Children's agency by design: Design parameters for personalization in story-making apps

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HIGHLIGHTS

- Children's agency with story-making apps is essential for their learning.
- There is no guiding framework for agentic personalization in children's apps.
- Framework of design principles and guiding questions is outlined.
- The framework consists of two axes: agency/structure & individualism/collectivism.
- The impact of design that corresponds to the framework is outlined.

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ABSTRACT

The importance of children's agency in the use of technologies is well-established but it continues to be challenged with applications that automatically personalize children's content. This paper integrates educational theory of personalization with the design principles and empirical work of a story-making app called Our Story, which places a child's agency at the center of its design. The impact of a series of studies with the OS app is summarized and implications for future design are offered. The Agentic Personalization Framework that consists of a design principle and a set of guiding questions is presented. The design principle is based on two continuous axes: agency/structure and individualism/collectivism, which give rise to four processes: personalization/customization and standardization/individualization. The guiding questions are intended to promote reflection among researchers and designers interested in supporting children's agency with stories that children can make or interact with on tablets. The Agentic Personalization Framework is rooted in empirical studies, iterative design and theoretical developments and provides a fertile ground for research-design collaborations that place children's agency at the heart of innovative work.

1. Introduction

Personalization is an umbrella term that refers to processes and products that have been tailored to an individual person, either by another human being or technology. Although not without its critics and limitations [1,2], technology-mediated personalization is increasingly perceived as a necessary reform in public education worldwide, with large investments from corporate organizations and significant political backing in Anglo-American countries [3]. Consequently, personalization in children's educational products is of increasing interest for human–computer interaction design and learning sciences.

Agency is central to socio-constructivist theories, which position learners as active and productive agents, as well as in child-centered design and participatory design approaches [e.g., 4] that have historically emphasized that children are active meaning-makers [5]. A noticeable shift in focus is apparent in recent design projects that seek to harness the multimedia properties of technologies to position children as content authors and creators [e.g., 6,7]. These efforts are commensurate with the data-based multimedia affordances of latest technologies that can individualize information according to children's learning profiles [8], lower the accessibility threshold and thus increase agentic participation for children even with complex educational needs [9].

A relatively strong body of literature exists on personalization applications for adult education, for example personalized instruction in higher education [e.g.,10] personalized content [e.g.,11] personalized assistance [12] or the principles of inter- and intrapersonal communication in designing personal web spaces [13]. However, there is less literature on personalization design for children. There are design models that address deployment principles of screen-based technologies with children, such as the Multimedia Design Model with 9–14-year olds described

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by Said [14]. However, there are very few studies concerned with personalization and the youngest age group: children of pre-school/early primary school age (typically children aged between two to twelve years). For this age group, personalization design needs to be re-conceptualized at a fundamental level, given that adult-oriented data-based design and personalized algorithms are based on assumptions about the user that are not applicable to the young child, such as for example informed consent or established preferences [15].

Personalization in early childhood is often subsumed under child-centered education that is concerned with children's autonomy in choosing or creating their own learning spaces and resources. Personalization is also used to refer to differentiated and individualized instruction and resources tailored to the needs of specific children. Current examples of agentic design, that is design that would empower children in technology use and position them as independent agents of action, include the focus on fostering children's decision-making [e.g., 16] and choices [e.g., 17]. Customization, individualization and personalization are often used interchangeably in describing these processes (Kucirkova, 2017) and this paper provides a theoretical grounding for differentiating the three terms.

This paper aims to enrich extant work with an interdisciplinary focus on children's agency with multimedia apps for creating and sharing stories (story-making apps hereafter). A theoretical rationale and design parameters related to the personalization design of children's story-making apps are presented to extend previous work with an integrative design principle that is underpinned by the socio-cultural theory [18,19] and grounded in empirical knowledge about the effects of personalization on children's learning. The psychological properties of five indices of personalization are synthesized to derive a set of corresponding features and guiding questions for the Agentic Personalization Framework. The argument is made that personalization, customization, individualization and standardization are different on theoretical and practical levels and this difference is demonstrated by positioning the personalization design principle in relation to two continuous axes of agency/structure and individualism/collectivism. With theoretical and practical insights from developmental psychology, education, learning sciences and human–computer interaction design, the work connected to the OS app is a unique multi-disciplinary work that addresses the rigor required for agency-centered design of children's story-making apps.

