Visualising Mechanical Heritage in Motion:

A Mixed Reality Installation for the Japanese Matchlock Gun

GCH 2026

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Research Object

- The Japanese matchlock gun
- Its snap-lock fires in an instant



Purpose

- See the firing structure intuitively
- Draw in young people via an MR shooting game

History of the Japanese Matchlock

1543
Arrival
Portuguese traders reach Tanegashima

1540s
Made in Japan
Copied within a few years

Sengoku
(~1590)
Mass orders
From warlords, then the shogunate

Edo
(1603–1868)
Decline
Fewer wars, fewer orders

Meiji
(1868–1912)
Ban
Military guns no longer made

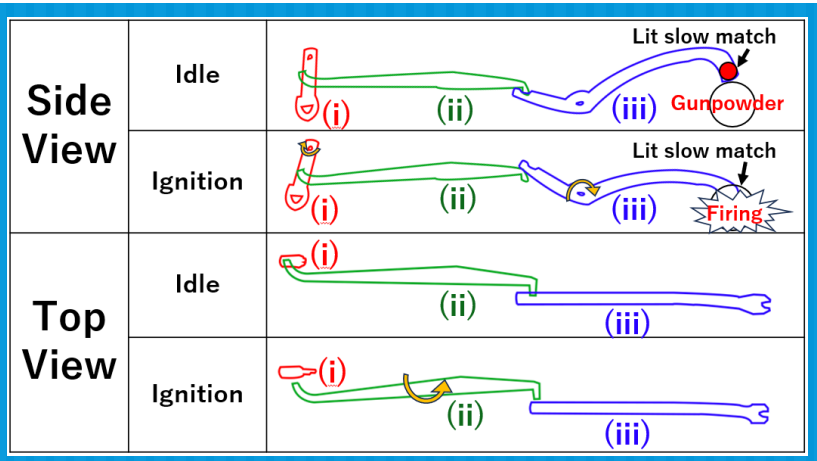
Taught at School

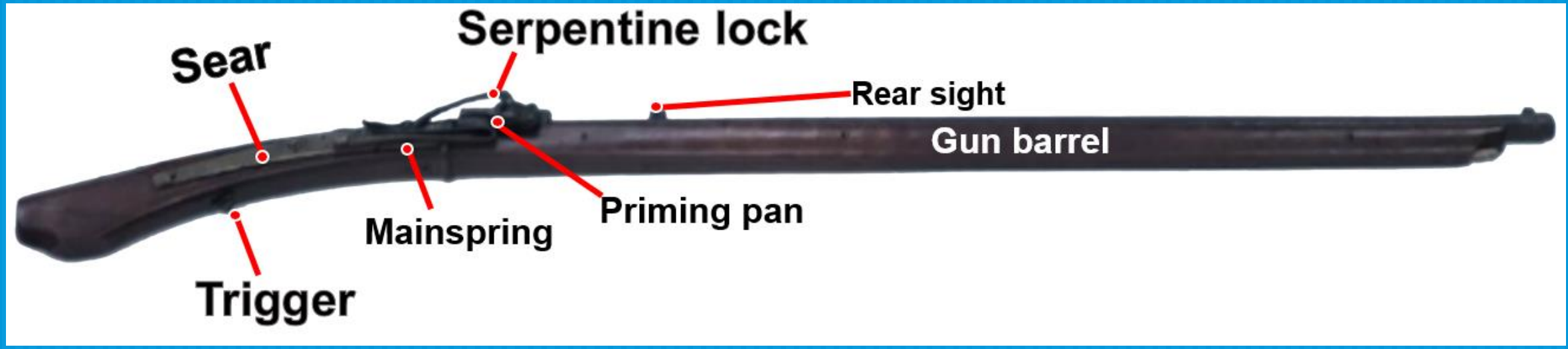
- Grade 4 Japanese: Gon, the Little Fox
- Grade 6 Social Studies: Arrival of firearms



Simple, Yet Hard to Explain

- **Trigger:** pulled, it moves the sear
- **Sear:** slides aside and frees the serpentine
- **Serpentine:** drops the lit match onto the pan
- **Pictures and text alone cannot show this motion**

