**Evaluation 3 and Final Reflection**

**Objective and Validation Metrics**

Key objectives from the XR block assembly testing plan:

1. To determine if challenges, and instant feedback in XR assembly tasks lower error rates and boost user confidence and satisfaction.
2. To understand how game elements in XR modules impact user effort, speed, and task accuracy, making skills more adaptable to real-world manufacturing settings.
3. To assess whether gamified XR environments increase engagement and retention (Final Objective)

Based on these objectives, the following metrics were used for evaluation:

Objective 1: To determine if challenges and instant feedback in XR assembly tasks lower error rates and boost user confidence and satisfaction.

Metric:

Number of errors during assembly, self-correction in response to feedback, and participant-reported satisfaction.

Objective 2: To investigate how competitive game elements in XR modules impact user effort, speed, and task accuracy, making skills more adaptable to real-world manufacturing settings.

Metric:

Task completion time, frequency of time checking, and observed increase in effort or speed due to competitive prompts like timers

Objective 3: To assess whether gamified XR environments increase engagement and retention.

Metric:

Observable engagement (e.g., playful experimentation, sharing results), retention (interest in replay, or ask for next levels), and willingness to share scores or participate further.

**Results**

This table shows a concise overview of participant experiences aligned to each evaluation objective, facilitating quick pattern recognition for further iteration and reporting

| Testing Objective | Analysis & Findings | Participant Insights |
| --- | --- | --- |
| Intuitive Assembly (Grid & Controls) | Mostly learned the controls quickly. Some initial questions about where to start but adapted after a few tries. | Dwij and Jeric talked aloud, testing placements and asking if they needed to move pieces physically. Shraddha and Bo adjusted easily. |
| Time Competition | Almost all participants checked or commented on the timer, showing awareness of speed and an interest in beating their own or others’ times. | Cimi wondered if the timer was still running, Dwij asked if he was the fastest, Jeric checked his time on finishing. |
| Feedback & Error Reduction | Positive cues especially highlights and snap sounds helped self-correction and built confidence. | All adjusted errors independently, shraddha and Bo highlighted the usefulness of feedback, Jeric relies on cues as well |
| Visual Cues | Visual cues like (colours) consistently sped up completion and reduced mistakes. | Cimi and Jeric looked for cues, Dwij enjoyed hints and visible grids. Discussion about score and levels also showed engagement. |
| Spatial Grounding / Movement | Participants asked if blocks could be brought closer or if they needed to move, showing awareness of their virtual space. | Cimi and Dwij both verbalized questions about proximity and moving within the XR space |
| Engagement | Described the experience as challenging but fun, with visible curiosity, experimentation, and playful interaction throughout. | Cimi and Jeric described “trying things out;” participants often talked themselves through the process out loud. |

| Participant | Task Completion Time (sec) | Notes |
| --- | --- | --- |
| Shraddha | 90 | Quickly adapted, minor errors |
| Bo Wang | 95 | Fast correction, needed verbal cues |
| Dwij | 100 | Thought aloud, checked time |
| Cimi | 110 | Asked about timer, playful |
| Jeric | 105 | Checked, swapped blocks |

**Analysis**

1. Most participants completed the assembly task within two minutes, demonstrating strong usability, however several found grabbing and moving blocks challenging due to spatial grounding.
2. Blue placement cues emerged as a key factor in reducing hesitation and guided users quickly to the correct placement, which positively influenced task speed and reduced completion times.
3. Nearly all users raised workspace comfort and interaction boundaries as ongoing issues, suggesting that even with quick task completion, overall ease and satisfaction were limited by physical setup constraints.
4. Finally, while feedback was mostly positive, users recommended that more explicit negative and positive feedback, combined with contextual guidance, would boost both user confidence and further improve speed and accuracy in future iterations.

**Evaluation of Aims**

**Objective 1: To determine if challenges, reward systems, and instant feedback in XR assembly tasks lower error rates and boost user confidence and satisfaction.**

**Partially Validated:**

Most users completed the task quickly (typically within two minutes), shows the testing was intuitive. However, issues with moving blocks where few participants struggled, pointing to areas where feedback mechanisms could further enhance success.

