

Learning to Use App Book Features During Buddy Reading

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Abstract

To understand how children learn to activate digital features through social interactions, we explored how 10 kindergarten peer buddies and digital features shaped the Zone of Free Movement (what is available in the learning environment) and Zone Promoted Action (what attempts to draw learners' attention in the learning environment) across 15 buddy reading sessions to support a shift from a buddy's Zone of Proximal Development (what they are ready to do with support) to their new Zone of Actual Development (what they can newly do independently—i.e., learning) for activating digital features in the app book. Emergent coding and constant comparative methods were used to develop codes and identify patterns. Buddies employed four actions to mediate their buddy toward effective use of the app book features: (1) verbal mediation and pointing; (2) modeling feature use; (3) both 1 and 2 and (4) physical support for activating a digital feature.

Keywords: Buddy reading, app books, digital books, electronic features, digital features, Zone Theory

1. Introduction

Technological progress has created an educational opportunity for children to use interactive, multimodal digital texts both at home and in school (Blackwell et al., 2015; Kabali et al., 2015; Rideout, 2017; Shuler, 2012; Wang et al., 2019). Interactive, multimodal app book reading is distinguished from reading traditional texts due to its multimodal features (e.g., sounds, animation, hotspots) that can be activated by children's touch. An app book is an interactive, multimodal, digital book accessed via tablet or phone via an app. Unlike traditional books, app books incorporate dynamic features such as animations, sounds, and interactive hotspots that can be activated through touch, offering a more engaging reading experience by combining visual, auditory, and tactile elements (Kucirkova et al., 2017; De Jong & Bus, 2003). In contrast to traditional text reading, app book features create new and more complex pathways of engaging children in reading (Geist, 2014; Marsh et al., 2015).

Digital features in these books can potentially assist children in making meaning (Wang et al., 2019). Thus, children's ability to use these features is important (Blackwell et al., 2015; Kabali et al., 2015; Rideout, 2017; Wang et al., 2019). However, while research has explored how children learn to engage in collaborative meaning-making while buddy reading with app books (Christ et al. 2018), it has not explored the more basic question of how children learn to use the digital features in app books. In prior research on app book buddy reading, the emphasis has largely been on understanding how young peer buddies contribute to each other's comprehension through meaning-making processes (Brown, 2016; Christ et al. 2018; Simpson et al., 2013; Wang et al., 2019). Recognizing the potential of digital features in these app books to enhance comprehension, this study undertakes a fine-grained, microgenetic analysis of the kindergarten peer buddy reading context to understand how both a child's buddy and the app

book features themselves potentially mediate a child's learning to use a digital feature. This study can inform improved design of peer buddy reading learning contexts and app book features.

1.1 Theoretical Framework

From a sociocultural perspective (Vygotsky, 1978), young children acquire knowledge via interactions with others and through the use of cultural instruments such as multimodal interactive app books (Plowman et al., 2010; Stephen, Stevenson, & Adey, 2013). The digital features, such as hotspots, navigation, etc., have the potential to mediate children's world through creating interactive media environments that support children's meaning-making experience (Kucirkova, Sheehy, & Messer, 2015; Marsh, 2016; Neumann & Neumann, 2014). Additionally, the digital buddy reading environment is replete with collaborative exploration and practice (e.g., sharing ideas, explanation). This environment could also assist students' experience of reading as a sociocultural phenomenon (Javorsky & Trainin, 2014).

To better understand how both digital features and buddies may mediate young children's learning to use digital features, this study adopted Valsiner's (1987) Zone Theory to undertake a microgenetic analysis. Inspired by Vygotsky's notion of Zone of Proximal Development, Valsiner (1987) introduced interactive zones as a developmental model by conceptualizing two more zones, the Zone of Free Movement (ZFM) and the Zone of Promoted Action (ZPA), which support or constrain a child's development. The ZFM refers to the boundaries, constraints, and restrictions that are applied to the context (Lightfoot, 1988; Blanton et al., 2005). For example, ZFM considers what digital features are available in the book, and what functions they allow. The ZPA refers to the "set of activities, objects, or areas in the environment" (Valsiner, 1987, pp. 99–100) that are used to convince a child to act in a certain way (Blanton et al., 2005). For

example, ZPA considers how a digital feature might light up, encouraging a child to touch it; or a buddy might suggest pressing a feature. The ZFM and ZPA could potentially support a student to shift from their Zone of Proximal Development (i.e., when they need support to use a digital feature effectively) to their new Zone of Actual Development (i.e., when they can newly use the digital feature effectively and independently; see Figure 1).