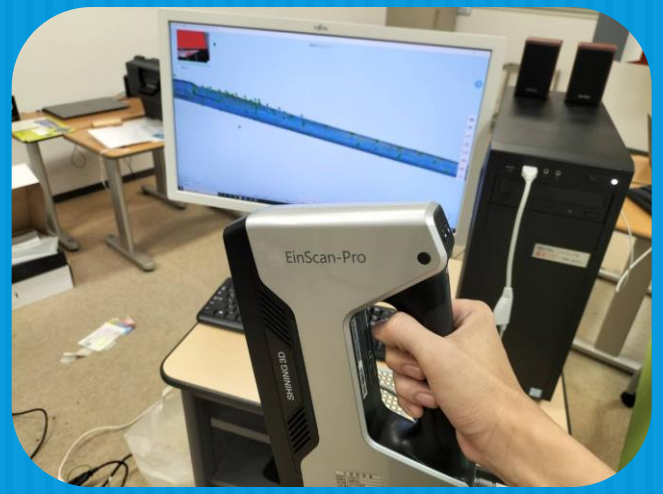




Our Previous Attempts

3D Scan

- Scanned Sakai City gun



CG Animation

- How it was made and fired



AR

- CG gun on a tablet



\+ More intuitive, and well received

− But few young people came to learn on their own

Related Work

Showing mechanical structure has long been hard

「Deepening to Antikythera Mechanism via Its Interactivity」

I. S. Diolatzis, G. Pavlogeorgatos (2018)

- Ancient Greek astronomical calculator
- Its gears as an interactive 3D model



「Digital Restoration of Ancient Loom: Yunjin Dahualou Loom」

H. Li, J. Zhang, W. Peng, X. Tian, J. Shi (2025)

- Traditional Chinese loom
- Parts decomposed and restored in 3D



Making the inner workings of a mechanism visible has long been a challenge

I. S. Diolatzis, G. Pavlogeorgatos: Deepening to Antikythera Mechanism via Its Interactivity, DAACH 8, pp.10-26 (2018)
H. Li et al.: Digital Restoration of Ancient Loom: Yunjin Dahualou Loom, npj Heritage Science 13, Art. 3 (2025)

Related Work

XR and cultural heritage: many precedents

「Mixed Reality Museum in Kyoto」

Kennin-ji × Kyoto National Museum, Microsoft (2018)

- HoloLens overlay on famous folding screens
- Guided by a holographic monk



「Revivre: Extinct Animals in Augmented Reality」

Muséum national d'Histoire naturelle, Paris (2021)

- Extinct animals shown life-size in the gallery
- Seen through AR glasses



XR has long been used with heritage (surveys: Bekele 2018; Rodriguez-Garcia 2024)

J. Hansen: Mixed Reality Museum in Kyoto, Microsoft Stories Asia (2018) · MNHN: Revivre, Extinct Animals in Augmented Reality (2021)
M. K. Bekele et al.: JOCCH 11(2) (2018) · B. Rodriguez-Garcia et al.: Multimedia Tools and Applications 83, pp.89743-89793 (2024)

Goal and Design Idea

Goal

- See the firing structure intuitively
- A hook for people with no interest in heritage

Design Idea

- Heritage rarely catches young eyes
- → An MR shooting game as the point of contact



Why a Shooting Game?

