# How Far Is Up?
# Bringing the Counterpointed Triad Technique to Digital Storybook Apps

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## ABSTRACT
Interactive storybooks, such as those available on the iPad, offer multiple ways to convey a story, mostly through visual, textual and audio content. How to effectively deliver this combination of content so that it supports positive social and educational development in pre-literate children is relatively underexplored. In order to address this issue we introduce the "Counterpointed Triad Technique". Drawing from traditional literary theory we design visual, textual and audio content that each conveys different aspects of a story. We explore the use of this technique through a storybook we designed ourselves called "How Far Is Up?". A study involving 26 kindergarten children shows that "How Far Is Up?" can engage pre-literature children while they are reading alone and also when they are reading with an adult. Based on our craft knowledge and study findings, we present a set of design strategies that aim to provide designers with practical guidance on how to create engaging interactive digital storybooks.

## Author Keywords
Storybook; children; mobile; apps;

## ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION
Apps for children, such as those available on the iPad, offer multiple ways to convey a story, mostly through visual, textual and audio content. We focus on apps that involve narrative based educational content, in particular those that aim to support reading and understanding text for pre-

literate children. These apps most often feature interactive content including a fusion of digital graphics, animation, text, audio narration, music and sound effects [41, 44, 45] that sit on the intersection between purely graphical games and purely textual books. They feature interactive content and a storyline, like many games, however, they are increasingly called storybook apps due to their textual content.



**Figure 1.** *How Far Is Up?* **We designed our own children's app using the Counterpointed Triad Technique.**

Of course storybooks existed before the digital age in the form of printed books for young children that contain stories told through combinations of text and imagery. A famous example is Sesame Studio's "The Monster at the End of this Book" a printed storybook that has now been also published as app [43]. Printed storybooks have been used for a long time to help pre-literate children learn to read and interpret written text [34, 35] and research suggests that they help children develop not only their literary but also social skills because when reading they are often engaged with others, not just other children, but also adults such as parents, teachers and carers [34, 35, 41]. There are benefits to both interaction modes: research suggests that engaging with these storybook apps alone can strengthen a child's connection with literature as well as pique their imagination [34, 35]. Shared engagement

between children and adults on the other hand can deepen a child's connection to the content, strengthen their understanding of the story, and help establish close social and emotional bonds [24, 41, 44, 45, 49].

Recent research suggests that most children do not enjoy engaging with current storybook apps when they are alongside an adult, as they consider that adults "get in the way" of their digital experience [44, 45]. This may be because most storybook apps are designed for children to use while they are alone [41, 44, 45]. For example, a common feature in many children's apps is an audio track that reads any textual content aloud. Providing such doubling-up of information may offer some benefits [45], however, we look to highlight the benefits of reading storybooks both alone and with adults. Research also suggests that when there is duplication of information within audio-visual-textual presentations, the text becomes redundant, this is known as the "redundancy effect" [25]. As a result of this effect the text can be ignored and the user can remain passive, missing opportunities for engagement. We believe that adults can provide additional value to the storybook app experience beyond being simple conveyors of text into audio, therefore a solution could be to not provide any audio narration to ensure a child engages with an adult in order to understand the textual content. However, then a child would have trouble understanding the app when alone, and we want to also support use when alone. Another solution might be an audio narration that can be turned on or off, however, if given the option, children prefer to listen to the recorded audio narration [45], and then the adult talking over the audio would "get in the way" of the child's experience [44, 45].

This suggests to us that the design of storybook apps that support children reading both alone and with adults is a complex task. We believe an enriched understanding of how storybook elements can be presented could help designers tackle this task, however, we agree with prior work that there is not much knowledge available around how storybooks can be designed to support both independent and shared reading, which is unfortunate, as then both the children and adults will miss out on the associated benefits of engagement with storybooks [44].

In response, we contribute towards the development of such knowledge by presenting related work in this area, including principles from traditional literary theory, which we extend to articulate a novel technique for the design of storybook apps for children aimed to support both independent and shared engagement. This research is relevant to practitioners who are interested in: creating apps that support reading, fostering the joy of engaging with text, and helping pre-literate children (usually 3-6 years old) understand written content.

We call our new technique the "Counterpointed Triad Technique" based on theory relating to the design of traditional printed picture books [34]. Our technique centers on the design of visuals, text and audio where each conveys different aspects of the story. We demonstrate our technique through our original storybook app "*How Far Is Up?*" (Fig. 1). *How far Is Up?* is an elaborate storybook app that we created, including story development, illustrations, animations, audio composition and programming. To understand its potential use, we studied 26 children reading it alone and with an adult in a kindergarten. Our exploratory study suggests that our storybook app seems to support both independent and shared engagement, therefore story app designers might benefit from knowing about our Counterpointed Triad Technique.

