frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 02 November 2023
DOI 10.3389/feduc.2023.1078001

OPEN ACCESS

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RECEIVED 23 October 2022
ACCEPTED 27 September 2023
PUBLISHED 02 November 2023

CITATION
Kaplan A, Garner JK, Rush A and Smith M (2023) Designing for diverse museum visitors' identity exploration around inventiveness.
Front. Educ. 8:1078001.
doi: 10.3389/feduc.2023.1078001

Designing for diverse museum visitors' identity exploration around inventiveness

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Introduction: This paper describes an initial phase of research to inform the design of Change YOUR Game—an exhibition at the Smithsonian National Museum of American History (NMAH) that aims to promote visitors' inventiveness in STEM and in other life domains. The exhibition's content focused on the history of inventions and innovations in sports. The research was framed by the Dynamic Systems Model of Role Identity (DSMRI) and by a set of design principles for promoting visitors' agentic identity exploration: The PRESS Principles.

Methods: Five data collection sessions engaged participants in a virtual, simulated visit to an early rendition of the exhibition. Diverse groups of participants were prompted to consider the self-relevance of the exhibition content to their identities and how they have been and can be inventive in their lives.

Results: Four themes captured participants' museum visitor role identities, varied readiness to engage in identity exploration of their inventiveness, and how these provided affordances and hindrances to participants' engagement in identity exploration in the context of the simulated visit. The themes served as bases for design recommendations.

Discussion: The study highlights the potential of the DSMRI and PRESS design principles to address conceptual and methodological challenges of research that aims to inform environmental design of a context that is not yet in existence and that will be relatively fixed. The findings suggest recommendations for design as well as theoretical insights about museum visitor role identities and the contexts that may promote visitors' active and agentic engagement in exploring their identities.

KEYWORDS

diversity, exploration, identity, inventiveness, museum visitors

Introduction

Inventiveness—the capacity to generate creative solutions to complex problems—has been highlighted as central to personal and societal success in the twenty-first century (OECD, 2008). Both in scientific, technological, engineering, and mathematics (STEM) domains and more broadly, being inventive is foundational to identifying problems and generating solutions that improve one's own and others' lives. However, promoting people's inventiveness is challenging (Sawyer, 2015). The Smithsonian's Lemelson Center for the Study of Invention and Innovation (LC)[1] is currently designing a museum exhibition for the Smithsonian National

1 https://invention.si.edu/

Museum of American History (NMAH) aiming to promote visitors' inventiveness. NMAH-LC contends that invention is an interdisciplinary process that incorporates science, technology, engineering, and math, as well as art, design, and even history. The exhibition and its activities aim to provide people of all ages the opportunity to learn STEM-related content and skills as well as practice twenty-first-century skills such as collaboration, creativity, problem-solving, risk-taking, and critical thinking, which support the development of inventiveness. The design prioritizes promoting inventiveness among visitors from groups that are currently underrepresented among visitors to the NMAH as well as in the innovation ecosystem: adolescent girls, African American youth, and people with disabilities. In order to garner broad appeal, the LC has chosen to focus the exhibition on the history of inventions and innovations in sports, and it has labeled the exhibition "Change YOUR Game." The exhibition is planned to open in March 2024 and be housed at the NMAH for a period of 7–10 years.

The LC views inventiveness as an aspect of a person's identity—an inventive identity. Correspondingly, it views the promotion of inventiveness as a process of identity change. Yet, there are multiple perspectives on identity that differ in assumptions regarding its stability, dimensionality, and locus (e.g., individual, activity, group, and society) and regarding the role of contexts and situations in identity expression and change (Schwartz et al., 2011; Kaplan et al., 2022). To design an environment that can facilitate identity change among visitors who are likely to spend but a short amount of time in the context, the LC has partnered with applied identity scholars that approach identity from a complex dynamic systems perspective (Kaplan and Garner, 2017). The current study describes the theoretical framework, methodological procedures, and findings from the initial phase of this research that has informed the conception, planning, and design of the "Change YOUR Game" exhibition (a second research cycle that is taking place during prototyping is currently underway).

"Change YOUR Game:" a sports exhibition to encourage inventive identity development

The "Change YOUR Game" exhibition[2] will be housed in a 3,500-square-foot hall in the Smithsonian National Museum of American History. The exhibition will include six areas: a Starting Line that introduces the exhibition, four Invention Motivation Zones, each highlighting a core motivation for invention in sports—achieving a competitive edge, promoting health and safety, facilitating fairness and accuracy, and enhancing the fun and accessibility of sports to diverse participants—and, finally, an End Zone in which visitors reflect on their visit and further explore their inventive identity.

Bilingual (English and Spanish) multimedia presentations in the Starting Line will present to visitors the focus of the exhibition on their own inventiveness (Change YOUR Game) by learning from examples of Game Changers—inventors and innovators in sports—and exploring how they can be inventive in their life.

Exhibits and bilingual stories of inventors and inventions in the four Motivation Zones were selected to highlight inventors of different genders, ethnicities, and physical abilities, and inventions spanning professional and popular sports from different historical periods that primarily involve innovations that build on STEM content, but also innovations in norms and rules of games. The exhibits and stories in the Motivation Zones will highlight the core motivations for inventing, describe different invention processes, and highlight different inventive strategies. Each zone will also include an interactive exhibit in which visitors will be able to exercise their inventive motivations and skills in a fun, game-like activity. The End Zone will involve interactive activities that encourage visitors to reflect on their experiences during the visit, view themselves as inventive in different areas of their lives, and consider an inventive project they would like to pursue. The aim is for visitors to use inventive examples that build on STEM content, engage in their own inventions, and explore the meaning of those experiences to their identity in a way that effectively integrates STEM learning with inventive identity formation. Figure 1 presents a schematic of the exhibition area. Figure 2 presents draft renditions of the Starting Line and the Fairness and Accuracy Motivation Zone.