The Agentic Personalization Framework takes account of usability and effectiveness findings from a series of empirical studies with the OS app for iPads and tablets. The Our Story app was co-developed by a team of educational researchers, psychologists and commercial app developers at the Open University, led by the author. The impact of the OS app has been studied in relation to a number of diverse outcomes and with children with diverse profiles, described by their carers as typically developing or with special needs. In this paper, the app is used as an example to concretize theoretical concepts and indicate the impact of the design principles embedded in the Agentic Personalization Framework.

2. Children's story-making apps

Story-making apps are software programs developed for touch-screen devices, such as tablets and smartphones, with the aim of supporting children to create their own stories. These applications (or apps for short) allow children to combine text, photographs, drawings, audio and video to tell stories and share them with others. Although digital story-making/story-sharing was possible also with desktop PCs, the advent of portable touch-screen technologies opened opportunities for innovative and straightforward approaches to storytelling and chronological retellings. These opportunities are materialized through seamless and immediate integration of videos and photographs with the touchscreens' camera and with easy and engaging drag-and-drop functions that can be manipulated by touch. Wifi-enabled devices facilitate the sharing of stories across distance and time and the portability and light weight of touchscreen devices contribute to their appeal for stories created during school trips, family outings or long journeys.

2.1. Examples of story-making apps

Several story-making apps exist on the Apple and Google's App stores, with varied quality and focus. Commercially-developed apps tend to use pre-established story templates that children can complete or embellish (e.g., Toontastic by Google Ltd., TikaTok by Pearson or My Story by BrightBot), while story-making apps developed by child-focused organizations tend to be more open-ended (for example StoryMaker by the British Council; StoryKit by the International Children's Digital Library Foundation, Scribjab developed by Drs Toohey and Dagenais from Simon Fraser University in Canada). A more exhaustive list of popular children's story-making apps can be found in [20].

2.2. The OS app

The first version of the OS app was released on the App store in 2011 as one of the first iOS apps designed for children's multimedia story-making and story-sharing. Several updated versions followed, with the latest one released in June 2019. The app has always had two main functionalities: to create and to share a multimedia story. The user interface is simple and icon-based, with large circular buttons of three bright colors (blue, green and yellow). In the create mode, users can insert audio-, text- or image-based content. Users can combine still images, text and audio-recordings in any way they like, but to create a story, they need to associate the text or audio files with a particular image and drag this image onto a filmstrip. In the use mode, users can give their stories a title and finished stories can be shared with other users, either digitally (sent via email or Dropbox) or they can be printed out in three formats (A4, A5 and A6 formats). If users decide to view their stories on an iPad, the story is presented as a set of multimedia slides.

Over the past eight years, the app has been used as a tool to support children's creation and sharing of stories, motivate children to read and engage with the school curriculum, but also to collect and conduct research. Most recently, the app's use was expanded to adult users, with a European project focused on young people who have difficulties associated with perception, memory, cognition and communication, and with elderly people in dementia care settings.

3. The 5As of personalization

Personalization in education can be conceptualized in terms of the so-called 5As: Authorship, Autonomy, Authenticity, Aesthetics and Attachment ([20], which can be used as a set of pedagogical strategies that support the language arts curriculum in primary schools[21]. The 5As of personalization do not distinguish whether a product is personalized by the user or the designer/provider. When it comes to the design of personalized products and particularly children's story-making apps, however, the agency of the user is a crucial consideration. In this article, the 5As are expanded with a focus on agentic personalization, and with design features that correspond to story-making apps.

Agency becomes manifest with resources and activities that support children's choices, volition and independence in constructing their own learning. From this perspective, agency is at the core of Bandura's social cognitive theory [22] that has informed decades of research on the cognitive and affective processes involved in self-efficacy, dealing with challenges, choices and decision-making. The relationship between agency and its counterpart – social structures – has been discussed by Giddens in social theory [23]. From a human-computer interaction perspective and in relation to adult users of technologies, agency has been theorized in terms of agency increase with challenging tasks [22] and users' emotional response to specific types of user interface [24].

