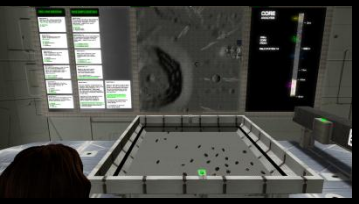
Virtual World for Inquiry and Planetary Geology Field Work

MoonWorld



COTF Classroom of the Future

CET Center for Educational Technologies®

WHEELING JESUIT UNIVERSITY
www.wju.edu

COTF/VWMW/April2012

Overview

- Accomplished
- MoonGazers and National Education Agenda
- MoonWorld
  - Overview Design-Development
  - Research
- Selene
- MoonGazers
- Recommendations

Accomplishments

Design, Development, Research

Accomplishments

Design and Development

- MoonWorld Second Life and OpenSim
- MoonGazers – Hands-on for real scientific investigations
- CyGaMEs -> Selene

Research

- MoonWorld findings
  - Effective if used as designed
  - Professional development
  - Collaboration -> Framework
  - Serious effort
- Selene – Measure
  - Learning
  - Affect
  - Rate & acceleration of learning

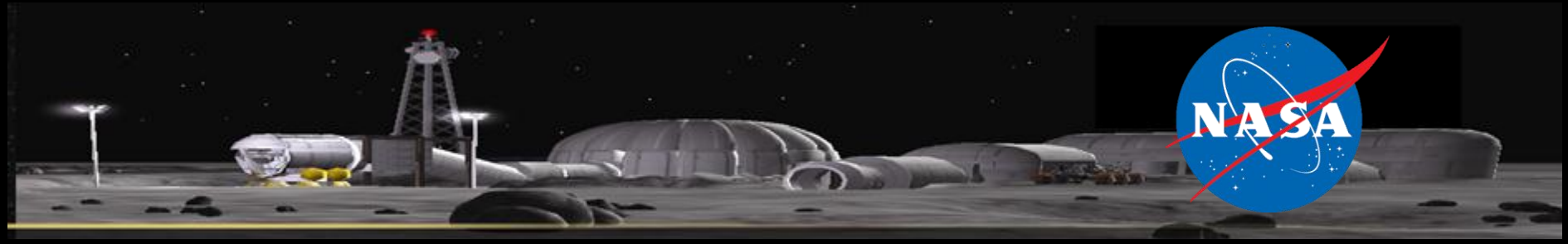
National Agenda

K-12 Framework

WV Standards

Successful STEM Education

Cyberlearning



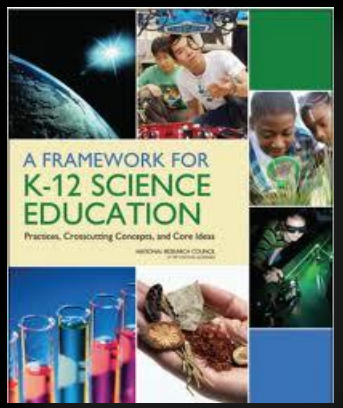
WV CSO Robin Anglin – WV Science Coordinator

- **SC.O.5.2.24 - geologic features determine the relative age of rock layers.**
- **SC.O.6.2.14** - **describe the composition and properties of matter** (e.g., **particles**, **melting point, density**).
- **SC.O.6.2.18** - **flow of heat between objects**
- **SC.O.6.2.20** - **relationship of mass to gravitational force (e.g., larger the mass the larger the gravitational force, or the closer the objects the stronger the force).**
- **SC.O.6.2.27** - **phases of the moon.**
- **SC.O.6.2.28** - **models of earth-moon-sun relationships**
- **SC.O.7.2.01 – interrelationships among physics, chemistry, earth and astronomy.**
- **SC.O.7.2.31 - determine the relevant age of rock layers using index fossils and the law of superposition.**

6

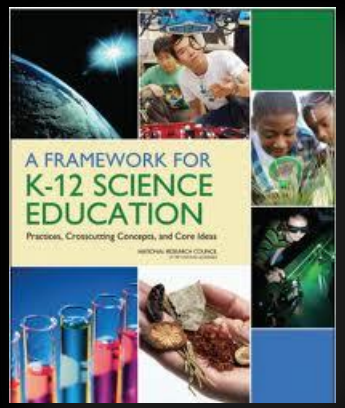
ESS1.C: The History of Planet Earth

How do people reconstruct and date events in Earth's planetary history? **Earth scientists use the structure, sequence, and properties of rocks, sediments, and fossils, as well as the locations of current and past ocean basins, lakes, and rivers, to reconstruct events in Earth's planetary history. For example, rock layers show the sequence of geological events. . .**



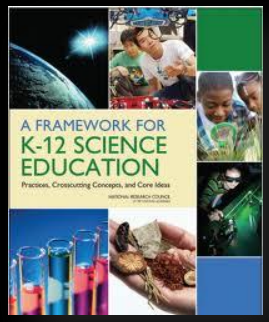
Analyses of rock formations and the fossil record are used to establish relative ages. **In an undisturbed column of rock, the youngest rocks are at the top, and the oldest are at the bottom. Rock layers have sometimes been rearranged by tectonic forces; rearrangements can be seen or inferred**.

Although active geological processes, such as plate tectonics (link to ESS2.B) and erosion, have destroyed or altered most of the very early rock record on Earth, **some other objects in the solar system**, such as asteroids and meteorites, **have changed little over billions of years**. **Studying these objects can help scientists deduce the solar system's age and history, including the formation of planet Earth**.



<u>Study of other planets and their moons, many of which exhibit such features as volcanism and meteor impacts similar to those found on the earth, also help to illuminate aspects of Earth's history and changes.</u>

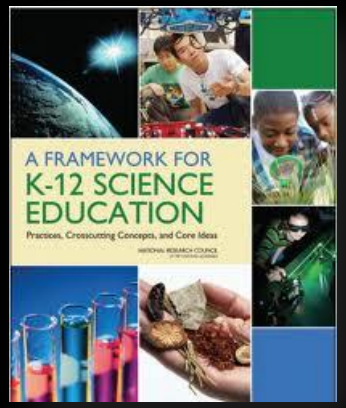
By the end of Grade 2 - Some events on Earth occur in **cycles**, like day and night, and others have a **beginning and an end**, like a volcanic eruption. Some events, like an earthquake, **happen very quickly**; others, such as the formation of the Grand Canyon, **occur very slowly**, over a time much longer than one can observe them.



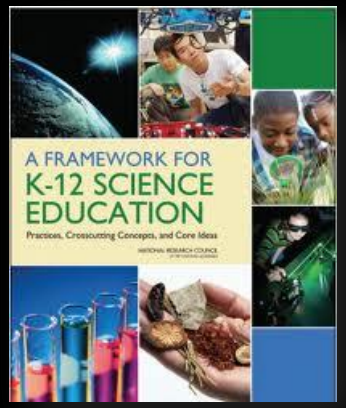
By the end of grade 8. **The geological time scale interpreted from rock strata provides a way to organize Earth's history**.

By the end of grade 12. Although active geological processes, such as plate tectonics . . . and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as **lunar rocks, asteroids and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.**

1. **Asking questions (for science)** and defining problems (for engineering)
2. **Developing and using models.**
3. **Planning and carrying out investigations.**
4. **Analyzing and interpreting data.**
5. Using mathematics and computational thinking.
6. **Constructing explanations (for science)** and designing solutions (for engineering).
7. **Engaging in argument from evidence.**
8. **Obtaining, evaluating, and communicating information.**



1. **Patterns**
2. Cause and effect: Mechanism and explanation
3. **Scale, proportion, and quantity**
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. **Stability and change**

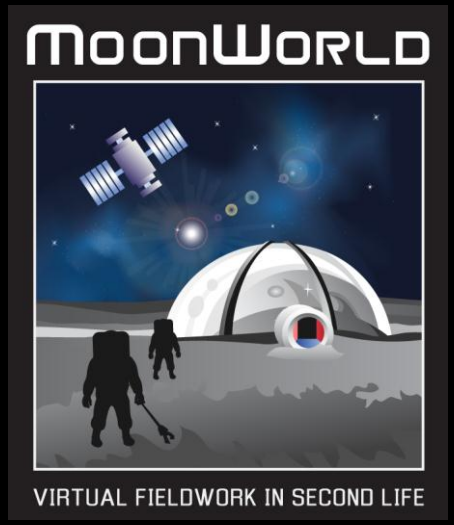


Design and Development

What is MoonWorld?

Be a Planetary Field Geologist

- Simulation
- Virtual world
- Realistic environment
- Authentic inquiry
- Collaborative learning



Imbrium Basin

Timocharis

Inquiry – What is the sequence of formation of features on the Moon?

 Image courtesy NASA: http://solarsystem.nasa.gov/multimedia/gallery/PIA004051.jpg

MoonWorld

Photo Courtesy
Debbie Denise Reese

Timocharis

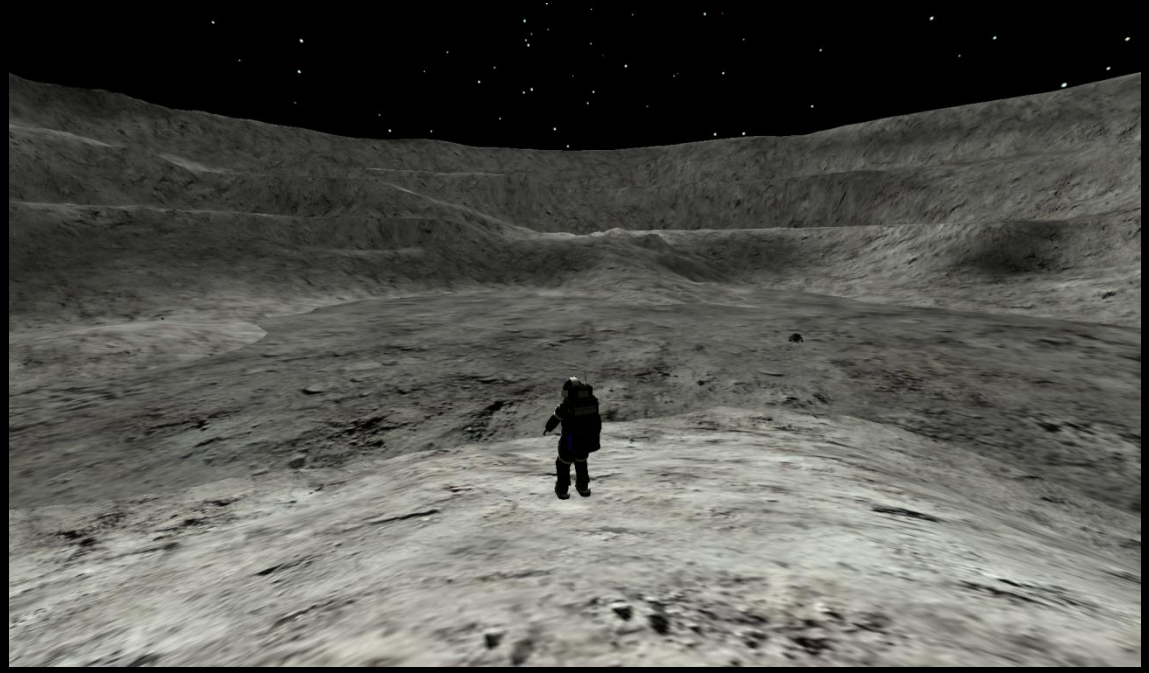


Image courtesy: COTF - MoonWorld

Timocharis

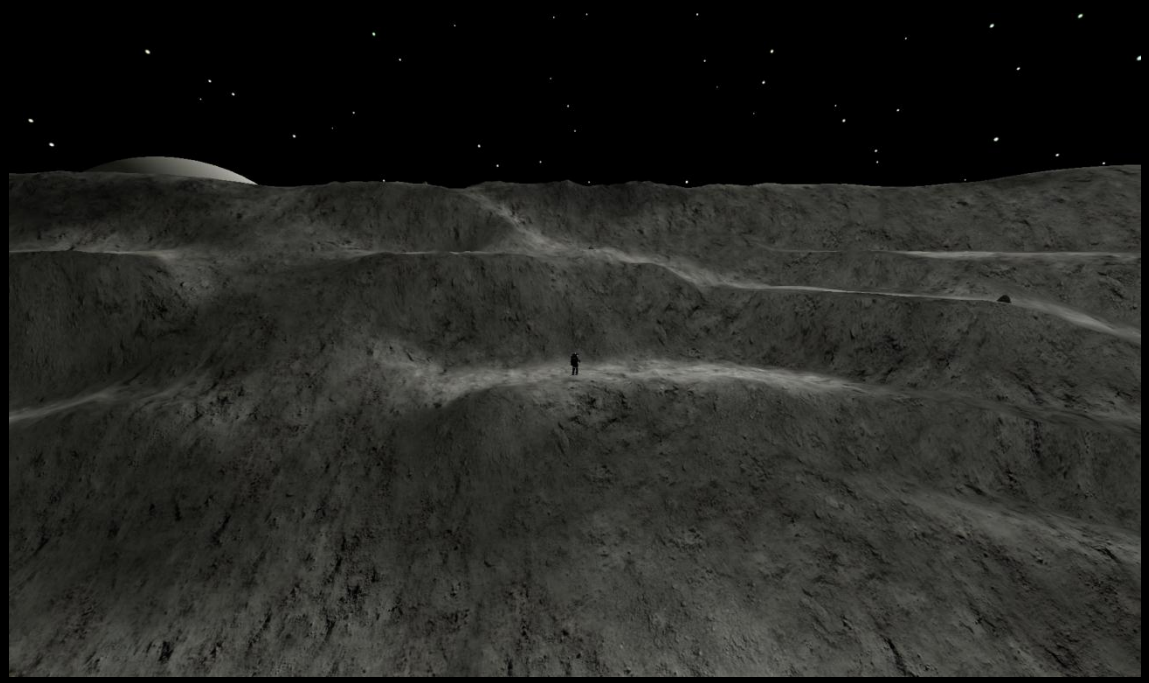


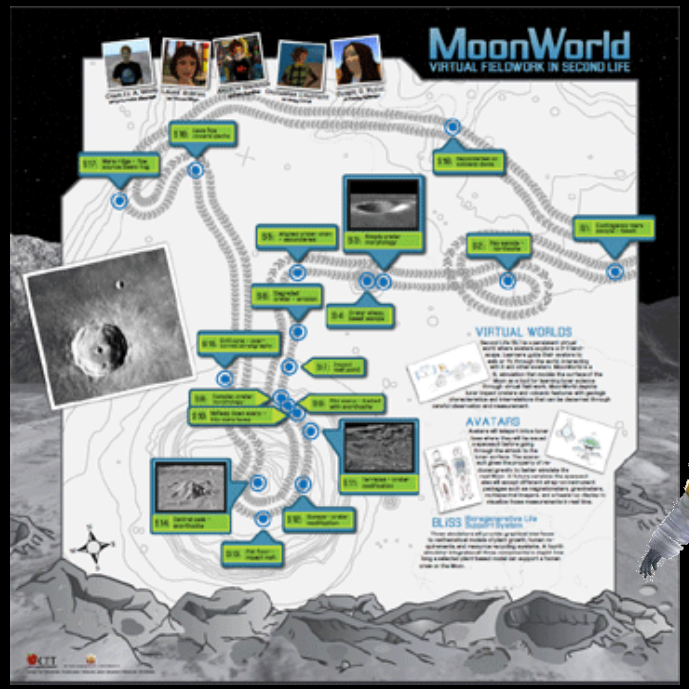
Image courtesy: COTF - MoonWorld

1. Avatar Registration
2. Mission Registration
3. Arrival
4. Moonbase
5. Equipment
5. Field stations
6. Rover
7. Research Facility
8. BLiSS
9. Space station - Mars