Further, since both buddies and features can potentially shape the ZFM and ZPA during interactive app book peer buddy reading, we adapt Valsiner's Zone Theory by creating subcategories that reflect this: Zone of Free Movement shaped by a buddy (ZFM-B), Zone of Free Movement shaped by a digital feature (ZFM-F), Zone of Promoted Action shaped by a buddy (ZPA-B) and Zone of Promoted Action shaped by a digital feature (ZPA-F; see Figure 2).

1.2. Research Question

Our research question is the following: How do kindergarten peer buddies and digital features shape the Zone of Free Movement (what is available in the learning environment) and Zone of Promoted Action (what attempts to draw learners' attention in the learning environment) during interactive, multimodal buddy reading to support development from their Zone of Proximal Development (what they can do only with support) to their new Zone of Actual Development (what they can do independently) for activating digital features in the book?

2. Literature Review

Buddy reading offers a social atmosphere in which emerging and beginning readers may collaborate to engage with text (Christ et al., 2014; Flint, 2010). Broadly, buddies' patterns of interactions during app book reading impact to what extent the buddies support one another's engagement with the text (Christ et al., 2015). Young children have been observed engaging in the following patterns during buddy reading: (a) parallel functioning where each buddy works on

their own without interacting with the other buddy; (b) collaborative interactions through which buddies interactively engage with the text; and (c) tutor-tutee interactions where one buddy instructs the other buddy about how to engage with the text.

More specifically, studies have shown specific impacts of children's interactions during buddy reading with digital books. For example, a case study by Erdemir and Brutt-Griffler (2020) underscored the importance of social interactions that provide language feedback for English Language Learners' vocabulary learning during app book buddy reading. Likewise, a series of studies by Shamir and colleagues showed that interaction between buddies during CD-ROM book reading supported their book comprehension (Shamir, 2009; Shamir & Korat, 2007; Shamir, Korat, & Barbi, 2008).

Further, studies of buddy reading with digital books have demonstrated that specific interactions support children's learning outcomes. For example, the social interactions between buddies engaged with e-readers or app books abound with monitoring behaviors, such as asking questions, drawing attention, and meaning negotiation that support deeper comprehension (Christ et al., 2018; Brown, 2016). Likewise, Christ et al., (2019) studied 53 kindergarteners' app book buddy reading interactions and observed that buddies supported one another's better inference, critical thinking, and vocabulary meaning generation by asking questions, drawing attention to book content, debating, or negotiating. Additionally, Brown (2016) qualitatively explored second graders' interactive e-book reading and found that buddies provided verbal support to help one another navigate the e-book.

Across previous app book buddy reading studies, the focus has been predominantly on buddies' meaning-making processes to improve their comprehension (Christ et al., 2018; Brown, 2016; Simpson et al., 2013; Wang et al., 2019). However, since using digital features can support

their comprehension process, it seems warranted to also explore how children learn to use digital features through app book buddy reading as well. Exploring this is the focus of the present article.

3. Methods

We employed a case study approach (Yin, 1984, p. 23) which provided an in-depth exploration of how buddies and digital features mediated both the Zone of Free Movement (ZFM) and the Zone of Promoted Action (ZPA) in ways that canalized buddies' movement from their Zone of Proximal Development (ZPD; i.e., when they need support to use a digital feature effectively) to their new Zone of Actual Development (ZAD; i.e., when they can newly use the digital feature effectively independently).

The data used in this paper were collected as part of a broader study (Christ et al., 2018, Christ et al., 2019) in which children across four classrooms engaged with 12 app books. For each book, the teacher first read it aloud and modeled activating the digital features while projecting it on a screen using a document camera (so children could see finger touch and swipe movements). Then, afterward, children were given two opportunities in the same week to read the modeled book with a same-aged buddy. This paper focuses on a subset of the buddy reading data to explore how children successfully supported one another to learn to use the digital features.

3.1. Setting

This paper focuses on data from two classrooms in a Midwest suburban school. These two classrooms' data were chosen because the video-recordings best showed children's finger movements while interacting with the app books (videos for the other two classrooms were more difficult to see and interpret). The school was chosen for the broader study because its students

were diverse ethnically, linguistically, and socio-economically. The kindergarten classrooms were chosen based on teachers in the school who allowed their students to participate in the study.

3.2 Selection of Focal Data from the Prior Study

The first author viewed all 253 buddy reading videos from the two focal classrooms that were part of the larger dataset. Videos to be included in this study were chosen if they had an example of (a) one child initially unable to use a digital feature, and (b) the second child somehow mediating that first child's activation of the digital feature, which resulted in (c) the first child successfully using the digital feature. All videos that did not meet these criteria were excluded from the study. Selecting this subset of data allowed us to focus on how buddies successfully mediated one another's learning to use digital features while reading the app book together. In all, 15 focal videos were identified for analysis.