Researchers and designers interested in *children's* agency have observed children's interactions with various screen-based technologies, including apps on tablets and iPads [e.g., 25]), tabletop storytelling systems [26] or Scratch and similar online community systems [27] to facilitate children's active, constructive and productive use of multimedia technologies. Previous evaluative work has documented the outcomes of child-centered multimedia design [e.g., 28] and the interactive dimension of multimedia and children's story*telling* [29, emphasis by the Author]. In relation to stories and children's agency, researchers have positioned children as story-makers [30], story-designers [31], story-creators [32], or story-authors [33]. This paper extends this work with a specific focus on the relationship between agentic personalization and the design of children's story-making apps.

In agentic personalization with children's story-apps, the agents are the children, who create their own stories. Such personalization is volitional and intentional; it is initiated and driven by the child. This is different from personalization that is externally imposed by others who accommodate a child's individuality or by automatic personalization based on children's data processed by algorithms. An example of agentic personalization is a child who visits a library and chooses a book based on the child's own likes and interests. An example of a non-agentic, automatic, personalization is a child browsing an online library and receiving a recommendation for a book that matches the child's likes and interests. In order to concretize the difference between agentic and non-agentic personalization in relation to children making their own multimedia stories, the next section connects the theoretical concepts of the 5As to design decisions that support children's agency in story-making. The OS app is used as an example to illustrate the design possibilities with tablet apps.

3.1. Authorship and the OS app

Authorship denotes action-related, self-regulatory processes that are part of goal-oriented behavior and the competing motivations experienced by individuals who seek volitional control [34]. From a developmental perspective, volitional behavior is an essential ingredient in children's willingness to devote effort to a learning task [35] and show motivation to contribute their own content [36].

In terms of human–computer interaction design, volitional authorship refers to the components of the user interface that allow children to express their own ideas. In the context of children's authorship with story-making apps, designers therefore need to consider the combined influence of volition with the authoring possibilities of multimedia technologies. Early learning models emphasized the influence of technology characteristics conducive to learning, e.g., the multimedia effect [see 37], while later models highlighted the importance of children's motivation in learning and information processing with multimedia [38]. A more recent and comprehensive model of learning with, or through, multimedia technologies, suggests an integration of volition with multimedia effects [39].

Design that supports volitional authorship offers children multiple and multimedia ways of representing meaning. Story apps that incorporate this principle provide children with diverse pathways through which children can express their feelings, experiences and knowledge *and* a possibility to manage their choices. In addition to composing their texts in writing (and the possibility to type or upload finished texts), children are given opportunities to audio-record and upload audio files, add pictures and drawings or short video recordings. As such, design for volitional authorship offers options to flexibly modify who or what appears on which page and in which mode of expression.

With the OS app, children's authorship is supported by integrating the multimedia available in tablets/smartphones with an open-ended design. Children can create their stories in three principal modes: audio, text and visual and any combination of the three. There is no hierarchy imposed on the modes, that is children can create an audio story or text-driven story, depending on their capabilities, resources and preferences.

3.2. Autonomy and the OS app

Autonomy captures the process of positioning children in control of the design process and supporting their independent and intrinsically motivated actions. Similarly to authorship, autonomy is from a psychological perspective related to the perception of being in control, but in comparison with volition, autonomy places greater emphasis on independence. This phenomenon was described by Heckhausen and Schulz [40] as *primary control* directed to the external environment rather than *secondary control,* which is internal cognitive control directed to self. Although perceived control influences children's motivation to participate in a task, autonomy accounts for additional unique variance in eight to ten-year-olds [41].

Extrapolating the autonomy concept to the design of children's story-making apps, designers need to consider how usable the final product is for children's independent navigation. As a practical design goal, autonomy is enabled and children's contribution are considered agentic, when children can select, edit, adjust and appropriate the design process and the product it leads to. For young story-makers this implies that designers need to use icons and colors in addition to, or instead of, textual navigation. In addition, for children to experience feelings of autonomy, design needs to be real-time responsive, that is respond to children's actions as soon as they are activated, without any time delay. This imperative relates to the intentionality binding effect, which was formulated by Haggard, Clark and Kalogeras [42] and captures the human tendency to experience a higher sense of agency when there is a causal effect between actions and effects.

