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Curiosity and Digital Stories: Exploring Preschoolers' Behaviors

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Abstract: Given curiosity's fundamental role in motivation and learning and considering the widespread use of digital stories as educational tools from the preschool age, we pursued measuring preschoolers' curiosity when interacting with digital stories. Using 129 toddlers and preschoolers as a sample, three groups (one for each class) were given different versions of the same digital story to listen to: interactive, non-interactive, and animated. Toddlers' verbal and nonverbal behaviors were utilized to quantify curiosity as a condition brought on by the app. The participants' verbal and nonverbal behaviors were recorded during the digital reading aloud. Every child's data was encoded at one-minute intervals to examine concurrent behavior, and the results were then compiled. The findings show that interactive presentation formats encourage more touching and language use but less noise production and that interaction and the creative use of hot spots in digital illustrations are key elements in piquing viewers' curiosity while contributing to the strengthening of the engagement to the activity and the cultivation of critical thinking, creativity, and imagination.

Keywords: *Child-computer interaction, curiosity measurement, digital stories, preschool age.*

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Introduction

In contemporary educational research, emotions are recognized as extremely important for learning, motivation, goals, use of strategies and academic performance (Muis et al., 2015; Pons et al., 2010). Furthermore, throughout the last two decades, there has been an effort to improve the school atmosphere by stressing how students feel and frequently mentioning happiness (Hartley, 2006). According to Griffin (2005, p. 140), it is the "pedagogy of pleasure" that connects enjoyment with students' motivation for learning, learning process, self-image development, and school well-being, whereas absence is one of the main reasons that students do not use their potential (T. Goetz et al., 2006) and result in multiple educational failures (Griffin, 2005).

Focusing on curiosity is a form of intrinsic motivation based on pleasure (Zillmann, 2000) that is the key to fostering active learning and spontaneous exploration and an important disposition for learners in the information age (Wojtowicz & Loewenstein, 2020). As a result, Freeman et al. (2014) believe that curiosity-driven learning and intrinsic motivation are essential components of effective education.

Specifically, curiosity has been connected with a lot of positive learning variables like educational achievement and academic learning (Eren & Coskun, 2016; Shah et al., 2018), the acquisition of knowledge (Rotgans & Schmidt, 2011) and the facilitation of cognitive development (Tamdogon, 2006), commitment (Arnone et al., 2011), goal orientation (Eren, 2009), perceived value (Rossing & Long, 1981) and reduction of boredom (Berlyne, 1960). Additionally, preschool teachers report that curiosity serves as a pedagogical tool in the classroom, fostering closer relationships with classmates during group activities, encouraging critical thinking, and establishing emotions of self-determination (Pekrun, 2019).

However, psychologists and educators have seen that children's curiosity declines as they progress through school (C. Engel, 2011), and according to J. J. Jirout et al. (2023), school satisfaction reduces even from preschool to kindergarten. Teachers are typically not effective at motivating students' interest to propose questions (Van Booven, 2015) or structuring learning activities to arouse inquiry (S. Engel, 2013). As a result, a considerable body of research in educational psychology has begun to investigate systematically how intrinsic motivation might be fostered or decreased in the classroom (Evans et al., 2023). Previous research has paid comparatively greater emphasis to

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exploring how an individual's personal trait of curiosity affects their behaviors or learning beliefs (Cheng et al., 2023; Lauriola et al., 2015; Litman & Mussel, 2013). However, researchers have urged for research that delves into what learning scenario can inspire curiosity from the state aspect, rather than the trait aspect (Grossnickle, 2016). As a result, it is a notable challenge for contemporary (preschool) education to consider what situational contexts generated by learning content may increase learners' curiosity (Nakamura et al., 2022).

Accordingly, considering what situational contexts constructed by learning content or environments may facilitate learners' curiosity is a noteworthy issue for contemporary education (Nakamura et al., 2022). This gap in the literature is called upon to be filled by the status scale that must be administrated in the context of an activity such as children's interaction with a digital story.

As educational technologies continue to thrive, particularly with the widespread use of various forms of digital stories as educational tools, as technology plays a major role in the lives of many children and as today's children have a broader range of current digital technology than previous generations (Marsh et al., 2016), it has become critical to investigate how fundamental understanding and measurement of curiosity can be leveraged to increase the efficiency of these educational tools while also improving skills important for student development. According to Oudeyer et al. (2016), a viable educational approach could be the technology-enhanced learning for stimulating curiosity. Additionally, curiosity has been associated with more effective learning in exploration-based educational experiences (van Schijndel et al., 2018). This is particularly true in the Internet age when information is easily accessible. In this digital environment of electronic stories and tablets, curiosity is an even more desired and vital attribute for children's learning (J. Jirout & Klahr, 2012).

Previous research has looked into ways to spark curiosity by employing new technologies, but there is no research on the arousal of children's curiosity when interacting with digital stories. For example, Gordon et al. (2015) and Ceha et al. (2019) have shown that adopting interactions with social robots exhibiting curious behaviors has a considerable favorable influence on children's own curiosity. Similarly, prior research indicates that deploying conversational agents in education to promote metacognitive techniques has significant benefits (Grigoriadou et al., 2005) and higher-level thinking (Aleven et al., 1999). Alaimi et al. (2020) and Abdelghani et al. (2022) studied the use of such agents to assist childs in practicing question-asking and question-guided learning and found that it had a good impact on exploratory behaviors and subsequent domain-knowledge acquisition progress.

Curiosity is thought to be enhanced when individuals are allowed to engage in activities that are personally meaningful (Black & Deci, 2000). According to Mantei and Kervin (2011), creative innovations in the use of digital technology, such as electronic stories, help children be authors, creators, and architects of their own co-constructed learning. Kervin (2016) believes that interactive digital stories have the ability to provide children with playful, compelling, and real experiences that are individually meaningful, develop and strengthen connections across settings, and promote children's engaged and interactive explorations. Additionally, digital stories having the characteristics of novelty (Dubey & Griffiths, 2020a; Gershman & Niv, 2015), surprise (Dubey & Griffiths, 2020b; Juechems & Summerfield, 2019) and uncertainty (van Lieshout et al., 2019; Verdugo et al., 2020) arouse the users' curiosity in upcoming events in a story, giving an additional reason to study curiosity in the context of digital stories.

This research presented the categories of preschool children's behavior as manifestations of curiosity (verbal and non-verbal) when interacting with a presentation format of a digital story (interactive, non-interactive, and animation). Furthermore, non-parametric tests were used to assess the differences between the different forms of digital stories in the median percentage of each behavior category as a function of the total number of behavioral categories in a session. Research focused on the role of interactivity in arousing curiosity and enhancing other skills, as well as interventions to optimize interactive design features for educational purposes.