This paper's contribution is threefold: we present the Counterpointed Triad Technique to support both independent and shared storybook app engagement, a novel storybook based on this technique, and an associated study using the app in a kindergarten. Although we focus on storybook apps in this paper, we believe our technique could also be applied to other narrative based interactive designs, such as games. We begin the next section by articulating related work. We then describe the design process, detail our creative work, explain the Counterpointed Triad Technique and report on our study. Finally, we discuss our results and conclude with future work.

## BACKGROUND

The use of interactive features to entertain and teach children is not new to the digital age: for centuries, interactive (analog) features have been incorporated into printed books in order to engage children [41]. Children's narrative theorist Madej explains: "Pop-up, open-the-flap, and peep-through-the-hole books give children the opportunity to play and learn as they make things happen" [24]. The inclusion of such features in children's books can be traced to a four-hundred-year-old educational tradition [20, 24]. In most recent years there has been extensive growth in the availability and range of technology for children [11, 12, 13, 25]. From a very young age, children can access and use mobile devices [4, 6, 14, 17, 29], which is the most common platform for apps. Children can interact with a mobile touchscreen in a manner that is suitably matched with their motor skills [14]. Due to the success of these mobile devices, it has been noted that children in networked cultures seem to increasingly spend more time using apps and less time reading printed books [29].

Research suggests that if children use an app while they are alone, they may consider it to be a "play thing" that serves an entertainment purpose [25]. However, when an adult and a child experience an app together, they consider it to be a "learning tool" [25]. It therefore appears that the manner in which apps are experienced influences the child's attitudes towards the content.

Research that focused on the ways that school and university students comprehend audio-visual-textual

content shows that this demographic has a stronger understanding of information when it is presented in both visual and audio form [26]. Furthermore, when an audio narrator reads text that appears on the screen, students will listen to the audio, watch the visuals and disregard the text [26]. This is important for our work as audio narration might also make text redundant for children, whereas adults who read text with the children may foster engagement with the text.

There is also research from a cognitive science perspective on how children read and learn from apps such as storybooks [44, 45, 46]. We were inspired by this work and are interested in developing a qualitative understanding of this design area from a designer's perspective. We learned from this range of prior work that some storybooks contain a "digital tutor" that functions as a "conversational agent" [31, 44]. These designs attempt to digitally replicate the role that an adult usually plays in shared reading experiences [31]. A digital tutor typically helps children navigate the app and may ask the children direct questions in order to assist them in learning from and understanding the content [44]. Associated studies revealed that the "the best dialogic reading occurs [when] the parents read the book together with their child" using the digital tutor to help promote discussion around the app's content [31]. We learn from this that a digital tutor can be a useful support tool, however adults still have a vital role to play when it comes to children's engagement with apps.

In summary, despite the associated benefits for children in engaging in shared reading of storybook apps, children tend to engage with them whilst they are alone. We believe the design of these apps is partially responsible for this. Yet if designers want to support both independent and shared experiences, there is not much knowledge available that could guide them. In order to address this gap, we answer the following research question: *How can we design children's storybook apps that support both independent and shared reading experiences?*

In order to address our research question we designed a storybook app *How far Is Up?* This work is informed by the Counterpointed Triad Technique, both of which we explain next.

**THE COUNTERPOINTED TRIAD TECHNIQUE**
The idea of counterpointing comes from the study of traditional picture books [34]. Some picture books contain the same story content in the text and visuals; this is called symmetrical design [34]. However, some picture books display text and visuals that tell different parts of a story, this is called counterpointed design [34]. Counterpointed design is where the focus is on emphasis by contrast. We use the word triad as we are inspired by the (analog) work of Nikolajeva and Scott who describe a counterpointed triad that occurred between the text, the photographic imagery and the hand drawn imagery that was displayed in one particular printed book [34]. We bring this notion of triad

and counterpointing to the digital realm by constructing a counterpointed triad involving the text, visuals and audio within apps. By articulating a set of strategies on how to engage the counterpointing technique, we also turn a previously descriptive structure into a prescriptive tool. In doing so, we formally name this "Counterpointed Triad Technique" and present it here as a design approach to guide the design of apps for children.
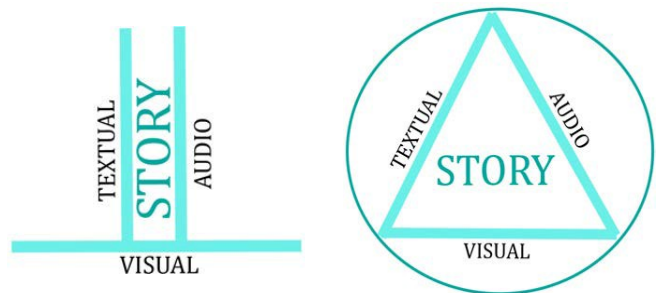