In its original conceptualization, the OS app was developed for children of pre-school age and was purposefully named "Our Story", to signal the importance of others in story-making/story-sharing. While some functionalities, such as adding pictures or audio recordings, can be easily mastered by children as young as two, other functionalities, such as adding text or sending the finished story off, require an adult's or older peer's support. These were deliberate design decisions commensurate with our sociocultural orientation [18] to children's learning which encourages the use of tools with peers or adults.

3.3. Authenticity and the OS app

Authenticity evokes notions of idiosyncrasy, uniqueness and heterogeneity. These notions are a central subject in philosophical debates [43] and have a long history in psychoanalysis and social

theories [e.g. 44] but are less known in child-computer design. Socio-culturally oriented psychological theories discuss the sense of individuality and authenticity in relation to others; it is in interaction with other people that children develop a sense of self [45]. Depending on the context and children's age, children might respond to others by mirroring what they experience (e.g., infants mimicking mother's laughter) or responding in their own, idiosyncratic, way. These notions are intimately linked to individualism, that is the ontological sense of self and separation from others. Psychology stage-theories describe how children develop identity through gradual de-association from their primary caregivers [46], while psychoanalytic theories consider how children's sense of self develops through extension with other people and physical objects [47]. The latter includes extension of self with story apps and the stories they hold.

Design that takes these notions into account considers the role of templates and exemplars in content production: story apps that aim to teach children's story-making through modeling will, by default, lead to less authentic products than apps that are open to children's creative and imaginative contributions [see 48]. Following this logic, pre-designed digital stories where children select from scenes, templates or different story plots are less personalized than those that leave the story-generation open-ended.

This principle corresponds to the design of the OS app in that there are no restrictions on the length or type of children's multimedia contributions: audio-recordings can be sounds taken from the Internet, recorded previously or recorded in the moment of story-making using the iPad's embedded microphone. Text can be typed up by using the keyboard and can be of any length, from one letter to long essays. The pictures can be photographs taken with the tablet camera or taken from the user's album of saved pictures, which, for young children, often include pictures of drawings (either photographs of paper-based drawings or digitally produced drawings).

3.4. Aesthetics and the OS app

Aesthetic judgments and visual perceptions are partly innate and partly learnt [49]. Psychologists have studied the development of children's aesthetic appreciation of music [e.g. 50] but little is known about children's aesthetic preferences in child-computer interaction. Oulasvirta and Blom [51] studied aesthetic preferences of adults who were encouraged to personalize the covers of their mobile phones. They found that the external appearance of the phones was important for the participants' relationship with others and 'benefits such as identity, social status and acceptance, and inclusion by others' (p.10, ibid). Extrapolating this to children's story-making apps, the act of changing the aesthetic appearance of children's multimedia stories is likely to be related to children's desire to please others' as well as their own aesthetic preferences.

It follows that designers need to provide spaces where children's aesthetic choices can be played out. This is typically the goal of participatory design that actively seeks out children's contributions [52]. Druin and colleagues have noted children's increased motivation to take part in activities that children can co-design [53]. In a participatory design approach to the design of children's story apps, children need to be able to adjust the look and feel of the user interface and of the final product/story (e.g., add or remove individual story "pages", individual story elements, templates for story backdrops and pre-recorded music files).

The OS app's use of a filmstrip for organizing children's multimedia content mirrors the use of filmstrips in structuring narratives in novels and creative writing [54] as well as arranging personal photographs in therapy settings [55]. In the context of the OS app, the filmstrip is used to prompt users to organize individual book "pages" (multimedia files) in a sequence. Unlike a slide show or photomontages, the filmstrip in the OS app does not follow a pre-arranged sequence or pre-set intervals for advancing individual slides but merely scaffolds the story-creation with a sequencing structure for the story pages (or slides).