Literature Review

Definition of Curiosity

Curiosity has been described as *"a basic instinct, an innate mechanism that allowed intelligent species to learn new things about their environment, promoting survival, the use of tools, and technological progress"* (Arnone et al., 2011, p. 181). There are various models defining what curiosity entails (Kashdan, 2004; Silvia, 2006). Curiosity focuses on motivation as well as the desire for completeness of experience (Dewey, 1913), while Berlyne (1970) suggested that innovative and extraordinary things set in motion a reward system that creates positive emotion. This reward system motivates the search for innovation and rewards the exploration of new things. Intense innovation and complexity trigger a system of opposite aversion. Common to all theories is the agreement that curiosity is a state of motivation oriented towards the approach related to exploration. Curious people study in depth (Day, 1968), and they insist on demanding projects (Rossing & Long, 1981).

Curiosity is considered to be associated with people (e.g., as a trait) and the situation. Berlyne (1954) focused on curiosity as a situation, considering that it interferes between exploratory responses and collective stimuli (like novelty, surprise, and sense of uncertainty). However, Boyle (1983) emphasizes curiosity as a trait by quoting the work

of Day (1968), who expanded on Berlyne's work. According to Day (1968, p. 10) "*it can be said that a person has the typical trait of curiosity if he tends to become either curious under more circumstances (specificity), becomes more easily curious (reactivity), and/or possibly remains in a state of curiosity for longer periods of time (temporality)".*

People begin to show signs of curiosity during the first few years of life. Piaget characterized children as *"little scientists"* (1952, p. 419) linking it to the children's strong desire to understand the world (Loewenstein, 1994). During preschool, children continue to show interest in how the world around them works. They are interested in new toys, people, and concepts (Luce & Hsi, 2015), which must be activated through stories and a variety of experiences in the arts and natural environment (Lindholm, 2018). Preschool education marks a crucial period in children's life, as it fosters the acknowledgement of their identity, and children acquire a series of lessons with stages of curiosity that will contribute to their overall development. Researchers have found that preschoolers are attracted to new and unknown facts, which motivate them to explore and ask questions (Miller, 2006), closely linking curiosity with interest and engagement (Arnone et al., 2011), as new discoveries enhance interest and increase curiosity.

The Features of Digital Stories That May Promote Curiosity

Stories having the characteristics of novelty (Dubey & Griffiths, 2020a; Gershman & Niv, 2015), surprise (Dubey & Griffiths, 2020b; Juechems & Summerfield, 2019), and uncertainty (van Lieshout et al., 2019; Verdugo et al., 2020) arouse the users' interest in upcoming events in a story.

The emergence of multimedia technology has transformed traditional stories, previously conveyed through print or oral means, into a dynamic and engaging digital format. Integrating technology through audiovisual techniques such as sound, images, digital characters, and emotions has made storytelling more fascinating, appealing, practical, and approachable. It promotes curiosity and excitement in students (Papadakis & Orfanakis, 2018). This captivating approach is gaining popularity among children at a rapid pace. Javorsky and Trainin (2014) identified the fundamental elements of electronic stories. The majority of digital stories include basic features (e.g., word highlighting and narration), but some have advanced capabilities (for example, hotspot interactivity).

Children can engage either as "consumers" of digital stories or can act as "creators" of interactive digital stories (Garzotto, 2014). Focusing on interaction, and especially in interactive digital stories, it is pointed out that, the user interacts with the system: (a) at the level of a virtual environment, where the system – through protagonists of the stories and digital illustration– will have to show that the player's contribution has been understood, and (b) at a higher level of storytelling, where user actions must essentially affect the development of the story (Murray, 2011). In the field of interactive digital narratives, Koenitz (2023) distinguishes between two kinds of interactions within an interactive digital story, namely "Interactivity 1" and "Interactivity 2". Interactivity 1, covers the personal interpretation of an artifact and, hence, refers to cognitive and interpretative acts that take place when engaging with all texts. On the other hand, interactivity 2 is the one typical of digital media where an interactor plans an action and executes it after having considered all the options made available by the system they are interacting with – to see the system's reaction to it.

The Role of Curiosity in Learning and Enjoyment

In interactive media, such as interactive digital stories, curiosity may refer to the development of the narrative but also to the choices of action that users can try ("What will happen if I do this?"). While watching a film, curiosity can refer to artistic ("What other movie did the actor play in?") or formal issues rather than character fidelity. Similarly, Berlyne (1960) distinguishes two types of curiosity: *perceptual curiosity,* which refers to individual's tendency to explore in order to understand the world and activates perceptions that relieve uncertainty, and *scientific curiosity*, that can be mentioned as "the impulse to know" (Berlyne, 1960, p.187) and according to Litman (2008, p. 1586) is defined as *"a desire for knowledge that motivates individuals to learn new ideas, eliminate information gaps, and solve mental problems."*

Several scholars believe that curiosity provides a psychophysiological underpinning for pleasure. Curiosity can be characterized as a desire to investigate and learn (Berlyne, 1950; Gottlieb & Oudeyer, 2018; Gruber & Ranganath, 2019). Curiosity about acquiring that information is usually seen as intrinsically pleasing and joyful (Marvin & Shohamy, 2016).

Specifically, when curiosity is expressed, individuals experience a sense of uncertainty, which is not very pronounced and accompanied by temporary stimulation - most individuals seem to enjoy this state. Humans generally dislike being in a condition of protracted uncertainty and find it uncomfortable (Bar-Anan et al., 2009; Jepma et al., 2012). As a result, receiving information and removing the uncomfortable condition of uncertainty may be gratifying, supporting the information-as-reward theory (Marvin & Shohamy, 2016). This is reinforced by the opponent-process theory of motivation (Solomon & Corbit, 1974), which posits that rewards (such as information) can have appetitive features, and incentive seeking reflects a desire to maximize the existence of the incentive. When the feeling of uncertainty decreases (e.g., viewers of a movie watch the next scene and discover what happens next), individuals have a feeling of

accomplishment, which makes temporary stimulation a pleasurable experience (Zillmann, 1996). If surprise follows the state of curiosity, the users often feel joy (Zillmann, 2000).

Interactive storytelling, like video games and movies, falls within the category of interactive entertainment media (Spierling, 2005). An entertainment system is a type of media that can induce a sense of delight in the user. Vorderer et al. (2004) contend that enjoyment is at the center of entertainment and occurs through the sensation of pleasure. As such, Interactive Storytelling systems should be viewed as attempting to elicit a sense of pleasure in their users, such as instilling exhilarating feelings of interest and suspense.

It is pointed out that Creative industries, like film, TV, video games, and interactive storytelling, create a chain of pleasurable emotional states through the production of repetitions of increased curiosity. It is worth noting that curiosity focuses on the future (i.e., what is going to happen), so it has the ability to maintain users' ongoing commitment to an entertainment experience of creative industries.