**Figure 2. Symmetrical (left) and counterpointed (right) design.**

The Counterpointed Triad Technique operates in contrast to most digital app designs where the textual and audio aspects are symmetrical [34]. Within a symmetrical design, the written and verbal content reflect the same narrative information (Fig. 2 left). Examples are the aforementioned apps for children that feature a narrating audio track that reads the written text that appears on the screen [41]. In contrast, the Counterpointed Triad Technique delivers different narrative information in the text, visuals and audio (Fig. 2 right). As a consequence, we propose that designs created using our Counterpointed Triad Technique will be able to maximize the communication potentials of different media, as suggested by Nikolajeva and Scott [34]. Readers may need to use their imagination in order to decipher meanings from counterpointed apps. In doing this they become "active" readers who are engaged in uncovering narrative meaning [34].

When designers use this approach in apps, we believe that the result may provide children with a more richly detailed story environment, resulting in the opportunity of adults and children becoming engaged together through discussing the content and consequently establishing a more richly formed notion of the story.

**The Counterpointed Triad Technique in *How Far Is Up?***
The relationship between the visual, textual and audio aspects of *How Far Is Up?* has been consciously designed so that each operates in relation to the others. We propose to use the term from the technique, i.e. we say that the visuals, text and audio have been *counterpointed*. As a result, the three central aspects of the app impart separate narrative messages, and together, they present a story [34].

The Counterpointed Triad Technique may be further understood through a study of Fig. 3. The visuals show some of the characters playing in a tree. The text further describes the visual action. The textual dialogue shows one

character exclaiming, "Yippee". It also shows another character saying, "Come down, you are too far up". Eye-tracking studies reveal that children's attention is drawn to animated visuals [44, 45], and when audio narration describes aspects of imagery, children tend to "fixate more often and longer" on the corresponding visual detail [46]. Consequently, in the scene displayed in Fig. 3 we used the allure of animation and accompanying audio with the aim of directing the child's attention to narrative content. For example, the audio narrator in this scene states: "Up. The tallest tree branch". If children try to match the audio information with the visuals, as prior work suggests they will [36, 45, 46], they may look and see one character in the house and another swinging from the tree. Upon further inspection they may discover a further character who is located on the tallest branch of the tree. The app's readers are rewarded for engaging with the counterpointed content; they are provided with extra narrative detail relating to the characters.



**Figure 3. The visuals show the action of the story; the text further describes the visual action.**

Each of the central aspects of the app contains different narrative messages. When combined, the visual, textual and audio content communicate multilayered levels of narrative information, where the combination is more powerful than the sum of the parts. One key aspect of our story app's counterpointed design lies in the way in which the written and verbal texts are formed. The text and audio present two distinct narrative strands across two different structures of the app. One effect of this technique is that in order to understand the text, a pre-literate child will need the text to be read aloud. Furthermore, the written text appears after the audio narration has concluded. This may suggest to readers that the written text contains different information to that in the narration. A child may still understand and enjoy the app while they are engaging with it independently, yet by engaging with an adult they may uncover deeper narrative content.
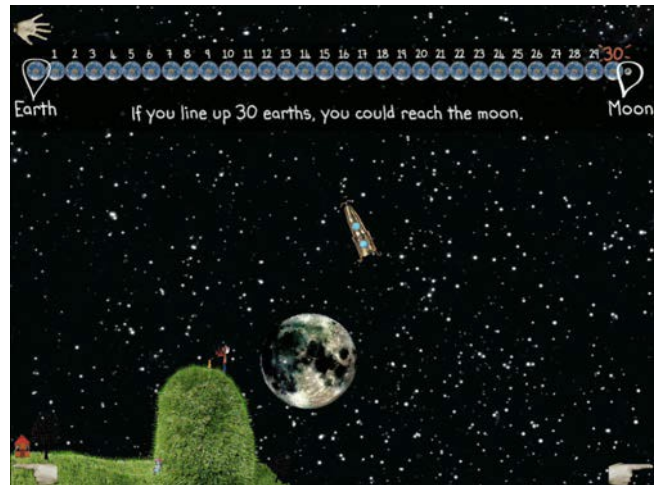


**Figure 4. The visuals and accompanying text are animated, offering children a playful counting activity.**

Another example of the Counterpointed Triad Technique can be examined through studying Fig. 4. The imagery in this figure shows the characters standing on a hill. The text shows facts about space and the audio narration tracks the story's progression through space. It says: "Up. Past clouds". When combined, the visual, textual and audio content communicate multilayered levels of narrative information.