MOONWORLD MISSION – REAL TIME

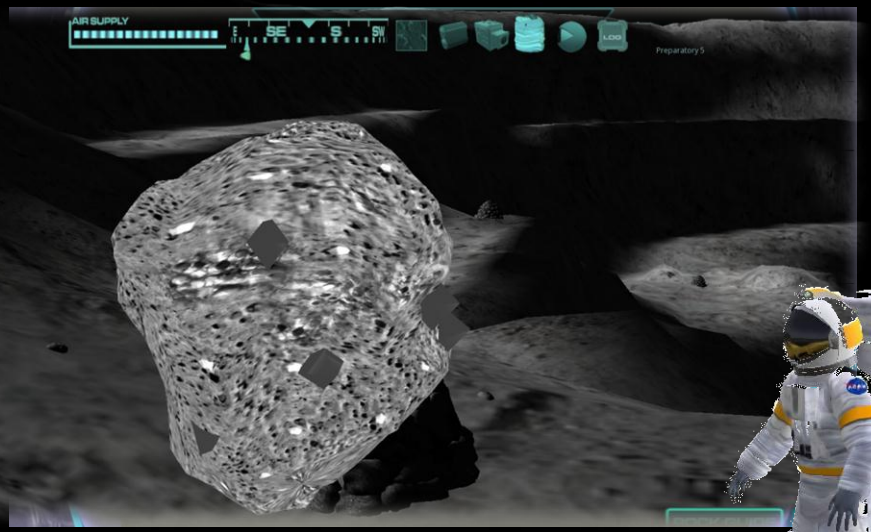
16 Field Stations

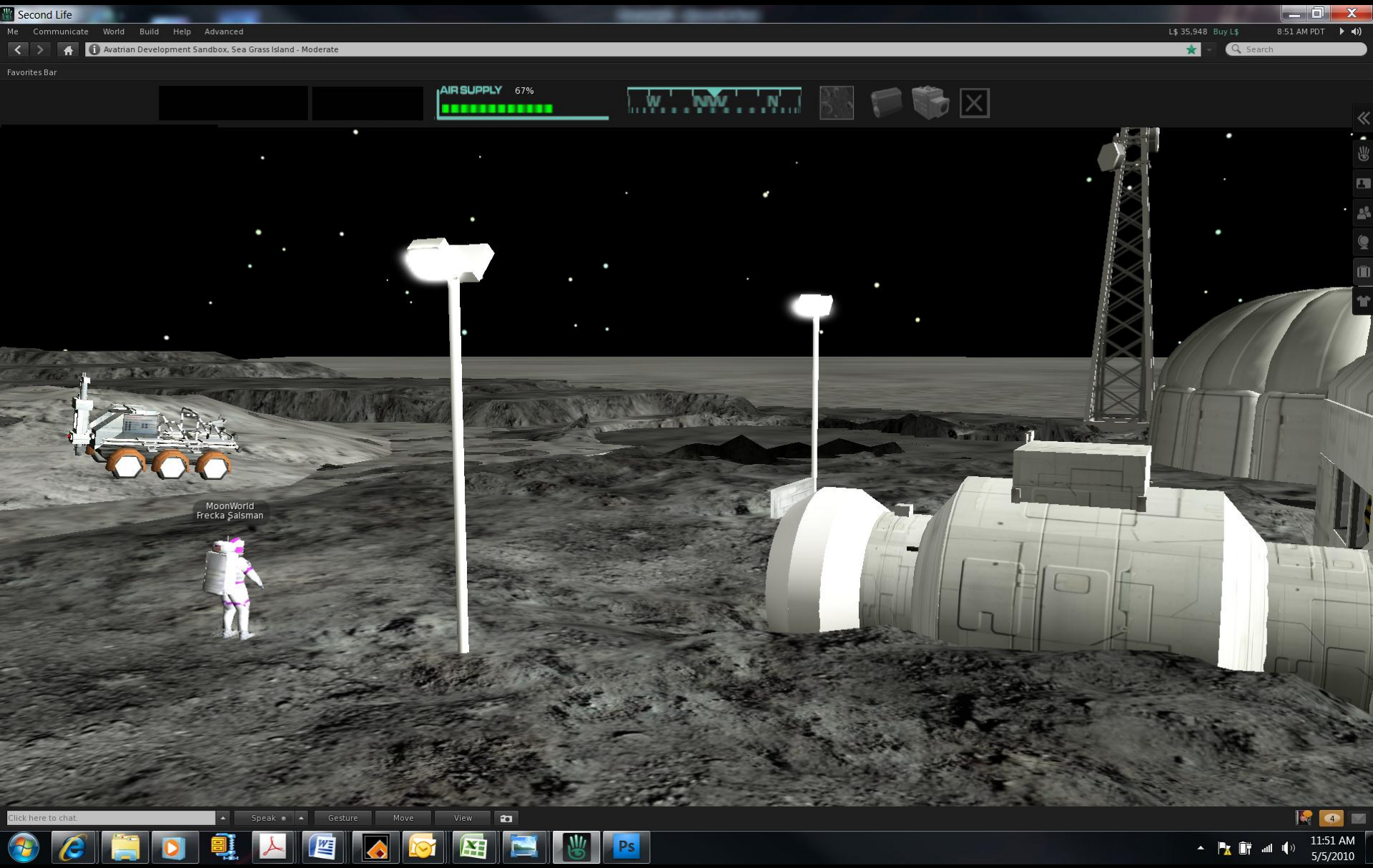
- Explore
- Topography - measure
- Morphology - describe
- Team work
- Analyze



16 Field Stations

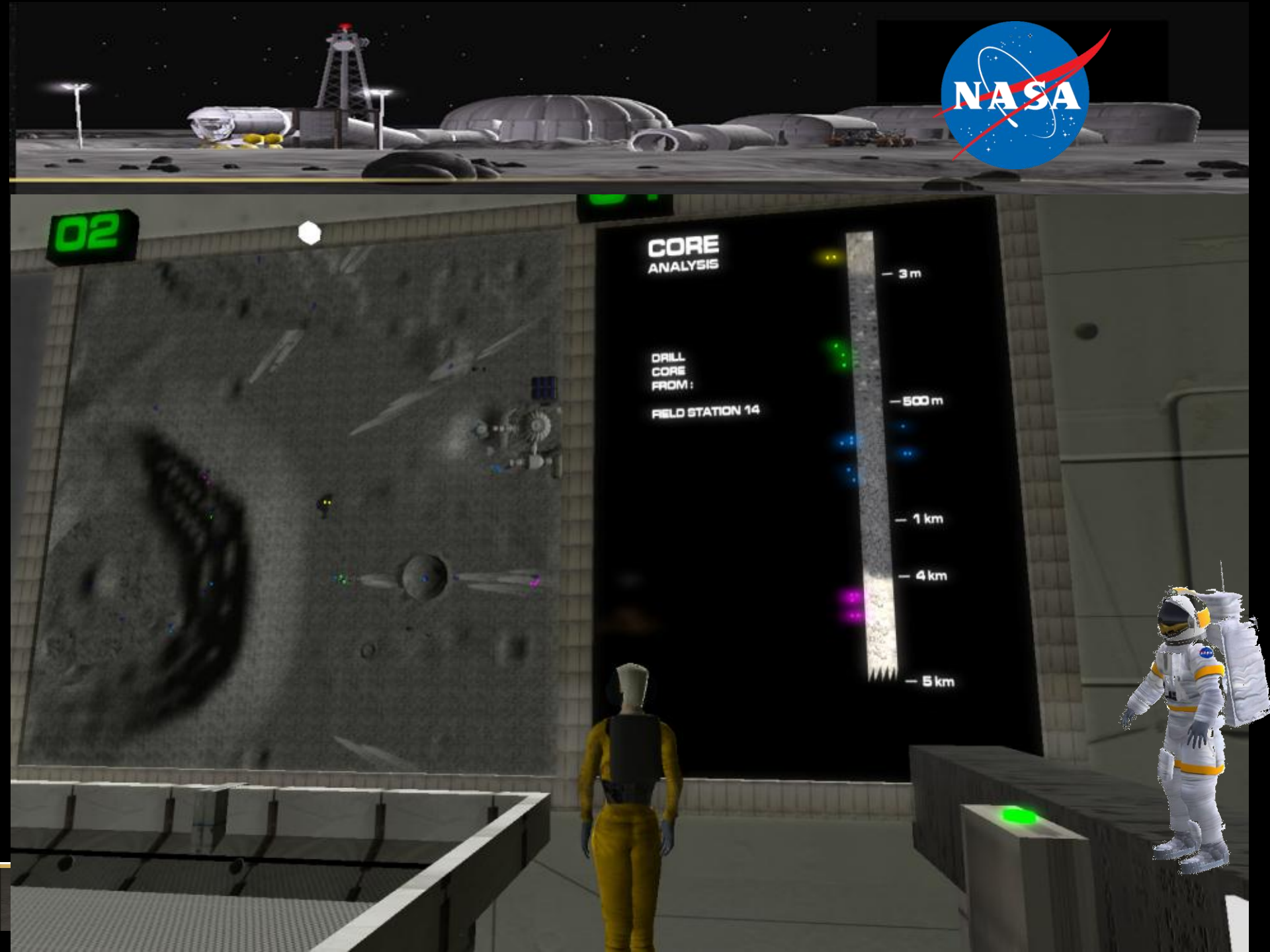
- Explore
- Topography - measure
- Morphology - describe
    1. Observe
    2. Collect data
    3. Analyze




Second Life
Me Communicate World Build Help Advanced
L$ 35,948 Buy L$
8:51 AM PDT
Avatrian Development Sandbox, Sea Grass Island - Moderate
Search
Favorites Bar
AIR SUPPLY 67%
W NW N
MoonWorld
Frecka Salsman
Click here to chat.
Speak
Gesture
Move
View
11:51 AM
5/5/2010

Research Facility

- Analyze samples
- Analyze core sample
- **Integration questions**


NASA
02
CORE
ANALYSIS
DRILL
CORE
FROM:
FIELD STATION 14
3 m
500 m
1 km
4 km
5 km

Mentar Training: Train the Trainer

Two Worlds

Second Life

- Adults only
- On their own
- Teams of 4.

Open Sim

- Adult PD
- Adult mentar training
- Youth missions
  - Recruiter
  - Mentar

OpenSim: Two Communities

Mentar

- Parents register youth
- Mentar
  - Adult
  - Adult/Youth- CBC

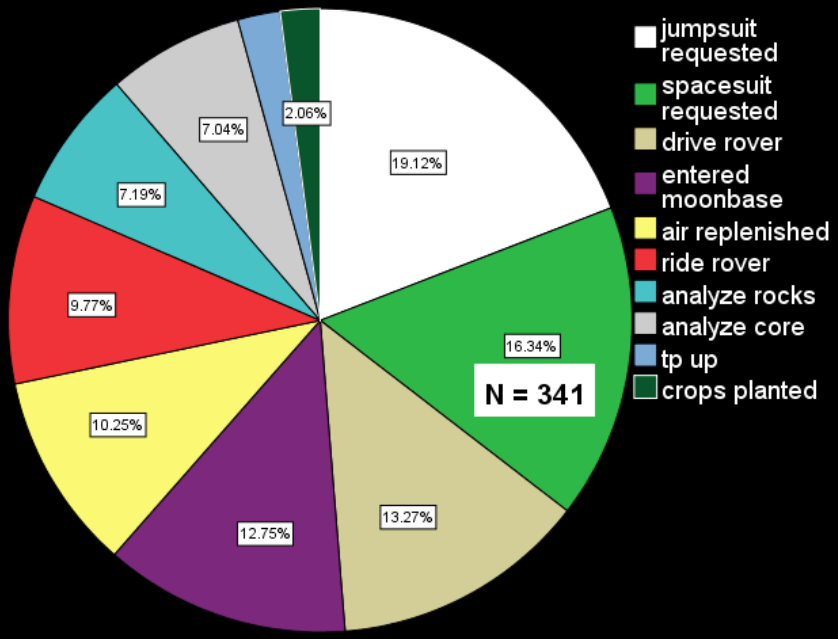
Recruiter - CBC

- Approved adult
- Registers
  - Adults
  - Youth 9 and up
- May request mentar

* CBC = Criminal Background Check

Activity	N	%
Jumpsuit requested	399	19.1
Spacesuit requested	341	16.3
Drive rover	277	13.3
Entered moonbase	266	12.7
Air replenished	214	10.3
Ride rover	204	9.8
Analyze rocks	150	7.2
Analyze core	147	7.0
Teleport up	46	2.2
Crops planted	43	2.1
Total	2087	100

Activities Aggregated by Avatar within Team



Research:

How effective is MoonWorld?

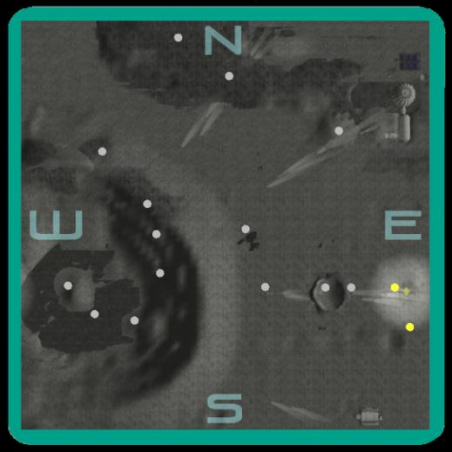
Cases and Results

Case 1.

What is the effect of MoonWorld Scaffolds on Achievement?

Do activity and conceptual scaffolds increase the number of correct responses to conceptual scaffolds?

Wayfaring folds Activity



Conceptual

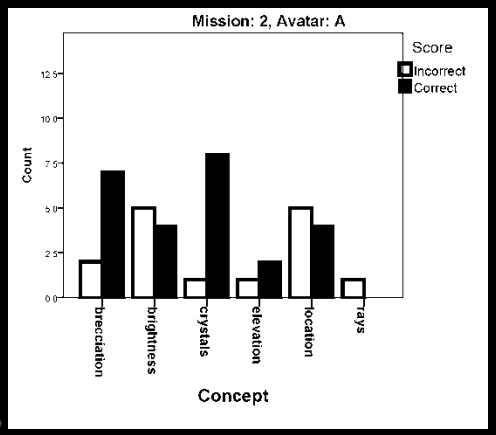
Frecka Salsman's 'Q&A'
Describe the setting here:
(choose the best answer)
A. Bright ray
B. Crater central mountain
C. Line of craters
D. Base of crater outer wall
E. Crater floor
F. Crater rim
G. Wall-floor mound
H. Crater terrace
I. Lava flow
J. Lava plain
K. Volcanic dome

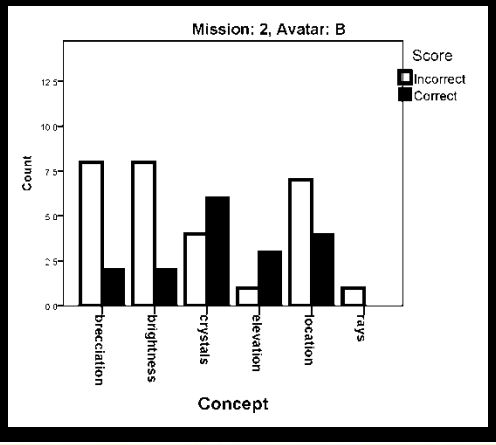
A B C
D E F
G H I
J K

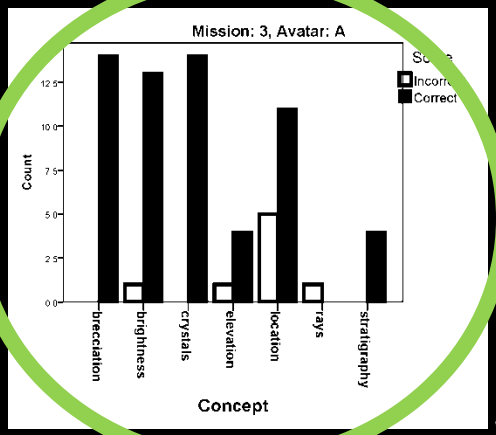
Block Ignore

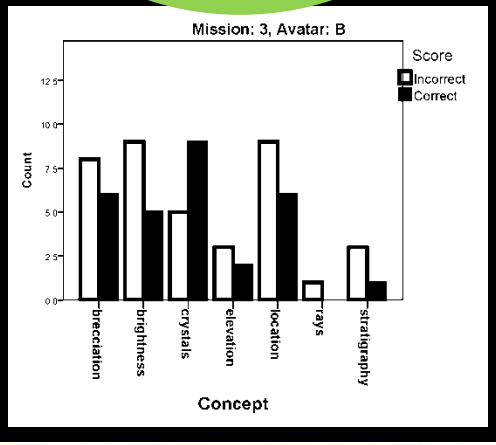
MoonWorld

2









3

1a.
Avatar A

		Mission 2	
		Correct	Incorrect
Mission 3	Correct	26	9
	Incorrect	0	6

1b.
Avatar B

		Mission 2	
		Correct	Incorrect
Mission 3	Correct	11	10
	Incorrect	6	19

MoonWorld's scaffolds increased learner achievement during [virtual] lunar science investigations for Avatar A, but not for Avatar B. Avatar A answered significantly more conceptual scaffold items after interacting with those scaffolds during Mission 2, $\chi^2_{\text{Avatar A}}(1) = 7.11$, $p < 0.01$; $\chi^2_{\text{Avatar B}}(1) = 0.56$, *NS*.

Case 1 Finding.

MoonWorld wayfaring, activity, and conceptual scaffolds can increase achievement.

Case 2.

The Case of an Educator Who Advocates Virtual Worlds and MoonWorld (MW) without MW Professional Development: What Was Student Success?