Interactive storytelling systems produce such experiences of curiosity. Users may feel curious about the predetermined progress of the story ("What happens next?"), the progress of the interactive story ("What happens if I make this choice?"), the activation of a hot spot ("What happens if I press this button or on digital illustration?"), character development ("Will the secondary character (antagonist) evolve and help solve the problem?"), the technological capability of the system ("How will the system visualize the seaside town or how will it musically invest the protagonist's regret for not winning the race?").

The Measure of Curiosity

Many scales have been constructed with the notion that curiosity causes high levels of arousal and favorable sensations. Day's (1968), Ontario Test of Intrinsic Motivation (110-item) is almost entirely composed of items describing emotions of fulfilment when chasing novelty or thoroughly exploring a particular stimulus. The State-Trait Personality Inventory (STPI-X) was created in 1979 to measure the state and trait components of anxiety, anger, and curiosity. The updated STPI-Y has eight 10-item scales for assessing state and curiosity, anger, trait anxiety, and depression.

The 10-item Trait Curiosity scale (Spielberger & Anton, 1976) and the 20-item Curiosity Trait scale (Naylor, 1981) measure how often people experience positive emotional reactions like "interested" and "stimulated". Values in Action Inventory of Strengths (Peterson et al., 2005a) contains a 10-item Curiosity scale, which measures curiosity as a reflection of interest and pleasure.

Two recently developed 10-item scales evaluate positive responses to various sorts of stimuli: Two newly created 10-item scales assess positive responses to a variety of stimuli: The Perceptual Curiosity scale (PC; Collins et al., 2004) measures feelings about sensory stimuli, whereas the Epistemic Curiosity scale (EC; Litman & Spielberger, 2003) measures sentiments about cognitive stimuli. However, it is a Likert measurement scale that adopts phrases such as *"I feel curious/inquisitive/bored etc."* It cannot be used with preschoolers.

Thus, research and theories on individual differences in curiosity have focused on measuring curiosity as a feeling of interest (CFI) involving extremely enjoyable emotional responses. On the other hand, measuring curiosity as a sense of deprivation (Litman & Jimerson, 2004) captures the sensations of ambiguity and stress that drive information-seeking and problem-solving action.

Also, other scales used to measure curiosity lend themselves to specific environments (e.g., Cantor & Cantor, 1964; Endsley et al., 1979; Greene, 1964; Henderson & Moore, 1980; Minuchin, 1971; Schulz & Bonawitz, 2007) or playing on tablets (Pelz et al., 2015), but no scale was found for the context of digital narratives aimed at preschool children.

As mentioned, Berlyne (1974) focused on curiosity as a situation, considering that it interferes between exploratory responses and collective stimuli (like novelty, surprise, and sense of uncertainty). Boyle (1983), however, highlights curiosity as a trait. State curiosity relates to curiosity in a specific context, whereas trait curiosity refers to the ability or proclivity to experience curiosity (Berlyne, 1974). Naylor's MCI, for example, contains state and trait subscales with highly comparable items. The trait scale asks participants to rate how they generally feel and includes items such as "I feel engaged in things I do," whereas the state scale asks respondents whether they feel engaged in what they are doing "at the particular moment" (Boyle, 1983), providing information about the situational contexts constructed by learning content or environments that may pique learners' curiosity. The state scale should be administrated in the context of an activity such as children's interaction with a digital story. Curiosity is usually measured as a personality trait, reflecting presumably stable individual differences in preferences for novelty and complexity through personality questionnaires or self-reports and teacher-peer ratings (Fang et al., 2021; Henderson & Moore, 1980). Although people with high trait curiosity are likely to be better students and scientists, the capacity to assess such variations would help in sorting or tracking students or scientists based on their curiosity. In contrast, a better knowledge of state curiosity has the potential to identify practical ways to stimulate curiosity in the general public (Boyle, 1983).

In this research, emphasis will be placed on curiosity (as a situation) caused by the application, although curiosity is likely to affect the experience of interactive storytelling applications. After all, while curiosity scales as a trait are useful

for examining the correlations of the diversity of structures they measure, they can't give information about educational practices to increase and harness this feeling. On the other hand, a situational curiosity scale could provide information about pedagogical approaches to promote curiosity. Additionally, if trait differences represent the combined impact of situational factors, then these interventions, if successful in promoting situational curiosity, may ultimately contribute to the enhancement of curiosity as a trait (Markey & Loewenstein, 2014).

However, since the conception and empirical evaluation of how preschoolers respond to a digital story is not sufficiently developed in the extant literature, this article studies curiosity through the exploration of young children's experiences when interacting with a different form of the same digital story (non-interactive, animation, interactive).

Methodology

Participants

The sample of the survey consisted of 129 preschool children (N=129) (76 toddlers - 4 years old, 53 preschoolers - 5 years old) who were students at 6 kindergartens in the city of Kastoria (Greece). Specifically, 60 were boys (32 toddlers and 29 preschoolers), and 68 were girls (44 toddlers and 24 preschoolers).

Role of Researcher

The researcher was a teacher at one of the kindergartens and also the orchestrator of the research as she explained the process to each student and provided them with an iPad to watch one form of the digital story. Also, she was a non-participant observer, taking notes and observing children's nonverbal and verbal behaviors that were manifestations of curiosity.

Materials

The interactive form of the digital story *"Catch the Thief"* was found on https://kuakomekiki.com/el/bookapp/nelly-tayle-book-two/website, the non-interactive and animation presentation format housed on CD-ROM technology. In this story, the central protagonists, imitating young detectives, try to solve the mystery of the theft of eggs and other materials (milk, sugar, flour) from the chicken coop and the kitchen counter of Grandmother Mary.

Table 1. Variations in the Design and Presentation of Digital Stories

	Interactive presentation format (IN)	**Non-interactive presentation format (NIN)**	**Animation (AN)**
Filmic effects	Full animation	Static images	Full animation
Hotspots	Illustration, page	Text, page	Absent
Extra textual discourse	Upon click	Automatic	None
Words read per minute	42	45	61
Duration	Unable to determine	11.92	13.27

The number of words read per minute was clearly linked to how long the read-aloud activity lasted, but this text-level variable across the three presentation formats also contributed to a vital feature variation in the story presentations. The three formats provided presentations with words read per minute that are significantly lower than the mean conversational rate found on television broadcasts for young children, as well as the recommended third-grade words read per minute measure of 110 words read per minute, which maintains the listener's curiosity and attention (Cummings et al., 2011). The read-alouds were frequently accompanied by music or animations depicting (a) plot action (interactive/ animated format) or (b) story intrusions. The number of words per minute in the interactive presentation format had a minimum limit of 42 words, which could be exceeded if a child did not activate the hotspots in the illustration; about 61 words per minute are found in the animated format, and in the non-interactive presentation format the word count was estimated at about 45.