We aimed to maintain a refined level of animation, as too much animated movement can visually "overload" young children [46]. An example of this refined animation style can be seen in Fig. 4. This figure shows a row of identical photographs of planet Earth with corresponding numbers. These visuals operate as an invitation for children to engage in a counting activity. The animated imagery shows the progressive appearance of planets and corresponding numbers; children can read the numbers and count each planet as it appears on the screen. The design draws on the alluring qualities of animation with the aim of directing children's attention to a simple counting task. The accompanying written text further describes the visuals; this text invites the children to imagine the distance between Earth and its moon. The counterpointed approach may encourage children to engage both their quantitative and imaginative skills.

We note that counterpointed content does not reinforce a single narrative viewpoint [34]. For example, both children and adults are invited to participate in forming their own narrative meanings from *How Far Is Up?*: they may play with the counting activity, or learn about the distance between Earth and its moon, or imagine embarking on a space voyage. There are a variety of ways to interpret the multilayered information contained in the storybook. Furthermore, the counterpointed design aims to provide children with a scaffolded learning experience; catering to a variety of skill levels. We designed *How Far Is Up?* so that it contains information that may challenge young minds.

For example Fig. 4 includes imagery and written text that describe the distance between the Earth and its moon. When engaged in shared experiences, we anticipate that adults may assist children in forming deeper understandings of this concept.

Lastly, we aimed to underline the counterpointed content by drawing from both digital and non-digital materials. For example, the app begins with a visual that depicts a hand-made theatre-style curtain. This curtain gradually opens to reveal the full fictional environment across the opening scenes of the app (Figs. 1 & 3). This curtain is designed to replicate conventions used in live theatre production. Similarly, the text is presented in the form of handcrafted typography, derived from the act of hand-embroidery and handwriting. The musical score features acoustic instrumentation while the sound effects include natural bird song recordings. These elements reference the cultural act of playing a musical instrument and the experience of being amongst geographic natural elements. As such, we aimed to deliberately offer audio-visual-textual connections to the geographic and cultural surroundings in order to underline the counterpoint in style [34].

## HOW FAR IS UP? THE DESIGN
*How Far Is Up?* is an iPad app that can be found on the App Store [42]. It is designed for audiences aged three to five. This story app combines a comic fictional narrative with factual NASA data. The story features a five-year-old child protagonist who is curious about how far he can travel into space. As a result, he embarks on a voyage to the outer reaches of the universe accompanied by a dog and a mouse. Finding themselves in peril, the shy dog leads the trio safely home to Earth. The app begins on the Earth's surface and the action moves progressively away from this starting point as the narrative unfolds.

The lead author wrote and illustrated the app's story, constructed and photographed the visual settings, animated the imagery, composed and performed the music, performed the audio narration, created the typography, and did the programming within the software Demibooks Composer Pro. The *How Far Is Up?* app took three years to make. A practice-based methodology was used to design the app, this involved studio practice and evaluation processes [2, 3]. Design-led methods were also adopted [18, 21, 22, 23], the aesthetic qualities, materials, and making practices informed the design process.

After an initial detailed design phase, the app was exhibited at a peer-reviewed interactivity conference venue where approximately 50 people interacted with it. Following this interactive exhibition, the design was further refined. The app was then exhibited at another interactivity showcase. At this second exhibition, approximately 150 people interacted with the app. Both adults and children engaged with it during these two exhibitions. Exhibition attendees had the opportunity to experience the app independently and to interact with it in social groupings. After the second exhibit,

further modifications were made, and the final version was then part of a "children as users" [9, 10] study.

## THE STUDY
We wanted to explore how children would engage with *How Far Is Up?* and conduced a study where children read the storybook independently and with an adult. We recruited 26 children from a kindergarten in a large English-speaking city. In alignment with our region's national curriculum for three- to five-year-old kindergarten students, the participants had been learning about outer space. *How Far Is Up?* provided further resources for this learning focus. Of the 26 children there were: 6 three-year-olds (3 girls, 3 boys); 12 four-year-olds (8 girls, 4 boys); and 8 five-year-olds (4 girls, 4 boys), fitting the target age group of the app. The uneven number of four-year-old girls to boys was due to absences on the days of the study.

We deliberated whether to conduct the study in a kindergarten or at children's homes. As this app supports educational attainment and it supports local kindergarten curriculum, we decided to test it in a kindergarten environment. This also enabled us to recruit a relatively large number of children.

The study was conducted in a kindergarten room known as the "library". The children regularly use this room for quiet reading. *How Far Is Up?* was the only app that the children had access to on the iPad we supplied. The children at the kindergarten do not normally use iPads in their daily routine. They do, however, use desktop computers, alongside adults, in order to conduct "research" activities. Almost all of the children (24 of 26) had previously used an iPad. Of those who had used an iPad before, most (20 of 24) had only used one whilst they were alone. 2 children had used an iPad with their siblings. 1 child had once used an iPad with their mother, and 1 child used an iPad regularly alongside their father in order to play games. This confirms the notion that most computational usage occurs whilst alone [33].