3.5. Attachment and the OS app

The psychology understanding of attachment is, as Bretherton [56] outlines, based on the relationship between children and their caregivers in the tradition of Bowlby [57] and Ainsworth [58] or between children and the wider family system [59]. In human–computer interaction design, attachment relates to the sense of ownership children experience with specific programs (such as story apps) and resources and products more broadly. Ownership is from a developmental perspective regarded as children's transition from an innate sense of body to a more shared and public understanding of their physical appearance [60], as children gradually build links between visual and tactile stimuli/responses.

Translating the ownership concept into design parameters implies that children's story-making with apps should take into account a child's physical engagement with the device, with particular attention paid to tactile navigation. This is an important consideration for all multimedia design, and some headway is being made by scholars dedicated to the study of touch and meaning-making with multimedia technologies [61]. For story-making apps in particular, ownership and sense of attachment become foregrounded with options around the access and sharing of children's stories. Designers need to consider whether children's ownership of self-made stories is confined to a device or whether it is stored in the cloud and can be shared with others (intentionally or unintentionally). Designers also need to consider app access in light of individual versus shared use of technologies and the fact that touchscreens are developed for individual use and are therefore perceived as more personal items than interactive whiteboards, for example [see 62]. With the OS app, stories can be shared either electronically or they can be printed out. The option of story-sharing both with printed and digital booklets corresponds to the idea of children's sensory and tactile engagement with stories.

4. Impact of the OS app

Despite a high number of apps designed for young children, very few have been theorized, studied by multiple research teams and over a longer time-span. As argued by researchers before [63], connecting design with theory is essential for a more precise and transparent evaluation of the impact attributable to design, or in our case, the impact of a story-making app in relation to a a range of outcomes documented by various research teams. Connecting theory with design is also key for encouraging reflection on different design solutions [64]. The next section summarizes research studies that used the OS app with various groups of children and their caregivers.

4.1. Methodology for establishing the OS app impact

Program evaluations, especially those that involve iterative design analysis, are often analyzed with an impact pathways analysis. A participatory impact analysis follows a constructivist rather than positivist view of evidence and is co-created with the stakeholders who are involved in the program [e.g., 65]. In educational research, impact narratives are used when there is a range of possible outcomes and contexts of use, where there

is a need to establish a knowledge base in a new domain and where past research employed both qualitative and quantitative methods [66]. This was the case for the OS app, which was part of several empirical studies carried out by diverse teams with distinct research purposes. It should be noted that the studies do not provide evidence for whether the app works but *how* it might work in different contexts. This approach towards evidence stems from the epistemological orientation towards educational research that is done 'with', not 'on' participants and is gauged in the perspective of multiple realities [67]. Such research follows a collaborative practitioner–researcher investigation and makes a conscious effort towards a mutually enriching understanding for all stakeholders involved in the research-design process. If a positive effect or change is noted, it ought to be conceptualized as not *causing* the changes but as 'something that can be used, by the school as well as the researcher, to support changes' [68, p.12]. Given the methodology of the reviewed research studies, the effects could be a result of the app's design as much as its particular use in the different contexts, or more likely, the combination of the two, as acknowledged in educational research impact studies [see 69]. The research foci were chosen by the individual research teams, they are thus an illustration of possible approaches and choice of outcomes, not an exhaustive list.

4.2. The OS' impact on children growing up in the UK

Kerawalla [70] explored the use of the app for supporting children's identity as co-researchers and children's capacity to conduct their own social research. Supported by Kerawalla and a school librarian, twelve 12-year-olds composed their own "multimodal experiential research narratives". The children acted as young scientists and conducted their own research about libraries. Their stories were a mixture of personal narratives with some research-related elements, such as description of the research site or "raw data" (audio recordings of interviews); and photos of the young researchers themselves. Based on these findings, Kerawalla [70] suggested that the app could be enhanced with the possibility of adding short video files and templates for conducting research (i.e. storyboards that contain the sub-headings "introduction", "methods", "findings" and "discussion" as in a traditional research project). These changes were implemented in the second iteration of the iPad version of OS, adding to the multiple ways of representing content with the app.