Young People and FPS

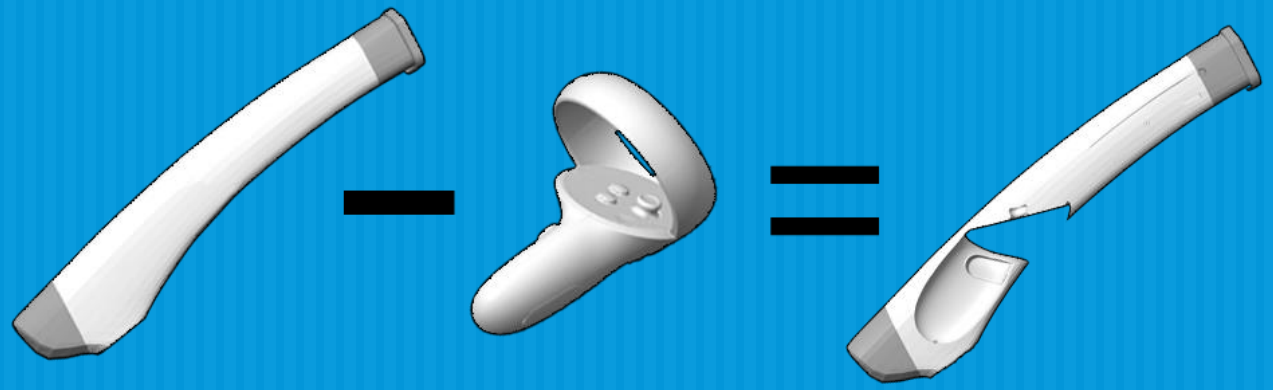
- Shooting games: a large, growing market (Market.us 2025)
- Popular: Overwatch, Counter-Strike, Valorant, Splatoon
- And my own experience as a player

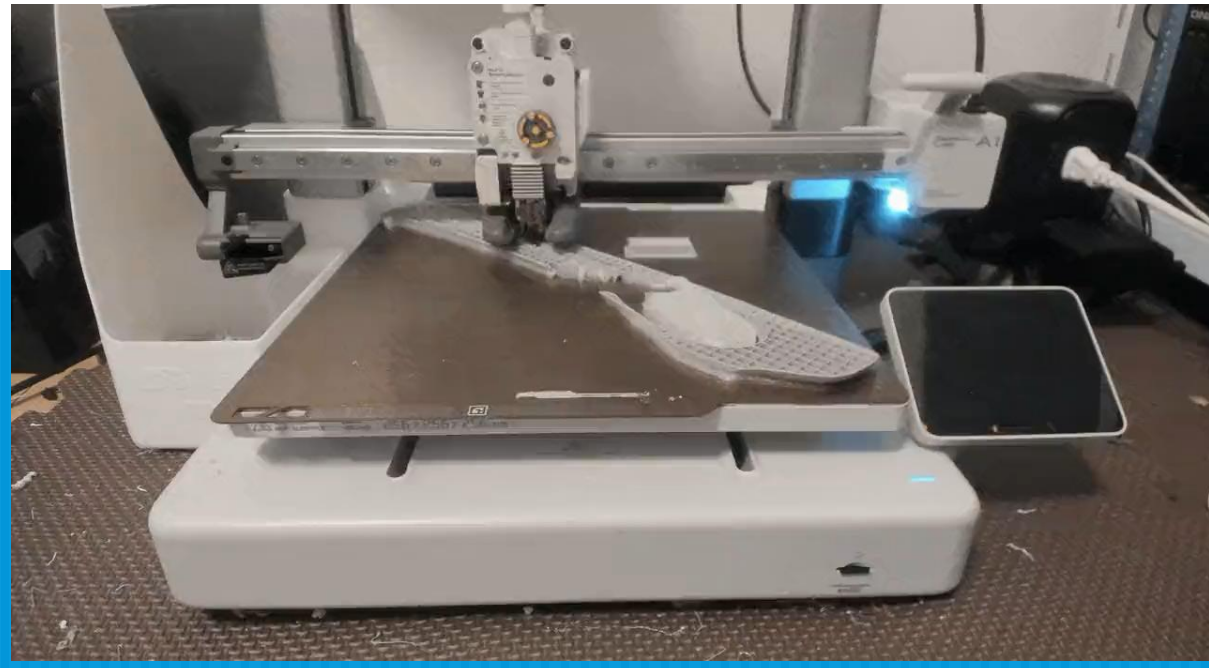
Same Finger, Same Action

- Real gun: index finger pulls the trigger
- FPS on a PC: index finger clicks the mouse
- Our system: index finger pulls the controller trigger