As part of the kindergarten's routine, the staff run daily structured storybook readings. During these times a kindergarten teacher reads printed picture books to the children as a group. There are also informal individual and shared reading activities that are carried out in an unstructured way throughout the course of each kindergarten day. As a part of these informal reading activities, children are encouraged to read books independently and staff also read stories with individual children.

It is known that children often read the same storybook multiple times [30]. They also read them in numerous ways: whilst alone, alongside friends, alongside siblings, with a parent or grandparent, at home or in a kindergarten. During this study we did not have the resources to study our app design in each of these situations, so we chose to give the children the autonomy [37, 38] to direct their storybook

experience. All of the children in the study chose to firstly engage with the storybook independently. They then engaged with it together with an adult. Two children started alone and partway through asked if they could share with an adult, which we allowed. We chose this approach (rather than, for example, a counterbalancing approach) because we wanted to provide an environment that was as close to "natural" as possible within the confines of a study.

During their storybook sessions, we observed and recorded data using a video camera and by taking written notes [13]. The children were accustomed to video devices being used in the kindergarten as the teachers regularly record some of the children's play activities in order to provide families with mementos of their children's kindergarten experience.

During the study there was only one child in the library room at any time. When a child entered the room we allowed them to sit or lie down in any place and in any way they wished. We directed a small camera towards the child's chosen position, rather than asking them to position themselves in front of the camera. This was with the aim of replicating the ways in which their activities are normally videoed at the kindergarten. We aimed to create the most comfortable, natural environment possible.

We did not leave the children alone in the room during the independent sessions; the adult took notes yet aimed not to draw attention to herself. If the children asked the adult in the room any questions about the storybook during their independent time, we politely replied that we cannot answer the question at the time but will answer them at a later stage. This was inspired by a domestic or educational setting where a child may be expected to have a storybook experience independent of an adult. It should be noted that none of the children who asked questions during their independent time appeared surprised or in any way upset by our response, they just continued on with the activity in the same manner in which they had previously been engaged.

Our study involved pre- and post-task interviews [25]. The children were interviewed before and after their first reading session and before and after their second reading session. The interviews and shared sessions were conducted either by one of the kindergarten's regular teachers or by the primary researcher. The primary researcher has conducted workshops and activity sessions in this kindergarten across a ten-year span. Children who participate in studies have been known to give responses that they think will "please" the adults who are conducting the study [13]. The primary researcher is familiar within this kindergarten community, as was known to the kindergarten teacher who assisted in the study. This helped create a relaxed atmosphere and may have assisted in garnering candid responses from the children.

We did not observe any engagement with the app over longer time periods as we did not want to further burden the kindergarten staff. Yet we acknowledge that longer-term studies could reveal additional insights into the use of such apps for children.

At the conclusion of the study, the data relating to each child's response was logged into a digital system. Our analysis followed thematic analysis [1]. In order to understand the different ways that the children engaged with the storybook we examined and organized the data, and arrived at seven coding categories. We then condensed and further organized the data creating four central categories of investigation. The central coding categories relate to: active engagement versus disengagement, how the children felt about the app's activities, the children's responses to the counterpointed design, and the children's responses to the shared activity.

## FINDINGS
We now report on the findings from our study with the 26 children. All of the names of the children have been changed in order to preserve anonymity.

### Active engagement versus disengagement
While reading the app alone, 24 (of 26) children were observed as being "actively engaged" in this activity. By actively engaged we mean that the children carefully watched the animated sequences, triggered interactive elements, and verbally commented on the story content. Two children were observed as being disengaged during this activity, exhibiting behavior that suggested paying little attention to the content.

During the shared sessions 25 of the 26 children were observed as being actively engaged. These children discussed the action shown in the animated sequences, triggered the interactive elements, and talked about personal experiences that related to the story. One child was observed as being disengaged during the shared session. This child only read part of the story during this activity and did not engage in conversation or trigger the animated sequences. However, the majority of the children appeared to be engaged in the storybook during both the independent and the shared session.

### How the children felt
Before and after both of the reading sessions, the children reported how they felt using a "smileyometer" [25]. We acknowledge that the smileyometer has limitations [25], yet we have used this method successfully in our prior work [15] so we decided to use it as a supplement to our observational, note and interview data.

After engaging with the storybook alone, most of the children (24 of 26) reported no change or an improvement in how they felt. 20 children reported that the storybook was "really good" or "brilliant" after their independent session.