Theoretical framework: inventiveness as based in situated identities

In this design project, the collaborative team is using the Dynamic Systems Model of Role Identity (DSMRI; Kaplan and Garner, 2017) to define inventiveness as actions that involve generating, developing, and implementing new or original ideas in response to a perceived need. The DSMRI conceptualizes actions as emerging within the person's situated role identity: the person's interpretation of the social-cultural role that they occupy in a particular situation and cultural activity system (e.g., a student in a science class, a teacher in a science class, a visitor in a museum exhibition, a research participant in a focus group session). The DSMRI defines role identity as a complex dynamic system (CDS) comprising a continuously emerging network of role-related perceptions, beliefs, and associated emotions that give rise to action. A basic premise of the DSMRI is that a person's action in any situation is selected (most often implicitly) among those actions that the person perceives at the moment to be available for them for pursuing their salient goals in light of their interpretation of the situation and of their positionality in that situation (cf. Maehr and Braskmap, 1986). Accordingly, the DSMRI identifies the role identity CDS as comprising elements from four role-related components: ontological and epistemological beliefs (i.e., a mental working model of reality and the nature of knowledge about that reality), self-perceptions and self-definitions, purpose and goals, and perceived action possibilities. Elements from these role identity components, and the emotions that are associated with them and with their connections with each other, interplay in interdependent and non-linear ways to

2 "Game Changers"—A Behind the Scenes Introduction. Available at: https://nam10.safelinks.protection.outlook.com/?url=https%3A%2F%2Fsmithsonian.zoom.us%2Frec%2Fplay%2F4_lW8jFQBlJDNTv0Q8-TEgrr97oU7S4dlMB1jvWkpvi_0kIPUY3RjWXS4HAg4FXtAw0m92aX8EaONNM.odTUfYsN9PoVXW0Q%3FcontinueMode%3Dtrue%26_x_zm_rtaid%3DD2e3MTrRTGiEMFWtApks0g.1648062294384.ff16a690ed80178e71c83be8a33cc307%26_x_zm_rhtaid%3D594&data=04%7C01%7Cavshalom.kaplan%40temple.edu%7C1b04d6ce88d34df2b11008da0d0db425%7C716e81efb52244738e3110bd02ccf6e5%7C0%7C0%7C637836649758283237%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000&sdata=GQ9mWfBTN3iDUdf9obZLYQgVsX9GPVDjSk0XaMVuBvU%3D&reserved=0

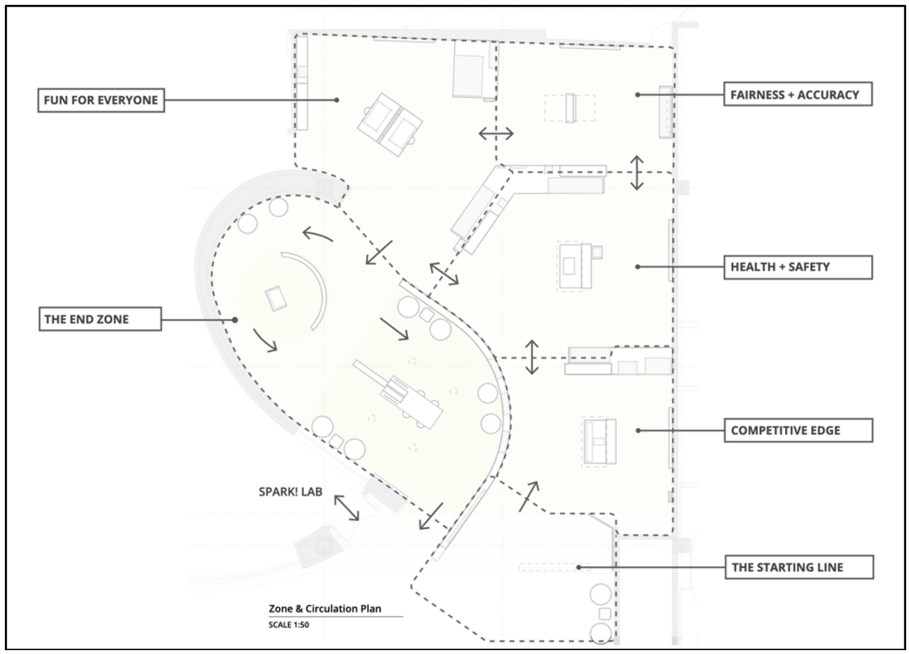

FIGURE 1
The Change YOUR Game exhibition layout.

FIGURE 2
Artist rendition of the exhibition's starting line and one of the motivation zones. Images produced by ROTO[8].

give rise to action. In turn, the internal and external feedback to the action triggers change to these components and the role identity system. Thus, the role identity continuously emerges, ebbs, and flows as the situation unfolds through the person's participation in the cultural activity. This emergence is framed by the contextual integration of four parameters: cultural meanings and mediating tools in the cultural activity system, social positioning and interactions, the subject domain, and the person's unconscious dispositions (Kaplan et al., 2019). Figure 3 presents a schematic of the DSMRI.

From the perspective of the DSMRI, a person's (or a team's) inventive actions emerge from situated beliefs, goals, self-perceptions, emotions, and perceived action possibilities that are oriented toward identifying creative solutions for complex problems within the role identity system. In turn, inventiveness (or inventive identity) refers to those beliefs, goals, self-perceptions, emotions, and perceived action possibilities that constitute together with other identity elements the person's role identity system and give rise to inventive action. Correspondingly, the goal of the exhibition is to engage people who are occupying the role identity of "visitors in the exhibition" (cf. Falk, 2009) in reformulating elements of that role identity as well as of other role identities in their life (e.g., student, parent, professional, and citizen) in ways that might promote more inventive actions in situations where they occupy those role identities. Figure 4 presents a conceptual representation of the goal of the exhibition in framing visitors' engagement.