→ Operational consistency for right-handed users

Interface





Boolean subtraction:

stock – controller

Meta Quest 3 prototype
Fits Quest 2 / 3 controllers

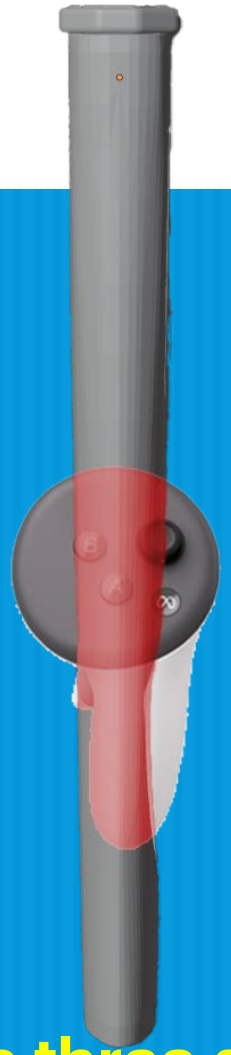


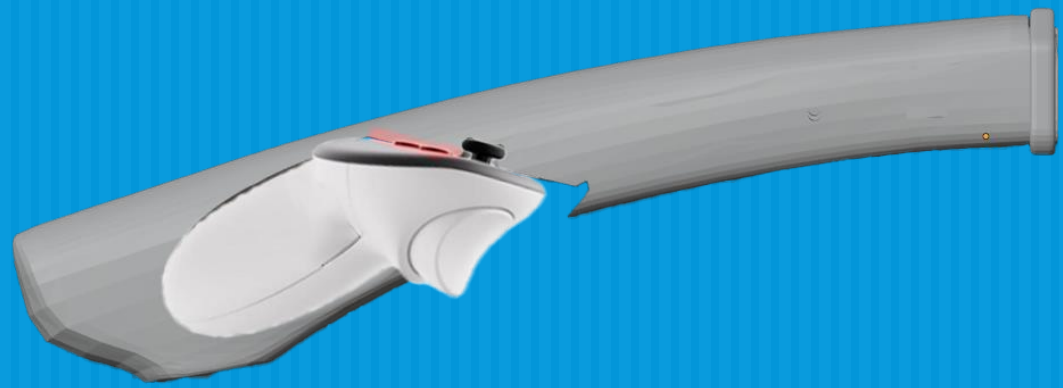
Embed the controller
in the printed stock