Interface Components

Educator Advocate & 5th/6th grade students

Educator Trips to MWSL

Educator	Student Mission
1	No
2	No
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	No
9	No

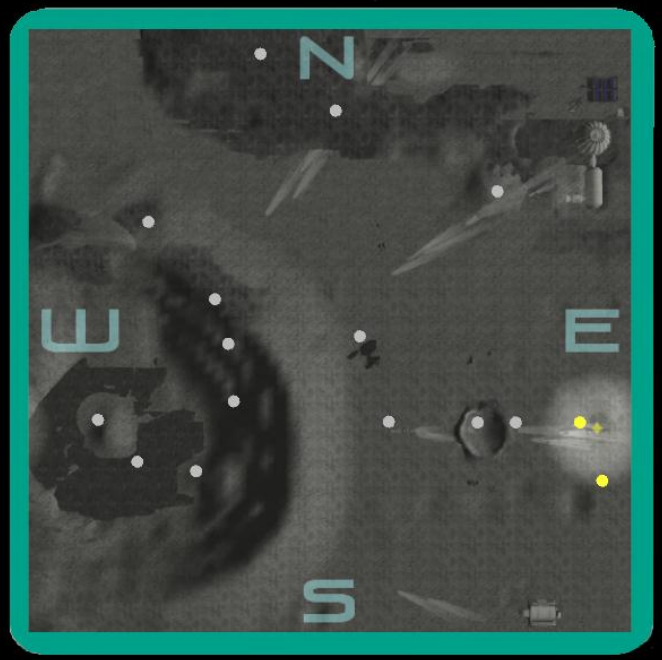
Number of Field Station Questions Possible

25 x 66 = 1,650

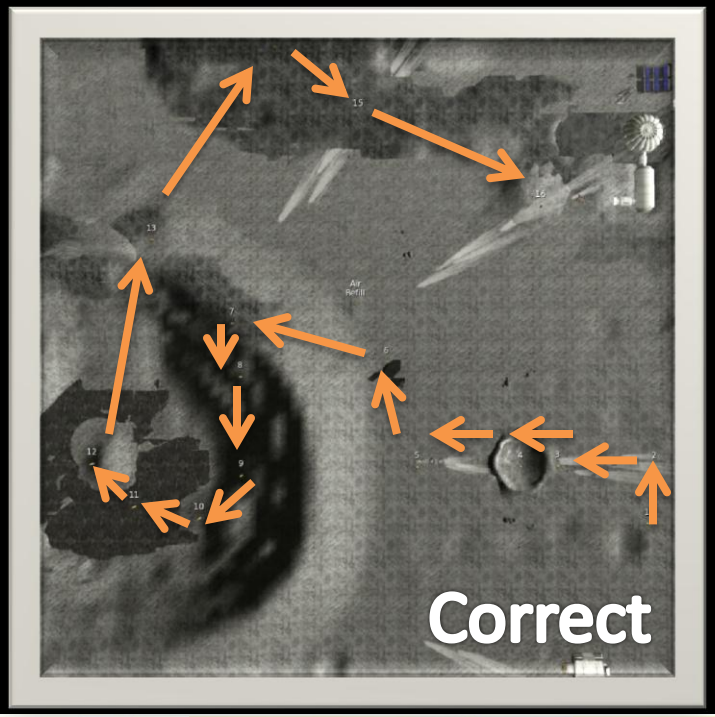
Number of Field Station Questions Answered

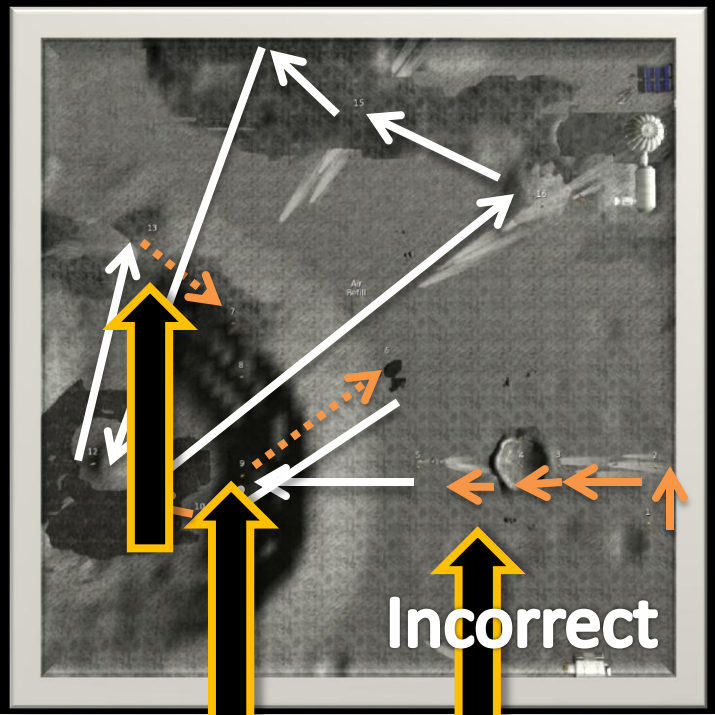
1

Wayfaring



Wayfaring





1
2
3
4
5
9
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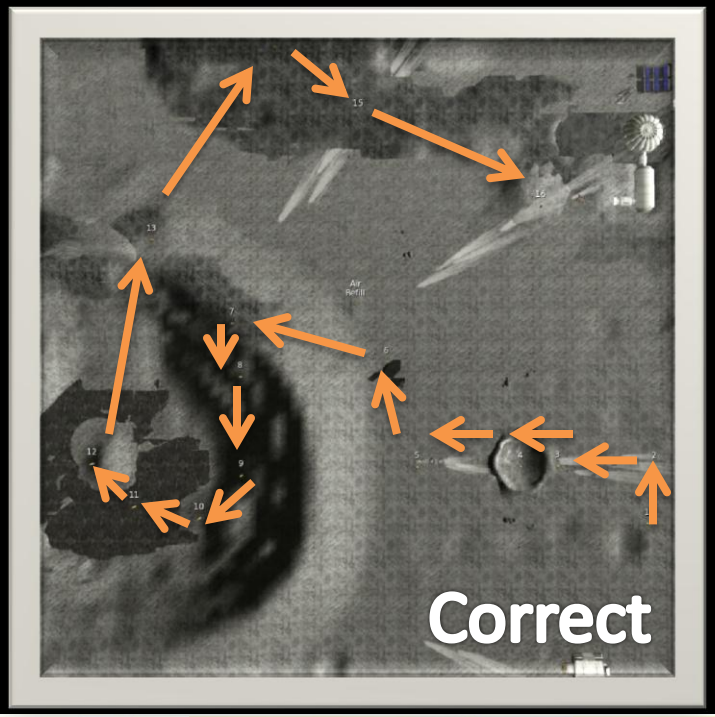
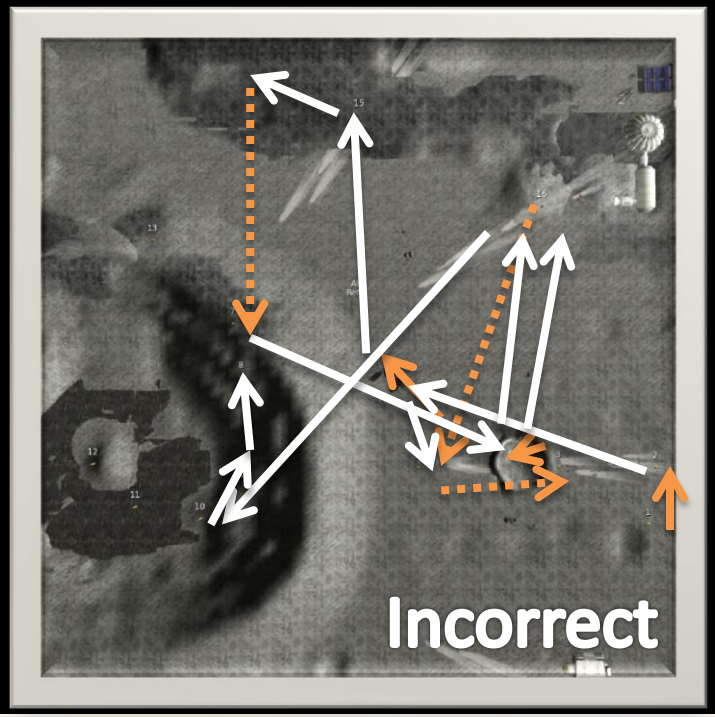
Wayfaring





Case 2 Finding.

Educators lacking professional development (uninformed about MoonWorld scaffolds) may fail to engage their students with MoonWorld's wayfaring, activity, and conceptual scaffolds.

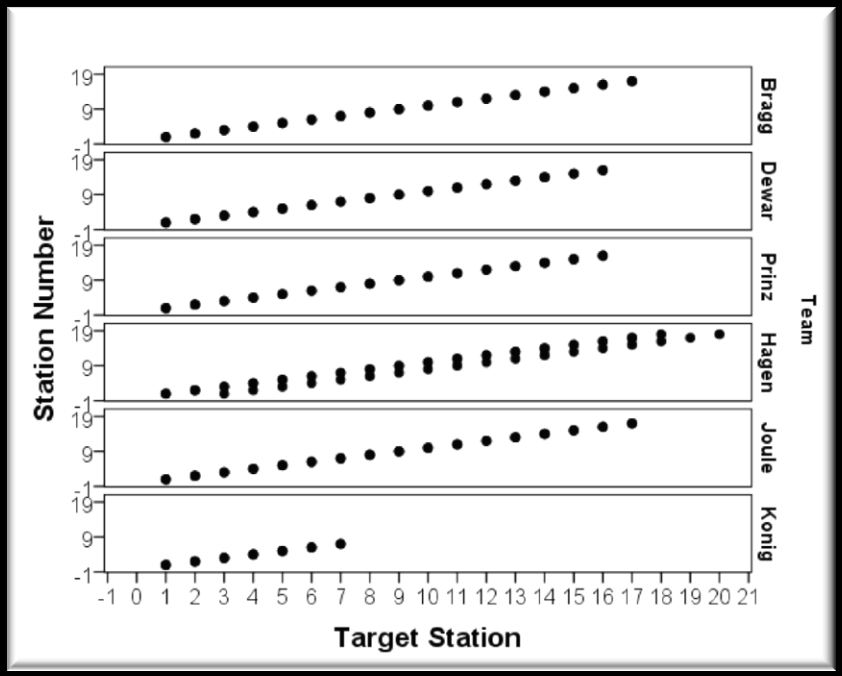
Case 3.

Lab-setting, Untrained Youth Mentars

Research Questions

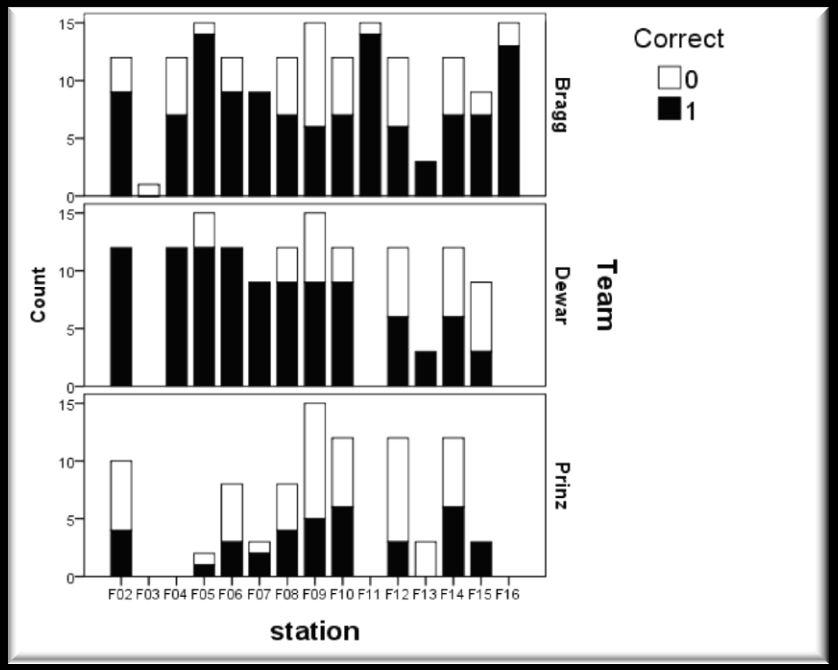
- Given orientation and a novice MoonWorld high school player mentar, will players correctly navigate a sim?
- Given orientation and a novice MoonWorld high school player mentar, will players answer field station questions?
- Given orientation and a novice MoonWorld high school player mentar, will players correctly answer field station questions?

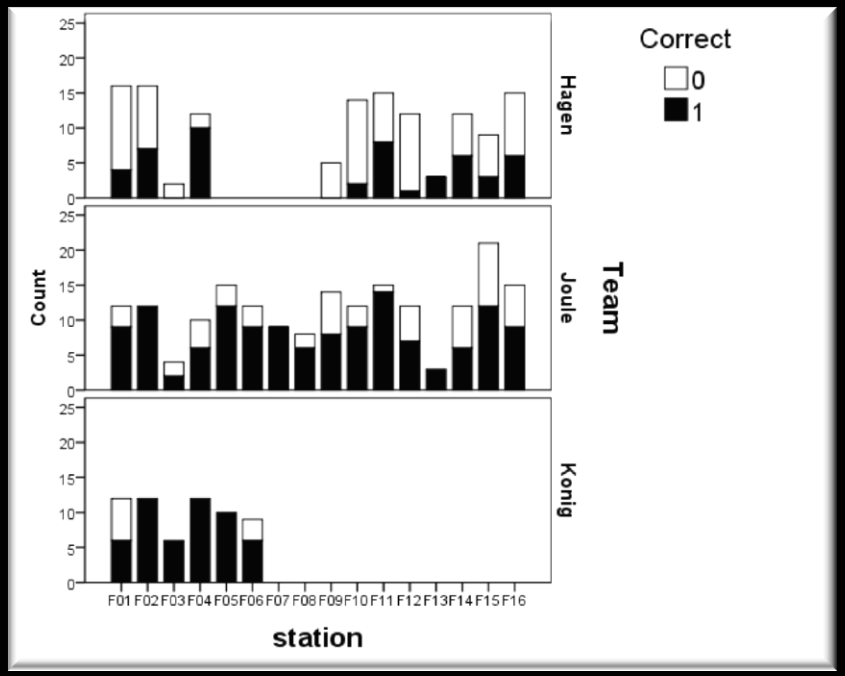
Navigation – Yes!



Three avatars per team

Number of Questions Attempted – Yes!