Additionally, research on reading motivation has shown that there is a strong positive relationship between engagement time and children's high achievement (Connor et al., 2009; Finn et al., 1995), suggesting that effective teachers orchestrate literacy instruction with ways that keep students engaged, that is, with their curiosity and attention focused and involved (Samuels & Turnure, 1974) for extended periods of time (Pressley et al., 1998). The duration of an electronic story presentation is the amount of time between when the book's cover is revealed, and the title is read, and when the story ends. The story in animated format lasts 11 minutes and 92 seconds. For the interactive story format, the duration of the read-aloud could not be determined because it relied on how much each child interacted with the hotspots.

Two of the presentation formats include filmic effects. The non-interactive presentation format does not incorporate any of the abovementioned filmic effects. This presentation format featured musical accompaniment between page turns. A limitation of this format in terms of filmic effects was the absence of visual gestures to aid in conveying the

story's meaning and pique curiosity. The other presentation formats contained full animation with accompanying music that enhanced the curiosity. In this way, they provided a story-listening experience that mirrored many television features. The participants in the story listening activity observed the character's gestures and changing facial expressions in the animations. Furthermore, both formats contained several animated images that were "gratuitous intrusions into the story" (Unsworth, 2003, p. 5) and were not present in the printed version in any way. Such an example is the continuous sound of chirping birds through the animated presentation of the story, as well as the focus on flying butterflies at two points in the story, which are located in the digital animated presentation. This is an example of a “gratuitous intrusion” because the birds are neither protagonists nor antagonists or related to any part of the story's plot or theme. Similar examples are also found in the interactive format, e.g., there are many image hotspots for the child to 'click' on, such as the clouds, the rooster, or the lamp that move to the accompaniment of characteristic sounds - they did not contribute to provoking curiosity.

In the interactive presentation format of the story, there are many hot spots in animation. Most of these are rated as supporting pieces of comprehension, such as the one showing Grandma Mary smiling with satisfaction at her granddaughter's success, the one showing Simon finding an acorn and exclaiming, 'it's the thief's' and the one shows the culprit laughing and saying "You beat me this time!" implicitly promising to do it again, which piques the listener's curiosity.

The existence of extra-textual discourse is found in the interactive and animated format contributing to the comprehension of the story. The omission of dialogue carriers, such as e.g., "he said" or "she shouted" combined with concomitant animation of characters offered children a more contextualized language than the fully decontextualized language of the non-interactive presentation format. Children immediately recognize who "he" or "she" is who shouted because the characters on the screen move their mouths and body parts as they speak, drawing their attention to specific visual and auditory details and maintaining their curiosity.

Data Collection Instruments

The research was conducted in kindergarten classrooms. The students of each class were randomly divided into three groups, and each group listened to one version of the same digital story (non-interactive / animation / interactive). The listening setting included an iPad, which was used for individual listening to a form of digital story. Each student individually used an iPad to listen to the digital story.

The research focuses on measuring curiosity as a state exploring preschoolers’ reactions when interacting with digital stories, according to Berlyne (1970) who pointed out that curiosity as a situation interferes between exploratory responses and collective stimuli, like novelty, surprise, and sense of uncertainty – features found in digital stories. According to Spielberger and Reheiser (2009, p. 127) intense curiosity as a state *"reflect a strong desire to seek, explore, and understand new features of the environment."*

Children tend to be curious, especially in early childhood. This emotional state is expressed by asking questions (J. Jirout & Klahr, 2012) and also by using all the senses. Therefore, to measure curiosity as a parameter of children's experience during their interaction with digital stories, both verbal and nonverbal exploratory behaviors are put in focus (Piotrowski & Krcmar, 2017). The literature review has revealed studies that emphasize such reactions to body language as manifestations of curiosity. In particular, these are *facial* expressions (e.g., pursing lips, focusing the gaze (Merleau-Ponty, 2010), scanning the environment with the eyes in search of new experiences/information (Maw & Maw, 1964), using gestures (placing the hand on the chin (Ekman & Friesen, 2003), turning the finger towards the object of interest (Heggen & Lynngard, 2021), touch/feel (persistence in exploring the environment (Maw & Maw, 1964), *use of movements* (e.g., putting nose and head in front (Heggen & Lynngard, 2021)). Understanding physical manifestations of curiosity is made easier by taking into account Merleau-Ponty's (2010) somatic phenomenology, which postulates that bodily exploration is how the world is experienced and comprehended.

In terms of verbal inquiry-based behaviors, reactions such as the use of language (asking questions) emerged (Patrick & Mantzicopoulos, 2015), commenting on specific aspects of the story (for example *"the thief always wears a mask"* (McReynolds et al., 1961), expressing the desire/need to learn more about the environment (Maw & Maw, 1964)) and *making noises* (using exclamations (e.g., Mmm) or single words (e.g., no..., you think?) (Heggen & Lynngard, 2021).

The research of Endsley and Clarey (1975) is in the same context, referring to the use of exclamations (Aha!) when filling information gaps; also, Kang et al. (2009) which highlight as a reaction the dilation of the pupil, Pavlov (1927) which refers to the orientation of the eyes, head and torso towards the source of stimulation. Furthermore, the research by Loewenstein et al. (1992) describes the repetitive, exploratory behavior of study participants in which they were asked to click on the screen 5 by 45 squares under the guise of familiarity with the mouse function. However, in the end, participants insisted on revealing many more icons, while the research of Hackmann and Engel (2002, as cited in C. Engel, 2011) points out that through verbal and nonverbal responses, such as intense gaze, smile, language use, participants show willingness to explore the present situation/object (a "curiosity box" with many drawers containing various objects).

Summarizing the aforementioned literature, researchers studying curiosity stimulation in young children mention that there are two categories of behavior: (a) *non-verbal behaviors*, including facial expressions, physical movement, touch, and gestures, and (b) *verbal behaviors*, such as asking questions, commenting on specific aspects of the story, expressing the desire/need to learn more about the environment, and making noises.

Data Coding

The researchers utilized a descriptive approach for observing preschoolers' curiosity when interacting with different presentations of digital stories. A typology was developed to study preschoolers' curiosity when interacting with digital stories, based on current research categories and emergent categories from videotaped observations.

27 children (N=27) (12 toddlers - 4 years old, 15 preschoolers - 5 years old) from nine classrooms (3 from each class) and their teachers participated in this stage. The duration of the observation cycle was eight weeks. Eight digital stories (in three presentation formats) were selected for children's independent listening/browsing. External webcams and USB microphones were used to capture children's independent interaction with the digital story. Video observations consisted of 56 video recordings, totaling 17 hours. Finally, 35 videos, each averaging 18 minutes, were selected for analysis, totaling 9.5 hours.