Design principles for facilitating inventive identity exploration

Although role identities change through numerous mechanisms, the collaborative research team targeted an agentic form of identity formation: identity exploration. Identity exploration refers to the

person's deliberate internal and/or external actions of seeking and processing information and experiences in relation to the self for the purpose of self-knowledge, growth, and decision-making (Flum and Kaplan, 2006). In the current project, the design of the exhibition aims to scaffold visitors' identity exploration around being inventive. This may manifest in various intra-personal and inter-personal reflections, deliberation, questioning, and experimentation concerning inventiveness in different role identities in life. From the perspective of DSMRI, such identity exploration would involve exploring elements in the four role identity components and their relations with each other,

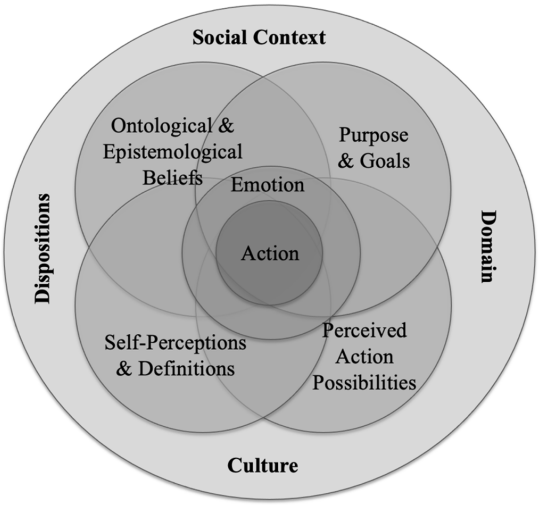

FIGURE 3
The Dynamic Systems Model of Role Identity (DSMRI; Kaplan and Garner, 2017).

including inventive beliefs about problems that require solution; purpose and goals of generating inventive ideas and pursuing their implementation; self-perceptions and self-definitions as creative, efficacious, value-oriented, and collaborative in inventing; and perceived inventive action possibilities such as transferring ideas across domains, tinkering, testing–adjusting–retesting, and recruiting collaborators with complementary expertise for collective inventing.

To guide the exhibition design, the team is applying a set of four conceptual design principles for environments that promote people's identity exploration that we have applied in other formal and informal education settings: (1) promoting perceived self-relevance of main inventive content (e.g., identification with an inventor; perceived self-relevance of an invention, of a motivation for inventing, or of an inventive strategy), (2) triggering identity exploration by creating a constructive identity tension (e.g., an experience that challenges one's self-perception as not inventive), (3) facilitating sense of safety to explore one's inventive identity (e.g., highlighting that mistakes are inevitable, the ubiquity of inventiveness, and the diversity of inventors; providing various spaces and different types of activities for exploring one's inventive role identity), and (4) scaffolding identity exploration actions (e.g., prompts for intra-personal reflection and inter-personal deliberations, interactives for experimentation and the acquisition and practicing of inventive strategies, activities for identity commitment making) (Kaplan et al., 2014; Garner et al., 2016). We have labeled this set of design principles PRESS (an acronym for Promoting Relevance, Exploration, Safety, and Scaffolding). To inform the design of the exhibition, the goal of the first phase of the research was to investigate the nature of inventive identity exploration engagement by visitors from the target audiences in PRESS-informed activities that include examples of sport inventive STEM-informed content.

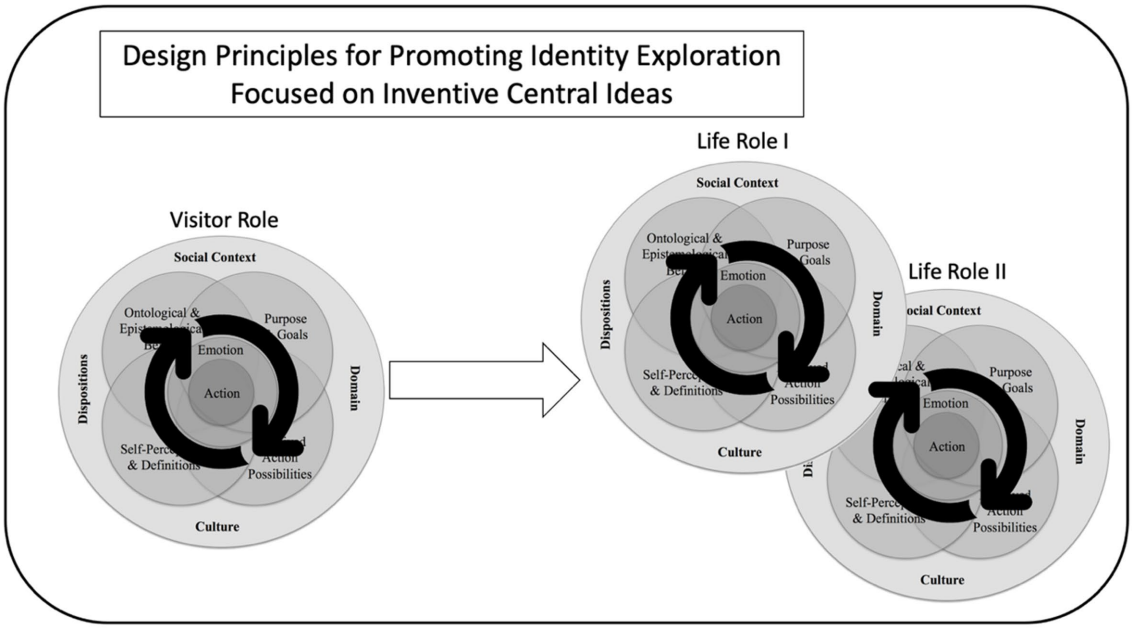

FIGURE 4
Conceptual representation of the exhibition's goals for visitors's engagement.

Situative research to inform environmental design

As a CDS, the DSMRI is based on the assumptions that identity, motivation, learning, and their change are situated; that is, they emerge continuously while being framed by the characteristics of the particular lived situation. These assumptions challenge the direct transfer of findings from research in a particular context and with certain participants to the design of another context with other participants. Instead, from a situative perspective, for research to inform effective design it should take place with the participants who are inhabiting the particular situation and should involve iterative changes to the environment while investigating the effects until the design is successful (e.g., Nolen et al., 2012; Fishman et al., 2013; Tierney et al., 2020; Penuel and Potvin, 2021). The outcomes of this research include both improved design in the particular context and more elaborated theories of the focal phenomenon and of the environmental design principles for promoting desirable processes in that phenomenon. As new contexts will always be somewhat unique, the transfer of knowledge from a particular case to the design of a new environment must be mediated by the theory and needs to involve using the enriched design principles as a *starting point* in another iterative process of contextualized design-investigation cycles—design-based research.