3.3 Participants

The 19 children who appeared in the selected focal videos were included as participants in this study. Of these, 10 were female and nine were male. Five children were Black, three were Asian, and 11 were White. All children were between 5 and 6 years old. All names used in this study are pseudonyms to maintain the confidentiality and privacy of the participants.

3.4 App Books

Across the 15 selected focal videos, eight app books out of the 12 from the broader study were represented. Table 1 presents the names of the app books that were included in the analysis and their interactive features.

3.5 Data Collection Procedures

The 15 selected focal videos were part of the broader study's 253 buddy reading videos. In the broader study, before buddy reading, children were told to "read with your buddy" and "help your buddy read the book." The sessions were video-recorded to capture the details of buddies' interactions with one another and the app book. Across the 15 videos, 225 minutes of buddy reading interactions were analyzed.

3.6 Data Coding and Analysis

The unit of analysis was the interactive turn each buddy took during collaborative reading. A "turn" started when one child spoke or touched and ended when the other child began talking or touching. Sometimes turns overlapped somewhat as both children talked/touched simultaneously.

We began coding with a sample of three of the focal videos, across which children showed different kinds of interactions related to using the digital features. Initially, the first author determined which Valsiner's Zone Theory construct (ZFM, ZPA, ZPD, or ZAD; Valsiner, 1998) seemed to correspond with each turn from the video data. Next, the first and second authors used emergent coding and constant comparative analysis (Corbin & Strauss, 2014) to generate codes that described how the turn was addressing that theoretical construct (e.g., a child addressed the ZPA by modeling how to touch and use a hotspot in the book). We discussed and honed the codes over time and across the three sample focal videos through a process of separately applying the codes, meeting to discuss coding discrepancies, and then developing consensus and refining the codes or their definitions to align with our developed understandings. This process yielded clearer definitions for each code. Through this process, the codes related to ZFM, ZPA, ZPD, and ZAD emerged (see Table 2) and were used for coding. After the final codes were developed, a sample of five additional sessions from the data pool were coded by two

coders. Inter-coder agreement was 93.1%. Once we had established the reliability of the codes, the remaining seven sessions were coded by just one coder.

Table 2

Zones, constructs, definitions, and codes

Finally, to identify patterns that depicted how the ZFM and ZPA turns were related to the canalization of a child's movement from their ZPD to ZAD regarding the use of a digital feature, we used constant comparative methods (Corbin & Strauss, 2014). Four patterns were found and are presented in the findings section.

4. Results

We found four patterns that described ways buddies mediated each other's shifts toward effective use of electronic features: (1) Children verbally mediated their buddy's digital feature use (i.e., telling them how to engage with the feature) and also pointed out the digital feature (without activating it); (2) Children mediated their buddy's digital feature use by modeling digital feature use; (3) Children mediated their buddy's digital feature use by integrating verbal mediation, pointing out the digital feature, and modeling digital feature use; and (4) Children mediated their buddy's digital feature use by physically supporting them to use a digital feature.

4.1. Verbal Mediation and Pointing Out Digital Features

Buddies used verbal mediation and pointing out digital features to guide their partner's feature use after they were initially unable to use the digital feature independently. Verbal mediation provided oral instructions about how to use a digital feature and pointing showed where the digital feature was located on the page (without activating it). The following excerpt was from a video of Thiago and Sarah (pseudonyms) engaging with the app book, *The Artist*

Mortimer. The page that they discussed in this excerpt had navigation features, such as turning the pages backward or forward, which was activated by touching the upper left or right part of the page.

Line	Student	Transcript	Code	Theoretical construct
A1	Thiago	[the iPad is between the children so that both buddies have easy access]	Share the device	ZFM-Buddy
A2	Thiago	Do you want to turn the page?	Buddy asks question	ZPA-Buddy
A3	Sarah	OK [trying to turn the page, but not finding the right spot to activate the page turn]	Developing ability to use the digital navigation feature (but not yet successful)	ZPD
A4	Thiago	No, come up here [showing the right corner of the screen] or up here [showing the left corner of the screen]	Buddy provides verbal mediation and points to show where the digital feature is located on the page (without activating it)	ZPA-Buddy
A5	Sarah	[Sara followed the successfully turns the page forward by touching the right corner of the iPad]	Developed ability to use the digital navigation feature (activated it)	ZAD

In this example, Thiago framed the Zone of Free Movement by sharing the device (line A1) and Zone of Promoted Action by suggesting his buddy turn the page (line A2). Sarah was unable to turn the page, showing that her ability to effectively use the digital navigation feature was still developing (Zone of Proximal Development, line A3). Thiago mediated Sarah's developing ability by providing a verbal mediation and pointing to show where the digital feature was located on the page (line, A4). This mediation provided enough support to canalize Sarah's developing ability into a developed ability to use the digital navigation feature (line A5). Figure 3 visually presents how movement in the zones interact to canalize learning in this example. The items in the figure numbered A1-A5 correspond with the transcript lines A1-A5.