The video samples were entered into NVivo -12 as classroom cases consisting of child codes (C1…C27). Using Carney's "ladder of abstraction" perspective (1990), a sequence of escalating qualitative assessments of preschoolers' behaviors was conducted. Adopting an analytic induction approach (L. P. Goetz & LeCompte, 1984), cases were assessed at 1-minute intervals for behavioral confirmations in current categories, as well as the emerging behavioral categories. The analysis resulted in a typology that included two groups of behaviors: (a) *non-verbal behaviors* (such as facial expressions), and (b) *verbal behaviors* (such as asking questions). Nonverbal communication is generally defined as the aspect of communication that is not expressed in words. Under the assumption that 'one cannot communicate' (Watzlawick *et al.*, 1967, p. 51) and that all movements are to some degree expressive (Wiener et al., 1972), all nonverbal behaviors are subsumed under this heading. Non-verbal's communication study is frequently divided into channels representing various modalities or bodily parts. Channels that are defined in terms of individual behavior include facial expressions, head movements, posture and body movement, hand movements, self-touching, leg positions and movements, and non-linguistic vocal behavior. Additional distinctions can be made within each of these, such as brow vs. mouth regions of the face and, within the vocal channel, variations in amplitude, speed, and contour (Hall, 2001). Verbal behavior is the aspect of communication/behavior that is expressed in words, responds to language, and expresses comprehension (Passos, 2012).

Using frequency counts, an enumerative technique was utilized to determine prominent behaviors in each of the categories. This approach helped to define a 'working' typology (behaviors and categories). The categories appeared suitably broad (covering various behaviors) for operational definitions and narrow enough for reliability goals (McWilliam & Ware, 1994).

Researchers used typology to code a sample of 150-minute video observations taken over 9 hours. The analytic purpose was the definition of categories/behaviors and the *operationalization* of the typology with the intention to be used in future research. At first, a three-person team coded 50 minutes of video observation from a 150-minute sample at 1-minute intervals to develop more exact definitions for categories and behaviors, as well as coding procedures. Coders stopped the videotape sample at each minute interval and then coded the prominent behaviors in each category for this period of time. Then, the researchers made a comparison of the data, debated to reach an agreement, and established coding decision guidelines (Appendix). Researchers subsequently coded the remaining 90 minutes with an inter-coder agreement of 87%. The developed typology may be used as a useful tool for observing preschoolers' curiosity when interacting with various presentation formats of digital stories. The behaviors are aggregated in Table 2.

Table 2. Categories of Behavior as Manifestations of Curiosity

Behaviors			
Non-verbal Behaviors		**Verbal Behaviors**	
Important Behaviors	**Definition/Interpretation**	**Important Behaviors**	**Definition/Interpretation**
Facial Expressions	Facial expressions to express thoughts and feelings	**Use of Language**	Questions Commentary Expression of desire/need for more information
Gestures	Hover over an object of interest Using the body as an expression of curiosity stimulation	**Noise Creation**	Sounds when filling information gaps or as an expression of curiosity stimulation such as exclamations

Table 2. Continued

Behaviors			
Non-verbal Behaviors		**Verbal Behaviors**	
Important Behaviors	**Definition/Interpretation**	**Important Behaviors**	**Definition/Interpretation**
Touch/Feel	Fingers on the screen (holding, clicking hot spots) as repetitive, exploratory behavior		
Physical Movement	Posture and orientation of the body in moments of curiosity stimulation Screen approach		

Analysis

The focus of this research was the study of curiosity as a situation by taking into account the verbal (questions, commentary, expression of desire/need for more information, noise creation) and non-verbal behaviors (facial expressions, gestures, touch/feel, and physical movement) of preschoolers when interacting with a presentation format of digital storytelling (non-interactive, animation, interactive). As the research involved independent listening to the digital story by the toddlers and preschoolers, there were not any analyses of answers to questions (verbal behavior - use of language).

The behavior categories of the toddlers and preschoolers were encoded using video and, more specifically, a camera focused on the students as well as taking notes during digital reading aloud. It should be noted that each student listened to the digital story by himself/herself. The observational data set was encoded at each 60-second interval and analyzed in NVivo-12. Each child's data was encoded every 60 seconds with a record of the presence and simultaneous evolution of the behavioral characteristics present during this period (a child could demonstrate an element of digital illustration and use language to make a comment at the same time). Based on typology, the study produced frequency measures of specific preschooler behaviors by type. Following the collection of data, the sample of toddlers and preschoolers in each of the digital story presentations had their average frequency of each behavior marker as well as their overall percentage of time created calculated. The initial set of data was rearranged to investigate the percentage of time spent watching and listening an electronic story by presenting every child's curiosity behaviors with a digital story's presentation type (IN; NIN; AN).

To assess the variations in presentation formats on the median percent of every category of behavior as a function of the total number of behavioral categories in a session, Kruskal-Wallis tests (Kruskal & Wallis, 1952) were performed (% of total number of behaviors observed per child each session). Generally, the Kruskal-Wallis One-Way analysis of variance is used to compare more than two groups that have skewed data. In this research, the Kruskal Wallis test was used to examine whether there was a significant difference between the presentation formats of digital stories in terms of median percentage of every category of children's curiosity behavior (Table 2). The non-parametric Kruskal-Wallis test was used to assess six distinct curiosity behaviors: language use, physical movement, touch/feel, facial expressions (2: positive, 1: neutral, 0: negative), gestures, and average noise creation. To prove significant differences in presentation types, a Bonferroni post-hoc test was used; the effect size (attributable difference) was ascertained using the Mann-Whitney U test (Mann & Whitney, 1947). The Mann-Whitney U Test is useful for comparing two independent groups with small sample sizes (typically less than 30), which are not normally distributed, and where the data are continuous. To compare whether there is a difference in the dependent variable (curiosity behaviors) for two independent groups (presentation formats of digital stories), the Mann-Whitney U test is used. It compares whether the distribution of the dependent variable is the same for the two groups and, therefore, from the same population.

Results

The first step of the analysis was to examine the frequency of each variable. Tables 3 and 4 present the descriptive statistics for each behavior (verbal and non-verbal) across conditions. The findings show that interactive presentation formats encourage more touching of the medium (M=68.60%, SD= 8.67) and language use (M=64.81%, SD=7.80) but less noise production (M=4.78%, SD=1.23). That interaction and the creative use of hot spots in digital illustrations are key elements in piquing viewers' curiosity.