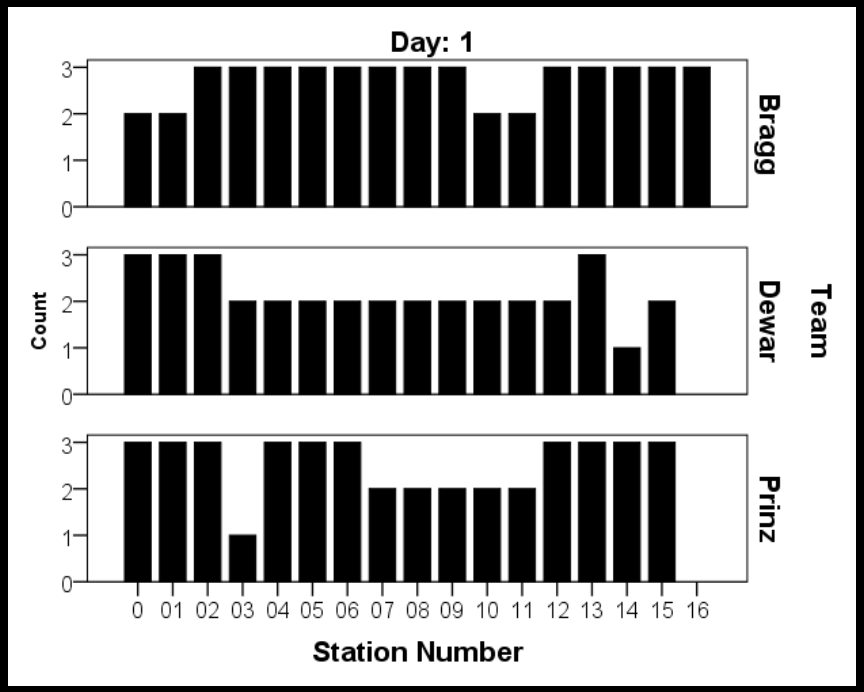


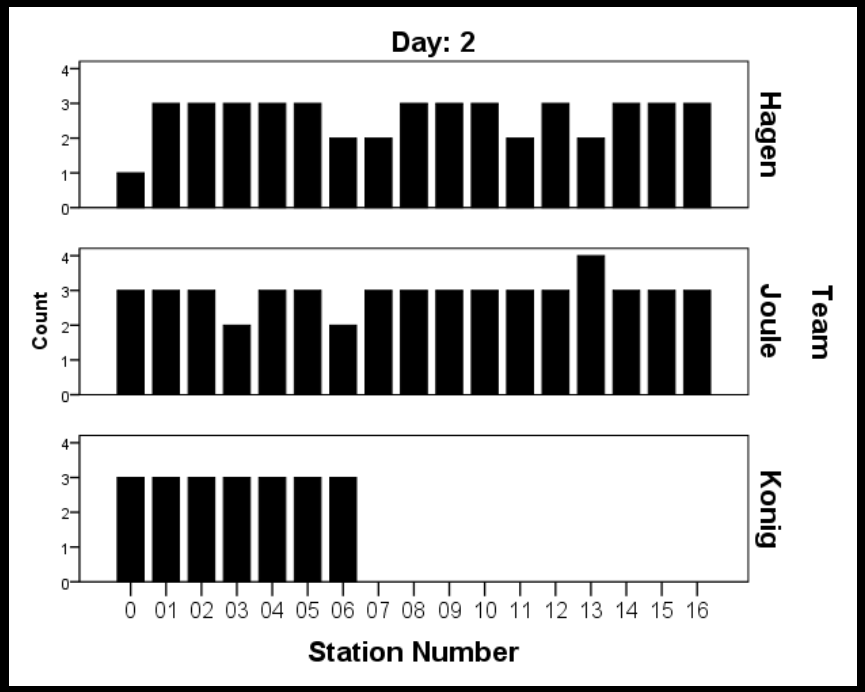


Three Avatars per Team

Novice Mentar at Work

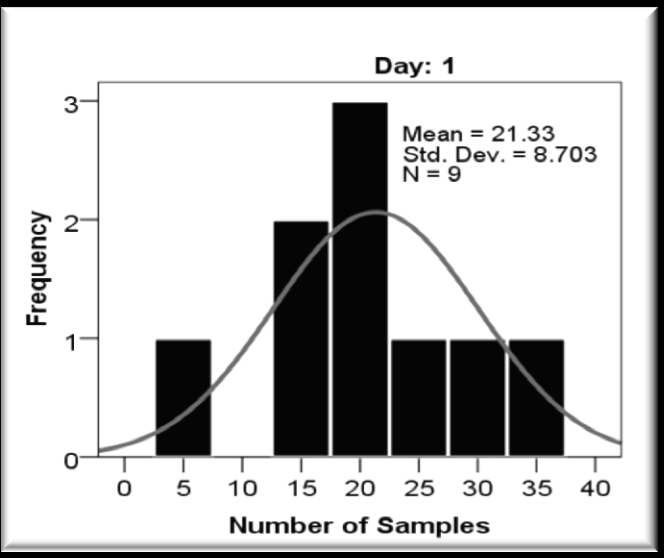
Number of Samples Collected

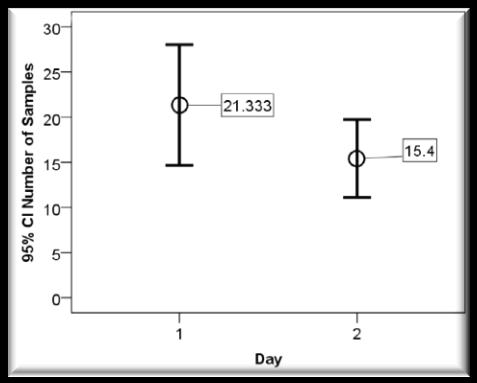


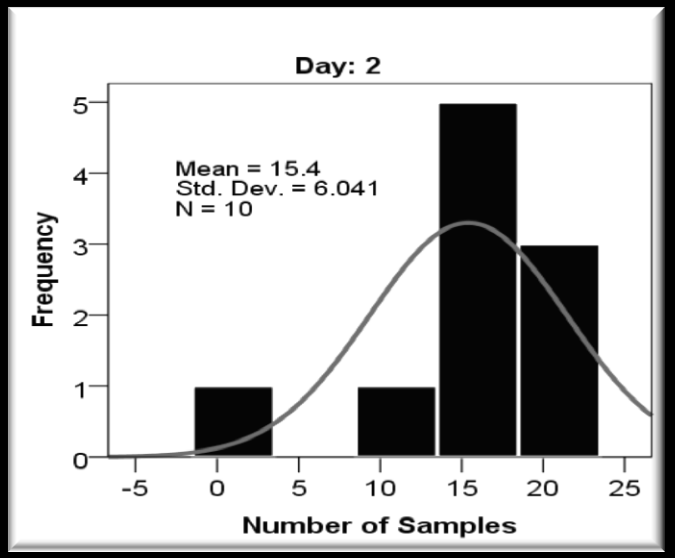


Three Avatars per Team

Number of Samples Collected

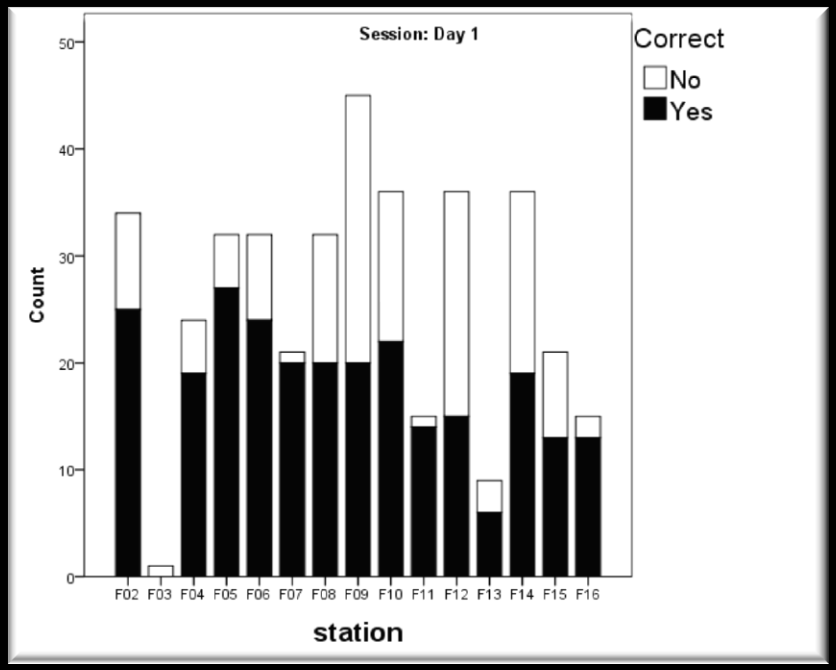


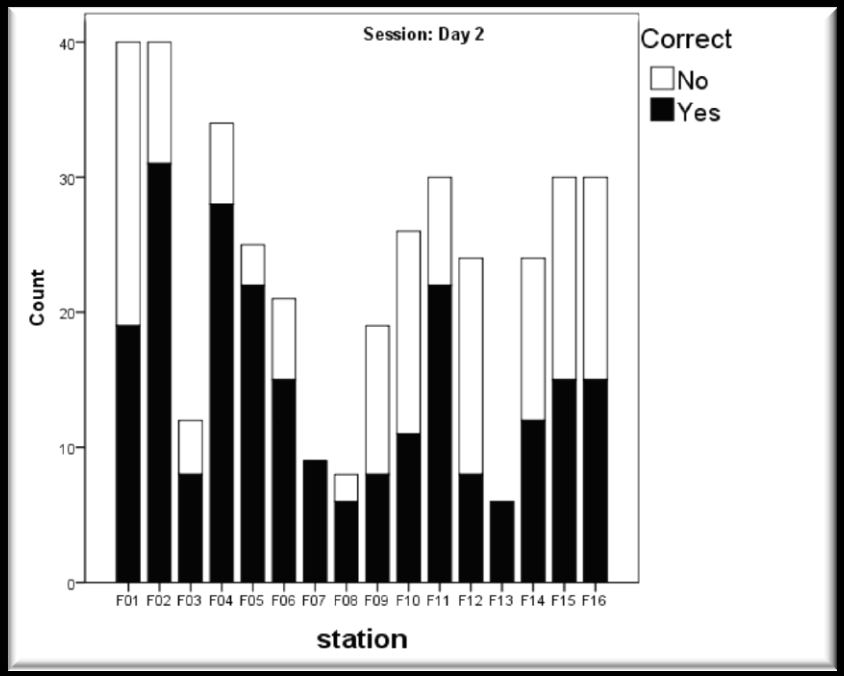




Samples Per Avatar

Number Correct? Sometimes. . .



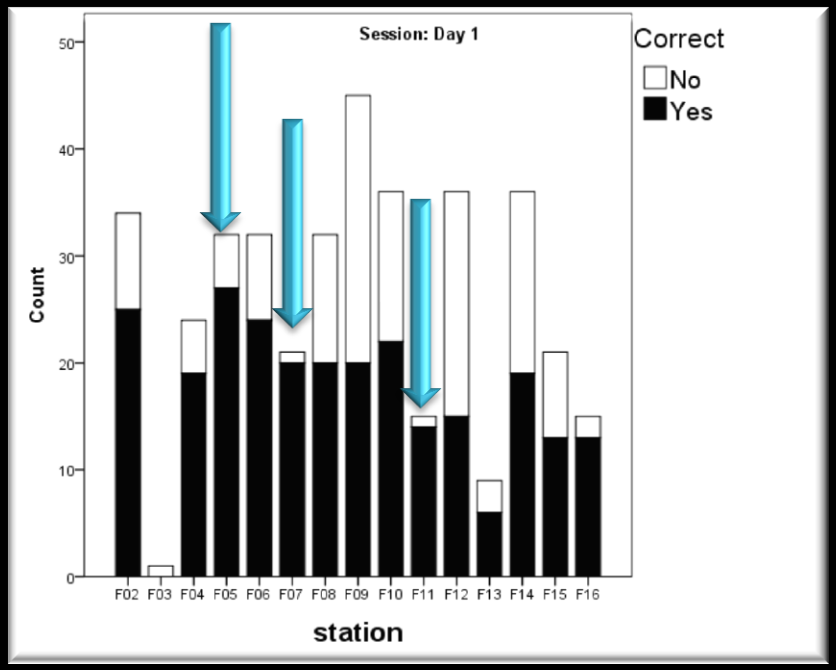


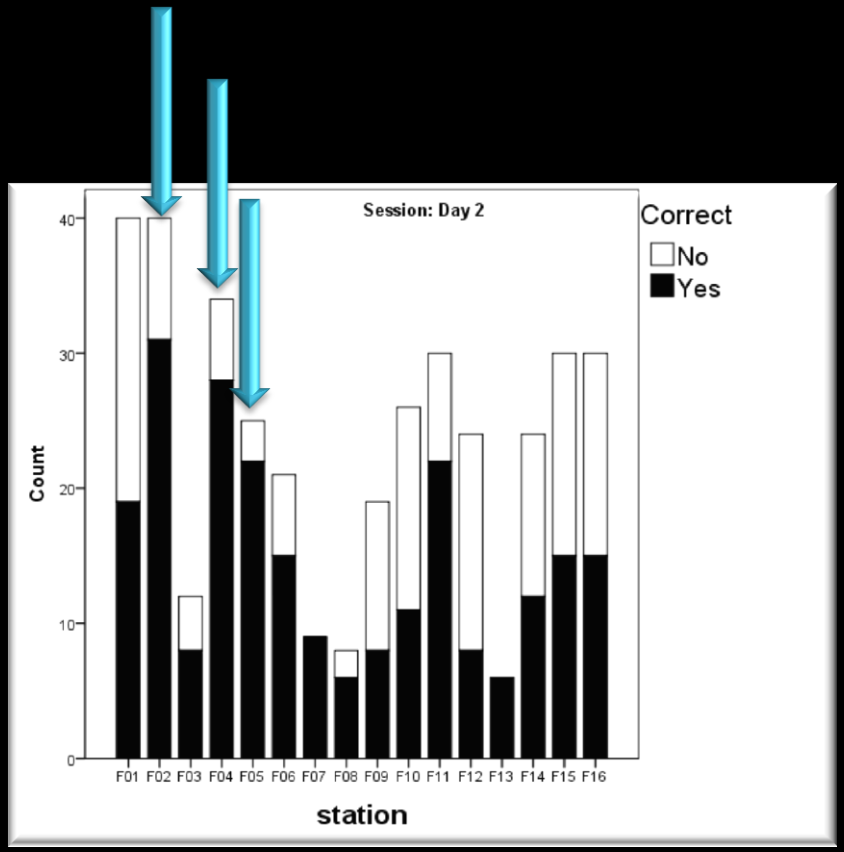
Aggregated by Session

Station	Day 1			Day 2		
	χ^2	(*df*)	Sig.	χ^2	(*df*)	Sig.
1	—		—	0.1	(1)	.752
2	7.6	(1)	0.006	**12.1**	**(1)***	**0.0005**
3	—		—	1.3	(1)	0.248
4	8.2	(1)	0.004	**14.2**	**(1)***	**0.0002**
5	**15.1**	**(1)***	**<0.0001**	**14.4**	**(1)***	**0.0001**
6	8.0	(1)	0.005	3.9	(1)	.05
7	**17.2**	**(1)***	**<0.00001**	—		—
8	2.0	(1)	0.157	2	(1)	.157
9	0.6	(1)	0.456	.47	(1)	.491
10	1.8	(1)	0.182	.62	(1)	.433
11	11.3	(1)*	0.0008	6.5	(1)	.01
12	1	(1)	0.317	2.67	(1)	.10
13	1	(1)	0.317	—		—
14	0.1	(1)	0.739	0	(1)	1.0
15	1.2	(1)	0.275	0	(1)	1.0
16	8.1	(1)	0.005	0	(1)	1.0

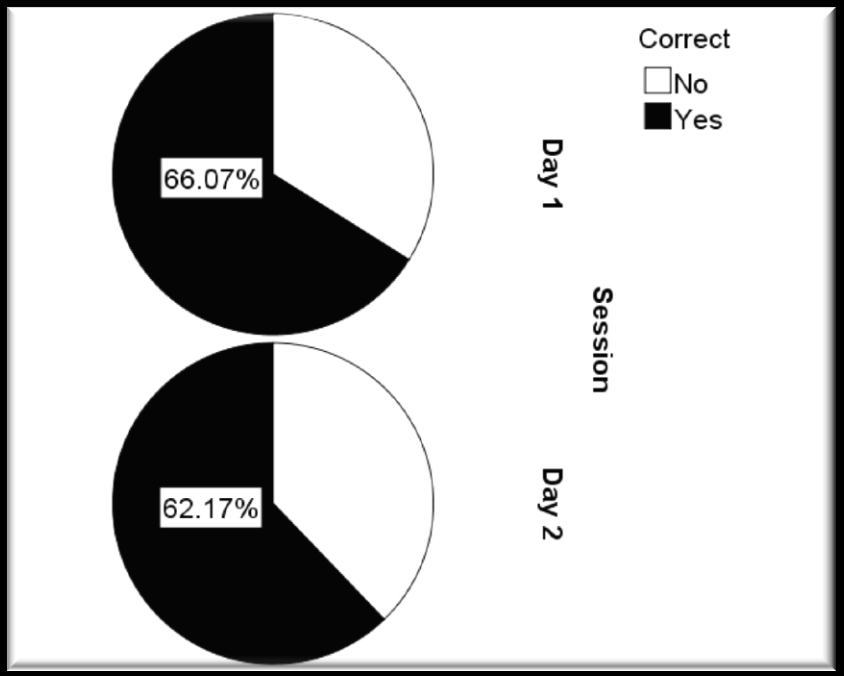
$p < .003$

One-way , correct vs. incorrect answers by field station

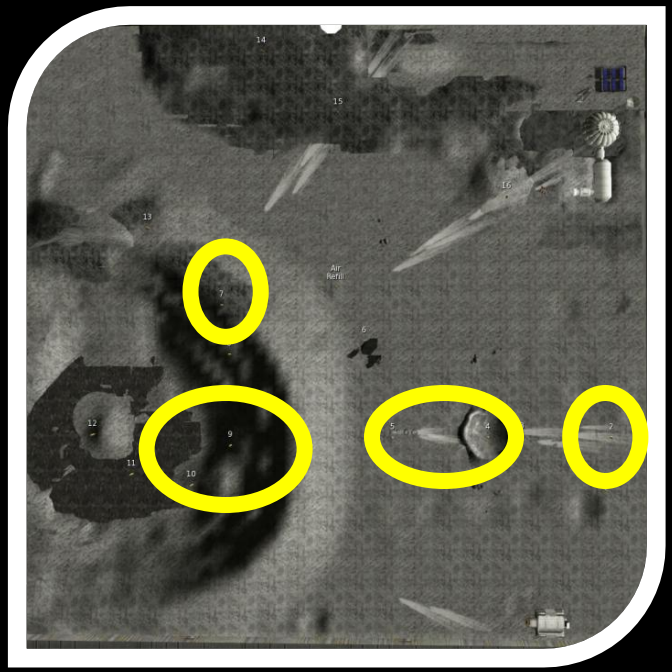




Percent Responses Correct



Station	Day 1			Day 2		
	χ^2	(*df*)	Sig.	χ^2	(*df*)	Sig.
2	7.6	(1)	0.006	**12.1**	**(1)***	**0.0005**
4	8.2	(1)	0.004	**14.2**	**(1)***	**0.0002**
5	**15.1**	**(1)***	**<0.0001**	**14.4**	**(1)***	**0.0001**
7	**17.2**	**(1)***	**<0.00001**	—		—
11	**11.3**	**(1)***	**0.0008**	**6.5**	**(1)**	**.01**



$p < .003$

One-way, number of correct answers.

