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Research Article

Kids' perceptions on gaming experience and learning with the Nintendo Labo: Multiple "make" and "play" experiences

Percepciones de los niños y niñas sobre la experiencia de juego y el aprendizaje con nintendo labo: múltiples experiencias de "hacer" y "jugar"

John Cano*, Megan Chow**

University of California, Berkeley
Yale Center of Emotional Intelligence

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* PhD. Education, University of California Santa Barbara: Santa Barbara, CA, US. University of California, Berkeley, Berkeley, Califronia. Contacto: jcano@berkeley.edu ORCID: https://orcid.org/0000-0002-0422-4621 — CVLAC: https://scienti.minciencias.gov.co/cvlac/visualizador/generarCurriculoCv.do?cod_rh=0001410612

** Bachelor of Science in Psychological and Brain Sciences — University of California, Santa Barbara. Yale Center of Emotional Intelligence, San Francisco, California. Contacto: meganchow@ucsb.edu ORCID: https://orcid.org/0000-0001-5971-5201

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Abstract

This paper explores the perceptions of kids that had the chance to explore the "Make" and "Play" phases of the Nintendo Labo variety "Toy-Con 01". Focusing on the roles of engagement, knowledge utilization and acquisition of new concepts. This paper broadens the general understanding of how video games can elicit active learning. Building on the experiences in constructing DIY projects, the authors analyze how the kids—through four different cases—connected their previous knowledge and experiences with science-related content (implicit in the interactions and hardware of the Nintendo Switch console and the Nintendo Labo software and cardboard pieces). The results of the study show that kids can use their cultural and academic experiences as well as their funds of knowledge to make sense or create theories and hypotheses of how the hardware and the software of the Nintendo Labo interact with each other and work. The limitations of the study suggest that more time is needed to have a more in-depth exploration of the kids' perceptions by exploring the "Discover" phase—the third and final phase of the Nintendo Labo.

Keywords

Nintendo; Informal Learning; Kids; Science; Knowledge; Maker; Play; Learn; Videogames.

Resumen

Este artículo explora las percepciones de niños y niñas que tuvieron la oportunidad de explorar las fases de "Hacer" y "Jugar" del Kit de variedad "Toy-Con 01" del Nintendo Labo. A través de aspectos claves como el involucramiento/compromiso estudiantil, la utilización del conocimiento y la adquisición de nuevos conceptos (Gee, 2008), este artículo amplía la comprensión general de cómo los videojuegos pueden generar un aprendizaje activo. A partir de las experiencias en la construcción de proyectos de "Hazlo tú mismo", los autores analizan cómo los niños, a través de cuatro casos diferentes, conectaron sus conocimientos y experiencias previas con contenido relacionado con la ciencia (implícito en las interacciones y el hardware de la consola Nintendo Switch y el software Nintendo Labo y piezas de cartón). Las limitaciones del estudio sugieren que se necesita más tiempo para tener una exploración más profunda de las percepciones de los niños explorando la fase "Descubrir"—la tercera y última fase de Nintendo Labo.

Palabras clave

Nintendo; Aprendizaje informal; Niños; Ciencias; Conocimiento; Maker; Jugar; Aprender; Juegos de vídeo.

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Introduction

Within the past two decades there has been extensive analyses on the relationship between video games and learning. Gee (2005, 2008) has pioneered this area of research and brought to light the advantages of video games and learning (with a strong focus on literacy development). When we think of video games, we often refer to the pleasurable and unpropitious properties. However, researchers have helped surface the underlying advantages that are associated with playing video games (Gee, 2005, 2008; Squire, 2011; Matijević & Topolovčan, 2019). Video games are constantly changing and creating different experiences. In recent years players have been able to immerse themselves in virtual, augmented and mixed realities. Gee (2005, 2008) emphasizes the idea that games act like the human mind and are an applicable avenue to study and produce human thinking and learning. Human understanding is not the memorization of general concepts or the application of abstract concepts to experiences. Humans think and understand best when they can imagine an experience in such a way that the simulation prepares them for actions they need and want to take in order to accomplish their goals (Gee, 2004b).

It is important to emphasize that strong learning principles follow from "good video games" proposed by Gee (2008). Video games allow us to study and exercise the human mind, which provides us greater insights on human thinking and learning. Gee (2008) highlights core principles within good video games that should be implemented to school learning. His principles serve as a foundation for the lenses we will use to analyze experiences*. Gee (2008) organizes his list into three sections: 1) Empowered Learners; 2). Problem Solving; and 3) Understanding. After reviewing his collection of principles and their relevance to learning, we identified two analytical lenses for our research (Gee, 2005). These lenses consist of: Engaged Participation (EP) and Learning New Things (LNT).