Usable Buttons

Still Reachable

- Trigger (index finger)
- Joystick: tilt left / right
- Joystick: press down





Every interaction is built on these three gestures

Operation

In the Headset

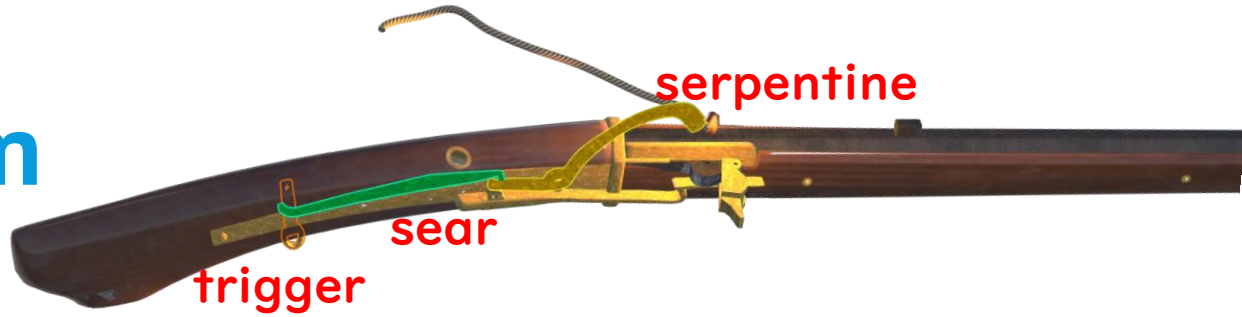
- The controller becomes the CG matchlock
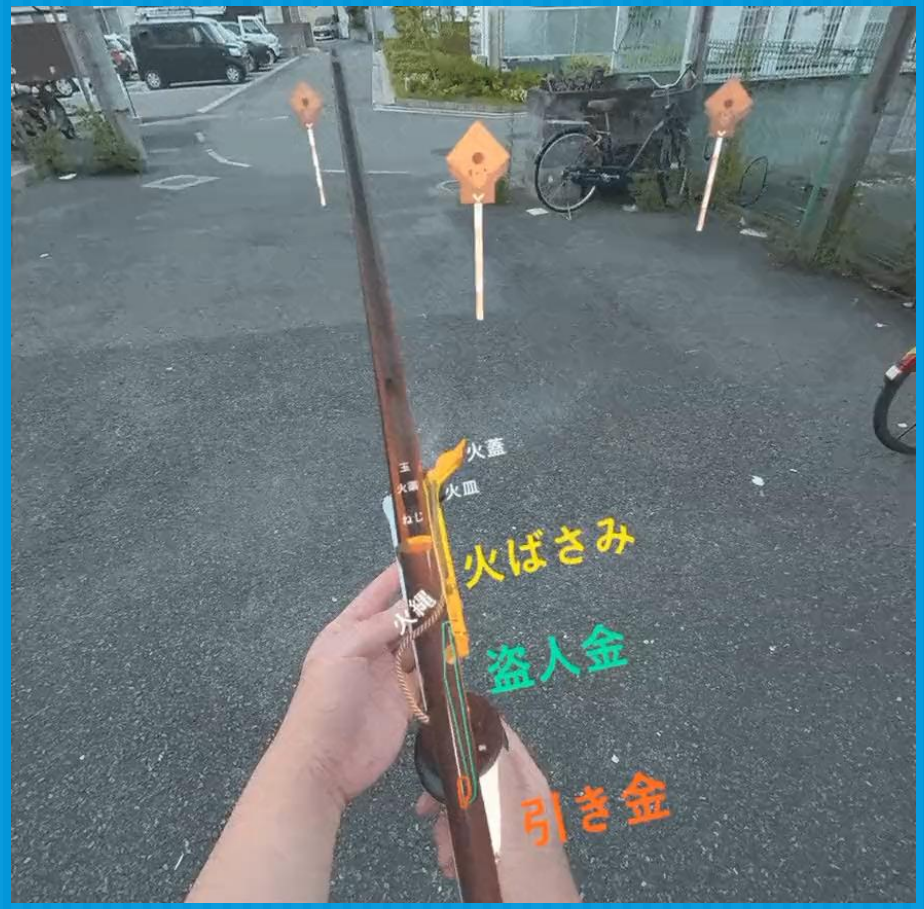
Controls

- Pull the trigger → fire (with sound)
- Tilt the joystick → take apart / put together
- Press the joystick → show part names



You Control the Mechanism





引き金 trigger・盗人金 sear・火ばさみ serpentine

As you pull the trigger, the trigger, sear and serpentine move with it

Pull slowly to watch the chain step by step

You set the speed

Trigger depression $t \in [0, 1]$ interpolates each part's rotation

Game Elements

Shooting

- 3 targets modelled on historical objects
- Hit → it vanishes with a particle effect
- All down → 3 new targets appear





After the Game

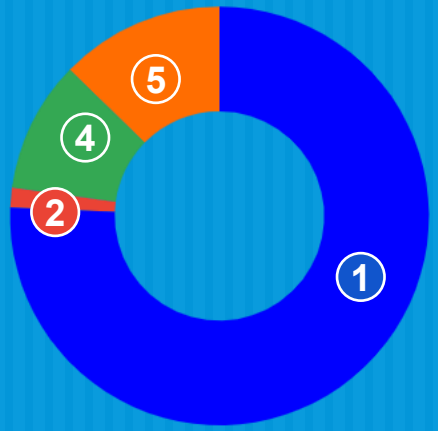
- A real matchlock can't fire repeatedly
- We explain this after play
- AR application, animations and a real-weight model



Exhibition & Questionnaire

- Open Campus, Kansai University: 2, 3 & 23 Aug 2025
- **202 questionnaires collected, 197 valid**

One A4 page: gender, age, prior knowledge, 9 Likert items, free comments · anonymous



1	10s	(149 / 75.6%)
2	20s	(3 / 1.5%)
3	30s	(0 / 0%)
4	40s	(20 / 10.2%)
5	50s	(25 / 12.7%)