Case 3 Finding.

Players with novice older youths acting as mentors successfully navigated and collect samples, but responses to questions were correct only 66% of the time.

***

OBSERVATION: Mentars has difficulty engaging their teams in deep scientific discussion.

Case 5.

Scientific Practices, Cross-cutting Concepts, & Achievement Through Collaboration

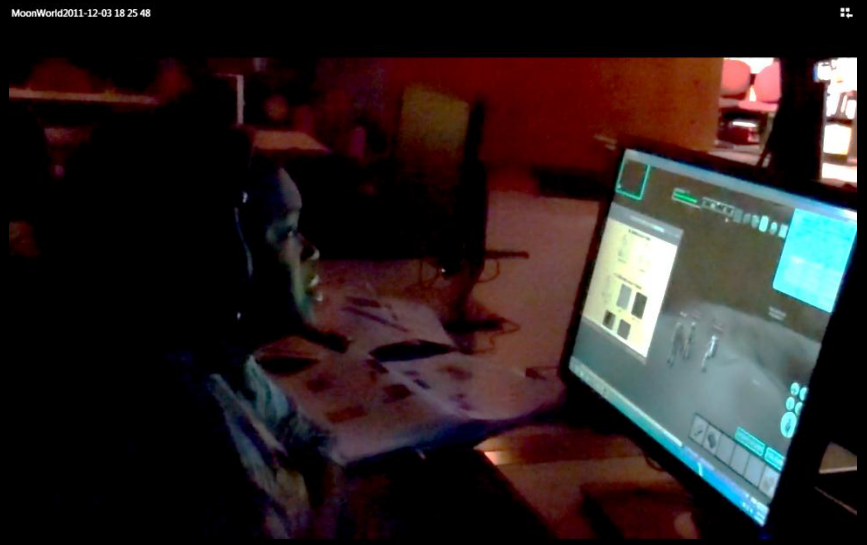
Professional Development

Research Questions

- What is the quality of scientific practice during mission?
  - questions, ,models, investigation, analyzing and interpreting data, constructing explanations, engaging in argumentation from evidence, obtaining, evaluating, and communicating information.
- Does MoonWorld inspire cross-cutting concepts?
  - patterns, cause and effect, scale/proportion/quantity, structure & function
- What is the relationship between achievement, scientific practices, and collaboration for a team of educators during professional development?

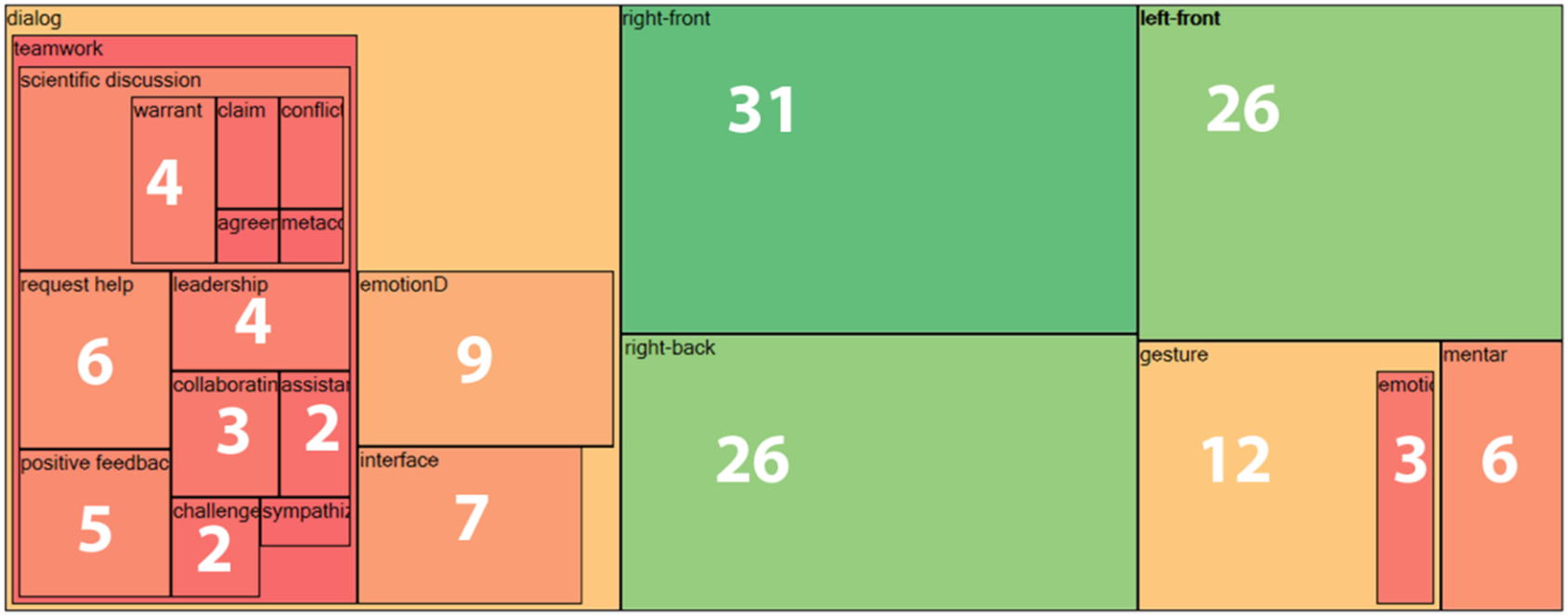
Professional Development

Charter Schools

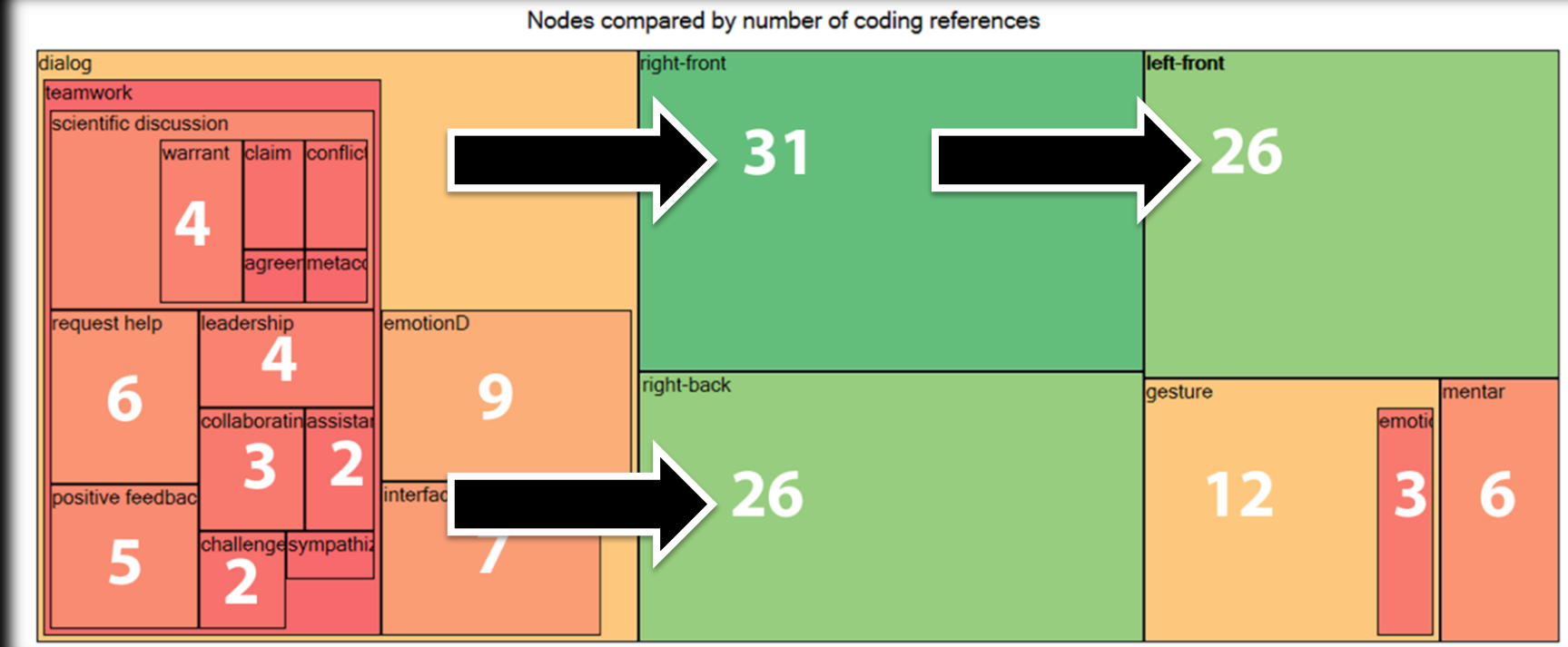


Professional Development

Nodes compared by number of coding references

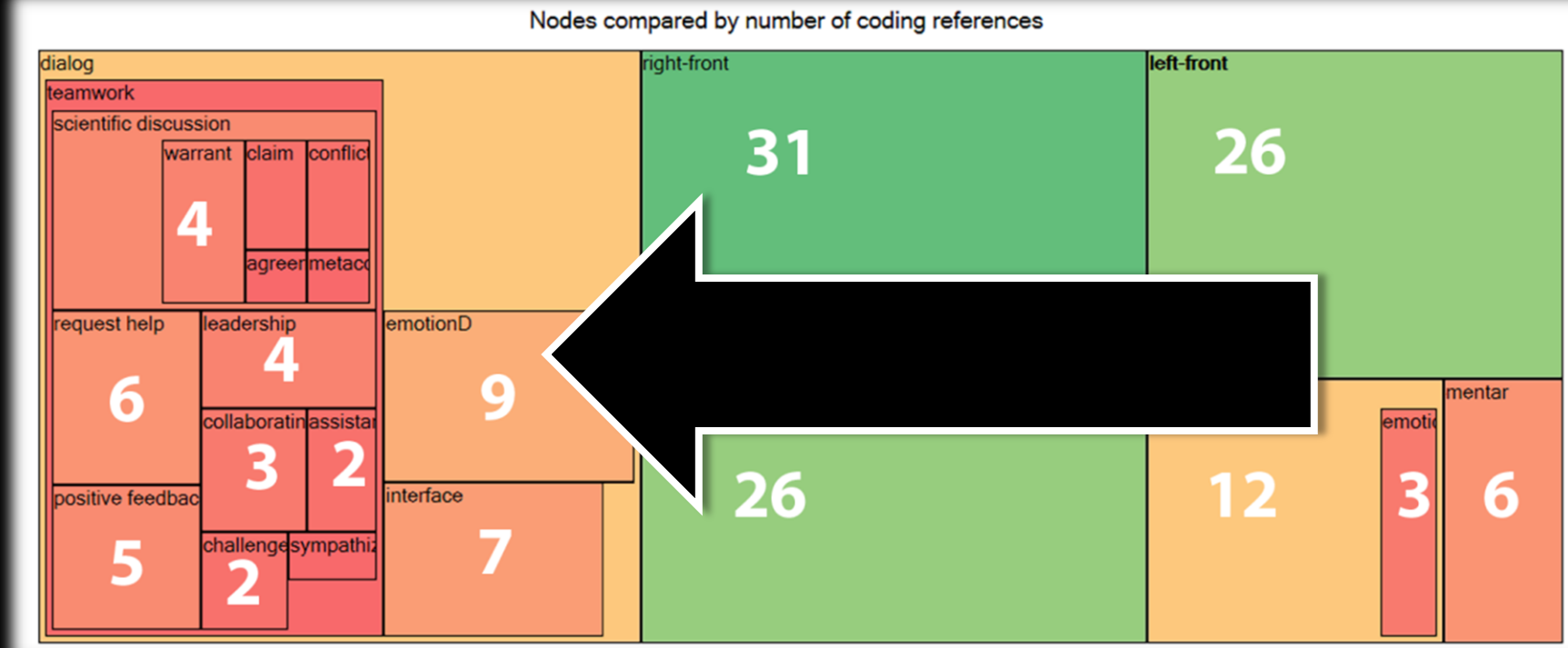


Contribution

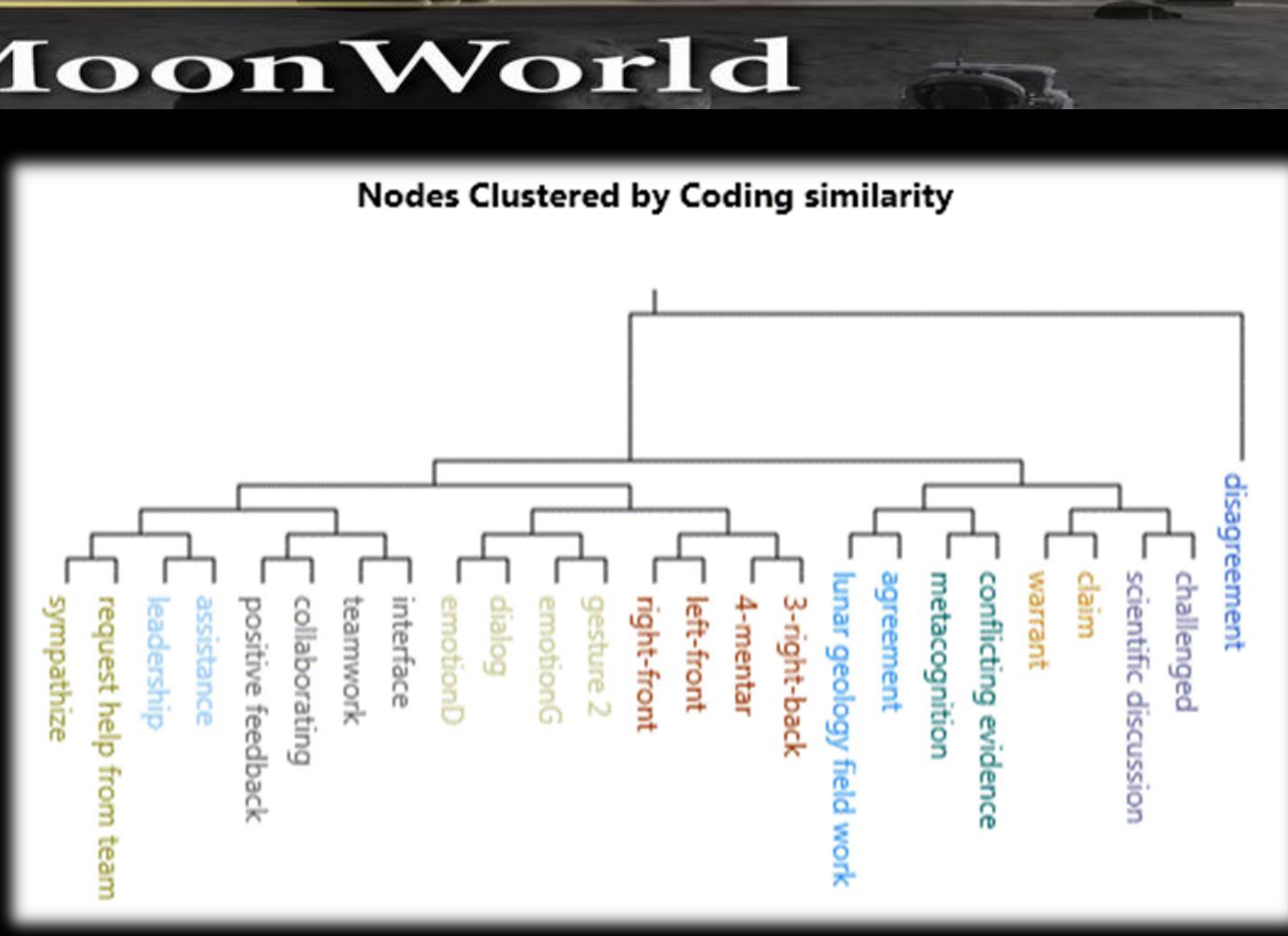



MoonWorld

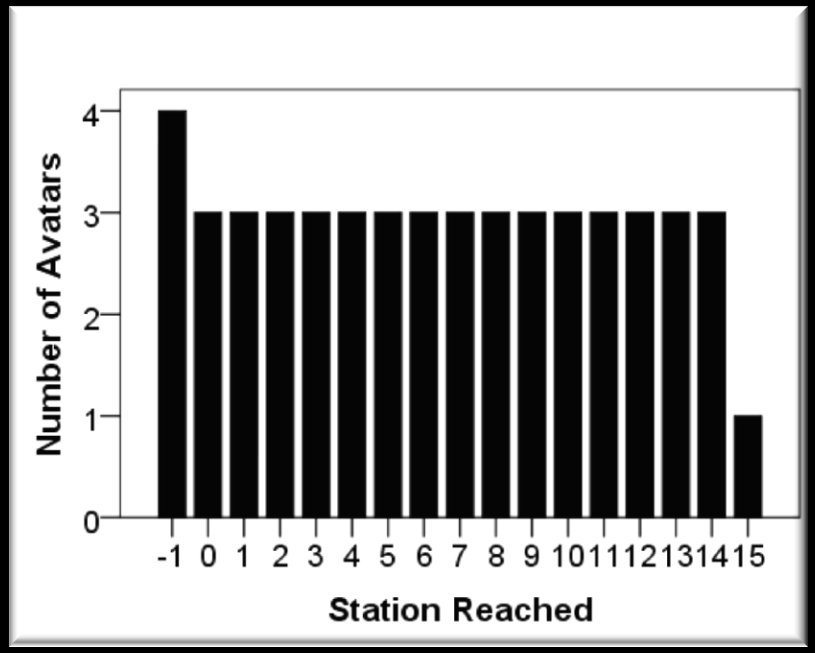
Practice


Nodes compared by number of coding references
dialog
teamwork
scientific discussion
warrant
4
claim
conflict
agreem
metac
request help
6
leadership
4
collaboratin
3
assistar
2
positive feedbac
5
challenge
2
sympathiz
emotionD
9
interface
7
right-front
31
26
left-front
26
12
emoti
3
mentar
6