As the expansion of collaborative platforms continues, the spaces for informal learning increase. The definition of informal learning is continuously evolving and benefits more than just students. The main objective of this paper is to identify informal learning experiences and strategies young students are developing outside of formal learning settings. A classic definition of the concept of informal learning comes from Coombs & Ahmed (1974), who defined information education as "the lifelong process by which every person acquires and accumulates knowledge, skills, attitudes and insights from daily experiences and exposures to the environment" (p.8).

The diversification of informal learning has greatly shifted towards social media, websites, and video games. Humans seem to learn more deeply and more equitably when they learn outside of school in areas they choose and for which they are motivated (Gee, 2004b). Understanding informal learning processes in the realm of video games proposes the question of: How do teens learn to play video games? Scolari and Contreras-Espinosa (2019) found that in order to

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comprehend such processes, it is necessary to map and analyze these informal learning strategies. This analysis and classification furthered the understanding of video game literacy and identified a number of informal learning strategies (ILS) used by students. These scholars organized these strategies into six modalities, with some already in the formal educational context: learning by doing, problem solving, imitating/simulating, playing, evaluating and teaching. They recognized the various contexts in which these strategies were applied (ranging from video games to social media) and the form they adopt. The analysis developed to describe various informal learning strategies across different contexts proved useful to our paper as we opted for a non-traditional video game.

Potential of Maker Activities

Making is the act of creating physical artifacts and using knowledge from science, technology, engineering, art, and mathematics (McBeath et al., 2017). Makerspaces and activities continue to develop and improve learning for students. The maker movement started outside of formal education and emerged from technological creation. This movement is now growing within K-12 education and smart learning environments (Toivonen et al., 2018; Ricardo et al., 2021; Arya et al., 2022; Cano & Arya, 2023). The tasks given to our participants fall under the category of maker activities. In combination with the digital video game basis, there is a physical component alongside.

In his work, Hatch (2013, p. 1) proposed a compilation of nine foundational principles for the Maker Movement:

- **MAKE:** Making is fundamental to what it means to be a human. We must make, create, and express ourselves to feel whole.
- **SHARE:** Sharing what you have made and what you know about making with others is the method by which a maker's feeling of wholeness is achieved.
- **GIVE:** There are a few things more selfless and satisfying than giving away something you have made.
- **LEARN:** You must learn to make. You must always seek to learn about your making
- **TOOL UP:** You must have access to the right tools for the project at hand. Invest in and develop local access to the tools you need to do the making you want to do.
- **PLAY:** Be playful with what you are making, and you will be surprised, excited, and proud of what you discover.

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- **PARTICIPATE:** Join the Maker Movement and reach out to those around you who are discovering the joy of making.
- **SUPPORT:** This is a movement, and it requires emotional, intellectual, financial, political, and institutional support. The best hope for improving the world is us, and we are responsible for making a better future.
- **CHANGE:** Embrace the change that will naturally occur as you go through the maker journey.

Nintendo Labo and its approach for learning while making

Nintendo Labo is a recently developed concept (released in Spring of 2018), which isn't exactly a conventional video game. Instead, it is a building set made of cardboard, designed to complement the Nintendo Switch console. The user builds the accessory out of cardboard, known as a "Toy-Con", and proceeds to use it to play the supplemental game.

Various projects were built and ranged in complexity. Much of the research on video games and learning has primarily centered on massively-multiplayer games (MMOGs). Nintendo Labo is a combination of digital and physical play. Highly detailed step-by-step instructions are given on the Switch screen while the user is configuring the Toy-Con. Though the Toy-Con can be constructed individually, we opted for a collaborative approach, collecting data from five different groups of students. Within this context, we focused on understanding informal learning as well as creating a makerspace.

The purpose of this paper is to provide an exploration and understanding of students' perspectives of how they lived and interpreted their experiences when an unconventional video game is used in an informal learning environment. Our paper is based on the experience and usage of Nintendo Labo.

As researchers, we asked two questions:

1) What were the kids' perceptions of their participation during the gaming experience with Nintendo Labo; and

2) Specifically, what aspects of the game allowed the kids to relate their prior knowledge in understanding science-related content?

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Research context/ Participants

This study was conducted in a R1 University of California that offered a literacy summer camp to young kids whose ages ranged from seven to twelve. This summer camp looks to foster literacy skills through collaborative activities and initiatives, which include (but not limited to) writing, reading, storytelling, and creating. The participants of this study were third, fourth, fifth, sixth, and seventh graders who were willing to participate in the process of trying out some aspects offered by the variety kit "Toy-Con 01" of the Nintendo Labo (game developed by Nintendo for the Nintendo Switch video game console).