**Objective 2: To investigate how competitive game elements in XR modules impact user effort, speed, and task accuracy, making skills more adaptable to real-world manufacturing settings.**

**Validated:**

Frequent time checking and participants’ remarks about “being the fastest” or finishing before the timer ran out highlighted the motivating impact of competition and time pressure. This led to efficient task strategies, rapid error correction, and consistently short completion times, mirroring real-world pressure to combine speed and accuracy.

**Objective 3: To assess whether playful, gamified XR environments increase engagement and retention for young girls and other underrepresented groups in technical fields.**

**Validated:**

All participants engaged playfully, asked questions, experimented with strategies, and displayed curiosity about their scores or next levels showing high engagement and positive attitudes. Observed behaviours and time-on-task data support that the environment succeeded at fostering interest and motivation.

**Reflection**

What Worked Well:

* Focused visual guidance, such as blue placement cues, played a critical role in supporting user learning and precision during the assembly tasks.
* Intuitive grabbing and movement mechanics, modelled on real-world actions, enabled most participants to onboard quickly and move confidently in the XR environment.

What Did Not Work as Well:

* Ergonomic constraints and a lack of negative feedback led to occasional user frustration, particularly when blocks were out of comfortable reach or errors were not clearly signalled.

Lessons Learned and Next Steps:

* Prioritise redesigning the physical workspace and refining feedback mechanisms to address ergonomic issues and make success/failure more apparent.
* Adding more cues, like overall structure to improve efficiency.
* Enhance onboarding with clearer, more explicit instructions.

**Final Reflection**

The three iterations have fundamentally shaped the evolution of the XR block assembly modules in Oddo platform, with every round of testing bringing new insights and pushing the prototype closer to its learning and engagement goals *( Testing 3 Objective )*

In my first iteration, rapid feedback after initial user testing confirmed that the navigation and basic object interaction were effective but also faced significant pain points. Many users needed more supportive onboarding, clearer rotation controls, and more meaningful terminology such as replacing “shortlist” with something less ambiguous. Importantly, it also became crucial that users use real-world expectations with them, wanting lighting and other controls to work on a per object basis, not just globally. These issues set the stage for the next iteration by highlighting the need for direct instruction and users to follow feedback cues.

Building on these insights, the second iteration introduced improved visual cues like the blue ghost cue for block placement with snap interactions. Users quickly understood these cues, describing the interaction as “smooth, like Lego,” and showing higher confidence assembling the blocks. At the same time, new problems emerged, frustrations with unreachable blocks, and confusion around colour cues added a layer to complicated gameplay. The validation of feedback was successful, but users want more explicit negative cues and more visual reference guides.   
  
The focus then shifted toward continually refining the boundaries of interaction and deepening our understanding of which engagement cues are most effective. Rather than overwhelming users with too many cues, the research indicated that keeping feedback concise and purposeful is crucial too much guidance can disrupt the flow and enjoyment of gameplay.

Reflecting these on third iterations, where the integration of game elements like timers introduced for engagement, especially for young girls in STEM (Refined the design concepts) which became central aim of the project. From last iteration keeping the gameplay simple with 9x9 grid (Evaluation 2 feedback) and using mental models of Lego based clues ( Evaluation 1 Feedback) Participants quickly learned the system, benefiting from immediate and intuitive feedback, but ergonomic and spatial issues continued to pose real challenges in these iterations. Some users struggled with reach and spatial movement, while others wanted clearer guidance for both successes and mistakes. This was a miss in both Iteration 2 and iteration 3.

This final iteration highlighted on easy gameplay with gamified *elements (Research Objective for Iteration 3.),* not only for user satisfaction but for ongoing participation and learning efficacy in XR environments ***(****Garbaya et al., 2019).* The Timer and Positive cues received positive reactions.

The learnings from each iteration carry forward to the next. Addressing spatial and ergonomic issues makes the module more accessible. Adding more layers of gamified elements and encouraging collaboration with *friends* helps improve engagement. Integrating these assembly gamified modules into Oddo will assist suppliers in introducing their modules on the platform and support the Australian construction industry in reducing the diversity gap.

**AI References**

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| In-text reference (citation) | When prompted with “Improve grammar and spellings for the draft and give me relevant feedback on structure?” the perplexity-generated text (OpenAI, 2025). |