Table 3. Descriptive Statistics for Each Non-verbal Behavior Across Conditions

Presentation Formats	Non- verbal Behaviors							
	Facial Expressions		Gestures		Touch/Feel		Physical Movement	
	M	SD	M	SD	M	SD	M	SD
Interactive	48.46%	6.87	23.61%	4.20	68.60%	8.67	28.15%	3.91
Non-interactive	41.89%	6.67	18.52%	3.78	33.93%	7.95	19.98%	2.56
Animation	45.64%	6.73	25.17%	4.56	54.65%	1.27	32.16%	3.98

Table 4. Descriptive Statistics for Each Verbal Behavior Across Conditions

Presentation Formats	Verbal Behaviors			
	Use of Language		Noise Creation	
	M	SD	M	SD
Interactive	64.81%	7.80	4.78%	1.23
Non-interactive	38.61%	6.91	17.89%	3.29
Animation	43.71%	7.45	15.89%	3.01

The results of the Kruskal-Wallis tests generally show that three of the six recorded curiosity behaviors were significantly impacted by the presentation forms. Table 5 provides a summary of the test outcomes. The use of language, noise creation, and touch/feel behaviors as manifestations of curiosity were significantly different when different presentation formats of digital stories were used. The test revealed a significant difference $\chi 2$ (2, N= 45) = 30.90, p<.01) between presentation formats in terms of median touching percentage; the presentation format accounted for .69 of the variability, demonstrating a strong relationship between presentation format and the percentage of time the toddler/preschooler spent touching of the medium. The test was significant on the median use of language percentage $\chi 2$ (2, N= 45) = 11.34, p<.01); the presentation format accounted for .27 of the variability, demonstrating a moderate relationship between presentation format and the percentage of time the toddler/preschooler spent using language. The test was significant for the median noise-creating percentage ($\chi 2$ (2, N = 45) =20.70, p<.01); the presentation format accounted for .48 of the variability, demonstrating a moderately strong relationship between presentation format and the percentage of time the toddler/preschooler spent noise creating.

Table 5. Test Statistics

	Facial Expressions	Gestures	Touch/Feel	Physical Movement	Use of Language	Noise Creation
$\chi 2$	1.582	4.535	30.890	1.186	11.342	20.691
df	2	2	2	2	2	2
Asymptotic Significance	.440	.098	.000	.559	.004	.000

The impact of the digital story presentation format on the amount of time spent touching during the read-aloud or browsing experience is noteworthy, especially considering the growing level of interactivity with the digital story content during the early reading stages (such as swiping, tapping, dragging, dropping, and pulling).

Furthermore, the presence of interactive elements plays a role in preschool children's use of language and the creation of sounds as manifestations of curiosity.

Evaluations of the differences between the presentation formats (IN; NIN; AN) on the facial expressions, physical movement and gesturing median percentages were not significant - facial expressions: $\chi 2$ (2, N = 43) = 1.58, p> .05; physical movement: $\chi 2$ (2, N = 43) = 1.19, p> .05; gesturing: $\chi 2$ (2, N = 43) = 4.54, p> .05.

Table 6. Differences Between Presentations Formats of Digital Story on Curiosity Behaviors

	***Z* scores**		
Behavior	**IN-NIN**	**IN-AN**	**NIN-AN**
Touch/Feel	**-4.698***	-2.208	**-5.108***
Use of Language	**-3.072***	-2.342	-1.463
Noise Creation	**-4.515****	**-3.187****	-1.102

IN= Interactive NIN=Non-Interactive AN=Animation
*p< .05. **p < .01.

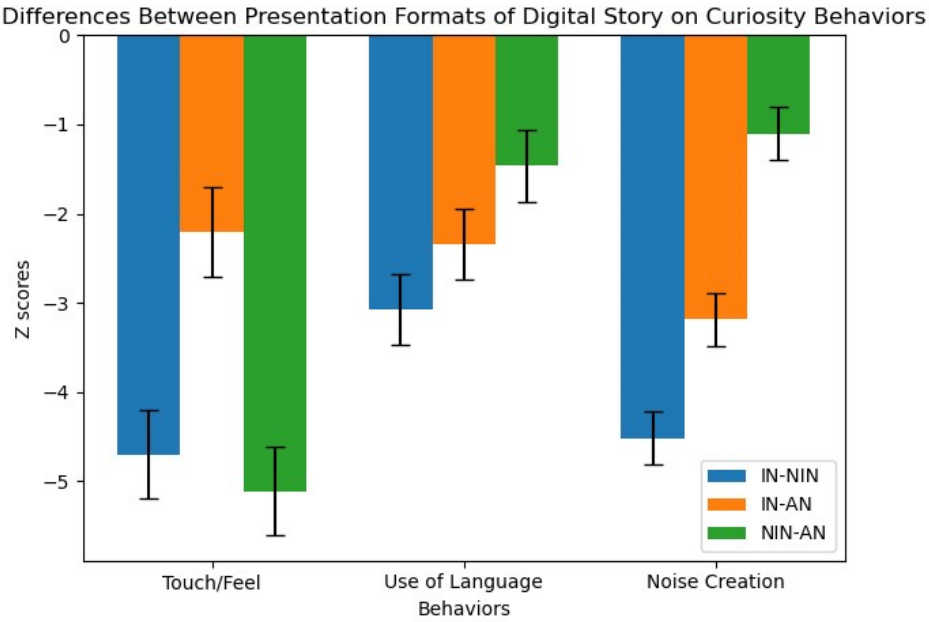

Figure 1. Effect Sizes of Differences Between Presentation Formats on Curiosity Behaviors

In order to account for Type I error across tests and examine pair wise differences between the various presentation formats, a Bonferroni post-hoc test was used; Mann-Whitney U tests provided effect sizes. Figure 1 and Table 6 present these findings, respectively.

The differences between the IN and NIN presentation format show that toddlers and preschoolers touch more while interacting with IN presentation format; thus, interactive presentation format exerted the greatest influence on this behavioral manifestation of curiosity. Furthermore, findings indicate that using of language and noise creation are also affected by presentation format in favor of IN digital story. The only notable distinction between the NIN and AN digital story presentation formats was touching behavior.

The difference in using of language behaviors between the NIN and AN presentation formats and between the AN and the IN presentation formats suggests that the affordances of the NIN and AN presentation formats of digital storybooks might be more similar than the AN and IN in enhancing using of language behavior for purposes of curiosity with digital stories.

Discussion

Children, especially preschoolers, tend to imitate and be curious. External stimuli such as digital stories are the source of their new cognitive feelings about ideas and concepts, and based on interest, activities are carried out. There are many ways children interact with media in studies looking at digital story activities when emerging readers are asked to follow a digital story read aloud – they just listen, listen and see, listen, see, and "they click". The level of animation (from fully animated to static production), the presentation of the text (captions with text, no text, etc.), the extra-textual support (e.g., semiotic support such as intonation, gestures, or character dialogue), and the degree of interactivity (hotspots, passive viewing, page-turning only), are factors that differentiate the digital stories to which toddlers are exposed with potential implications for eliciting curiosity during digital read-alouds.