Yet, two central features in the current design project made applying design-based research untenable. First, the context of the exhibition does not yet exist, and the goal of the research is to inform its initial design. Second, once designed, the exhibition is going to be mostly fixed, with little affordances for iterative changes. Contending with these constraints framed the goal and methodology of the current study. Specifically, following assumptions of the CDS approach, while concrete manifestations of a person's identity processes and actions are situated and unique, these phenomena do manifest patterns across cases that may reflect general principles underlying the complex and dynamic role identity system's behavior (e.g., each pedestrian on each street is unique, and their behavior reflects idiosyncrasies, yet the behavior of different pedestrians across different streets is framed by similar principles; Dachner et al., 2022). Thus, whereas each exhibition visitor's role identity is unique, and whereas the research context is different from the exhibition context, research that simulates visitors' experience in a context that shares characteristics with the intended environment might shed light on conceptual principles of the visitor role identity system and engagement that could inform the design of the exhibition—a humbler epistemological goal than design-based research, yet nevertheless informative.

Correspondingly, the current study aimed to identify concrete and conceptual features of participants' role identities, and conceptual patterns of their engagement, in a research context that simulated features of the "Change YOUR Game" exhibition and involved the application of the PRESS principles with participants from particular focal audiences of the exhibition: adolescent girls, African American youth, and people with disabilities. Specifically, the research used the available rendition of the exhibition at the time (similar to the images in Figure 2) in an initial investigation of participants' experiences within a research participant role identity of (a) assuming a visitor role identity in the exhibition, (b) constructing self-relevance connections between central ideas concerning sports inventiveness in the content and aspects of their identity of the exhibition, (c) engaging in identity exploration of their inventiveness in their visitor role identity and about other role identities in the domain of sport and in other life domains, (d) feeling safe to engage in such identity exploration, and (e) engaging in different exploratory actions in ways that provide data as evidence. At the early stage of the design of the exhibition, the research question was: *What are the manifestations of participants' inventive identity and identity exploration, within the visitor role and other life roles, in the context of a PRESS-informed and facilitated visit in an early rendition of the exhibition?*

Materials and methods

Researchers' positionality

The four core members of the research team that has engaged in conceptualizing the study, data collection, and data analysis and interpretation include educational psychology scholars with expertise in conceptual and applied identity work in diverse formal and informal educational settings, an educational psychology doctoral student with experience in informal education settings, and the project director of the Change YOUR Game exhibition at the Smithsonian's Lemelson Center who is a historian of inventions and a museum curator with expertise in informal education design. The team reflects diversity in age (25–58 years old), gender (three women and one man), ethnicity (one African American and three white), and immigration status (two US-born and two immigrants from different countries). This diversity of background and domains of expertise provided for rich discussions that intentionally invited diverse interpretations of the data. Importantly, none of the team members shares the focal characteristics of the target audiences: adolescent girls, African American youth, or people with disabilities. Thus, the researchers adopted an epistemologically humble frame by considering the participants as experts in their experiences during data collection and when interpreting the participants' engagement and data—being particularly mindful about limiting far inferences and about staying close to the meanings expressed in participants' expressions.

The researchers' inquiry worldview is anchored in the CDS perspective, with its paradigmatic assumptions about phenomena as contextually emergent, non-linear, and complex, and its practices of combining a deductive systems lens (here, that of the DSMRI and PRESS-guided conceptual categories) with an inductive lens that anchors in the participants' role identities content, structure, and processes as unique and situated. Specifically, the CDS inquiry worldview and DSMRI assumptions guided our expectations that participants' role identity manifestations would be varied and dependent on each visitor's idiosyncratic life experiences and initial orientation to inventiveness while framed by their participation in the data collection context and activities. The PRESS principles framed our anticipation that the designed activities would result in role identity manifestations that reflect perceived self-relevance, recognizing sport as linked to processes of invention and innovation beyond sports, and perceiving oneself as innovative in different domains in life. Based on the DSMRI, we anticipated participants' exploration of inventiveness to involve expressions of role identity components: purpose and goals, beliefs, self-perceptions, emotions, and perceived possibilities for action, both within the visitor role and in one or more other life roles and domains. To increase the trustworthiness of our findings, we bracketed these assumptions by reflecting on the way they guided our expectations, and by intentionally seeking indications in the data that deviated from them.

Participants

We conducted five data collection sessions. Two sessions, each with four participants, included ethnically diverse adolescent girls ranging in age from 13 to 17 years old.[3] These girls were recruited through a local Girl Scout community partner organization. In addition, two sessions, each with two participants, and one session with a single participant, included collectively five ethnically diverse adults with disabilities. These participants were recruited through the Access Smithsonian partner organization. To recruit the adolescents, we sent an interest survey with an information sheet for guardians and a scheduling form. Over 20 participants completed the interest survey, and we selected a random subsample of participants.[4] Recruitment of the Access participants was conducted through the coordinator of the group who used the information sheet to solicit participants from its members. Participants were informed that their participation is sought to support the design of the exhibition, that the researchers seek their honest perspectives and attitudes, and that they will receive a $25 gift card in thanks for their hour of participation.

Procedure

To create a simulation of a visitor role experience in a context that shares central characteristics with the intended exhibition environment, we used the DSMRI and PRESS principles to design the data collection sessions as a facilitated activity that involved participants in an imagined "visit" to pictorial renditions of the Change YOUR Game exhibits. The activity was designed to encourage participants to imagine themselves as visitors (i.e., construct a visitor role identity that is integrated with the research participant role identity), construct self-relevance for the exhibit content, and engage in identity exploration in a safe and inclusive context, while reflecting on and explicating their experiences and thoughts in ways that provided data.

Due to COVID conditions, the data were collected using a virtual meeting platform, which created an additional dimension of difference between the research context and the eventual context of the exhibition. Scheduling processes resulted in different numbers of participants in the sessions. When only one person participated in a session, the data collection protocol assumed the form of an interview. When more than one person participated in a session, the data collection protocol assumed the form of a focus group. The protocol included an introduction, prompts to guide participants to assume a visitor role identity in a virtual tour of Change YOUR Game, descriptions of the exhibition objects, and prompts based on the PRESS principles that aimed to promote participants' engagement in identity exploration of their visitor role identity and other life roles. Participants' engagement included posting notes on a Google Jamboard and describing orally their perceptions, preferences, emotions, and thinking.

Each session lasted approximately one hour and was conducted virtually over Zoom. The Smithsonian IRB prohibits video and audio recordings of participants. Unlike other transcription files, Google Docs transcription does not record and store an audio file. One researcher served as the facilitator and two other researchers served as off-camera notetakers, with one monitoring an automated transcription by Google Docs and the other taking verbatim notes.