In another video-recorded buddy reading session, Abby and Kate read the last page of the app book *Pat the Cat*. On this page, buddies could select a menu to start the app book. The following interactions occurred between the buddies while they were preparing to read the book together.

Line	Student	Transcript	Code	Theoretical construct
B1	Abby	[Takes control of the iPad]	Turn taking/controlling device	ZFM-Buddy
B2	Abby	[Tries to go to the menu page, but unsuccessfully]	Developing ability to use the digital navigation feature (but not yet successful)	ZPD
B3	Abby	How can I find menu?	Request information	ZPA-Buddy
B4	Kate	[Takes control of the iPad]	Turn taking/controlling device	ZFM-Buddy

B5	Kate	[Finds the icon that goes to menu] You press this [showing the icon]	Buddy provides verbal mediation and points to show where the digital feature is located on the page (without activating it)	ZPA-Buddy
B6	Abby	[Takes control of the iPad]	Turn taking/controlling device	ZFM-Buddy
B7	Abby	[Presses the menu icon and successfully use the digital menu feature]	Developed ability to use the digital navigation feature (activated it)	ZAD

In the above example, the Zone of Free Movement-Buddy was framed by Abby taking control of the iPad (line B1). She demonstrated developing ability (ZPD) to use the digital menu feature when she tried unsuccessfully to activate it (line B2). Then, she requested help from her buddy (line B3), which shaped the Zone of Promoted Action-Buddy. Kate provided verbal mediation for Abby (“you press this”) and also pointed to show her where to activate the menu on the page (line B5). This mediation helped to turn Abby’s developing ability to developed ability in using the digital menu feature (ZAD). Figure 4 visually presents how movement in the zones interact to canalize learning in this example.

4.2. Modeling Digital Feature Use

In another form of mediation, buddies physically modeled how to use the digital feature after their buddy tried unsuccessfully to use it. This mediation physically showed the buddies how to use the app book’s features without articulating any verbal hints. The following excerpt is from an interaction between Ann and Tanner as they read the app book, *A Shiver of Sharks*. The

app book read the words aloud, highlighted words as it read them, and had hotspots. The hotspot on the page they were reading was a shark that moved and showed its teeth when activated.

Line	Student	Transcript	Code	Theoretical construct
C1	Ann	[Shares the iPad]	Share the device	ZFM-Buddy
C2	Ann	[Tries to activate the shark hotspot] How its [shark's] teeth come out?	Developing ability to move the hotspot (but not yet successful)	ZPD
C3	Tanner	[Touches the shark's head to activate the hotspot. The shark's moves and shows its teeth.]	Buddy models digital feature use to activate the hotspot Developed ability to move the hotspot	ZPA-Buddy ZAD
C4	Ann	Watch its teeth [successfully touches the shark's head to activate the hotspot]	Developed ability to move the hotspot	ZAD

The interaction started with Ann shaping the Zone of Free Movement (ZFM-Buddy) by sharing the device with her buddy (line C1). Immediately, Ann wanted to activate the shark hotspot; however, she was unsuccessful, showing that her ability to activate the hotspot was still developing (line C2, Zone of Proximal Development). To mediate her developing ability to use the hotspot, Tanner created the Zone of Promoted Action by modeling how to activate the hotspot (line, C3). This mediation helped to bridge Ann's developing ability to developed ability to use the hotspot independently (ZAD; C4). Figure 5 visually presents how movement in the zones interact to canalize learning in this example.

Likewise, in another buddy reading session, Vivian and Kyla read the app book, *Being Global*. On the page they were reading, there were two automatically animated color circles that could also be reactivated as a hotspot. The content along with the color circles explained the concept of *Globe* to the children.

Line	Student	Transcript	Code	Theoretical Construct
D1	Kyla	[Kyla holds the iPad closer to herself, but so that the buddy can still reach it, while the book reads aloud.]	Turn taking/controlling device	ZFM-Buddy
D2	Vivian	[Two automatically animated color circles catch Vivian's eye while the text is reading aloud.]	Automatic animations	ZPA-Feature
D3	Vivian	[Vivian touches the color circles, which re-activates them]	Developed ability to move the hotspots	ZAD
D4	Kyla	[Kyla is tapping outside the circle on the screen to try to change the circle's color, but she is unsuccessful because she is not tapping directly <i>on</i> the spot to change the color of the circles.]	Developing ability to move the hotspots (but not yet successful)	ZPD
D5	Vivian	I hit it [the color circles] they both blue. [Shows Kyla how to re-activate the color circle hotspot by tapping <i>on</i> the color circle.]	Buddy models digital feature use to activate the hotspot Developed ability to move the hotspot	ZPA-Buddy ZAD