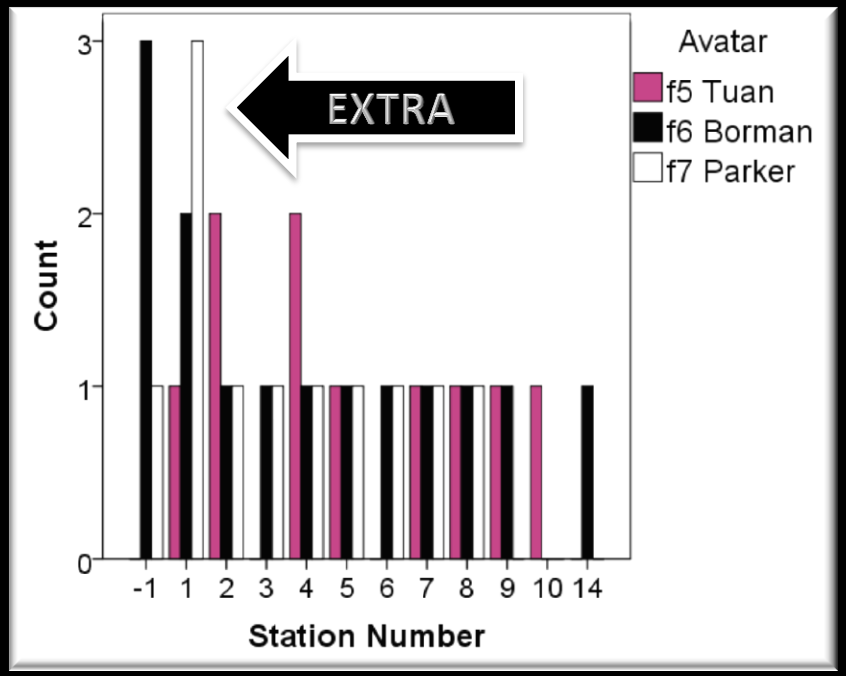
MoonWorld


Nodes Clustered by Coding similarity
disagreement
challenged
scientific discussion
claim
warrant
conflicting evidence
metacognition
agreement
lunar geology field work
3-right-back
4-mentar
left-front
right-front
gesture 2
emotionG
dialog
emotionD
interface
teamwork
collaborating
positive feedback
assistance
leadership
request help from team
sympathize

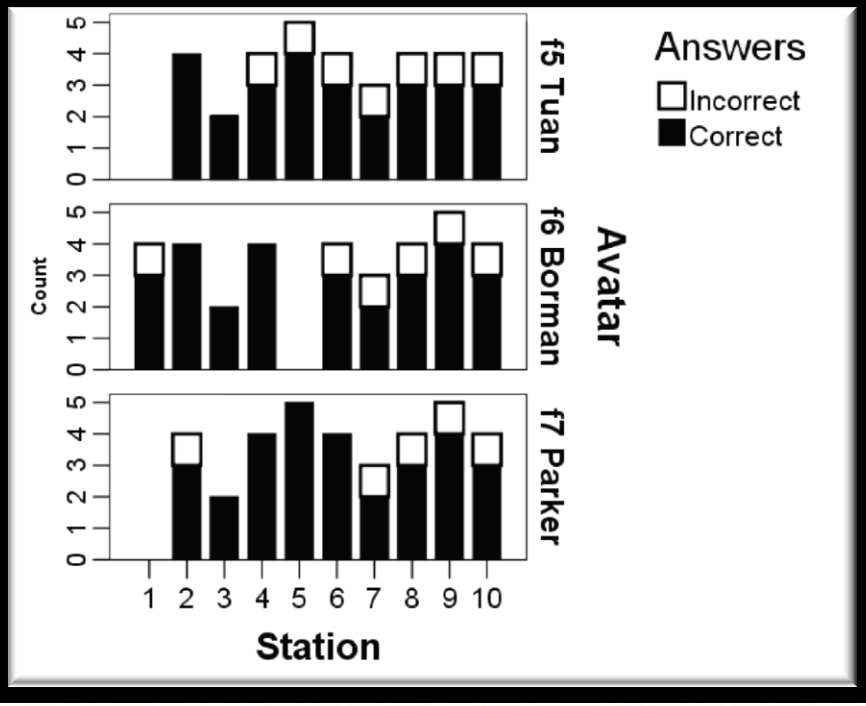
Wayfaring and Scaffolds

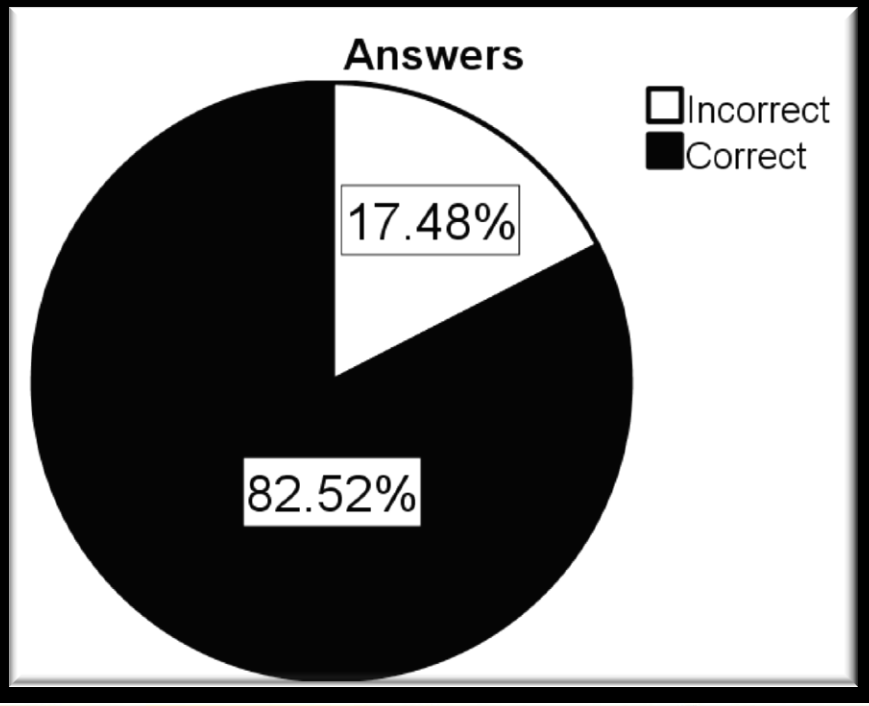


Samples Collected at Stations

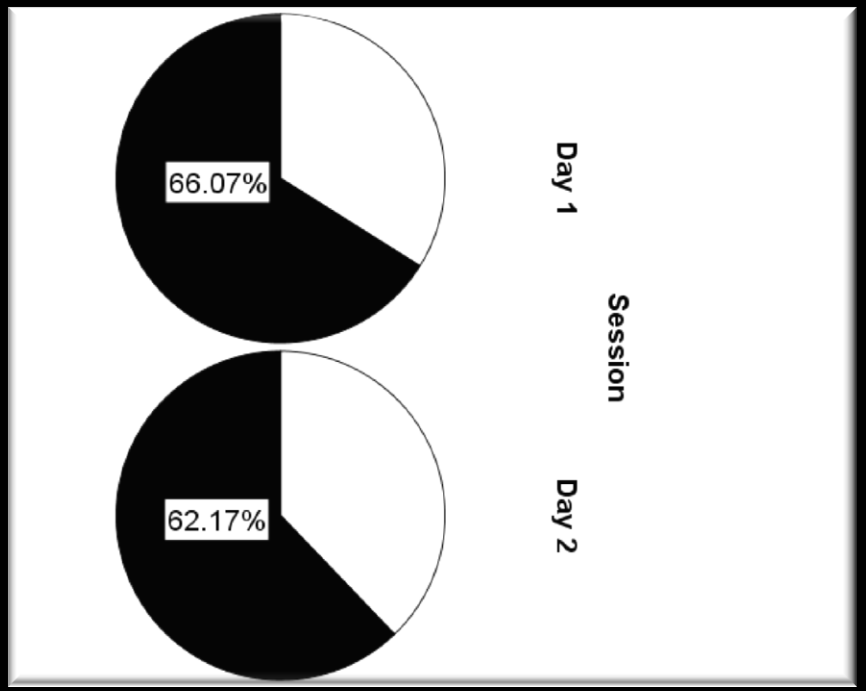


High Achievement

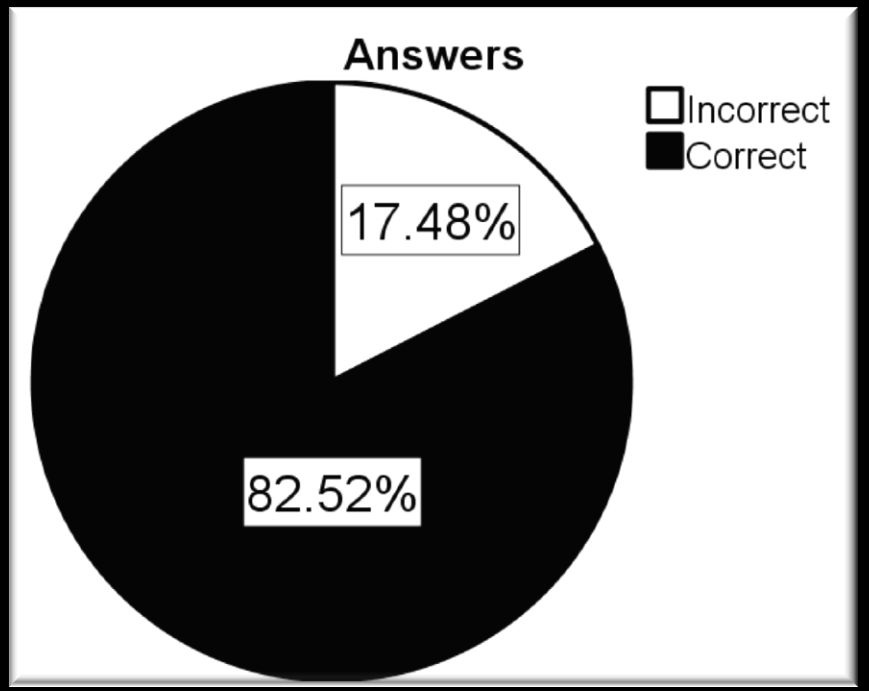




Case 3: Robotics Kids



Case 5: Adult Educators



Propel Rewards: Telescope

Propel Rewards: Telescope

Case 5 Finding.

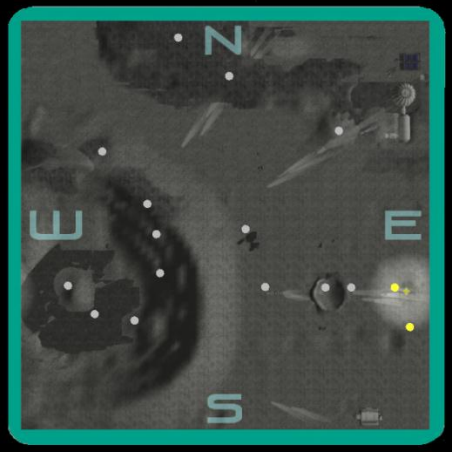
After MoonWorld professional development (30 minutes of mentored mission training followed by mission), MoonWorld educators successfully collaborate to engage in scientific practices, apply cross-cutting concepts, and build content knowledge.

Case 6.

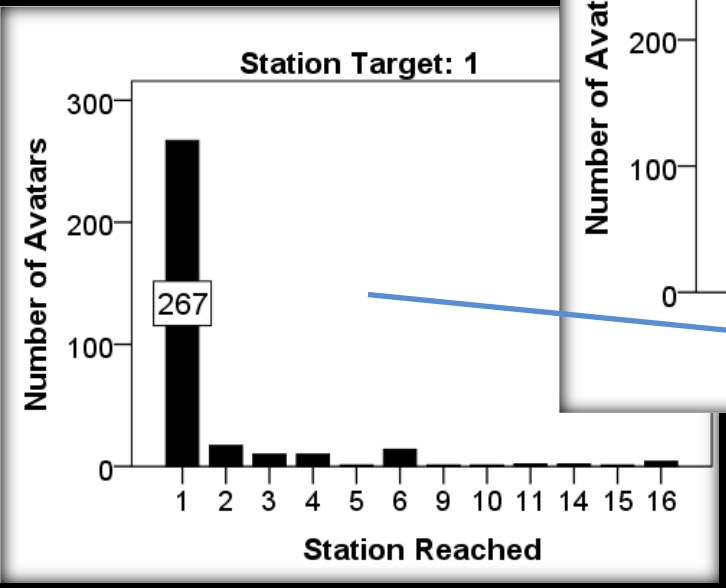
Wayfaring and Scaffolds: Station Visits

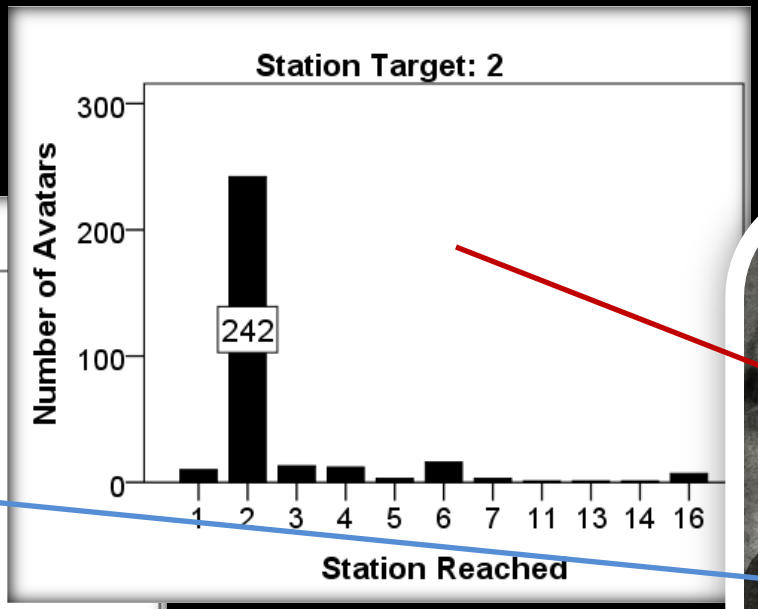
Research Question

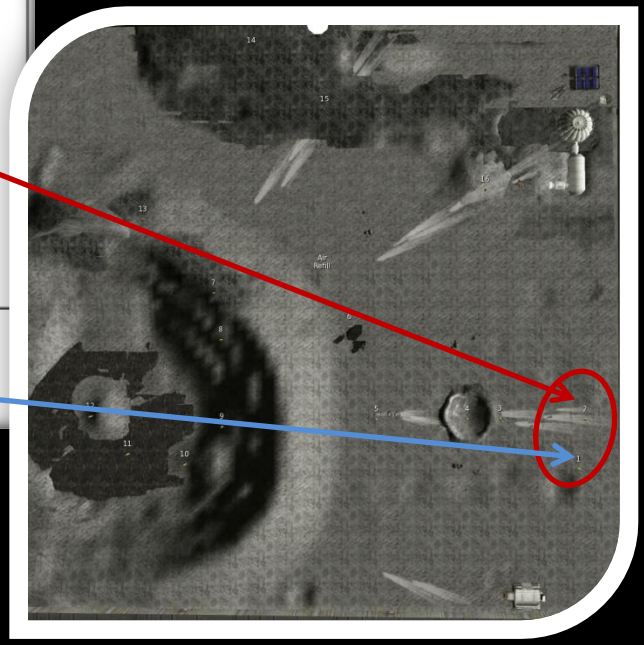
- To what extent is MoonWorld's scaffolded guidance employed, as evidenced in wayfaring by sequential research station visits?