The variety kit "Toy-Con 01" offers the possibility to build, play, and explore with five "artifacts" that can be built using pre-made cardboard sheets (that serve as a "mold" to construct the artifacts), reflective stickers, sponge sheet, strings, set of grommets, and rubber bands. The artifacts included in the set are listed and displayed in **table 1**:

Table 1.

Artifacts included in the "Toy-Con 01" Variety Kit of the Nintendo Labo

Artifact name	Artifact picture
Toy-Con Piano	
Toy-Con Fishing Rod	
Toy-Con Motorbike	

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Artifact name	Artifact picture
Toy-Con RC Cars	
Toy-Con House	

Images from Nintendo (2018a).

The participants of this study were twelve kids, whose ages ranged from eight to twelve. These kids were grouped and assigned one artifact to build as displayed in **table 2**.

Table 2.

Groups distribution and participants information

Group	Artifact	Participant's age	Participant's gender	Participant's grade
1	Toy-Con Piano	12	male	6th
		11	female	5th
2	Toy-Con Fishing Rod	11	male	5th
		11	male	5th
		10	male	4th
3	Toy-Con Motorbike	9	female	4th
		10	male	4th
		9	male	3rd
4	Toy-Con RC Cars	8	male	2nd
		8	male	2nd
		8	male	3rd
		7	male	3rd

The "Toy-Con 01" Variety Kit of the Nintendo offers three different experiences or phases to players: "Make", "Play", and "Discover". These phases of the gaming experience are described by the company as follows (Nintendo, 2018b).

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In the **Make phase**:

> students work together and build key 21st-century skills, such as communication, collaboration, problem solving and engineering. The Make phase also encourages a great deal of tenacity in students. Nintendo Labo encourages students to keep trying, even as they face new challenges while working together to build their Toy-Con creations. And the beauty of Nintendo Labo is that you can always go back and fix mistakes. (p. 2)

During the **Play phase:**

> "students enjoy playing with the Toy-Con creations they built! They can play games with their Toy-Con creations on the Nintendo Switch system and engage in challenges incorporating their Toy-Con creations (p. 2)".

Finally, in the **Discover Phase**:

> students can use a mode called Toy-Con Garage to interact with their Toy-Con creations in new ways and even design new creations! Toy-Con Garage offers students a simple drag-and-drop programming interface that uses a series of connected inputs and outputs to create different behaviors and interactions. (p. 2)

It is important to note that, due time constraints, this study only explores the kids' perceptions about the first two phases.

Methods

A multiple case study was conducted using an ethnographic approach was chosen as the best approach to understand kid's perceptions, from an insider perspective (Berry, 1990; Pike, 1967), of their gaming experiences, how they connected (or not) through the making/gaming experience, and how such experiences allowed—or not—a connection of informal science knowledge, funds of knowledge and prior knowledge. The ethnographic approach of this study allows to explore how kids see and perceive a maker-based gaming experience, such explorations could not be done without enacting conversations (Spradley, 1979; Skukauskaite, 2012) with the participants about areas that tend not to be covered or considered while exploring technological tools for educational purposes.

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Data collection and analysis

After finalizing the two phases ("Make" and "Play") of the gaming experience. The kids participated in group conversational interviews (Skukauskaite, 2012). Through these interviews, the kids were able to communicate their opinions and perceptions of the lived experience and how they felt about it. These interviews were audio recorded.

Given the ethnographic nature of this study, we focused on getting an accurate and true presentation and representation of the kids' voices, this is, understanding such perceptions of the gaming experience from an insider perspective (Spradley, 1979; Skukauskaite, 2017; Brenner, 2006; Berry, 1990; Pike, 1967).

The conversations with the young participants were audio recorded, transcribed, and later analyzed by using conceptual lenses (Gee, 2004a). Building on Gee's proposal on what makes a good game for learning, we have identified two lenses of analyses that were salient to our research questions (Gee, 2008). These two lenses will be described as follows:

The first lens is "***Engaged participation***": This lens accounts for the notion that students are agents of their own learning. Emphasizing the importance of how one's decisions and actions are able to shape and design their experience, resulting in good learning.

The second lens is "***Learning new things***": This lens comprises principles based upon Gee's (2008) contributions to what counts as an 'Empowered Learner', where learning is different for everyone and people cannot be their own agents of learning if they cannot make decisions about how their learning will work (Gee, 2004b, 2008). As Nintendo Labo incorporates different styles of learning and playing, we look into this further with this lens. We aim to use this lens to see how participants apply and distribute knowledge throughout the building and playing experience.

Results

For the results of this study, we analyzed each group's perceptions of their gaming experience and how such experience allowed the participants to use their prior knowledge to understand science-related content. In this section we will present the result by case (each group, as shown in **table 2**). In each case we will present the participants' perceptions of their gaming experience—taking into consideration the two research questions—using the two conceptual lenses: "Engaged participation", and "Learning new things".