D6	Kyla	No, they are not [activated because of you. Kyla thinks she is re-activating the color circle, but she is still not activating them.]	Developing ability to move the hotspots (but not yet successful)	ZPD
D7	Vivian	Now, they both blue [tapping on the color circles several times to re-activate them and make them both blue again.]	Buddy models digital feature use to activate the hotspot	ZPA-Buddy
D8	Kyla	[Kyla figures out that she has to tap <i>on</i> the color circle to change the color, and does so successfully.]	Developed ability to move the hotspots	ZAD

Vivian framed the Zone of Free Movement-Buddy by taking control of the iPad and moving it closer to herself, but still allowed her buddy access (ZFM-B; line D1). Then, the color wheel automatic animation focused the Zone of Promoted Action by catching Vivian’s attention (ZPA-feature; line D2). Kyla unsuccessfully attempted to re-activate the color wheels, demonstrating her ZPD (line D4, D6). Then, Vivian further focused the ZPA by modeling the digital feature use by re-activating the color wheel hotspot by tapping on them (ZPA-buddy; lines D5, D7). This mediation helped to bridge Kyla’s developing ability to a developed ability to use the hotspot independently (ZAD; line D8). Figure 6 visually presents how movement in the zones interact to canalize learning in this example.

4.3 Integrated Verbal Mediation, Pointing, and Modeling Digital Feature Use

Buddies also integrated the use of verbal mediation, pointing, and modeling digital feature use to assist their buddies in effective use of the app book features. The following excerpt

is from a video of Nina and Quinlan engaging with the app book, *The Artist Mortimer*. The book had hotspots and read aloud to the children as each page was turned.

Line	Student	Transcript	Code	Theoretical Construct
E1	Nina	[Places the iPad in the middle where both buddies have close access]	Share the device	ZFM-Buddy
E2	Quinlan	Where do you press to turn the page?	Request information	ZPA-Buddy
E3	Nina	I don't know [begins pressing different spots on the screen, trying to figure this out]	Developing ability to use the digital navigation feature (but not yet successful)	ZPD
E4	Quinlan	[Simultaneously pressing different spots on the screen, also trying to figure this out]	Developing ability to use the digital navigation feature (but not yet successful)	ZPD
E5	Nina	[Finds the spot to turn the page, and turns the page]	Developed ability to use the digital navigation feature (activated it)	ZAD
E6	Quinlan	[Asks again] Where do you press to turn the page?	Request information	ZPA-Buddy
E7	Nina	Here [Points to the spot to activate the digital navigation feature]	Buddy provides verbal mediation and points to show where the digital feature is located on the page (without activating it)	ZPA-Buddy

E8	Quinlan	Oh [Presses the digital navigation feature, and the page turns backward]	Developed ability to use the digital navigation feature (activated it)	ZAD
E9	Nina	[Turns the page forward and backward to show Quinlan]	Buddy models digital feature use (particularly how you can turn the page both forward and backward)	ZPA-Buddy
E10	Quinlan	[Activates the digital navigation feature to turn the page forward]	Developed ability to use the digital navigation feature (activated it)	ZAD

By sharing the device, Nina created the Zone of Free Movement-Buddy where both buddies had access to the device (line E1). When Quinlan asked about how to turn the page, he focused on the Zone of Promoted Action-Buddy (line E2). Then, both buddies demonstrated actions in their Zones of Proximal Development, as they investigated (unsuccessfully) how to use the digital page-turn feature (lines E3-E4). When Nina figured out how to press the correct spot to use the page-turn feature, this represented her transition from a developing (ZPD) to developed ability to use this feature (ZAD; line E5). After this, Quinlan asked again for help activating the page-turn feature, further focusing the Zone of Promoted Action-Buddy (line E6). Therefore, Nina mediated Quinlan’s developing use of the page-turn feature both verbally (“here”), by pointing to the place to activate the page turn (line E7), and by modeling the digital navigation feature uses (line E9). This mediation supported Quinlan’s transition from developing (ZPD) to developed use of this digital navigation feature (ZAD) (lines E8 and E10). Figure 7 visually presents how the context was microgenetically framed to effectively canalize the buddies’ developmental process in acquiring app book page turn skills.

Likewise, the same pattern is illustrated in the following excerpt of Stella and Jayden reading the app book, *The Going to Bed Book*. The page they read had star hotspots that twinkled when activated.

