

- ★ Snake ladder media improved students' mathematics learning outcomes
- ★ Completion rate increased across cycles
- ★ 47% → 67% → 80%

(Saputra, Yuliati & Rachmadtullah, 2019)



Study 3

Student Activity & Engagement

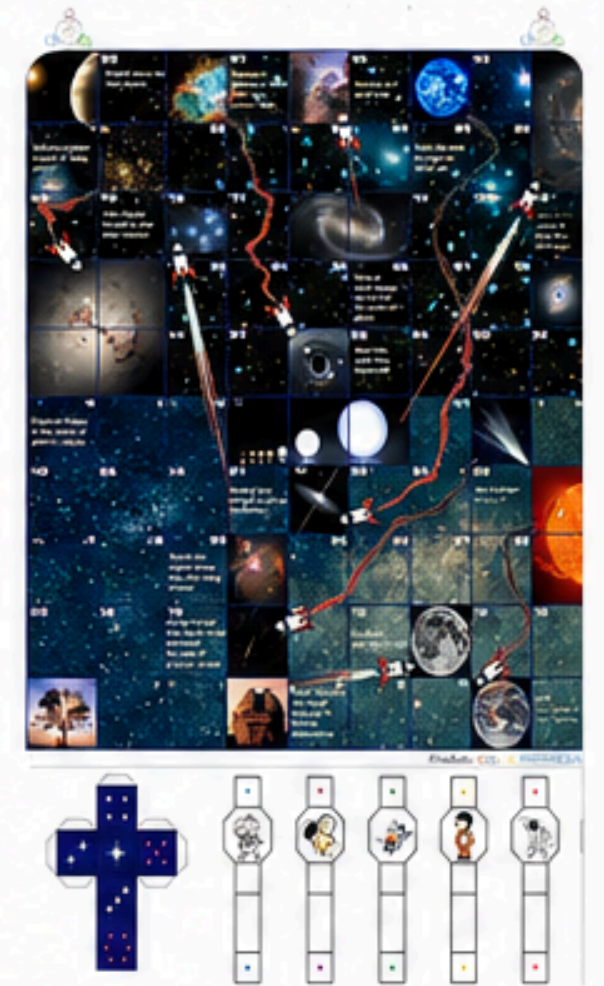
- ★ Smart snake ladder media improved:
- ★ Teacher activity (+20.45%)
- ★ Student activity (+27.17%)
- ★ Learning outcomes (+8.91 points)

(Hariyadi, 2018)

Existing Astronomy Game

UNAWE Astronomy Snakes and Ladders

- ★ Astronomy-themed snakes and ladders board
- ★ Uses space images and astronomy facts
- ★ Focus on board-based facts and movement
- ★ No interactive card system



(UNAWE Indonesia)



Research Gap / Our Contribution



Interactive Cards



Giant Physical Play



Inclusive Participation



Astronomy Misconception Correction



Project Gap and Innovation

1



Giant Walk-On Board

- ★ A large snakes and ladders game that can be stepped on and played physically.

2



Astronomy Theme

- ★ Learning through planets, stars, space exploration, and astronomy concepts.

3



Interactive Cards

- ★ Booster, Observation, Team Mission, and Black Hole Trap cards.

4



Inclusive Design

- ★ Supports teamwork, multiple roles, and accessible participation.

5



Myth Buster

- ★ Corrects astronomy misconceptions through simple true/false prompts.



Innovation

From a traditional board game to an **inclusive, interactive astronomy outreach** experience.



Project Objective



1

Basic Astronomy

Introduce basic astronomy concepts



2

Active Participation

Encourage active student participation



3

Inclusive Learning

Support inclusive learning experiences



4

Integrated Learning

Combine movement, visuals, discussion, and scientific literacy



Game Concept Overview



1. 6×6 Board



2. Rocket = Move Up



3. Meteor = Move Down



4. Interactive Cards



5. Cosmic Fact

This giant walk-on game introduces basic astronomy through movement, visual prompts, teamwork, and playful challenges. Players explore the universe by moving across a 6×6 board, using rockets to climb up, meteors to move down, interactive cards to trigger activities, and Cosmic Fact tiles to reinforce astronomy knowledge.



Game Components



Giant Board



Dice



Booster Card



Observation Card



Team Mission Card



Black Hole Trap Card



Cosmic Fact Card

Game Mechanics / Rules



- Roll the dice



- Move forward based on the number rolled



- Rocket = move up



- If players move up through a rocket, they read a Cosmic Fact



- Meteor = move down



- Cards trigger challenges



- To win, players must reach **FINISH** with the exact number



Interactive Card System



Booster Card

★ Question ★

What is the name of the planet where we live?

★ Reward ★ ★ Punishment ★

Move 2 boxes Stay in place

1

Booster Card

Quick question

Observation Card

★ Observation ★



What is this Moon phase?

★ Reward ★ ★ Punishment ★

Move 2 boxes Stay in place

2

Observation Card

 Guess the image /
Moon phase

Team Mission Card

★ Mission ★



List the planets in order from closest to farthest from the Sun.

★ Reward ★ ★ Punishment ★

All members move 2 boxes All members stay in place

3

Team Mission Card

Group mission

Black Hole Trap Card

★ Statement ★

The Sun goes around the Earth.

TRUE FALSE

★ Reward ★ ★ Punishment ★

Stay in place Move back 2 boxes

4

Black Hole Trap Card

 True / false
misconception

Cosmic Fact

★ Fact ★



The Sun is a star. Its light takes about 8 minutes to reach Earth.

5

Cosmic Fact

Short astronomy fact



Each card type supports a different mode of learning: questioning, observing, collaborating, correcting misconceptions, and reinforcing facts.



Inclusive Design Features



- Played in groups



- Involves both active and shy children



- Different roles: reader, observer, mover, responder



- Not all activities are physical



- Clear colors, icons, and text



Tactile Dice

- Tactile dice with raised dots / raised number markers



Tactile Tile Borders

- Tactile board support: taped tile borders to help visually impaired participants feel and identify tile positions



The game is designed to support participation, accessibility, and multiple ways of engagement.

Documentation of Play Session



Main gameplay session



Moving on the board



Reading cards



Board play



Discussion & tabletop play

Observed Learning Potential



- Students were more active and enthusiastic



- Discussion emerged naturally among participants



- Astronomy concepts were easier to connect with movement and visual cues



- Misconceptions could be addressed through the cards



- Long gameplay may reduce engagement when players do not reach the finish



- A facilitator is needed to verify answers and guide concept correction

Reflection and Future Development

Reflection



Teacher validation



Science literacy effectiveness testing

Future Development



Multi-level development for elementary, middle, and high school students



Tabletop and giant versions



Adaptation for students with different inclusion needs



Answer-key card design to support independent play without a facilitator



Further refinement of rules and play duration

Thank You

Questions and suggestions are welcome
for the future development of this game.

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