McPake & Stephen [71] studied OS's use in two Gaelic-medium nurseries. The researchers focused on the potential of the app to enrich the early years provision with bilingual stories and pictorial dictionaries and found that it can support children's development of early literacy skills and the Gaelic language.

Our team explored the use of multimedia options and the multiple ways of meaning expression they facilitate in two case studies [2]. We analyzed the parent–child conversation with a digital book that the mothers and their daughters jointly created using the OS app. We used thematic and multimodal discourse data analysis and concluded that the app acted as an enabling factor in facilitating a happy and intimate parent–child exchange and contributed to a collaborative use of touchscreens at home.

4.3. The OS' impact on children in Taiwan and Spain

In an extended program of research, Sung & Siraj-Blatchford [72] and Sung, Siraj-Blatchford & Chen [73] used the OS app in three public libraries in Taiwan in workshops with 2-6-year-old children and their parents. The goal of the workshops was to encourage positive parent–child dialog around technology. The objective of using the OS app was to introduce the parents to a piece of technology that supports adult–child interaction but is designed with young children in mind. The process was documented using triangulation of evidence from questionnaires, participant observation, recording, and analysis of participants' comments. The authors found that the app encouraged children to learn about self and others and supported a co-constructive use of technology by parents and children, which continued beyond the library workshops. In addition, Sung [74] used the app in a public library in Taiwan as part of a 'winter storytelling' session that included a storytelling and story re-telling (story creation) part. The storying process consisted of a librarian delivering a story to the children and children taking pictures during the session, followed by children re-creating the story with the OS app, using the pictures they have taken and their own audio-recordings or texts. The app's easy-to-follow navigation was positively perceived by the participating librarians, who, overall, reported positive attitudes towards technology use after the study.

In Kucirkova, Messer, Sheehy & Fernandez-Panadero (2014) [75], we examined the app's use in the school context with 41 Spanish 4–5-year-olds. We compared children's use of collaborative talk and attempts at joint problem-solving between the OS app and a suite of age-appropriate apps selected by the teachers. We found increased peer collaboration with the OS app as opposed to template-based apps, such as puzzle-making or construction apps. Even though the children worked independently with the Our Story, they talked to each other and negotiated which pictures or text to add to their stories, whereas with the puzzle-making apps children followed the design with minimal talk and peer interaction.

4.4. The OS' impact on diverse communities of users

The advantage of an open-ended design for authentic content was further documented in two community-oriented studies conducted by our research teams. In Kucirkova & Littleton, (2017) [76] we documented how the app facilitated the narration and sharing of community-based stories about WWII. The stories were created by Year6 children, based on interviews with elderly community members who shared with the children their memories of the war. The final stories were personal and unique to the veterans. The stories were celebrated as part of a school assembly and included in the local archive of the village, thus strengthening community relationships and the longevity of personal histories.

In addition to studying typically developing children, in Kucirkova, Messer, Critten, & Harwood (2014) [77] we conducted two case studies in special needs schools. The children who used the app had complex language and communication difficulties and we documented how the app faciliated children's communication of feelings in diverse modes (visual, text or audio). These positive findings were mirrored in Critten & Kucirkova (2015) [78] where two African adolescents with significant behavioral problems used the app to make a multimedia story about their perception of the school and shared it with the school staff. The possibility for children to express their own meanings directly through the app, rather than those mediated by the adults around them, was a significant motivator factor for children to use and like the app.

Other researchers noted similarly positive effects of the OS' open-ended design. Canning, Payler, & Horsley [79] used ethnographic methods to examine the way the app facilitated children's imagination and curiosity when used with childminders and practitioners in England. In another project, Kumrai, Chauhan and Shah [see 80] encouraged parents, carers and children to share personal multimedia stories among family members in a London-based community. The research team, led by Family Learning Haringey Adult Learning Services, concluded that the

use of the app had a positive impact on community relationships and parent–child communication.

This brief summary of selected studies maps the long-term impact of the OS app in relation to its potential to support agentic personalization. Collectively, the reviewed empirical studies illustrate the diverse ways in which the OS app can be used to support a range of learning-related outcomes. The cycle of knowledge-building was not linear as the different studies used the app for different foci and purposes. The next section takes a broader view of the underlying factors which may have contributed to the impact of the OS app and which may inform the design of future story-making apps. These factors are framed in terms of the theoretical aspects of agentic personalization and their relationship to design is defined in the form of the Agentic Personalization Framework.