Line	Student	Transcript	Code	Theoretical Construct
F1	Jayden	[Places the iPad in the middle where both buddies can access it]	Share the device	ZFM-Buddy
F2	Stella	I am popping [activates the star hotspots by tapping them]	Buddy provides verbal mediation (“I am popping”) Buddy models digital feature use (activating stars hotspot) Developed ability to move the hotspots	ZPA- Buddy ZPA-Buddy ZAD
F3	Jayden	[Jayden is rubbing his finger on the screen, trying to activate the stars to make them twinkle, but this is the wrong action and does not activate them.]	Developing ability to move the hotspots (but not successful yet)	ZPD
F4	Stella	[Stella shows Jayden how to <i>tap</i> the stars to activate them.]	Buddy models digital feature use	ZPA-Buddy
F5	Jayden	[Taps finger on the screen and successfully activates the stars.]	Developed ability to move the hotspot	ZAD

In this example, the availability of the device for both buddies framed the Zone of Free Movement (line F1; ZFM-Buddy). Initially, Stella demonstrated a developed ability to activate the star hotspots (line F2; ZAD). She verbally explained what she was doing to Jayden and

pointed to the place on the screen to activate the hotspot (line F2), which framed the Zone of Promoted Action (ZPA-Buddy). However, this mediation did not result in Jayden being able to use the hotspot (line F3; ZPD). Thus, Stella modeled how to activate the hotspot for him (line F4). This modeling helped to shift Jayden’s ability to activate the hotspot from his ZPD (line F3) to his ZAD (line F5). Figure 8 visually presents how movement in the zones interact to canalize learning in this example.

4.4. Physical Support for Activating a Digital Feature

One kind of physical support for helping a buddy enact digital feature use occurred when a student took their buddy's finger and moved it on the screen to show them how to effectively use the electronic feature. The following excerpt occurred between Adena and Jasper while they were reading the app book, *Barnyard Dance*. The app book read the text aloud, highlighting the text as it read it, and had hotspots. One hotspot made a cow play a violin when activated.

Line	Student	Transcript	Code	Theoretical Construct
G1	Adena	[Turns the page]	Navigating throughout the app	ZFM-Buddy
G2	Adena	[Tries to activate the feature to make the violin play, but was unsuccessful.]	Developing ability to move the hotspots (but not successful yet)	ZPD
G3	Jasper	[Tries to activate the feature to make the violin play, but was also unsuccessful.] We	Developing ability to move the hotspots (but not successful yet)	ZPD

		are doing it together [i.e., trying to activate the hotspot].		
G4	Adena	[Tries multiple ways to activate the hotspot--taps, touches, then runs finger back and forth on screen. When she runs her finger back and forth on screen, this activates the hotspot.]	Developed ability to move the hotspots	ZAD
G5	Adena	Now you try. [Takes Jasper's finger moves it back and forth on the screen to activate the violin hotspot.]	Buddy enacts the motion for their partner	ZFM/ZPA-Buddy
G6	Jasper	[Independently moves his finger back and forth to activate the violin hotspot.]	Developed ability to move the hotspots	ZAD

The interaction was initiated with Adena framing the Zone of Free Movement for her buddy (ZFM-Buddy) by navigating to the page with the cow playing the violin hotspot (line G1). At first, both buddies explored how to use the hotspot, which showed developing knowledge (ZPD; lines G2-G3). Adena figured out how to use the hotspot first (ZAD; line G4), and then tried to support her buddy, Jasper, by moving his finger over the screen in a back-and-forth motion to activate the hotspot (line G5). Her focus on the violin hotspot reflected the Zone of Promoted Action (ZPA-Buddy). Her control of Jasper's finger, by restricting his movements to activate the hotspot, reflected the Zone of Free Movement (ZFM-Buddy). Mediating both zones

bridged Jasper's developing ability to use the hotspot (ZPD) to a developed ability (ZAD, line E7). Figure 9 visually presents how movement in the zones interact to canalize learning in this example.

Another kind of physical support for helping a buddy enact digital feature use occurred when a child prevented their buddy from doing a certain action. The following interaction between Kevin and Mia occurred while they were trying to record their voice by touching a recording icon programmed in the *Pat the Cat* app book. The color of the voice recording icon changed from green (when it was ready to be pressed and start recording) to red (when it was already recording and should not be pressed until the recording is complete). That is, tapping on the green or red icon turned it on and off, respectively.

Line	Student	Transcript	Code	Theoretical Construct
H1	Kevin	[Takes control of the iPad while the text reads aloud]	Turn taking/controlling device	ZFM-Buddy
H2	Kevin	[The green recoding icon is flashing, and catches his eye.]	Voice recording feature	ZPA-F
H3	Kevin	[Taps on the green icon, then the red icon, then the green icon, etc. several times.]	Developing ability to activate the recording feature	ZPD

H4	Mia	You have to wait [after you press the green icon.] [Holds his hand to keep him from touching the red icon]	Buddy restricts their partner to provide prompt	ZFM/ZPA-Buddy
H5	Kevin	[Stops to see what happens.]	Developing ability to activate the recording feature	ZPD
H6	Mia	[Reads the text in order to be recorded] CAT...	Developed ability to activate the recording feature	ZAD
H7	Kevin	[Listens to Mia's recording. Then presses the green icon and begins to read to begin his own recording.] CAT...	Developed ability to activate the recording feature	ZAD