In particular, the purpose of the research was to study preschoolers' curiosity when listening to a different format of the same digital story (animation, non-interactive, and interactive). According to the results, digital storytelling in three listening conditions stimulated the curiosity of preschoolers, which escalated as the young detectives collected the clues to solve the mystery. Besides, curiosity is an emotion that activates, on the one hand, perceptions that relieve uncertainty (van Lieshout et al., 2019; Verdugo et al., 2020) and, on the other hand, searches for knowledge (Berlyne, 1978). However, in addition to causing uncertainty, a digital story holds the promise of reducing user's uncertainty before the end of the story, as listeners/viewers must know that their queries will be solved by satisfying their curiosity (Zillmann, 1996), something which is achieved by gradually revealing the clues that lead to the identification of the thief. Moreover, the alleviation of uncertainty by information disclosure (Gottlieb & Oudeyer, 2018; Gruber & Ranganath, 2019; Loewenstein, 1994) by revealing the culprit was manifested through the creation of sounds (use of exclamations) in both interactive, animation, and non-interactive forms of a digital story, while temporary uncertainty was followed by a positive emotional state (Marvin & Shohamy, 2016; Zillmann, 1996), which was expressed through verbal (commentary, expression of desire/need for more information, questions) and nonverbal reactions (gestures and facial expressions) of toddlers, leading to the conclusion that designing digital stories taking in consideration both experience and emotion lets children feel entertained and curious through interaction.

The Role of Interactivity in Promoting Curiosity

On a second level, according to the results, the presentation format of the electronic story has an influence on the curiosity stimulation of listeners during digital reading aloud, which is reflected in the percentages of nonverbal and verbal behaviors of the three listening conditions. The predominance of the interactive format seems to be due to the innovative element of the presence of hot spots in digital illustration, as the interactive features of digital stories create additional uncertainty, which is not only related to the results of the story. As a result, the stimulation of curiosity was reflected (a) in touching/feeling and (b) in questions, comments, and the expression of desire for further information about both the function of the hot spots and the relationship/connection to the plot of the story.

Specifically, these were high-level questions that require making hypotheses, predictions, inferences, ideas - in line with Murayama's process account of curiosity in learning (Murayama et al., 2019) and Loewenstein's "Information gap theory" (1994) - they suggested that improving curiosity-driven learning should center on developing awareness of lacking information and the effective inquiry tactics to compensate for it. Therefore, it appears that hot spots act as a trigger/motivator for asking questions which is among the most significant inquiry strategies that students need to be taught. This is crucial since teachers are frequently not adept at inspiring students' interest to propose questions (Van Booven, 2015), or at structuring learning activities that arouse curiosity (C. Engel, 2011). Curiosity-based question-asking behaviors, in particular, have been shown to be almost non-existent in today's classrooms: children's inquiries are frequently low-level, memory-based questions that are and do not require much cognitive work (Humphries & Ness, 2015), doing little to increase their curiosity (Bjork, 2017). Furthermore, the interactive presentation format consists of a process between an environment and a user, and provides an observation (e.g., hot spots) and reward (pleasure caused by curiosity) to the user (Sutton & Barto, 2018). This viewpoint is congruent with the incentive salience model of learning, which claims that expected reward value consists of two different appetitive components—liking and wanting (Berridge, 2004). Liking is defined as hedonic experiences or subjective sentiments linked to rewards or predicted rewards. In contrast, desiring (also known as incentive salience) is merely an incentive motivational value (i.e., sense of vigor or craving), and this state of wanting is frequently activated when the expectation of a reward (Niv et al., 2007). In general, interaction, external rewards, and identification with the character(s) support children's interpersonal and internal learning and development (Mantilla & Edwards, 2019). Interactive digital stories provide various learning opportunities for children while also allowing them to actively participate in the learning process (Papadakis & Kalogiannakis, 2017), engaging and entertaining them at the same time. It promotes the growth of memory, imagination, concentration, and manual abilities in children (Fang et al., 2021). In a well-designed interactive digital story, children desire to listen to the story, and motivation is built into it (Mantilla & Edwards, 2019).

It is worth noting, however, that the interactivity of this interactive digital story is limited to the 'hot spots' of digital illustration, which can be 'clicked' by the listener and activate animation, music, and text without, however, giving him the opportunity to interfere in the story and development of the plot. Therefore, the interactive presentation format of the digital stories is among the closed environments, as the animation and non-interactive condition of listening to the story, where the narrative is mainly linear, and the plot is already prescribed by the creator of the narrative (Szilas, 2003). Consequently, the receiver of narration in all three listening conditions is not able to become a facilitator (Barbas & Correia, 2009) and to co-create the development of the story (Aylett & Louchart, 2003), which could arouse an increase in curiosity in the interactive presentation form of a digital story, because the listener/viewer would be very curious about the results of his choices. Also, it would be interesting for users of the interactive digital story to become protagonists of the plot through, e.g., an avatar, which would intensify their curiosity about the evolution of their choices, as they would realize that they can play a decisive role in the story. In terms of curiosity about the users' choices on plot evolution, this should be a motivation for digital story designers to both present an unpredictable story development and have the system present at a later time how and when the users affected the plot, since according to Zillmann (1996) and Marvin and Shohamy (2016) the experience of a sense of uncertainty is pleasant when it is not very intense and when this feeling reduces alongside a sense of completion, which is experienced as pleasant. Therefore, stimulating curiosity to a greater extent can be achieved either if the user participates in the writing of the story or if he/she becomes the inner protagonist of the plot, which would make listening to the interactive story more enjoyable.

Additionally, according to Ryan's (2006) typology, the user's action in the interactive listening condition is external and exploratory, similar to the interaction the user has in the non-interactive form of digital narration, which also takes into account the user's role in interactive narratives and the outcomes of his or her action. As a result, these types of narration have varying degrees of interaction between the person who created the story and the person who is listening to it, with low (non-interactive) and medium (interactive) levels (the user only controls the flow speed.) (Szilas, 2003). The user's involvement and level of participation in the digital story are thereby diminished to a significant level.

Implications for Digital Story Design

The research results provide directions for interventions to optimize interactive design features for educational purposes. Digital stories' interactive design should focus on children's interests and needs, with the aim of promoting their participation and enhancing their interests (Domagk et al., 2010). According to Papadakis and Kalogiannakis (2017) and Soni et al. (TIDRC, touch screen interaction design proposals for children) (2019) suggested that digital technology and apps for children should respond to socio-emotional, physical, and cognitive needs. After all, children's interaction with apps occurs in both cognitive and emotional levels. Specifically, software developers and authors creating digital storybooks could collaborate to offer extra-textual assistance to stimulate curiosity that is directly related to plot and story design. That is, digital stories can include extra-textual discourse as comments/questions a) on the listener's information gap and enhancing certainty ("Will the protagonist manage to get out of the maze?"), b) about choice and activation hot spots that lead to another element or plot point/relevant to the progress of the interactive story ("What will happen if I make this choice?") or ("What will happen if I press this button or on the digital illustration?") enhancing the listener's suspense with which curiosity is connected according to the Theory of the multidimensional narrative tension of enjoyment (Bellini, 2022).