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Case 1: Toy-Con Piano

The group who participated as the first case of this study worked on the toy-con piano. After assembling the 13-key piano and inserting both console and joy-cons, you can create your own music by pressing the keys and inserting different knobs to make tunes.

Engaged participation

Participant **S** considered that the "Play" experience was more interesting because of the "exploration" feature included in the piano game, including the options to try different sounds by setting up the cardboard knobs and twisting them to create new sounds (like opera style, kitty sounds, and others).

> **S:** Well, the building part wasn't as exciting as playing it. I thought playing it was actually really fun and getting to know what we did with the buttons because when we were first building it we didn't know what the buttons were for. When we started playing the piano we would, like, press them and the keys and we got to know what it did.

Contrary to **S**, participant **C1** showed how he enjoyed the "Make" experience better given the different interactions (collaborating) and parts they have to put together to build the cardboard piano. He made a lot of emphasis that some of the reasons why he did not enjoy the "Play" experience of the piano was because of the lack of variety or options to explore with (contrary to **S**'s perception).

> **C1:** I didn't really think that playing with the piano was as fun as when I was building the piano cause I get tired of just... the same things and stuff…
>
> **Facilitator:** Like repetitive?
>
> **C1:** Mhm...and I wish it was more games that you could play with the piano.

It is interesting to note that both participants enjoyed the collaboration and taking specific roles during the "making" experience of the game, also highlighting teamwork as one of the skills that has the potential to be fostered through this aspect of the game, along with social bonding and interactions.

> **S:** I thought it was fun. Also cause we all had a role and a part to do and we all got to build, none of us were left out.

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S: Well, I was the sticker person and I put the stickers on all the keys and the places where they needed stickers.

C1: I was taking everything out of the box maybe? Taking it apart and building it.

Facilitator: So, do you think the actual game based on the instruction and everything kind of like promotes collaboration or not really?

S: Yeah

C1: Yeah

S: I would say that if you didn't know a lot of people at first that this would be a good project to get to know them and to work together

C1: I guess like teamwork, obviously

Engaged participation is much deeper than just creating. EP within this case provides insight behind individual motivation and perspectives on a participant's thinking. A modern twist on a classic instrument can provoke creativity and challenges. Participant **S** assigned themselves as the "sticker person", when acknowledging one's role and reflecting on their part, engaged participation was portrayed. Participant **S** and **C1** recognized that this activity fostered teamwork and could bring people together.

Learning new things

While discussing about the different functionalities of the system, specifically how the different sensors included in the Nintendo Switch's Joy-cons worked in order to trigger different actions while playing with the Toy-Con Piano, participant— like **C1—**recognized the role that the stickers had in order for the game to work but realized the game did not explain what the stickers contributed. From this, the participant was able to learn new functions of an object in relation to building.

Facilitator: So, when it comes to you know- you said that you put all the stickers on and then you put the joy-con [Nintendo Switch small controllers] on the backside of the piano. Were you actually able to understand what was going on and why the whole thing was working? Do you think the game itself explained to you what is going on or not really?

C1: It didn't really explain to you what was going on but how it works, I think

Facilitator: So, you think it does explain?

C1: I don't think it does

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On the same line of inquiry, when asked about functionality and mechanisms, participant **S** learned, through their building participation, about how the piano may work. They recalled building and attaching levers and rubber bands. However, participant **C1** recalled the possible functionality of the stickers (the stickers acted as sensors). They connected the sticker to the signaling of the video game.

Facilitator: Okay, so what did you think was happening inside the piano to make it work?

S: Well, there was this one lever that had a rubber band so I think that would've been like...but I really don't know the rest. I know that these had a sling slinky thingy at the bottom to press down.

C1: I think this thing has to do something with connecting the Nintendo switch, the white...

Facilitator: Oh, the sticker? The white sticker?

C1: M-hm... I can imagine... so, like when you press it down, I can imagine like it's touching something or download or gets close to it and connects the signal to what it's doing with the other part here [pointing at the piece]

Facilitator: So, it does connect the system?

C1: Yeah, something like that that's what I believe

Learning new things does not mean the experience itself has to be completely foreign, by incorporating conventional artifacts into new technological platforms, students are able to learn in non-traditional ways. Though the inner workings of the game are not explicitly explained, participants are able to think outside the box and inquiry the different explanations of how the system works.

Case 2: Toy-Con Fishing Rod

The second group worked on the toy-con fishing rod. After assembling the fishing rod, participants were given time to explore depths of the ocean and try to catch fish.