5. The Agentic Personalization Framework (APF)

The Agentic Personalization Framework was derived iteratively, based on the theoretical conceptualization of agency, personalization and empirical research with the OS app. The framework consists of a design principle and a set of guiding questions. A design principle is not a technique but a 'statement… based on research about how people learn and work' [81, p. 53], The Agentic Personalization Design Principle consists of two continuums: agency/structure and individualism/collectivism. Agency/individualism and structure/collectivism allow for a clear delimitation and demonstration of the distinction between design relevant for individual children, i.e. personalized, versus design relevant for groups of children or larger collectives, i.e. standardized or generic design. Agency refers to an individual's volition and structures refers to established practices of groups, institutions, organizations and society as a whole. The continuous axes of agency/structure and individualism/collectivism give rise to four quadrants: personalization, customization, individualization and standardization. These four quadrants denote the four possible processes related to users' agency in product making: standardization, personalization, customization or individualization.

As Fig. 1 illustrates, higher agency and individualism lead to personalized design, while higher structure and collectivism to generic and standardized design. These axes explain that personalized design applies to individual children, while customized design applies to groups of children (e.g., boys and girls). Personalized products are unique to a child because their production started with the child. Individualized products, on the other hand, are unique to a child because their production arose from a generic product that was later tailored to a specific child.

For example, with the myStory Book, which is part of the Pearson's myWorld Social Studies curriculum, children can *customize* stories by adding their own stories into pre-designed books for individual subject areas. The templates are organized per groups of children (level/age) and contain a rich set of content that individual children can add to, but not fully personalize. With another commercially-produced story-making app, Collins Big Cat: Playing Story Creator by HarperCollins Publishers Ltd., children can *individualize* their own stories. The Collins app presents children with a digital story that children can read on their own, or that the app reads to them automatically, and at the end of the story, they can create their own story, based on the pictures, characters and selection of words from the Collins Big Cat story. Children are here positioned as story authors, but the authentic and aesthetic character of their contributions is constrained by the availability of templates and story elements from the publisher.

The more designers approach the personalization quadrant, the more they support children's agency, but also the greater the challenge to ensure children's structured collaboration and collective interaction. The OS app's emphasis on autonomy and authorship distinguishes its design from other story-making apps, as it positions children as creators and tellers, rather than re-makers or re-tellers of stories. This is an important distinction as it is relevant to children's agency and the underlying psychological constructs of independence, control and volition. It is also directly related to the app's audience: young children who are at the beginning of their reading journeys. While some story apps begin the authoring process with the reading process as read-create-share [e.g., 82], the OS app reverses the order to create-read-share. This means that the story-making starts from the child's creative expression. There is no story for children to read and emulate or complete. Instead, the child's imagination, experiences and ideas are taken as starting point of the composing process. This aspect is desirable in learning contexts where children need to be empowered with the aim of supporting their curiosity and creativity. Personalization is less desirable in contexts where children are expected to learn from previous stories and build on existing content.

A design principle can be made explicit with designer statement or implicit with designer choices and decisions. If we look at existing story-making apps and their features, we can see how the four quadrants set out in Fig. 1 help to explain the different importance attached by designers to children's agency. Future and existing design work concerned with children's agency can be guided by a set of open-ended questions that encourage reflection, discussion among designers and researchers and a more conscious design. Table 1 summarizes the theoretical constructs, their corresponding design features and guiding questions.

It should be noted that the theoretical constructs interact with each other: for example, autonomy and authorship are very closely related. Designers therefore need to determine the combination of the individual elements and the extent to which they are jointly present in a story-making app. The considerations presented in Table 1 can be translated into a scoring framework, with answers considered in terms of high, middle and low scores. An example of such a scoring framework applied to children's story apps is outlined in [83].

While not considered in the APF, the platform for story creation is another important design consideration, given that the choice of the learning hardware is known to influence children's learning experiences [84]. A critical reflection on the affordances of the hardware is important in light of pre-tablet, computer-based story authoring software programs (e.g., RealeBooks™), which are stationary and require mouse manipulation.