Respondents: mostly high-school students (**75.6% teens**) and their guardians

Ethical Considerations

Protecting Participants

- Approved by our university's ethics committee: stricter rules for a gun
- Explained in writing and in person; participants signed
- Short stock: less risk of hitting others; players kept apart

Showing the Gun as Heritage

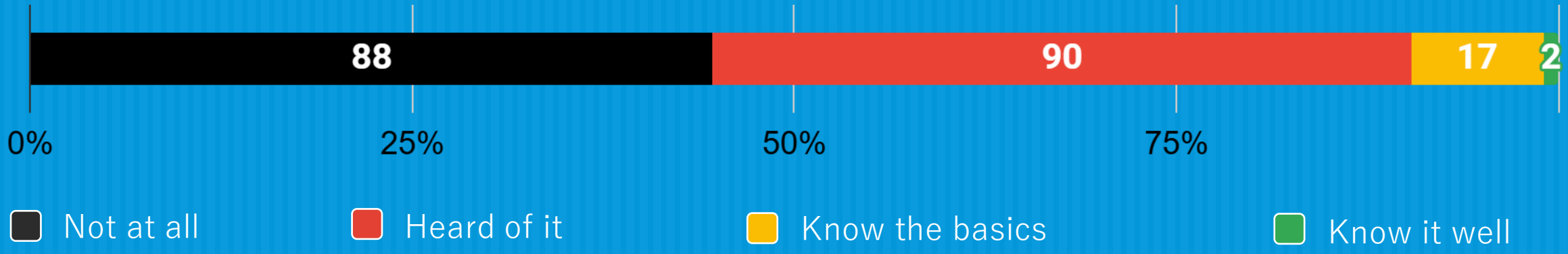
- Targets are historical objects, not living things
- No injury or blood: a hit only shows a particle effect



Prior Knowledge

- Asked before the questions on the experience

Do you know the structure and mechanism of the matchlock gun?

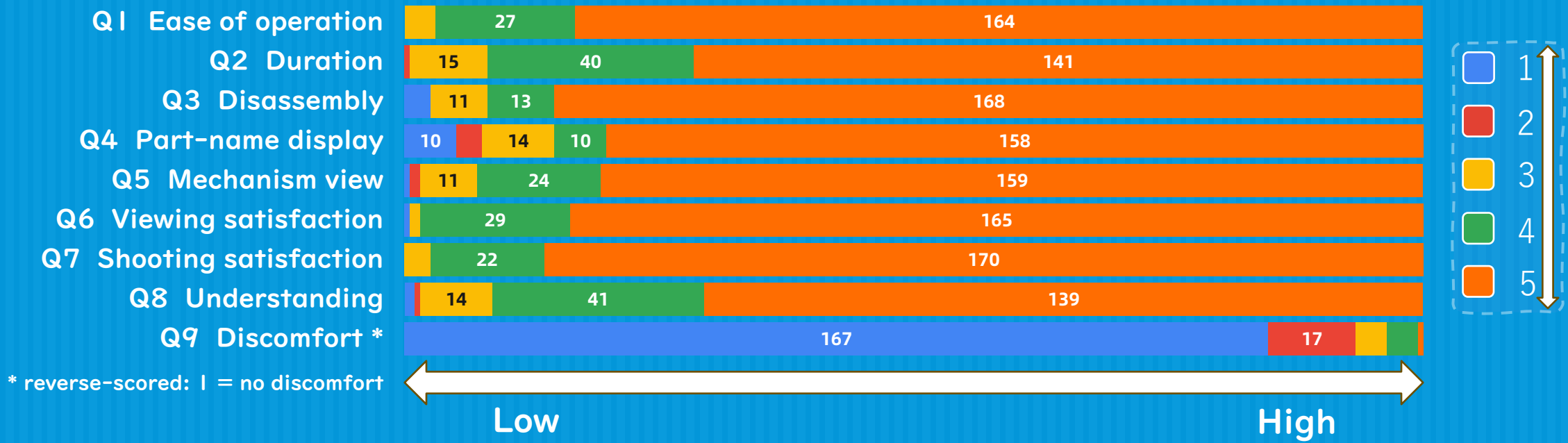


About 90% did not know it, or had only heard of it

Even heritage taught twice in compulsory education can show a large knowledge gap