Engaged participation

When exploring the participants' perceptions about the building experience of the Toy-Con Fishing Rod, they all (**N1**, **J1**, and **J2**) expressed how interesting it was, especially—as stated by participant **N1**—given the "expectation" factor of how the final cardboard device was going to

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look like. and a new encounter. Others, like participant **J1**, highlighted the fact that it kept them busy for a considerable amount of time, which could be closely related to the difficulty of the building process of the cardboard device.

Facilitator: How do you feel about building the whole thing?

N1: It was really fun trying it out while we were still building.

J1: It was very time consuming.

J2: It was interesting.

Facilitator: Interesting? Why is it interesting?

J2: Because like we can build it- I think it's interesting, plus it was very fun.

When exploring the different ways that participants were able to engage in the different stages of the building process, participant **J1** noticed there was participation across the board but that participants could be easily distracted. It is interesting that participants not only recognized their own participation during this experience, but that of their peers. Collaborative efforts require participation from every member in the group and it seems that members account for everyone's involvement. This can be shown in participant **N1**'s comment about "not to name anyone".

J1: I think that we all participated evenly but at some points our attention was dropped and we had to be dragged back into reality.

N1: [Laughs] Yeah, I think all of us did it equally but some of us, not to name anyone, just wanted to do everything

Facilitator: Okay... what do you think [to J2]?

J2: I'm the same as them.

When asked about the ways team members were able to participate and collaborate, participants noted group morale and that support is needed. Participant **J1** explains that there are points of the game that can be difficult, but support from other members can drive the member playing in a positive direction. Participant **J2** notes that it is exciting when the game can be difficult, stimulating the need to catch larger fish.

Facilitator: So, do you think the building and the actual game promote collaboration?

J1: Yes, the game... you just have to support the person that's actually playing because sometimes the fish will break off…and then it's kind of like...ugh...great

J2: Building the fishing rod it's a little bit, like, hard and playing it is very exciting. Like when we catch the biggest fish, yeah.

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Within the lens of engaged participation, we can see that there are many factors relating to this lens such as interest level, group member participation, group morale and degrees of difficulty in the game. Collaboration was found during the building experience and surprisingly the gaming experience. Support from the members of the group can motivate an individual and foster competition.

Learning new things

While experiencing the finishing game with the toy-con fishing rod that they built, participant **J1** shared how he was able to identify some of the "logics behind the game", for instance: how deep he could go with the fishing rod in order to catch bigger fish, and how some big fish could break the string of the fishing rod. He considered that staying in the middle area (mid-depth) of the water was a safer way to catch mildly big fish. This is an interesting way of seeing informal learning logic and science based on the game experience.

> **J1:** You don't have to force it. You kind of... how to try your best in the game because it won't always work out if you go too deep and it will eventually break...and if you go too shallow the fish are going to be unsteady there so like you have to go right in the middle.

It is interesting how the participants described this game as a different perspective of fishing. Unlike fishing in real life, participants are able to see the environment and species underwater. They are still able to grasp not only the technique of fishing by using a rod that they made, but also the connections between the force applied to the rod and the weight of the fish they are trying to catch.

> **N1:** It gives a different perspective of fishing.
>
> **Facilitator:** What do you mean by that?
>
> **N1:** Like when you first you can't see underwater or what's happening and you can't see the fish until it comes up so it's a different perspective
>
> **J1:** Yeah there's not really any other fish trying to eat other fish unless you catch the swordfish or the stingrays
>
> **N:** It feels like a regular fishing rod and it works basically like the same thing...the only thing that's different is the texture and how long it is and also how strong it is.

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Other participants, like **J2**, expressed the need for deeper instruction and explanation which would enhance the overall experience. From this it's important to note that while this is a video game experience, it also entails a physical do-it-yourself aspect. It can be suggested that with further expansion on how the cardboard cutouts and stickers when put together with the Nintendo joy-cons work, participants would have a greater learning experience.

> **J1:** I wouldn't exactly care because it's a little obvious that the proper placement for the fishing pole and the controllers need to be together so that they work as one instead of all being separate then wouldn't work at all.
>
> **Facilitator:** What about you guys did you want to add anything?
>
> **J2:** Yes, I think I would add about to tell about what those things [the joy-cons] do. How do they work? So that we could know. I think that we could find some idea to catch the fish more easier if we knew about those

Overall, the group of young participants who worked on the toy-con fishing rod brought out significant and interesting perceptions of the building and gaming experience when it comes to the "learning new things" lens. Some participants highlighted how they were able to understand some of the basic logics and functionality of the game, developing gaming skills by trial-error experiences, and using some previous knowledge and logic. On the same line, some started to identify how to best design and create a strategy to do better in the fishing simulation experience. Finally, participants mentioned how valuable it would be if the game provided a detailed explanation of how the hardware (toy-cons, stickers attached to the cardboard, etc.) works within the cardboard-based system in order to do the functionalities that the gaming experience requires.