The protocol

The facilitator welcomed the participants as they joined the virtual meeting and explained the purpose and procedure of the activity as participating in a virtual tour of an exhibition under construction in order to inform its design. This introduction aimed to support the participants in constructing a "participant role identity" that includes an "imagined visitor role identity." The content of that intended role identity included ontological and epistemological beliefs about what is involved in participating, and that the activity context is safe and inclusive; the purpose and goals of participation; and action possibilities for participating, with the anticipation that participants would incorporate their salient self-perceptions and self-definitions into these role identities. The introduction aimed to enhance the sense of safety by positioning the participants as experts of their own experiences and as helpers in the design of the exhibition and by emphasizing that participation in any of the tasks during the session is up to the participant. With the adolescents, the facilitator guided a warm-up activity on Google Jamboard to ensure that the participants could access and use the tool to promote its use as a participation action possibility. With the Access participants, the protocol was similar but did not include the Jamboard.

To further support participants' integration of their participant role identity with an imagined visitor role identity to the Smithsonian National Museum of American History (NMAH), before the virtual tour began, the facilitator showed participants a picture of the NMAH building and asked them to imagine that they are visiting the museum. They were then presented with an image of the starting line of the exhibition.

Applying the PRESS principles, the facilitator then asked the participants several questions about the self-relevance to them of sports and invention, including: "How interested would you be in visiting an exhibition in sports and why?," "When you think about inventions in sports, what comes to mind?," and "How is sport connected to your life as a player or a fan or a viewer?" Then, to elicit participants' ontological and epistemological beliefs about inventors and inventions, the facilitator asked the participants to share their definition of a Game Changer.[5] Then, the facilitator read aloud a brief

3 Participants' ethnic background was not collected from them directly. It was inferred from observations and the data. The ethnic backgrounds of the Girl Scout participants included African American, white, and South-East Asian American. The ethnic backgrounds of the Access participants included African American and white.

4 Logistical challenges hindered data collection with partner organizations serving African American boys at this time. Follow-up data collection including African American boys has since transpired and will be included in subsequent publications.

5 The original title of the exhibition was "Game Changers," with the idea that introducing inventors as game changers would position them as role models and serve to trigger visitors' identity exploration of themselves as game changers. This was the reason for the incorporation of this question into the

description of the Change YOUR Game exhibition and triggered participants' identity exploration of inventiveness by asking them to describe how they are game changers in sports or other areas of their lives, mirroring an emphasis that will be located in text and video at the Starting Line of the exhibition.

Then, the facilitator guided participants through a sequence of images of three areas of the exhibition: the Competitive Edge Motivation Zone, the Health and Safety Motivation Zone, and the wearable technology and innovations in home exercise resources. When showing the image of each area, the facilitator read a brief description of the objects in the area to familiarize the participants with content that visitors could read in the exhibition. The facilitator then scaffolded self-relevance of the content by asking participants to indicate the object they would like to visit first and why it interested them. Adolescent participants responded by using Jamboard posts, and Access participants responded orally (or through an ASL interpreter). Then, the facilitator encouraged participants' identity exploration of their inventiveness by asking them to orally elaborate on their preferences, share their thoughts about the inventors and artifacts represented in the exhibition, and consider whether and how they had ever done something similar to those inventors in their own lives.

After visiting the three areas, the facilitator further encouraged participants' identity exploration of their inventiveness by asking them to consider an area in their life where they could be inventive and how. Adolescent participants were asked to write their responses on a Jamboard post, and adult participants were asked to describe them orally or through the ASL interpreter. The facilitator then asked participants to explain their responses. At the end of the virtual tour, the facilitator asked the participants to provide feedback to the team about the exhibition and about their experience as participants in the activity.

Data analysis

Data from the automated transcription and note-taking were integrated to create a transcript of each session. Two researchers analyzed independently each transcript, and Jamboard entries when available, using the DSMRI analysis guide and codebook (Kaplan and Garner, 2020). The third researcher served as an auditor of the analysis process. The DSMRI analysis guide and codebook details steps for analysis that begin with identifying the role identities manifesting in the text, coding for the content, structure, and process of these role identities, and using the codes to generate a narrative about the role identities that uses the DSMRI terminology and assumptions. In the current analysis, each segment of data (e.g., a written post, a speech act) was coded as reflecting a target role identity (e.g., Girl Scout) and DSMRI components, their relations, and process of formation (e.g., self-perceptions, ontological beliefs, their alignment or misalignment, and whether there was an indication for their change). For example, in response to the question about the artifact in the exhibit they would like to see first and why, one adolescent girl participant said: "*I wanted to look at the swimsuit because I swim competitively and I think it would be cool to look at how something in a sport that I'm interested in changed so much*." This statement was coded as indicating a situated integration of the participant's imagined exhibition visitor role identity with her competitive swimmer role identity, which, in this instance, involved incorporating her competitive swimmer role identity as a self-definition within her imagined exhibition visitor role identity. The DSMRI facets analysis involved coding the statement as indicating harmony between the participant's self-definition as a competitive swimmer with her self-perception as interested in the sport of swimming, which, in turn, she aligned with her ontological and epistemological beliefs about the sport (in this case, what she knows and does not know about competitive swimming) and her goal of learning how the sport changed through engaging in the swimsuit exhibit.

Following the situative approach and DSMRI assumptions, the analysis premised the interpretation of participants' data as emerging within the role identity of a participant in a virtual focus group imagining being a visitor in a virtual exhibition. Analyses of the different sessions were then compared, integrated through discussion, and synthesized into emerging concrete and conceptual themes across participants and sessions pertaining to the content, structure, and process of participants' visitor role identity and their identity exploration of inventiveness in different life role identities. Notably, when generating themes across participants and sessions, we considered the manifestation of intersectional diversity among the participants, both explicit and implicit, including age (e.g., adolescents and adults, younger and older adolescents) and visible disability status and type of disability. The analysis sought to highlight both the shared and the unique manifestation of role identities and identity exploration across participants with different characteristics, to inform the exhibit design as well as theoretical understanding regarding inventive identity exploration among people with different characteristics.

Results and implications for design

Generally, most participants appeared comfortable about integrating the "virtual research participant" role identity with the imagined "visitor in the virtual exhibition" role identity they were asked to construe. While the level of participation varied, all participants responded to the prompts as intended, and most participants in the groups reacted to or built on each other's words. The analysis generated four general themes pertaining to participants' role identities as imagined virtual visitors and their engagement in identity exploration around inventiveness in the context of a PRESS-informed context and activity.