The interaction started when Kevin took control of the iPad and placed it in front of himself, which created the Zone of Free Movement- Buddy (ZFM-Buddy; line H1). The recording voice feature itself created the Zone of Promoted Action (ZPA-Feature) by flashing to grab Kevin's attention (line H2). Kevin showed that his ability to use the recording feature was at the developing state when he pressed the feature several times in succession without recording, which is not how the feature was intended to be used (ZPD- line H3). Mia mediated Kevin's use of the recording feature in two ways (lines H4 and H6). First, Mia's focus on the recording feature reflected the Zone of Promoted Action (ZPA-Buddy). Second, her restriction of his finger movements (so he would not stop the recording feature prematurely), reflected the Zone of Free Movement (ZFM-Buddy). Mediating both zones canalized Kevin's learning from

developing the ability to use the recording hotspot correctly to a newly developed ability to do so (line H7). Figure 10 visually presents how movement in the zones interact to canalize learning in this example.

5. Discussion

5.1 What We Can Learn from Our Application of Zone Theory

Using Zone Theory allowed us to trace the buddies' development using a microgenetic process, which revealed that verbal mediations, modeling, and physical mediations were employed to improve effective activation of app features. However, for this development to occur, the digital features needed to be within the Zone of Free Movement (i.e., the buddy was physically able to interact with the book, and digital features were available in the book), and buddies needed to share a focus in the Zone of Promoted Action (e.g., working on activating a specific hotspot together). Using Zone Theory showed not only the mediations that were necessary to canalize learning, but also the context in which this learning could occur (i.e., Zone of Free Movement) and the canalization process (i.e., moving from not being able to activate the digital feature independently [ZPD] to being able to effectively activate it independently [ZAD]).

Further, our findings expanded how Zone Theory has been applied to data analysis. For example, while previous research focused on how another person expanded or constricted the Zone of Free Movement (Blanton et al., 2005; Hussain et al 2012), our study also considered how technology itself sometimes plays this role (e.g., buddies were restricted based on the digital features that were available on each page of the app book). Particularly in this digital age, exploring how digital features expanded or constricted the possibilities for children's engagement seemed important. Moreover, while previous research focused on how another person shifted the Zone of Promoted Action (Blanton et al., 2005; Hussain et al 2012), our

findings demonstrated that digital features did this as well (e.g., automatic animations that attracted their attention to a hotspot). Therefore, we were able to explore two ways that the Zone of Free Movement and Zone of Promoted Action were shifted to support canalizing a child's learning to effectively activate a digital feature.

5.2 Extensions and Insights about the Mediation of Buddies' Digital Feature Use

Our findings underscore the importance of the social and interactional context of buddy reading for supporting learning on how to effectively use digital features, and that there are multiple ways to mediate this learning (i.e., verbal mediation and pointing out digital features, modeling digital feature use, integrated verbal mediation, pointing, modeling digital feature use, and physical support for enacting digital feature use). While previous research explored buddies' use of digital features as part of the meaning-making process (Christ et al., 2019; Korat & Falk, 2017; Xu et al., 2020), their focus was not on how children learned to effectively use the features themselves. Our research extended these studies by exploring this aspect. For example, while prior studies showed that automatic animations garnered children's attention (Christ et al., 2018; Smeets & Bus 2014; Verhallen & Bus, 2010), our study showed how this attention was used to canalize children's learning to use these hotspot features. Likewise, previous studies demonstrated that children struggled to navigate app books effectively when reading individually (Plowman & McPake, 2013; Kelley & Warburton, 2011; Sung et al., 2019a); however, our research extended this by showing how buddies' mediations supported learning how to use the navigational features—e.g., Buddy provides verbal mediation and points to show where the digital feature is located on the page (without activating it) (E7). Finally, while previous research identified the use of verbal mediations and modeling to support app book meaning-making (Javorsky & Trainin, 2014; Wang et al., 2014), our findings also showed that buddies use

physical mediations (e.g., moving their buddy's finger to swipe) to mediate one another's use of digital features. Buddies used these physical mediations to both create a narrower Zone of Promoted Action (e.g., Transcript G) and Zone of Free Movement (e.g., Transcript H).

5.3 Implications for Practice

Our results suggest important implications for early childhood classroom practices. First, it is clear children need to share access to the iPad (i.e., the Zone of Free Movement needs to include both buddies having access to the book). Without sharing, they cannot engage in any shared focus (i.e., the Zone of Promoted Action), which is needed to canalize learning.