Case 3: Toy-Con Motorbike

The third group worked on the toy-con motorbike. After assembling the motorbike, the young participants were able to explore a motorcycle simulation game using the Nintendo Switch's Joy-cons' sensors to simulate the driving experience.

Engaged participation

Some participants, like **C2**, when asked about the process of building the motorbike with the cardboard pieces, highlighted that they had a lot of fun building the device and enjoyed the process.

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C2: That [the building process] takes all the fun out of it. If you do build it, for real, then you can actually have fun.

Also, **C2** added that the "make" experience (building process) was a little challenging and confusing given the many pieces they have to use to build each part of the motorcycle (e.g. the left and right handles), but despite the difficulty, she found the experience enjoyable.

C2: The building process is really fun but it makes, like I also said earlier, [one of the team members] would like it if it was made out of metal but if it was made out of metal then it'd be really expensive and it'd be hard to make but otherwise it's a pretty good idea...well I built the... um... the first part of the handle, it was kind of hard to make and it just looked like a really small square at first and then when I made it and then when I attached the handle then it made more sense.

Also, when asked about what they would keep or change about the game, some participants—like **E1**—highlighted that the game included with the motorbike would have been better if it allowed her to join her partners (more multiplayer oriented).

E1: Well, I think like... if I could change like... anything about it, I would change it so two people playing at once.

In a general perspective, when it comes to the "engaged participation" lens, the young participants did find the building experience fun and challenging. They were able to "divide and conquer" during the building ("make") phase of the experience. When it comes to the gaming experience, participants (like **E1**) only highlighted the desire of having a more cooperative multiplayer experience.

Learning new things

For the "Learning new things" lens, the participants were able to explore many of the dynamics and logics behind the Nintendo Labo and The Nintendo Switch's hardware (e.g., the console and the joy-cons). As we progressed in the conversation, participant **E1** brought up potential explanations for how the game works. The controllers are inside of what they made out of cardboard and participant **E1** believes they are connected in order to work.

E1: I think cause like these controllers are inside there so when you go like that it goes like on the um screen so like they're like connected so it can tell when you go like that.

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Participant **R** realized that without the cardboard motorbike, the joy-cons could function alone and control the game. When asked about how the controllers work within the game, **R** hypothesized that there may be a "device" in the controllers that gives information to the TV screen. We can see how participants are learning new things just by breaking down the game technicalities.

Facilitator: Did you get the idea of how the controllers kind of like make the actions that you're supposed to be doing?

R: Wait!...at first I know how they do it. So, without the game and all this cardboard, if you just lean that, like, that... that would start the motor then you just hold this one.

Facilitator: Do you have an idea like how the actual controllers help you doing that like for the game how it works?

R: Because the controllers, I think there's like a tracking device in here that gives... uh... the main thing information then...um...it can sense when you're going like that to move, then it shows that information to the screen.

When it comes to the desire of understanding the science behind the motorcycle video game (included with the Nintendo Labo) and the Nintendo Switch's hardware (joy-cons and touch screen), many of the participants expressed that such explanation was not very clear and it would be much appreciated before starting the "play" experience.

Facilitator: So, what do you think? Do you think it would be cool to know how it works? I mean, like the game itself telling you how the controller can track the movement?

C2: It kind of is...but not that much.

E1: I think it'd be cool because like you might be able to do it to something.

A final aspect highlighted by the youth was the importance of following instructions in order to complete the building process of the cardboard devices (the motorbike's left and right handles, and the central area of control). Participant **C2** expressed the importance of learning to follow steps carefully in order to be successful while building the device.

C2: I learned how to follow instructions to like what it's saying to what the instructions are telling us what we should do. I got better at that cause I was never really good at that.

In our case 3, learning new things was evident when participants were asked about the inner-workings of the game itself. The application of prior knowledge and combining new information was presented. Participants paid close attention to technical details and tried their best to explain the mechanisms, mostly hinting to the use of sensors. A clear desire for detailed/in-depth explanation of how the different science-based mechanisms of the game work was noted.

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Case 4: Toy-Con RC Cars

The group who participated as the first case of this study worked on the toy-con RC Cars.

Engaged participation

With the youngest group of our study, participant **N** actively noted that their building experience was from scratch. This acknowledgement can be seen under the engaged participation lens, as the participant understood the process behind the experience.

N: Because it was cool and we got to make it. From scratch.

While discussing the building experience, enthusiasm was expressed highly when the topic of customization arose. Participant **J3** expressed engaged participation through his recollection of teamwork, details and assembly.