Evaluation

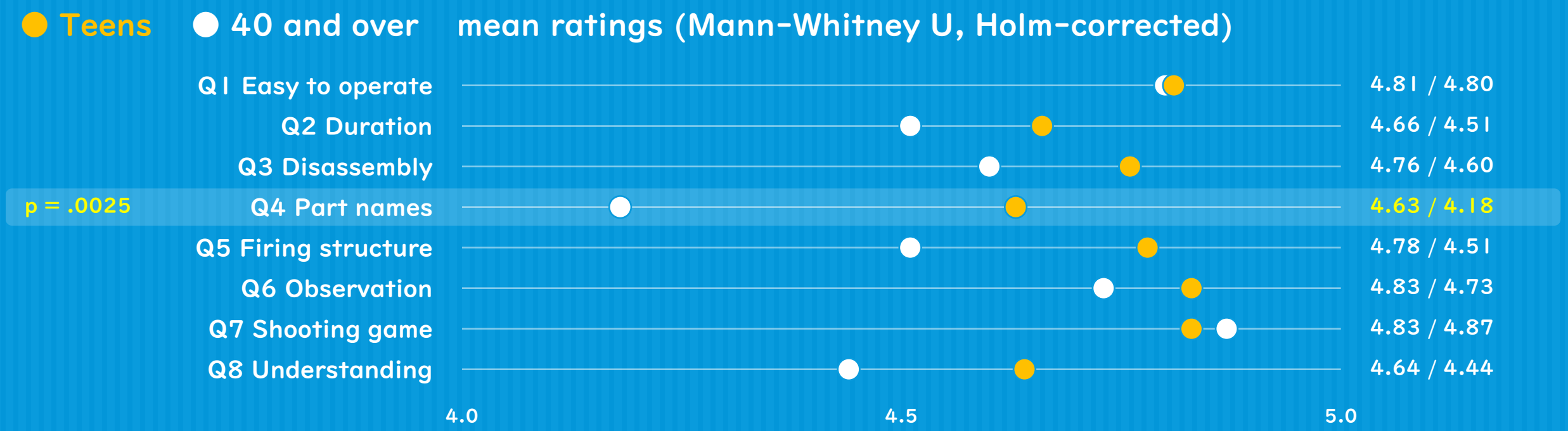
- 9 five-point Likert items on the system (N = 197)
- **Rated 4–5 on every positive item: 85.3% – 98.5%**



Very high ratings, but a strong ceiling effect: improving the questionnaire is future work

Comparison by Age

- Teens (n = 149) vs. visitors 40 and over (n = 45)



Only Q4 (part-name display) differed: rated lower by visitors 40 and over

Hypothesis: Pressing the Stick

Part names = press the joystick down

Easier if you already know sticks can be pressed







Pressable sticks became common





1983 Famicom

D-pad only

1996 N64

Analogue stick, not pressable

1997 DualShock

Pressable sticks

2012 Wii U

Standard on Nintendo

2017 Switch

Everywhere

Visitors 40+ passed ages 8-18 before 2003; today's teens grew up with pressable sticks.
(A hypothesis, to be verified.)

Free Comments

Main Themes

- Enjoyment and engagement (37)
- Understanding the structure (33)
- MR realism: size, sound, visuals (24)

45.7%

wrote a comment (90 of 197)
avg. about 35 Japanese characters

Voices

- "Parts could be disassembled and reassembled, very easy to understand."
- "Surprises kept coming and it was really fun."

Suggestions: vibration / recoil, label legibility, operation, more game modes

Summary

Results

- An MR matchlock where your trigger pull drives the mechanism
- Open campus: 197 responses, high ratings
- Two observations: a 90% knowledge gap, and an age gap on the stick press

Limitations

- Self-reported only: no knowledge test, no non-XR comparison
- Ceiling effect in the questionnaire; mostly teenagers



Thank you for your attention

Presenter: Wenze Song

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