As far as story design is concerned, pre-reading assessments of children's curiosity could be designed to feed into the planning of digital stories to determine the range of interaction a child will be exposed to when interacting with a digital story. Children who would experience more curiosity regarding the innovative elements and the elements of surprise would be exposed to more interactive elements of the story (hot spots of words and pictures) and more choices in the development of the plot, for example, themselves as protagonists of the story (avatars) or as directors of the story's plot development by being curious about the outcome of their choices. After all, interactions with an interactive digital story are traditionally considered meaningful when they have an impact on the development of the story when the interactor is afforded "dramatic agency" (Murray, 2011). Dramatic agency is the ability to make 'meaningful choices' and see their effects (Kolhoff & Nack, 2019; Roth & Koenitz, 2019). Such choices in digital story design spark curiosity and, at the same time, contribute to enhancing student engagement in the activity and consequent understanding, as when students experience curiosity, they learn in deeper and more meaningful ways with better recall, dedicate greater levels of concentration, and persevere until their goals are met (Silvia, 2006). In addition, the experience of curiosity contributes to the cultivation of critical thinking (Pekrun, 2019; Ritter & Mostert, 2016) "e.g., What choice must I make to save the hero?", is a necessary condition for creativity (Kashdan & Fincham, 2002) and cultivates the imagination (Canning et al., 2017), as in the case of increased interactivity where the user also acts as co-author of the story or even participates in designing the setting of the story "How the setting of the story can be designed? E.g., the planet of colors or a state at the bottom of the sea?".

Conclusion

Digital stories are important educational tools, as through the introduction and export of a variety of information such as images, sounds, actions, etc., the senses of young users can be fully mobilized in a richer form, so that they can participate more actively in current behaviors and activities forming a body of cognitive and environmental dynamics as a single cognitive structure (Chwyl, 2018; Hirsh-Pasek et al., 2015). Digital stories are, therefore, a teaching tool that is an *"optimal challenge"* and creates an environment of learning that emphasizes learning for pleasure and interest, *"rather than just completing external requirements"* (Aunola et al., 2006, p. 35) while arousing the user's curiosity depending on the degree of interactivity.

The purpose of the research was to study preschoolers' curiosity when listening to a different format of the same digital story (animation, non-interactive, and interactive). Specifically, we wanted to identify the main categories and features of children's curiosity when interacting with a digital story and study how the presentation format of the digital story influences preschoolers' curiosity.

Our study derived a typology for observing children's curiosity when listening to electronic stories and explored what it looked like at different presentation formats of digital stories. The resulting descriptive observations inform about the existence of verbal and non-verbal behaviors as indicators of curiosity that capture their enjoyment, engagement and interest in the listening experience and primes children for learning. Children's curiosity in school can be used to promote and motivate learning (e.g., J. J. Jirout et al., 2023) since it is associated with higher levels of teacher-rated attention, competence, persistence, and motivation in students (J. Jirout & Klahr, 2012). Measuring children's curiosity as they interact with digital stories provides new directions for designing digital stories, increasing the effectiveness of this educational tool and linking it to other skills important to student development.

Furthermore, the findings show that interactive presentation formats encourage more touching and language use and that interaction and the creative use of hot spots in digital illustrations are key elements in piquing viewers' curiosity while contributing to the strengthening of engagement with the activity and the cultivation of critical thinking, creativity, and imagination. These results are in line with our initial hypothesis about the important role of interactivity in provoking curiosity, acting as a trigger/motivator for asking questions, providing an observation, a reward to the user (Sutton & Barto, 2018), and identification with character(s), and consequently supporting children's interpersonal

and internal learning and development (Mantilla & Edwards, 2019) while also allowing them to actively participate in the learning process (Papadakis & Kalogiannakis, 2017). In sum, we learned some, but need to learn more, about what digital stories can do to motivate and structure supporting learning activities at preschool considering that in a well-designed interactive digital story, children desire to listen to the story and motivation is built into it (Mantilla & Edwards, 2019).

Recommendations

It would be interesting, then, to explore the multitude of experiences of emerging readers when interacting with interactive digital stories, such as enjoyment, aesthetic pleasantness, and presence in the sense of becoming the inner protagonist of the plot, suggesting engagement, absorption, and transfer to the world of the story. Besides, if a digital story has the ability to activate the feelings of pleasure of the user, it can also awaken his/her desire to use digital stories (Khalid & Helander, 2004) while, in addition, understanding the role of emotions is of paramount importance, as it will find out which emotions facilitate or inhibit learning and what are the mechanisms behind them. Finally, it would be important to conduct longitudinal studies to examine the long-term effects of digital storytelling on curiosity development.

Limitations

This study's limitations include using a medium convenience sample of preschoolers from six kindergartens in Kastoria (Greece). This group of characteristics may have harmed the validity of the typology as an observational tool. The observational data used for analysis may not have covered the entire range of curiosity behaviors possible in kindergarten. However, the typology captured the fundamental characteristics identified in traditional book reading that may be applicable to the browsing environment and the digital story reading. Furthermore, the investigation did not account for preferences that influence curiosity toward technology and the usage of inquisitive behaviors. When considering the device's function in the curious behaviors that children use/adopt, it is important to examine what the child brings to the dynamics of the browsing learning environment and digital story reading.

Ethics Statements

The participants' parents gave their written, informed consent so their children could participate in the research.

Authorship Contribution Statement:

Gkantia: Conceptualization, design, data acquisition, data analysis, drafting manuscript, statistical analysis, writing. Dinas: Critical revision of manuscript, supervision.

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Appendix

Table A1. Coding Definitions and Rules

Category	Definition	Salient Behavior(s)	Definition	Rule
Non-verbal	The aspect of communication/behavior that is not expressed in words, respond to language and express comprehension	**Facial Expressions**	Facial expressions to express thoughts and feelings	Code A (positive) if pursing the lips or scanning the environment with the eyes; Code B (neutral) No expression; gazing; Code N (negative) if seems bored
		Gestures	Hover over an object of interest Using the body as an expression of curiosity stimulation	Code C when using hands & body to make motions; placing the hand on the chin, turning the fingers towards the object of interest
		Touch/Feel	Fingers on the screen (holding, clicking hot spots) as repetitive exploratory behavior	Code D If the user holds the device, touches and/or clicks hot spots
		Physical Movement	Posture and orientation of the body in moments of curiosity stimulation Screen approach	Code E if approaching the screen by putting the nose and head in front
Verbal	The aspect of communication/behavior that is expressed in words, respond to language and express comprehension	**Use of Language**	Questions Commentary Expression of desire/need for more information	Code F for Commenting; A for Asking questions; E for Expressing the desire/need to learn more about the environment
		Noise Creation	Sounds when filling information gaps or as an expression of curiosity stimulation such as exclamations	Code G if using exclamations or single words when filling information gaps