After the shared session 24 children reported no change or an improvement in how they felt. 22 children reported that the app was "really good" or "brilliant". Most of the

children reported that they enjoyed the storybook during both independent and shared sessions, a small number of children (2) enjoyed the shared session more than the independent session.

**The children's responses to the design**
During the independent sessions 17 children engaged in the counting activity that appears in Fig. 5. For many of the children this was one of the first times that they paused their progress through the narrative to explore the digital environment. 3 children returned to this activity multiple times, completing the task two or three times. During the shared session 25 children engaged in this activity. These children watched the animation, counted out aloud, asked questions about the space objects and the meaning of the written text. This simple animation earned prompt and repeated attention from the majority of the children (refer to Fig. 5). The counting task provided the children with not only animated features but with opportunities to interact with the app's content.


**Figure 5. Five-year-old Deepti during the shared session.**

One challenge in designing for adult participation is that the adult "might not know which words to comment on or which events to discuss" [45]. The counting activity appeared to provide the children as well as the adults with a clear opportunity to pause and discuss narrative content while engaging in a story-related task.

During their independent session 16 children activated all or many of the interactive activities in the app, while 7 children engaged in some activities and 3 engaged only the navigational features. During both independent and shared sessions, the interactive activities allowed the children to relate to the content in individualized ways. For example, 2 of the three-year-old boys and 1 three-year-old girl were observed writing the first letter of their name in the light blue "particle images" displayed in Fig. 6.
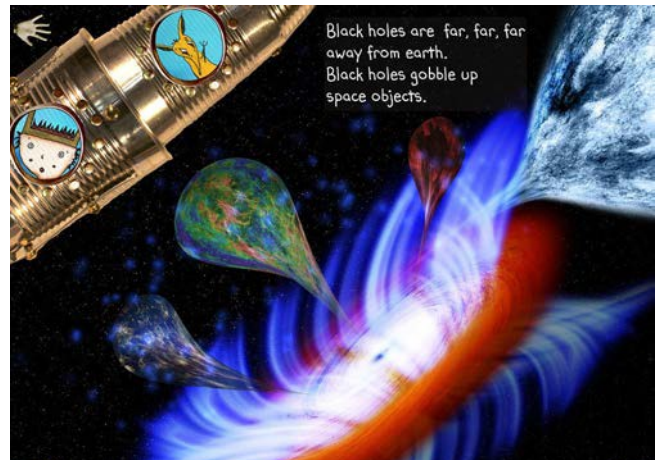

**Figure 6. The child is able to draw particle image shapes on the screen. In doing this, some children wrote their names.**

After engaging with the app independently, 18 children could articulate what they thought the story was about. All of the 26 children could articulate what they thought the story was about after they had engaged with the app together with an adult. The children who articulated their concept of the narrative included the words "up", "travel", "space," "sky," "rocket" or "moon" in their story descriptions. That is, they acknowledged that the story related to space travel or space objects. 4 of the children who did not articulate an account of the narrative after their individual sessions instead discussed how the app reminded them of their own experiences. For example, when discussing the app, Zac talked about how the stars in the app reminded him of the night sky during a recent camping trip. Other children discussed experiences including visiting planetary museums. Three-year-old Li looked at the image of the moon in the app and then picked up a globe of the world (one of the kindergarten's regular objects). Li then spent twenty minutes discussing his ideas relating to his physical location on Earth, using the globe as a point of reference. The children who related the app's content to their own experiences displayed what we would describe as high levels of excited behavior and very high levels of engagement at the conclusion of their shared reading sessions.

During the sessions 4 children asked the adult about the meaning of the written text. The low number of inquiries regarding the written text is perhaps not surprising, as it is known that pre- and semi-literate children spend about 90% of their time looking at digital picture book imagery and apply little attention to textual content [45]. The children had a variety of responses to the text. For example, 5-year-old Sarah pointed to the text (after the narrative audio was played) and asked: "What does that say?" The children who enquired about the meaning of the written text appeared to be eager to discuss the textual content with the adult. For example, Deepti seemed excited at the prospect of reading together with an adult (Fig. 5). She said: "OK, let's read a

story!" Many of the children showed visual signs of excitement at the prospect of reading the app alongside an adult.



**Figure 7. Five-year-old Zac during the independent session.**

**The children's responses to shared reading**

At the beginning of the shared session 15 children handed the iPad to the adult, with the expectation that the adult would hold and operate the device. These children were leaning forward towards the adult and the device, or they used verbal language that showed that they expected that the adult would have some story information to offer during the shared session. For example, five-year-old Zac (Fig. 8) did not use many words at the end of his independent time but showed physical signs of excitement and interest, such as wiggling with delight and leaning forward towards the adult and the device, prior to his shared session. At the end of his shared session, Zac used a total of 36 words describing what he thought the app was about and he concluded with the statement, "Reading really makes you think". Zac was engaged during the independent session but showed more verbal signs of engagement after his shared session. It should be noted that we expect that children's understanding of the story would have improved after reading the app a second time. Only one child showed a reluctance to share the device with the adult during the shared session; she said to the adult: "Don't touch it!" (referring to the device).