6. Conclusion

The level of personalization incorporated into the final product and the way it provides space for children's agency, are important theoretical and educational considerations in multimedia design. Although commercially produced story-making children's apps might have a more polished user interface, they have not been empirically evaluated to the same extent as the OS app. Nevertheless, it is worth noting that thanks to institutional and external funding support, the OS app has always been offered for free. Commercial designers are driven by a different business model and it would be interesting to investigate whether an app that supports personalized stories might be attractive to the child, but less economically viable than apps that support customized and individualized stories.

This paper synthesizes international research with the OS app with a view to fostering design that strategically employs agentic personalization and understands the nuanced relationships between personalization, customization and individualization. The
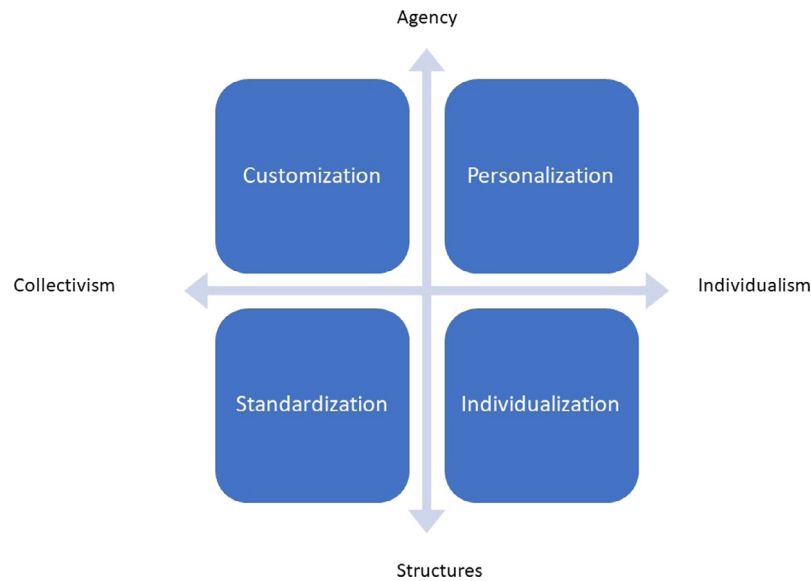
Fig. 1. Schematic representation of agency/structures, individualism/collectivism with four quadrants: customization, personalization, standardization and individualization.

Table 1
A set of constructs, features and guiding questions for facilitating reflection on the extent of agentic personalization in design of children's story apps.

Theoretical construct	Psychological properties	Design features	Guiding questions
Authorship	Volition	Multimedia options Multiple ways of meaning expression Multiple ways of story-representations	To what extent can children express meaning in more than one way? How much flexibility does the app offer for changing and adapting multimedia content?
Autonomy	Independence	Easy-to-follow navigation Iconic representation Inbuilt guidance	To what extent are individual features immediately responsive to children's actions? To what extent can children use the app on their own and personalize it for their own use?
Authenticity	Schemas Singularity	Templates Open-ended design	To what extent is children's story-making based on their own ideas? How much is children's story content driven by pre-established frameworks and templates?
Aesthetics	Interpersonal intentionality	Participatory design approach Flexible design	To what extent can children adjust the look of the story app and its individual elements? To what extent can children participate in creating the rules around design?
Attachment	Ownership Bonding	Ownership markers Story-sharing possibilities	Who owns the final story created with the app? How can children share their finished stories with others?

design parameters and guiding questions of the Agentic Personalization Framework are intended to enrich the discussions between designers and researchers collaborating on children's story apps.

Adults mediate and structure the learning contexts in which children advance their knowledge of the 'society's technology, its signs and tools; through education in all its forms' [85, p.1]. From a socio-cultural perspective, stories are essential meaning-making tools that help us make sense of everyday experiences, consider who we are and who we could become. Granting children agency in representing their personal stories in multimedia is essential for an optimal balance between their individual and collective selves. The personalization design principle supports this complex learning process with 21st century technologies.

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Declaration of competing interest

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