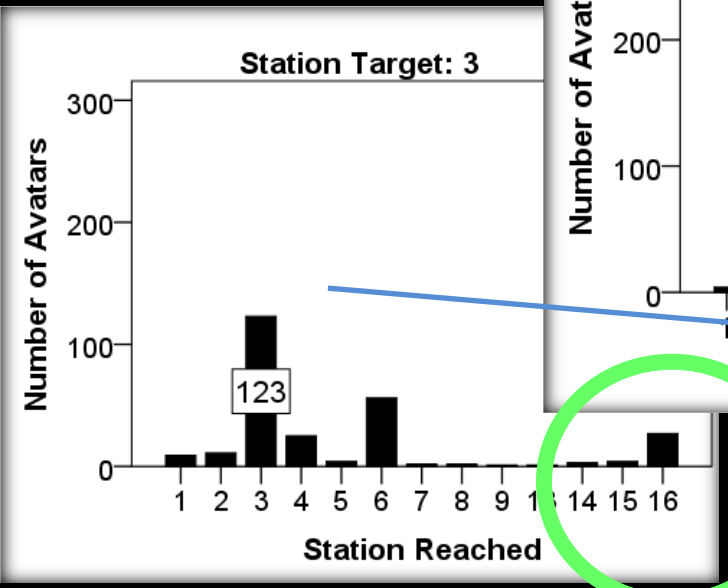

NASA
MoonWorld

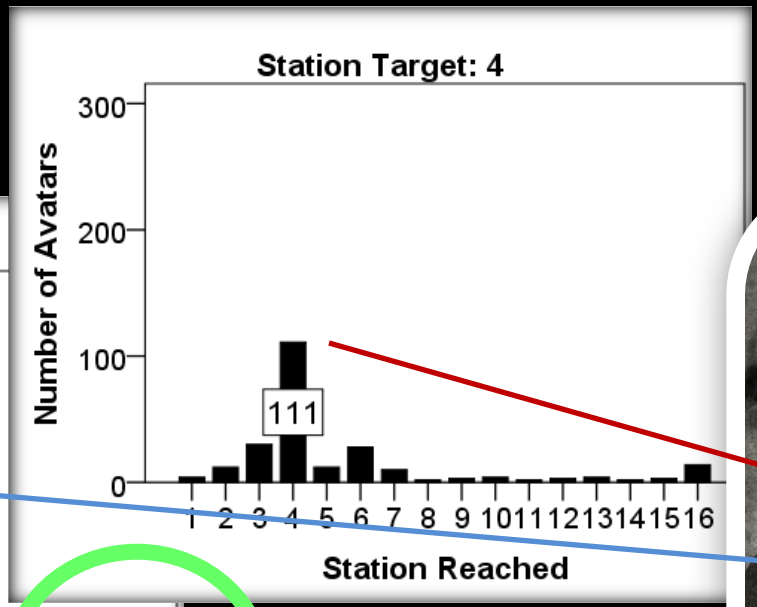

Station Target: 1
Number of Avatars
300
200
100
0
267
1 2 3 4 5 6 9 10 11 14 15 16
Station Reached

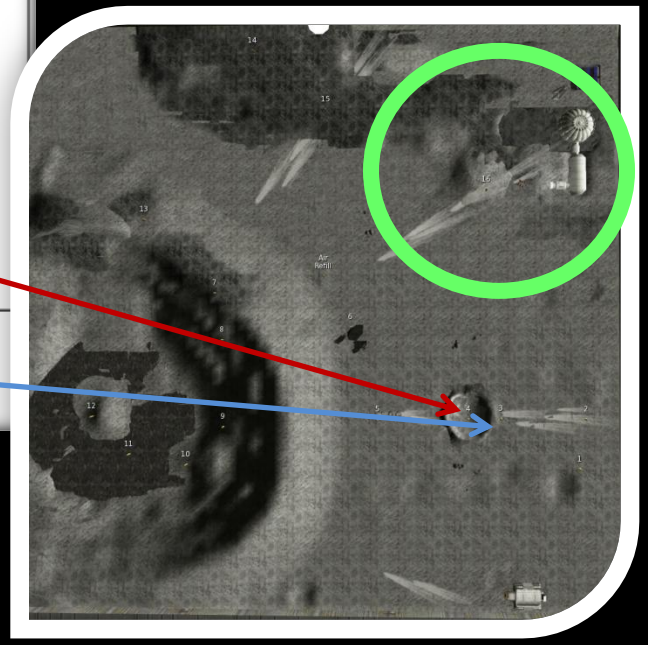

Station Target: 2
Number of Avatars
300
200
100
0
242
1 2 3 4 5 6 7 11 13 14 16
Station Reached



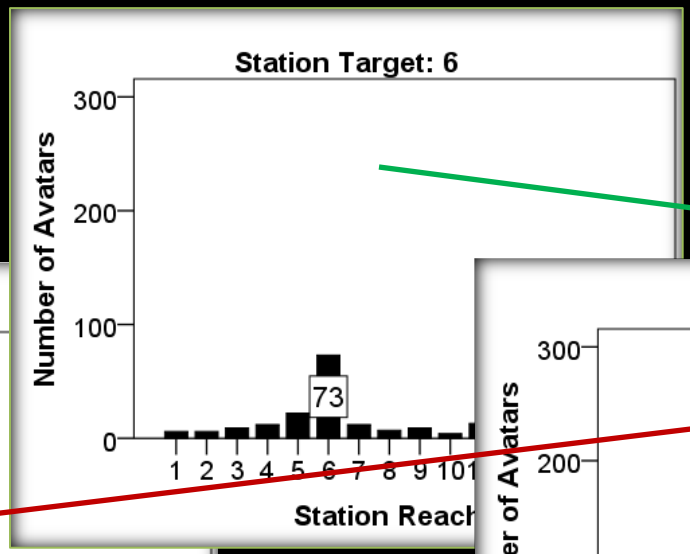

NASA
MoonWorld

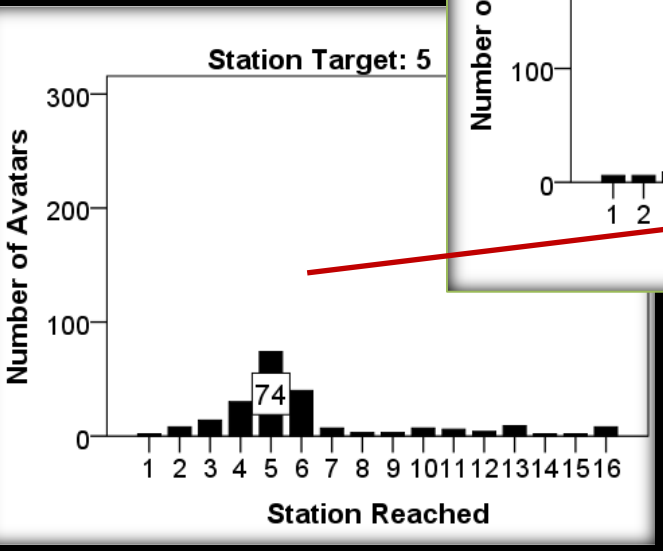

Station Target: 3
Number of Avatars
300
200
100
0
123
1 2 3 4 5 6 7 8 9 14 15 16
Station Reached

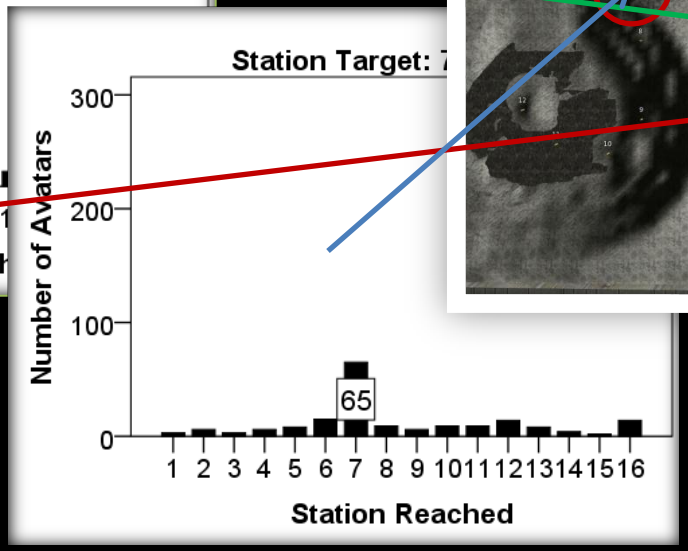

Station Target: 4
Number of Avatars
300
200
100
0
111
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Station Reached

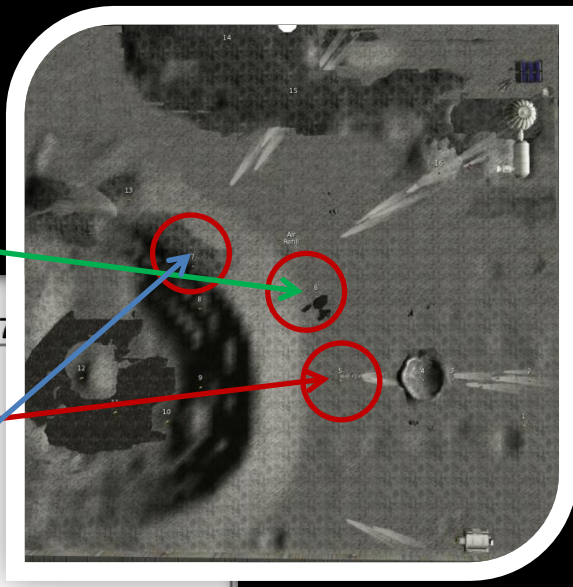



NASA
MoonWorld

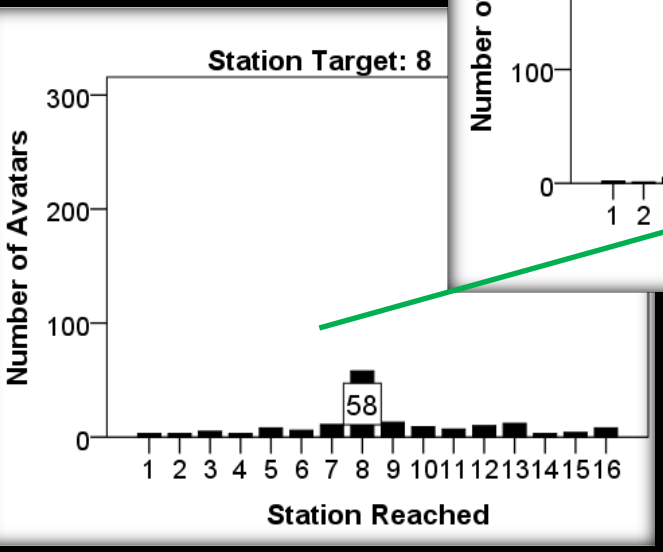

Station Target: 6
Number of Avatars
300
200
100
0
73
1 2 3 4 5 6 7 8 9 101
Station Reach

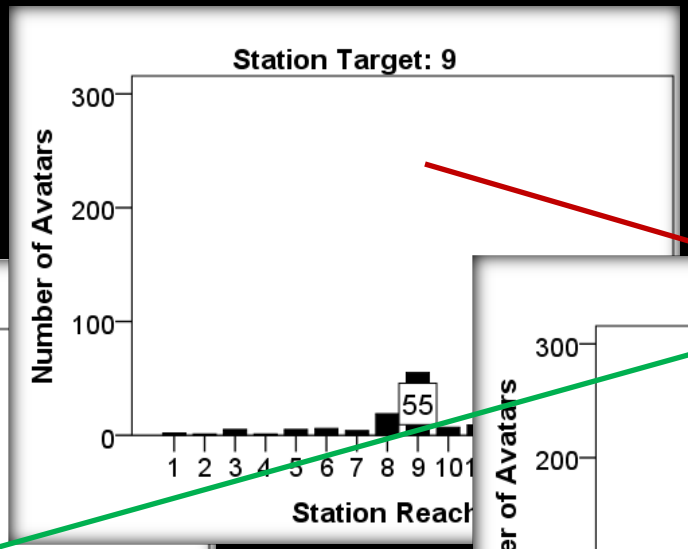

Station Target: 5
Number of Avatars
300
200
100
0
74
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Station Reached

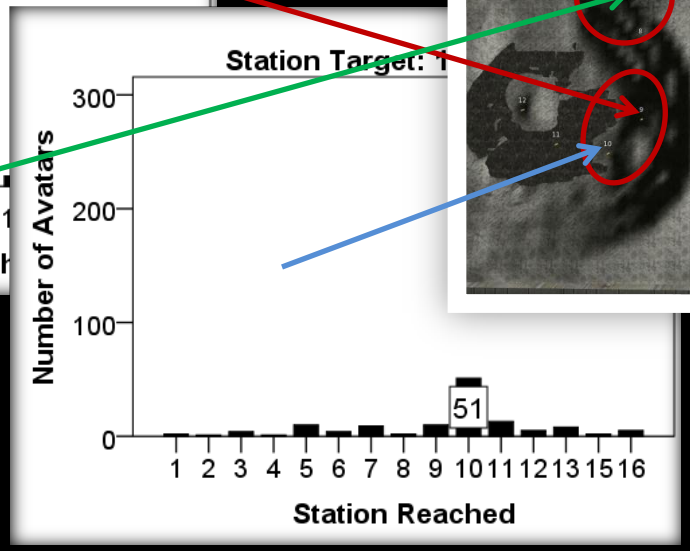

Station Target: 7
Number of Avatars
300
200
100
0
65
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Station Reached

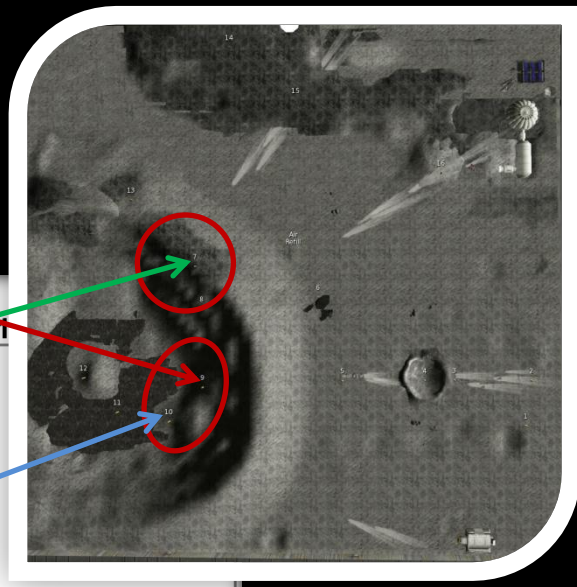



NASA
MoonWorld

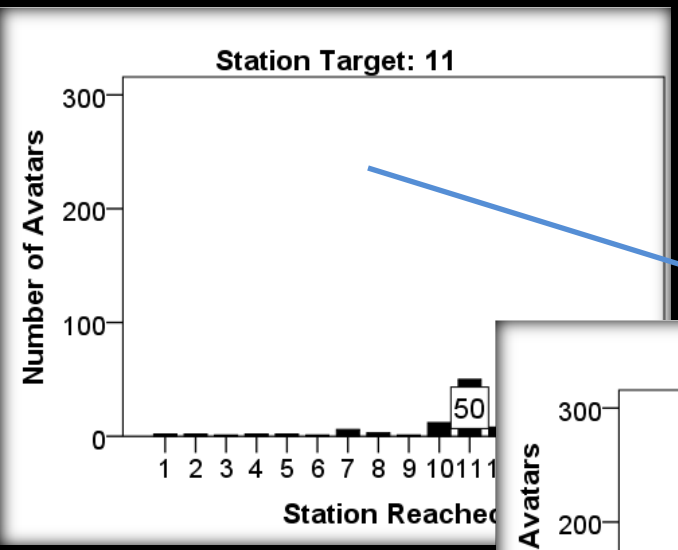

Station Target: 8
Number of Avatars
300
200
100
0
58
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Station Reached

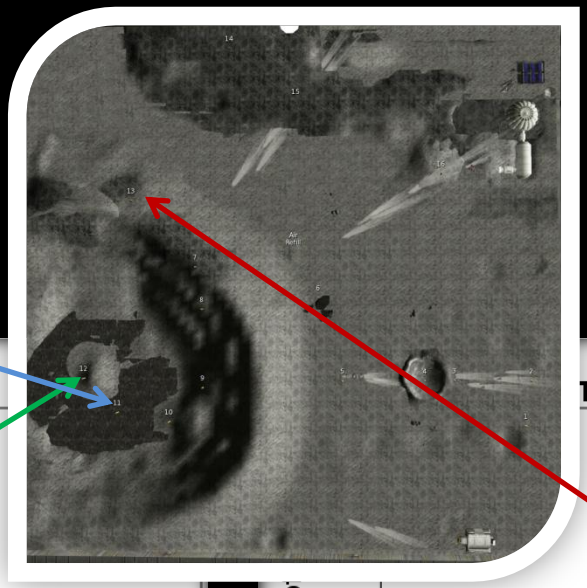

Station Target: 9
Number of Avatars
300
200
100
0
55
1 2 3 4 5 6 7 8 9 10
Station Reach