**STRATEGIES FOR DESIGNING ENGAGING COUNTERPOINTED STORYBOOKS**

We now put forward five strategies for designing engaging counterpointed storybooks based on our craft knowledge having designed *How Far Is Up?* and from our findings from the study. These strategies are intended for designers as practical guidance on how to engage with the Counterpointed Triad Technique when aiming to create engaging storybooks. Although we focus on storybooks here, we believe the strategies could also be applicable to a wider range of apps that include a narrative (such as many games), and hence they might be useful for a range of practitioners who create interactive content creation.

**Consider using animation to direct users' attention to narrative or educational content within the counterpointed design**

During our design process, we found that the use of animation could be very helpful in directing a user's attention to crucial narrative or deeper educational content within the counterpointed design. The children's responses to the content shown in Fig. 4 seem to confirm this.

We are aware that although animation has been previously used successfully to engage children in digital content [5, 45, 46], the use of high levels of moving imagery can visually overload children; the result being that the overuse of the alluring qualities of the animation may distract them from the narrative content [41, 44, 45]. We therefore suggest that designers may elect to utilize animation judiciously. For example, we used minimal levels of animation in combination with implied visual movement (within our static illustrations).

**Consider pausing reading momentum to allow for engagement with the narrative or educational content within the counterpointed design**

As the "active engagement versus disengagement" study section highlights, users can acquire a momentum when engaging with the story, which is welcomed. However, our observations suggested that users can also benefit from a brief pause in the narrative momentum. For example, when reading alone some children engaged with the counting activity in Fig. 6. Others continued reading with the same momentum, not pausing to engage in the counting activity. Most children stopped to engage in the counting activity during the shared reading time, this paused their reading of the story. This pause offered opportunities to engage with content that directly related to and further informed the central narrative. This pause may also allow children the opportunity to process the narrative action that has occurred so far and imagine what may occur next. This pause was placed at a crucial time in the narrative; the moment before the characters engaged in space travel. When engaging with an adult, this pause facilitated a moment for discussion between the child and the adult around the narrative content. Designers should be aware that interrupting reading momentum with unrelated or more involved activities may cause users to become distracted and not complete the story. As such, we highlight to designers that a small narrative-related activity may be placed at a crucial point in the story to provide a brief pause in reading momentum. This may allow readers the time to process and more deeply consider the narrative content.

**Consider supporting self-expression within the counterpointed design**

The particle drawing activity (Fig. 6) was a focus for users during both independent and shared reading sessions, as detailed in the results section. This simple activity provided

the children with the opportunity to draw and have fun within the narrative environment. The fact that the children used the particle drawing activity to write their names' letters suggest that they used the activity to express themselves, and this self-expression was then shared during the adult-child reading time. This sharing facilitated further engagement with the story through social means, providing a self-directed entry point to the narrative content.

We know from prior research that interactive activities as part of iPad experiences are appealing to children [31, 45]. Furthermore, we also know that supporting self-expression as part of such interactive experiences is welcomed as it can offer users a sense of autonomy [39]. Here we extend this prior work by proposing that interactive activities that support autonomy, such as allowing for self-expression, can serve as self-directed entry point to counterpointed content. However, we acknowledge that so far we only have implemented one example in our app that supports such autonomy, hence we encourage other designers to explore additional ways to utilize self-expression.

### Consider using style as a counterpointed design element

The Counterpointed Triad Technique suggests that text, visuals and audio each can tell a different part of a story. Through our design process, we also counterpointed stylistic elements of the app. In particular, the *How Far Is Up?* story often related to abstract concepts that can be hard for children to grasp, for example, outer space, infinity and black holes. To provide a contrast to these abstract concepts we designed visuals that were tangible and material, such as maps and globes, and created them using crafting techniques, for example, we scanned in hand-drawn images, took photos of actual models we built, etc. Our study results suggest that our style of using handcrafted materials in combination with complex conceptual ideas was a useful trigger that helped the children create a link between the physical qualities of the visuals and their own experiences in the geographic world that they inhabit. The material qualities used in the app seemed to remind the children that they are situated in a physical world. When engaging together with an adult, the material qualities appeared to invite the child to discuss the story's content in relation to the geographic environment they inhabit. The example of the child grabbing a globe of the world to talk about his location on earth and his own holiday experiences as described under the "children's responses to the design" section is a case in point here.