Theme 1: initial visitor role identities were based on prior experiences characterized by normative passivity and anchored by the sports content of the exhibition

Participants' initial imagined visitor role identities were expressed in beliefs, goals, self-perceptions, and action possibilities that reflected the normative passive visitor in a museum. Across participants, these initial role identities involved the ontological beliefs that the exhibition will focus on inventors and inventions in sports and that the purpose of visiting is to learn about them. In framing participants' initial

protocol. As described below, the findings of this research provided the basis for changing the exhibition's title to "Change YOUR Game."

engagement, these beliefs and goals were intertwined with participants' self-perceptions and self-definitions that were based on sports-related role identities triggered by the content of the exhibition (e.g., an athlete, a sports fan, a viewer) and, more generally, the self-definitions as a "sport" or a "non-sport" person. This manifested in the responses of the participants to the question about their interest in visiting the exhibition. One adolescent girl participant described her interest by stating: "*I think I'll be pretty interested because I like playing sports and being outside, so I think it'd be pretty cool to learn about, you know, the things that made up the sports and how they came to be*." A different adolescent girl reflected the same role identity formation process when she stated: "*I'm not really a big sports person. I used to do cheer, but I do like sports but I'm not, I do not play sports, but I like to understand, to learn about the history*." Access adult participants reflected similar initial visitor role identities. For example, one participant said: "*…when I go to any like large museum and you go, you aim to go to a couple of sections…and walk past the section that does not.did not.that might not interest you. And you are like, well, on my way, like, I'll see it. But personally, I'm not as interested in sports*." One Access participant was very clear that her visitor role identity would involve interest and engagement only if it was clear that the exhibition content was concerned with diverse abilities:

> Well, I'm going to be I mean, I'm going to be honest, I don't know. It wouldn't be on the top of my list. I think there'd have to be something to really grab me. So it's interesting when […] was speaking about adaptive sports… is that going to be integrated into this exhibition? So you're looking at sports, across all abilities? I think if it were framed that way, that would be super interesting to me, …. If it wasn't clear to me that that was part of the story, I would probably be less interested. You know, simply because I'm not a huge follower of sports.

Additionally, most participants' visitor role identity focused on the content of sports, their history, and how the sports have changed. However, one or two participants did respond to the idea in the exhibition that sports involve inventions. As one adolescent girl said: "*I think I would find it interesting 'cause like you do not really think about all the different inventions and stuff and sports*."

Implications for design: these findings highlight the need to incorporate into the design of the starting line area of the exhibition and of advertising materials about the exhibition, explicit scaffolds for audience formation of expectations and formation of visitor role identities that are active, rather than passive, and that involves the purpose of the visit as engaging in identity exploration around inventiveness in life roles beyond the domain of sports.

Theme 2: initial visitor role identities involved beliefs about oneself as not, or as minorly, inventive relative to inventors and game changers

Initially, almost all of the participants expressed self-perceptions as not inventive. Almost all the participants responded to the early prompt "how is invention related to your life?" by describing themselves as consumers of inventions rather than as being inventive themselves. Notably, the prompt triggered participants to consider their life roles as consumers of invention beyond sports. For example, an adolescent girl said: "*I feel like invention's connected to everything in my life, 'cause like again like we use electricity … and I bake sometimes so just I mean basically everything's an intervention [sic].*" Similarly, an Access participant said: "*I use a wheelchair. I think invention is very connected to my life, in terms of just with using a mobility device. Like without the invention of a wheelchair I would not get to a lot of places*." Another Access participant stated: "*I have zero talent, and creativity for this stuff … But what I, what I do like, is seeing how, over the years, and this is a little bit related to blindness, because there are certain things that we never would have thought of ten years ago. And the fact is that things that are created and developed for the blind typically make their way far more into general use than people realize*."

Some participants described initial self-perceptions as inventive, but almost apologetically, speaking about their inventiveness as small, and different from the inventions that define inventors. For example, one Access participant described being inventive by mentioning her creative writing: "*So I'm a writer. And so it's not like invention, like I'm sitting here, you know, like creating the next pen and like putting stuff, but you know, it's still a creative endeavor. And so you are inventing new stories, you are inventing new characters*, etc." These initial self-perceptions as being inventive, but in a small way, seemed to be aligned with initial ontological beliefs about inventions as grand endeavors with broad impact. As one adolescent girl stated: "*I was saying that the invention is like a very big thing of expressing yourself and learning new things and creating a different mindset that others can agree with*."

Along the same line, the initial ontological beliefs of the participants about the term Game Changers were almost grandiose, were mostly in the domain of sports, and used language that suggested relatively little self-relevance. For example, in response to the question "what do you imagine it means to be a game changer?," one adolescent girl said, "*I feel like the word would have to be someone who is able to adapt to certain situations and be able to make an impact within whatever sport it is that they have and be able to make things more proactive or positive within their own sport or team.*" Participants viewed game changers as inspirational role models, as people who notice and solve problems, who are passionate, determined, and change sports, and life beyond sport. For example, another adolescent girl stated: "*To be a game changer, it means that you change the current manner of doing or even thinking about something and not just in sports but everything*." Access participants viewed game changers in similar ways. One described her ontological beliefs about Game Changers as "*People who have a passion, their shine, but when they want to improve sports, it's more for everyone*." Another was even more explicit: "*…game changing to me is something reasonably monumental, it is a significant new direction in something or something that is so significant that it, it has permanent permanency. That it will have an effect for a very, very, very long time, perhaps forever. But certainly, Game Changing to me is something quite extraordinary*." Such ontological beliefs appeared to be a hindrance to the participants' reformulation of their self-perceptions as Game Changers, inventors, and inventive, and of the aligned goals and action possibilities when asked whether they did something similar to the inventors in the exhibition, constraining their reformulation of inventive experiences in different life roles.