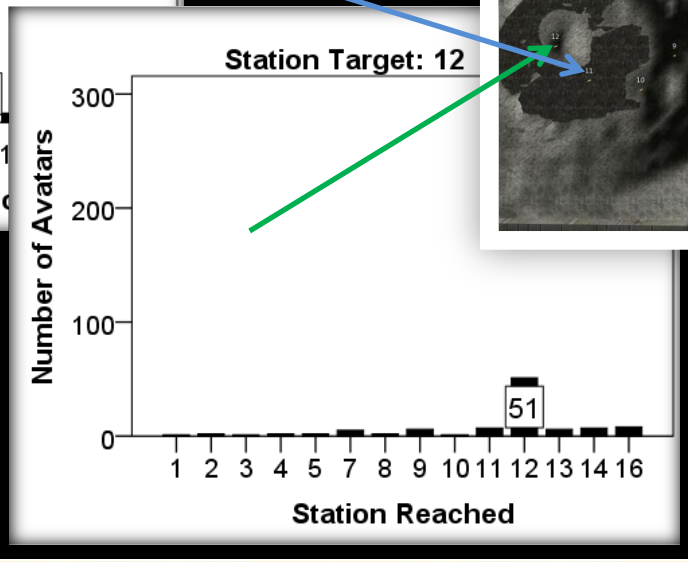

Station Target:
Number of Avatars
300
200
100
0
51
1 2 3 4 5 6 7 8 9 10 11 12 13 15 16
Station Reached

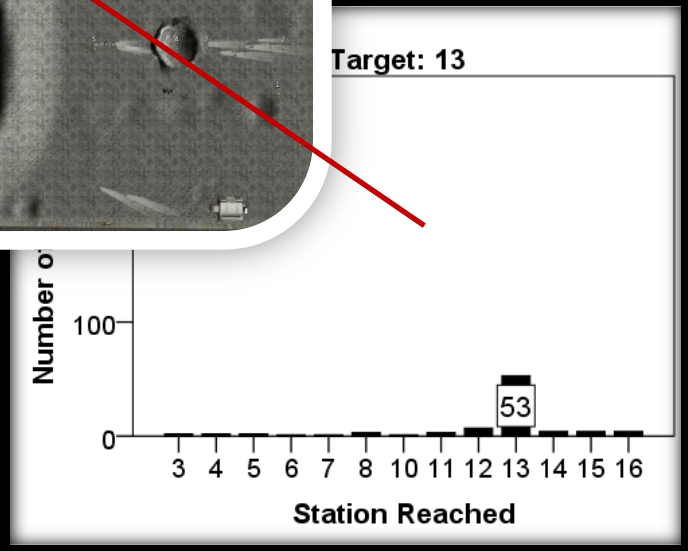


MoonWorld

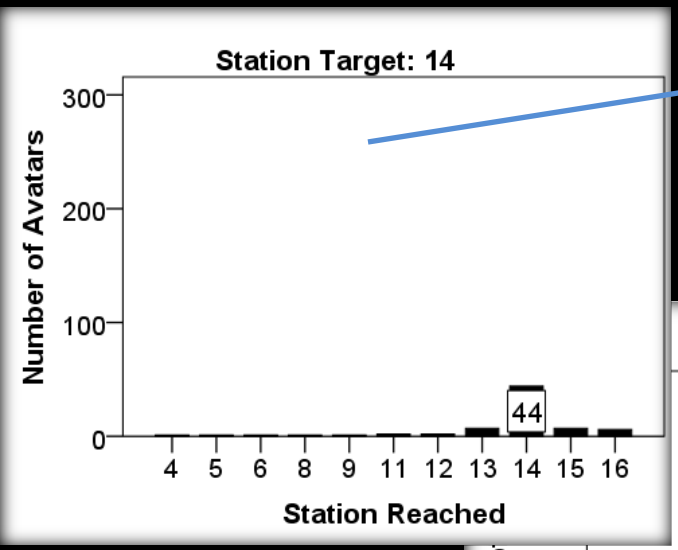

Station Target: 11
Number of Avatars
300
200
100
0
50
1 2 3 4 5 6 7 8 9 10 11 1
Station Reached

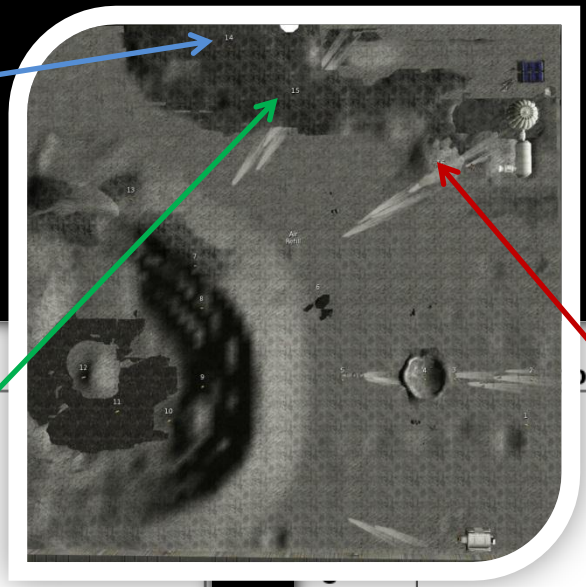


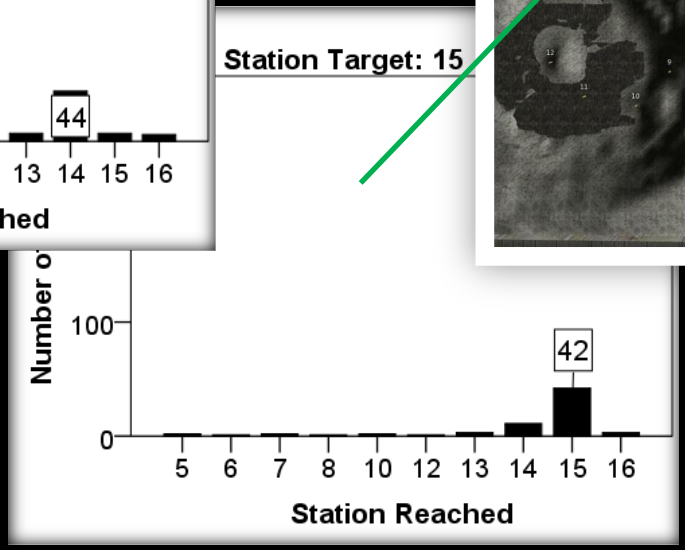

Station Target: 12
Number of Avatars
300
200
100
0
51
1 2 3 4 5 7 8 9 10 11 12 13 14 16
Station Reached

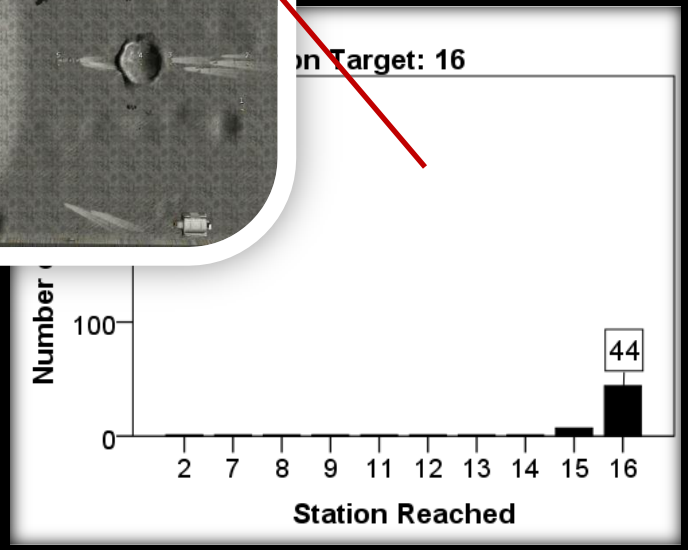

Target: 13
100
0
53
3 4 5 6 7 8 10 11 12 13 14 15 16
Station Reached

MoonWorld


Station Target: 14
Number of Avatars
300
200
100
0
44
4 5 6 8 9 11 12 13 14 15 16
Station Reached




Station Target: 15
100
0
42
5 6 7 8 10 12 13 14 15 16
Station Reached


Target: 16
100
0
44
2 7 8 9 11 12 13 14 15 16
Station Reached

Station	Count		Chi-square (*df*)
	Correct	Incorrect	
1	267	63	3139 (1)*
2	242	67	2739 (1)*
3	123	145	719 (1)*
4	111	133	641 (1)*
5	74	145	283 (1)*
6	102	102	666 (1)*
7	65	116	272 (1)*
8	58	105	239 (1)*
9	55	86	258 (1)*
10	51	76	249 (1)*
11	50	61	285 (1)*
12	51	50	337 (1)*
13	53	34	444 (1)*
14	44	29	364 (1)*
15	42	26	358 (1)*
16	44	15	470 (1)*

α = .05/16 = 0.003, correcting for multiple inference testing
* $p < 0.0001$

For each sequential field station visit (1 – 16) conducted by Avatars, Avatars were more likely to visit the correct field station than an incorrect field station.

MoonWorld successfully scaffolds navigation for untrained visitors.

34 Correct Missions
Naviation

Avatar	Missions Completed
A	4
B	3
C	2
D	2
All others	23

244 Avatars - Station

Number of Avatars	Missions Runs
1	9
1	8
2	7
3	5
1	4
10	3
24	2
202	1

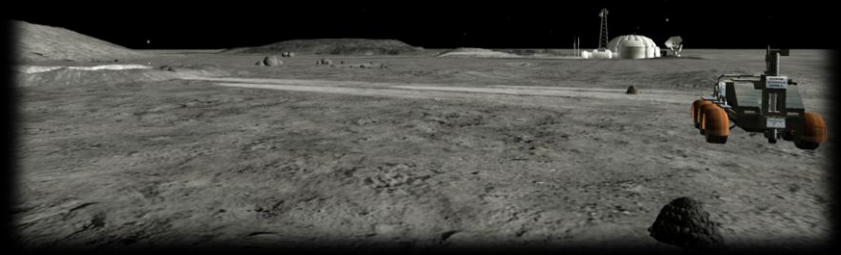
Per-Avatar Missions with Field Station Visits

Number of Correct Slots per Avatar Visit	Number of Avatars with that Sum
0	43
1	28
2	110
3	33
4	38
5	9
6	10
7	5
8	5
9	3
10	2
12	2
13	4
14	3
15	1
16	34

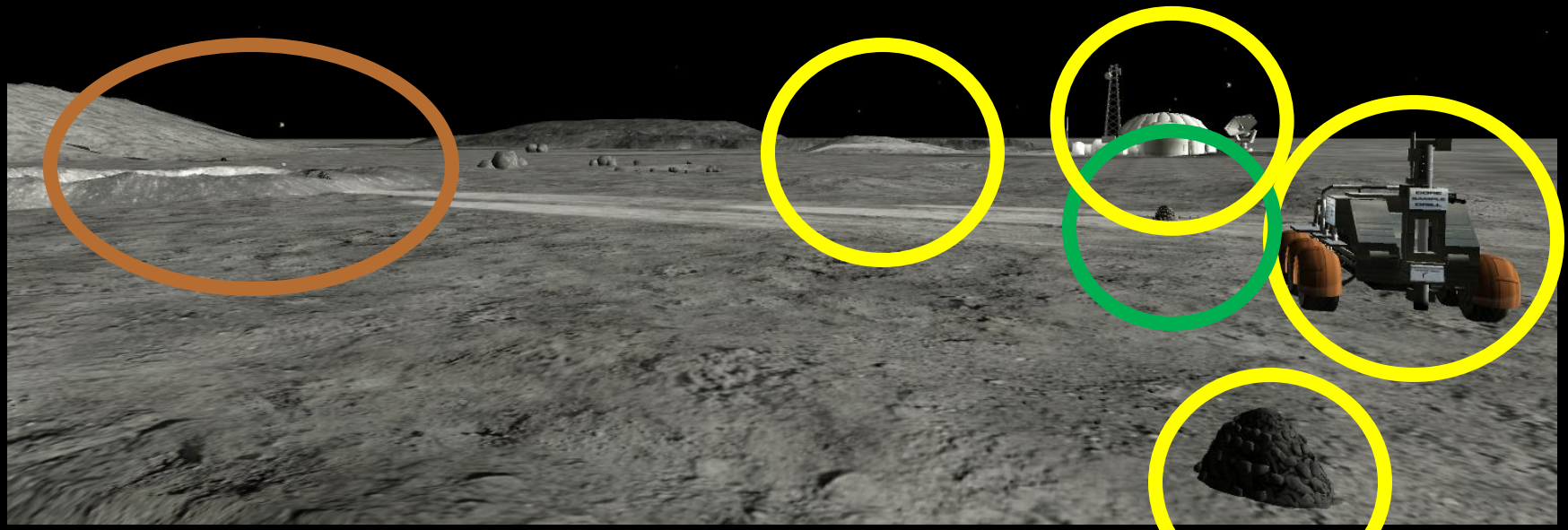
244 Avatars – Station

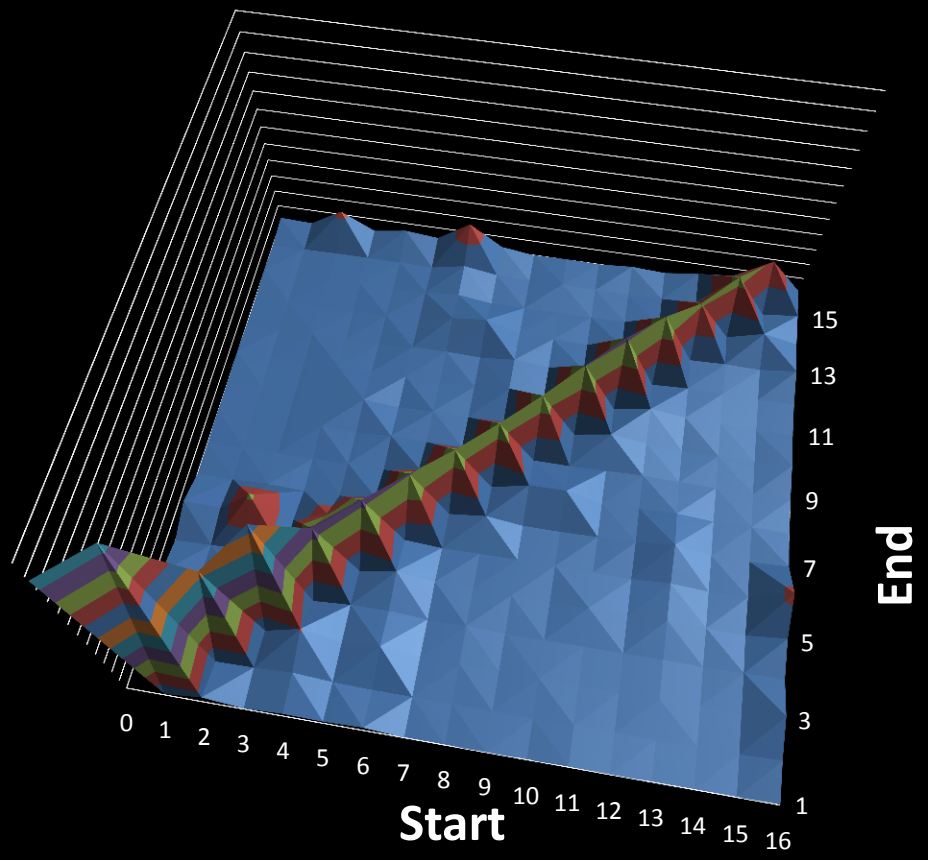
330 Avatar Missions

Non-scaffolded Routes



Non-scaffolded, Obvious Path





Number of Dyads

- 275-300
- 250-275
- 225-250
- 200-225
- 175-200
- 150-175
- 125-150
- 100-125
- 75-100
- 50-75
- 25-50
- 0-25

Case 6 Finding.

MoonWorld successfully scaffolds navigation for untrained visitors.

Research Findings

- MoonWorld scaffolds navigation for untrained visitors.
- Professional development enhances implementation.
- MoonWorld causes collaboration
  - Scientific practices.
  - Apply cross-cutting concepts
  - Build content knowledge.
- MoonWorld increases achievement.

Visitors Say

"The images of lunar surface structure are fascinating. I now want to find out more about the formation of the impact craters. Are these (I assume that they are) accurate representations of actual areas of the surface? One could really get excited. . . . Extremely immersive."

-Professor of Information Technology – specializing in e-Learning

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Visitors Say

The proverb says, “Show me and I’ll forget; Show me and I may remember; Involve me and I’ll understand.” So when we learned about the moon surface and rocks I didn’t tell my students the facts or merely show them pictures. I got them involved in a mission to explore the moon. The freedom to explore allowed them to question…discover…It was not easy. They failed many times. They kept trying and wondering. . . My students were interested. Motivated. And curious.

-Science teacher for grades 5/6

.

Recommendations

- Continue professional development and implementation
- Migrate MoonWorld to a more stable and robust platform, such as Unity.

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MoonGazers
Selene
A Lunar Construction GaME
MoonWorld
MoonGazers
Hands-on Activities
NASA
NSF
CET
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NASA
NSF
CET
Center for Educational Technologies®