The benefit of using crafting materials within technology designs for children and their parents has been previously highlighted [15]. Here we extend this work by advocating its benefits within counterpointed designs. As such, we highlight to designers that style could also be a counterpoint content opportunity, which can potentially support users in relating digital story content to their personal experiences.

### Consider timing when designing text and audio within the counterpointed design

Within our app's design we counterpointed the text with the audio, as described in Fig. 4. The audio tracks the characters' progression through space, whilst the written text presents dialogue and provides factual and educational information relating to distances that occur in space. During our design process, we found that this counterpointing appeared to work better when we displayed the text *after* the audio narration concluded, rather than at the same time. We experimented with different timings as to when to present text and audio, and in the final design displayed text directly after the audio narration concluded. However, we acknowledge that of course we have not explored all possible temporal offsets.

## DISCUSSION

We now discuss our findings, and highlight what designers might learn from our work, what the advantages and limitations of our approach are, and how additional counterpointed designs could be evaluated further in kindergarten and home settings.

### What designers might learn from our work

Our results suggest that the Counterpointed Triad Technique could be useful when creating app designs for independent and shared reading experiences. In particular, we have shown that the technique can result in a storybook that is engaging for children who are alone yet provides a role for adults during shared reading sessions. Our results highlight that children can enjoy apps with adults, contrasting previous studies where children have reported that they do not enjoy shared app engagement with adults; these studies were conducted with symmetrical storybooks. Hence we propose that the Counterpointed Triad Technique may be a useful tool for practitioners who aim to create engaging app experiences that suit a variety of contexts.

We acknowledge that our work has limitations, as do most studies that involve children. For example, we acknowledge that the children could have been uncomfortable during the study due to our presence; however, the children did not display visible verbal or physical signs that they were uncomfortable. Although most of the children were familiar with using iPads we also acknowledge that it is not a device regularly used in this kindergarten, so some children were more familiar with the device than others. Furthermore, due to the practicalities of the kindergarten context, our children's age range was between 3-6 years, this range is slightly different to the age range the smileyometer is designed for (5-7) [25], yet we believe that our children were able to use it in the intended way. Lab-based studies could recruit children of specific development stages (rather than across an age-range), and we believe this could complement our work. The same applies to comparative studies that compare our design to others, however, we highlight that our focus was on providing a qualitative

design understanding that pays attention to experiential qualities, hence our choice of methods.

### The advantages and limitations of our approach

One advantage of a non-randomized study is the ability to provide participants with autonomy [48]. This may be an important factor within a kindergarten setting; it indeed supports the ways that activities are run within our kindergarten system. Our non-randomized approach provided the children with the autonomy to choose if they wanted to start with an independent or with a shared reading activity. They could engage in both activities and do the activities in any order. This approach had the added advantage of providing us with data on the children's reading preferences. It should be noted however that this approach does have disadvantages. These disadvantages include limited replicability and comparability to other studies.

### How counterpointed designs could be evaluated in kindergarten and home settings

Future studies involving additional methods may provide further insights into the effects of counterpointed design and the Counterpointed Triad Technique. This may involve studies in homes and in educational settings such as kindergartens. These studies may provide us with deeper understandings of the relationship between counterpointed techniques and individual and shared readings of narrative apps.

We also acknowledge that as we only examined one app (albeit one that is extensive with a significant amount of content), other implementations of the Counterpointed Triad Technique as well as other approaches towards studying the accompanying user experience could reveal additional insights.

### CONCLUSION

Interactive storybooks, such as those designed for the iPad, are continually popular with young children. These storybooks offer multiple ways to convey a story, however, there is the need for further research into how to design for both independent and shared reading of story apps. We introduced the Counterpointed Triad Technique. Derived from traditional literary theory we extended it to digital storybook design. In doing this we emphasize that visual, textual and audio content can each convey different aspects of a story. We present this as one possible approach that may be adopted by designers in order to support individual and shared reading of story apps. We explore the use of this technique through the design of *How Far Is Up?*. A study involving 26 kindergarten children suggests that *How Far Is Up?* can engage them alone and when reading with an adult. Based on our craft knowledge and study findings, we propose five design strategies that aim to provide designers with practical guidance on how to create engaging interactive storybooks.

Our research provides designers with a technique that results in counterpointed app content. It operates as an alternative to current symmetrical design content that features redundancy within its content. Although our approach focuses on the design of apps that feature a story, we believe it may also be applicable to other interactive experiences that use other hardware, such as augmented reality where virtual and real-world story content could be counterpointed and other content forms, such as games, where interactive features direct players to counterpointed content. Our work represents a beginning towards a more comprehensive understanding of counterpointed design in order to support both independent and shared sessions, so that ultimately, more and more children as well as adults can profit from the benefits of engaging in both experiences.

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