Implications for design: these findings suggest that, in addition to presenting recognized inventors who invented technologies that

transformed sports, the exhibition also should incorporate inventions, inventors, inventive processes, and prompts that present inventiveness as an everyday and popular activity to promote visitors' formation of ontological beliefs, self-perceptions, goals, and action possibilities about inventiveness as accessible, self-relevant, and readily done.[6]

Theme 3: imagining and exploring inventiveness in sports-related and other existing life role identities (current and future) were triggered by the perceived self-relevance of the content of the exhibition to those role identities

Participants gravitated toward exhibition content that they perceived as self-relevant to their sports-related and life-related role identities. For example, one adolescent girl noted her interest in an innovative swimsuit exhibit by expressing the self-relevance to her swimming-athletic role identity: "*I wanted to look at the swimsuit because I swim competitively and I think it would be cool to look at how something in a sport that I'm interested in changed so much.*" Another adolescent girl constructed self-relevance of an exhibit describing a prosthesis to her future-imagined role identity in the medical field: "*I have a strong desire to become something within the medical field and hearing about the invention with prosthetics, it really intrigued me because I'm really into STEM and that, you know, consists of physics, like anatomy etcetera.*" An Access participant described constructing self-relevance of these two different exhibits in the zone to two self-perceptions and self-definitions in her visitor role identity of having a disability and being committed to social justice: "*I think the para-athlete, because you never see disabilities exhibited in a museum. It's so inspiring for me to see that. Now, that's on one part. The second part, I'm more interested in the swimsuit… Because I think it's very controversial… because… not all athletes could afford that. So that became an unfair advantage to those who, who had the means… and that makes me think, also of the social issues…. I think I like that best because of the social justice issue, but I gotta say, I'm going to go back to my first choice, which was the, the para-athlete with the foot. I think both really. I'm torn.*" Participants across groups also commented on being drawn to the exhibit presenting wearable fitness inventions that they perceived to be self-relevant as well as relevant to "everyday people." As one adolescent girl noted: "*I would want to look at other wearable technology because it's cool that people have invented things to help everyday people who maybe are sick and have to go to a doctor often and manage their health the way you could in a doctor's office.*"

Implications for design: the findings suggest that the exhibition is doing well in incorporating diverse primary content that provides opportunities for constructing self-relevance by visitors with diverse backgrounds, interests, ages, and abilities, with an emphasis, perhaps, on the visibility of popular-interest activities. The findings also suggest that the exhibition should include prompts that scaffold visitors' self-relevance of exhibition content to which they might not do so readily—for example, by asking visitors to consider how a certain inventor story, a particular invention, or a certain process of innovating *could be* related to their life (cf. Hulleman and Harackiewicz, 2009).

Theme 4: promoting identity exploration around inventiveness in life required different types of scaffolds for different participants

Participants differed in their readiness to explore inventiveness in their sports and other life role identities. Two participants among all who participated responded elaborately to prompts that asked them to consider the role of inventiveness in their life, and whether they have engaged in something similar to what the inventors in the exhibition have done. These participants, who seemed "exploration-ready," elaborated on inventive role identities they had already enacted. For example, one adolescent girl described aligned inventive ontological beliefs, goals, and actions related to immigrants' language challenges that she enacted in her role identity as a Girl Scout completing her Gold Award activity. Notably, she seemed apologetic that it was unrelated to sports:

> Me personally, I don't think it relates to sports, but I would have to say my Gold Award did help adhere to the goals I wanted to do and, for me, I feel like I was able to invent something to be more efficient for others. I based my Gold Award on education for minorities and how immigrants have a really hard time, you know, learning English and coming to a new country and adapting to the new lifestyle they have here. So, I created a free online tutoring center and partnered with a book company to provide them with free books in Spanish and English so that they could be tutored and have their transition to America become less stressful, especially during these times. So, I think that's innovative in my head.

The other participants required different degrees of scaffolding to engage in exploring their inventiveness in life. For example, the Access participant in the single interview initially responded to the question of whether they did something even a little like the inventors in the exhibition by saying: "*No, nothing that I can recall.*" Yet, later, after hearing more examples of inventors at the exhibition and being prompted further, the participant described an administrative professional role identity in which they engage with others in inventive problem-solving: "*we have tried to improve our services with the academic side of the [institution]. We have a lot of deaf-blind visitors, so we have been collaborating with the academic departments trying to be inventive and creative to meet their needs.*" Still, the participant continued to express self-perceptions as not inventive even later in the interview.

The experience seemed somewhat different in the group sessions, where scaffolding occurred both by the facilitator and by peers. It was when prompted, that one Access participant noted that, having a disability requires them to be inventive: "*Yeah, all the time. As a wheelchair user, you are always having to [be inventive], you know, in a world that is not always wheelchair friendly. You're*

6 These were the findings that promoted the change in the exhibition's title from "Game Changers" to "Change YOUR Game" to emphasize the shift in the exhibition's focus and goal from learning about the sports inventors to the visitors' identity exploration and change.

always having to, to adapt and find solutions. So it's, yeah, it's very much a part of my life." It was then that the other participant in the focus group elaborated on an inventive action within her role identity as a wheelchair user, beginning by indicating the role of the peer in scaffolding their recollection and identity exploration of this incident as being inventive, and as just one instance of many in her life:

> "Yeah, I would agree. When you answered the questions, one of the first things that came to mind for me was, recently, I mentioned being a chair user, and this challenge with my feet when I'm pushing, that they don't stay in the right position, but I couldn't find the right, I guess the right strap for my feet that would work comfortably. So I ended up looking at different items that were not exactly a strap, were not created to be straps for feet. And I found like this [thing], looking like a belt, that is not a traditional belt, it's just like a different looking belt I, I found, and I like quartered it to see if that would work for what I needed, and it turned out great. And I used it as like my, my foot strap; but it's not really a foot strap. It's like an untraditional belt. But yeah, those things, just, yeah, there's a lot of inventions. And sometimes they just don't work."

Similarly, the combination of the facilitator prompts and peer responses served as scaffolds for inventive identity exploration among some of the adolescent girl participants. These were commonly initial explorations of certain role identity components in a particular life role. However, the instances demonstrated the potential of contextual scaffolding to promote such identity exploration. For example, toward the end of one group session, after hearing a peer describing an inventive project and prompted by the facilitator to consider where in their life they could be inventive, one participant described ontological beliefs regarding a problem she identified in her role identity as a gymnast, and an aligned general inventive goal, again, apologizing for the smallness of her idea: "*I'm sorry this is so specific. I do rhythmic gymnastics and I know personally and a lot of my friends as well when we compete, we get a lot of rug burns and so I think it [would] be nice to invent something that could prevent that while also keeping the same look of our leotards that we have…*" A peer followed immediately with an inventive example, while also apologizing for the specificity of her idea in her role identity as a Girl Scout: "*Mine is also very specific. I said I could invent things to help with crochet because there aren't really a lot of ergonomic tools so that people who have arthritis and other joint problems may have to give up*." These initial exploratory examples, which were followed by a third participant's statement about inventing different study habits to help students in school, demonstrated how some participants were able, with scaffolding, to go beyond the sports content that was presented in the exhibition to explore being inventive in other life roles.