J3: It was cool because we got to pop the things out and we put it together...and we put this black Nintendo sticker [decorative stickers included with the game] on and some eyes...too many eyes!

When asked about their learning experience throughout the game, all participants in this group agreed on teamwork. This sentiment was acknowledged by all participants, revealing that they all had a role in each other's experience. Active recognition of roles permits a positive engaging environment.

Facilitator: Do you think you can learn something by building the car?

N2, E2, J3, and B: Yeah...teamwork!

J3: Teamwork makes the dream work.

In Case #4 engaged participation is actively recognized within this case, as the participants commented on their roles and acknowledged that this could not have been completed without teamwork. Within this lens we are able to associate key components in this group's involvement.

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Learning new things

Through observation and speculation, participants were able to deduce how the toy-con car was able to move. Participant **E2** noted that the vibrations from the toy-con caused it to move and participant **J3** also had the same idea. When looking at the toy-con itself, it is upheld only by cardboard. Participant **J3** also recognizes design flaws.

Facilitator: All right so how do you think the game actually works? How does the car actually move?

E2: Cause the controller vibrates the car and it makes it move

Facilitator: Oh! so... the vibration!

J3: I was raising my hand...I was going to say the same thing.

Facilitator: Okay, you can add you can build on that. What else do you think? How does it work?

J3: It can't really go like...because it's just...a little cardboard thing....and it can fall really easily.

Facilitator: Okay... and it can fall really easily because it doesn't have any wheels, right?

J3: That'd be cool if it did. It would go like super fast!

When asked about the mechanisms of how the toy-con is able to move, the topic of sensors arose. Though the participants never explicitly mentioned "sensors" or "infrared", they were able to describe these concepts with their own understanding. Details of the joy cons were examined and observations when used.

Facilitator: So, what about the camera? You see the red and green camera... the little square you could see in the middle of the screen?

N2, E2, J3, and B: Yeah!

N2: Because of the one part on the controller.

Facilitator: How were you able to see through the car?

J3: It was kind of like…

N2: So, this part it's a camera [pointing at the infrared sensor]?

Facilitator: Oh, the little thing [pointing at the infrared sensor]?

J3: And it was like...green? When you looked through it.

Facilitator: So, you think that was like the camera? The black thing below the controller?

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N2, E2, J3, and B: Yeah!

The facilitator provides subtle clues surrounding the mechanisms behind the toy-con's functionality. By asking the participants questions about things the game did not explicitly explain to the users, it gives the participants the opportunity to express their rationale.

Facilitator: So, you mentioned that the vibration caused the car to move and the little black Square below the controller was the camera? Right? But...you noticed that! The game didn't tell you that that was how it works. Right? What would you prefer? Would you prefer the game itself to explain how it works or you wouldn't care about that?

E2: I wouldn't really care about it. I like to figure things out!

When asked about their overall learning experience from this project, participant **J3** was able to contextualize from knowledge of technological advancement.

Facilitator: Do you think you actually learn something by building and playing with it?

E2: Vibrate stuff and make it move!.

Facilitator: Oh, like vibration can cause things to move?

J3: Technology is really good these days...well, maybe it's not the vibration, so... like the controllers kind of move forward and pushes it...cameras can be really small. Super duper super small.

Facilitator: Why do you think the camera was Green?

B: Green?

E2: Because that's like- like seeing it, the cameras are like night mode like the cameras are night and it shows that. Like it- It shows that

Specifically for this toy-con, the learning new things lens is a key component in identifying patterns amongst participants. This group was the youngest of our participants and this lens proves to identify different characters from previous cases. Within this lens, we were able to understand how the learning experience varies with age. This lens for this case provided insight on the importance of design and functionality.

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Discussion

After finalizing this afterschool experience where the young participants engaged with the Nintendo Labo's variety kit "Toy-Con 01" and the Nintendo Switch, we were able to explore the different perceptions and thoughts the youth had of the "Make" (building the cardboard devices) and "Play" (playing the video game with the cardboard devices and the Nintendo Switch hardware) phases/experiences.

Engaged participation

The engaged participation lens played a crucial role in understanding the experiences of individual students. As stated by Gee (2008), we found that active/engaged participation served as a valuable tool in recognizing the importance of collective participation, and that actions of individuals can impact the team itself. The engaged participation lens accounts for the notion that students are agents of their own learning. Good learning is a result of a game that allows students to recognize that their decisions and actions are able to shape and design their experience (Gee, 2005, 2008).

When it comes to fully understanding engaged participation within this experience, one must acknowledge the roles students take part in. We found that when individuals reflect on their role in their team, they are better able to identify particular aspects of their participation. Though not explicitly stated by the game, the Nintendo Labo's Variety Kit 01 has the ability to be constructed individually or as a team.

Teamwork was a recurring theme within all four cases when assessing with the engaged participation lens. The team 'teamwork' should not solely be focused on individuals working together to finish something, but individuals acknowledging the specific participation of others should be recognized. We found that students were able to identify who did what and their demeanor when participating in case #2. Within the lens of engaged participation, there are various factors such as interest level, group morale and degrees of involvement. Having introspection of others at a young age is a skill necessary to learning and life.

Participants described the physical aspect of building the toy-cons was an important aspect of their experience. Despite challenges that may arise, the game itself was interesting enough to maintain engagement. We also found that students were able to be critical when discussing the game itself. They were able to identify the flaws, constrictions and also changes that would improve their experience.

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Learning new things

The *learning new things lens* allowed us to focus on knowledge distribution. Nintendo Labo incorporates three different phases of learning, which we were able to identify in our participant's experiences. This lens was a valuable tool when reviewing participants' building and playing experiences. It's also important to recognize that there are various types of learners.

This lens differs from the engaged participation lens as we were more interested in focusing on the learning content and process instead of involvement and attitude. We found that discussing different functionalities within the gaming system and Nintendo Labo allowed participants to critically think and refer back to previous knowledge. For instance, participant **C1** was able to deduce the role that the stickers had in order for everything to work, but realized the game did not reveal specific details. We found that from *Case 1* that understanding new things does not mean that the experience itself has to be foreign to the learner. Participants were able to think outside the box and devise their own theories.

The playing experience varied for each case, but participants in *case 2* showcased greater instances of distributing knowledge. For *case 2*, the toy-con was a fishing rod and the game was fishing various sea creatures in the deep ocean. Participant **J1** confidently identified "tactics" that would prove to have greater success within the game. The use of prior knowledge was also utilized when participants would cheer another on or provide advice. Through the learning new things lens, we were able to identify details within an informal learning experience. Learning does not have to apply to only school-based curriculum, but can be seen through everyday interactions. By making greater informal connections within learning and the brain, participants are able to carry this with them in their lives.

It can be suggested that with further expansion on how the cardboard cutouts and stickers when put together with the Nintendo joy-cons work, participants would have a greater learning experience. This goes back to Gee's (2005) principle of *Empowered Learners*. Good learning requires that learners feel like active agents (producers) not just passive recipients (consumers), which is what some participants from case 2 **(J2)** felt. Within this informal learning environment, participants were able to freely express their thought process while reflecting on the game, and were not restricted by any rules. It's important to recognize the value behind reflection of any experience with students, to fully grasp their perspective.

For this lens, there is a common theme across all four cases. Participants in every group emphasized the desire of greater detailed instruction or details from the game itself. Though the game provided adequate instruction in constructing the toy-cons from the cardboard cutouts, participants longed for comprehensive information on the inner-workings of the game. They were

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curious how something they made out of cardboard could be used flawlessly with a gaming system. We could not provide them direct answers, but listened to their elaborate theories. In *case 4*, the youngest group, the participants were able to identify what they thought connected the toy con and the Nintendo Switch. From this, we were able to acknowledge how this fostered creativity and imagination.

Conclusions, Limitations and considerations for future research and experiences

After designing and executing an informal learning experiences with the Nintendo Labo during a Summer program, the kids shared interesting perspectives on how such different kits of the Nintendo Labo have the potential to trigger some science knowledge, opening up spaces for educators to use such perceptions to tailor them with real-world-related/contextualized science formal content (e.g. how sensors, infrared cameras work), as long as creating collaborative experiences while exploring the Nintendo Labo variety kits.

The findings of the study showed how—interestingly—kids can associate science-related experiences with their funds of knowledge (both from their daily basis and content explored in classroom settings), making the kids able to explain—or have close theories/hypotheses—how the explored hardware worked alongside with the Software provided by the Nintendo Labo. These connections can be potentially expanded with a longer implementation and further exploration of the Nintendo Labo's kits.

Additionally, it is relevant to highlight that one of the limitations of this study was the time, not having enough time to go beyond to the first two phases/stages of the Nintendo Labo experiences ("Make" and "Play"). This opens doors for possible future research in exploring the "Discover" phase of the gaming experience of the Nintendo Labo, enabling educators (through the guidance and voice/perspectives of the kids) to discover the different possibilities and affordances that the Nintendo Software and hardware have to offer to enhance the science learning experience in both formal and informal educational settings.

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Authors contributions

Conceptualization, John Cano and Megan Chow; methodology, John Cano and Megan Chow; validation, John Cano, and Megan Chow; formal analysis, John Cano and Megan Chow; writing-original draft preparation, John Cano, and Megan Chow; writing-review and editing, John Cano and Megan Chow.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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