Still, some of the younger participants seemed to have less developmental readiness for identity exploration and may have required more extensive scaffolding than what the data collection context provided. These participants' expressions about being inventive when prompted at the end of the session were general, vague, and distal. For example, one participant said: *I would love to be able to help and advocate for the creation of mental health programs throughout the nation…*" And another referred to a goal within her Girl Scout role by saying: "*My idea for my Gold Award is basically about helping my generation and they are more about having good food but in a healthier and fresh way… so I would like to teach people that they can grow their own food….*"

Implications for design: each visitor's extent and nature of inventive role identity exploration in the exhibition would vary depending on the contextual integration of their developmental readiness, background, and prior inventive experiences, and the contextual mediating tools and scaffolds by the exhibition and by other visitors and how these unfold throughout that visitor's visit. In addition to including diverse examples of accessible inventiveness to diverse audiences, the exhibition should incorporate scaffolds that involve exposure of visitors to other visitors' identity exploration about their inventiveness, scaffolds for situated intra-personal and inter-personal interaction around being inventive, and scaffolds that support the belief that meaningful inventive actions can be small scale and personalized.

Discussion

Using the DSMRI in this investigation provided theoretical and practical insights concerning the ways visitors' role identities afford and constrain their engagement. This seems of particular importance when informing the design of an exhibition that aims for visitor identity exploration, which is a different type of engagement from those normative among museum visitors.

Theoretically, the findings highlighted the nature, function, and pervasiveness of habitual visitor role identities that people construe by default in a museum. Whereas people differ in their museum visitor role identities (Falk, 2009), the participants in this study adopted what seems to be a normative passive role identity that reflects beliefs about the museum cultural activity system, self-perceptions, purpose and goals, and action possibilities that were incommensurate with the goals of the exhibition for visitors to engage actively in identity exploration of their own inventiveness. During development, people are socialized into cultural activity systems, with their respective purposes, roles, and behavior scripts that become routinized and automatized, and the formation of role identities and identity commitments within these activity systems (Wenger, 1998). Throughout the day, most people move between such familiar cultural activity systems and occupy habitual role identities that frame their expectations, perceptions, emotions, and actions, with little motivation to reflecting on and exploring them. Once a role identity has become habitual (e.g., student, teacher, museum visitor), its activation in relevant activity systems occurs subconsciously and automatically (occupying an "attractor" state, in complex dynamic systems terminology; Kaplan and Garner, 2017). Whereas environmental design may incorporate mediating means that aim to elicit the emergence of particular visitor role identities, habitual role identities are less likely to be perturbed by such cues. Thus, environmental design and interventions that aim to promote role identity exploration and change may need to involve strategies that target those habitual role identities by triggering specific identity tensions—experiences of a self-relevant difference—that would perturb visitors' identity systems and encourage their revaluation.

Similarly, the findings highlighted the role of strong associative cultural content, such as sports, inventions, and the phrase "Game Changers," in the emergence of visitors' role identities. Such associated content triggered identity commitments (e.g., self-perceptions as not a sports person, narrow ontological beliefs about a sport) that might

be challenging for visitors to reconsider, and that could hinder their identity exploration. However, the findings also pointed to the great variability of participants' visitor and other life role identities, and to the interplay among multiple contextual and personal factors in visitors' construction of self-relevance and in their readiness to engage in identity exploration of their diverse role identities.

Practically, these findings challenge designers to incorporate contextual features that aim to perturb people's habitual museum visitor role identities, signaling the need to reevaluate and reformulate them into visitor role identities with ontological and epistemological beliefs, purpose and goals, self-perceptions and self-definitions, and perceived action possibilities that are oriented toward active engagement in exploring one's own identity through the content of the exhibition. The PRESS principles—designing to encourage visitors to construct self-relevance of the exhibition content, trigger experiences of relevant difference from habitual role identities, signal safety for identity exploration, and scaffold different identity exploration strategies—provide a framework for designers to strategize about the features that would scaffold such engagement among visitors of different backgrounds, developmental characteristics, and interests.

Methodologically, the DSMRI emphasizes the separation between the role identities that the participants occupied during the data collection in the current research and the role identities of visitors in the Change YOUR Game exhibition, those that the exhibition aims to impact. This raises questions regarding the relevance of the research findings to inform the design of the exhibit. Yet, the DSMRI also provides a conceptual framework for designing a methodology that integrates such role identities as much as possible. In the current research, this integration was between the Research Participant Role Identity and the Imagined Virtual Visitor to the Exhibition Role Identity. Whereas the latter role identity is different from the Visitor in the Exhibition Role Identity on many dimensions, it was the closest under the circumstances, and the principles derived from participants' experiences and expressions as they enacted it provided important insights to inform the design of the exhibition as well as into an emerging theory of inventive identity and its exploration among people with diverse characteristics.

Data availability statement

Researchers interested in the raw data supporting the conclusions of this article should write to the authors.

Ethics statement

This study was approved by the Smithsonian Institution Institutional Review Board. It was conducted in accordance with the local legislation and institutional requirements. Informed consent for participation in this study was provided by the participants or their legal guardians.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This research was supported by a grant from the National Science Foundation, award #2005404, to the Smithsonian Institution. The opinions expressed in this manuscript are the authors' and do not represent those of the National Science Foundation.

Acknowledgments

This study is part of a collaborative project that involves the researchers, the Lemelson Center at the Smithsonian Institution, a museum evaluation company,[7] and a museum exhibition design firm.[8] The authors acknowledge the contribution of Sharon Klotz to the project and this study. Part of the content of this manuscript was presented at the 2022 Annual Convention of the American Educational Research Association (AERA). The authors have retained the copyrights for this material.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

7 https://rka-learnwithus.com/

8 https://roto.com/

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