Second, our findings showed a shared focus can be accomplished two ways—via programmed digital features that jointly draw buddies' attention to a feature, or one buddy drawing the other buddy's attention to said feature. Therefore, choosing app books with digital features that draw children's attention, and encouraging children to help their buddy use the features while reading, are two ways to support a shared focus. Further, app book programmers should consider the design of app features in terms of drawing children's attention to them.

Third, our findings suggest that teachers should encourage children to engage in the following effective mediation behaviors to support their buddy's learning of how to effectively activate a digital feature: (1) verbal mediation and pointing out digital features; (2) modeling digital feature use; (3) integrated verbal mediation, pointing, and modeling digital feature use; and (4) physical support for enacting digital feature use.

5.4 Limitations and Suggestions for Future Research

There were three important limitations of our study, and each suggested a direction for future research. First, the findings in this research were limited to an exploration of kindergarteners who were mostly in the emergent stage of reading. Future research might explore

app book buddy reading with children at other ages and stages of development. Second, our study focused on buddies' interactions with one another and the app book. Future research might compare these findings with the kinds of mediations provided by a teacher or parent who is supporting children's learning to use digital features. Third, we took a microgenetic look at the canalization process within short episodes of buddy reading interactions. Future research might trace these processes for children across time.

6. Conclusion

This study microgenetically traced the learners' development of their ability to use digital features in the context of collaborative app book buddy reading. Findings showed that learners provided (1) verbal mediation and pointing out digital features; (2) modeling digital feature use; (3) integrated verbal mediation, pointing, and modeling digital feature use; and (4) physical support for activating a digital feature to support their buddy's digital feature use. These mediational moves canalized buddies' learning process, shifting from their developing ability to use a digital feature into a developed ability. Teachers should promote buddies' use of these mediational moves during app book buddy reading.

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Table 1
App Book Features

App book	Automatic animation	Navigation features	Hotspots	Other
Barnyard Dance	Images in illustrations move (e.g., rocking boat)	Page turn	When hotspots in illustration are pressed, animations are activated	None
Going to Bed Book				
Artist Mortimer			• 60% to 80% congruent	
X is for X-Ray	Images in illustrations move (e.g., monkey swinging on a vine)	Page turn and menu	When hotspots in illustration are pressed, animations are activated	None
Being Global				
Shiver of Sharks			• 100% congruent	
Hop on Pop	Panning is used to focus the readers' attention to the pages	Page turn and menu	When hotspots in illustration are pressed, the word appears and is read aloud	None
	Images in illustrations move		• 100% congruent	
Pat the Cat	Images in illustrations move	Page turn	None	Users can record their reading and play it back

Table 2*Zones, constructs, definitions, and codes*

Zones	Constructs	Definition	Codes
Zone of Free Movement (ZFM)	ZFM-Buddy	The availability and accessibility of the device	<ol style="list-style-type: none"> 1. Turn taking/controlling device 2. Share the device 3. Request to share the device 4. Turning the page 5. Navigating throughout the app 6. Buddy enacts the motion for their Partner 7. Buddy restricts their partner to provide prompt
	ZFM-Feature	The availability and accessibility of features in each page	<ol style="list-style-type: none"> 1. Navigation 2. Highlight text 3. Read aloud text 4. Congruent hotspots 5. Incongruent hotspots 6. Automatic animations 7. Voice recording feature
Zone of Promoted Action (ZPA)	ZPA-Buddy	The actions and behavior that support the other buddy's development	<ol style="list-style-type: none"> 1. Request information 2. Buddy asks question 3. Buddy provides verbal mediation and points to show where the digital feature is located on the page (without activating it) 4. Buddy models digital feature use to activate the hotspot

			<p>5. Buddy provides verbal mediation</p> <p>6. Playing the recorded voices</p> <p>7. Buddy enacts the motion for their Partner</p> <p>8. Buddy restricts their partner to provide prompt</p>
	ZPA-Feature	The electronic features that attract the buddy's attention	<p>1. Navigation</p> <p>2. Highlight text</p> <p>3. Read aloud text</p> <p>4. Congruent hotspots</p> <p>5. Incongruent hotspots</p> <p>6. Automatic animations</p> <p>7. Voice recording feature</p>
Zone of Proximal Development (ZPD)	ZPD	The buddy shows their developing ability regarding the use of the digital features	<p>1. Developing ability to use the digital navigation feature (but not yet successful)</p> <p>2. Developing ability to move the hotspot (but not yet successful)</p> <p>3. Developing ability to activate the recording feature</p>
Zone of Actual Development (ZAD)	ZAD	The buddy shows their developed ability to use the digital features	<p>1. Developed ability to use the digital navigation feature (activated it)</p> <p>2. Developed ability to move the hotspots</p> <p>3. Developed ability to activate the</p>

recording feature

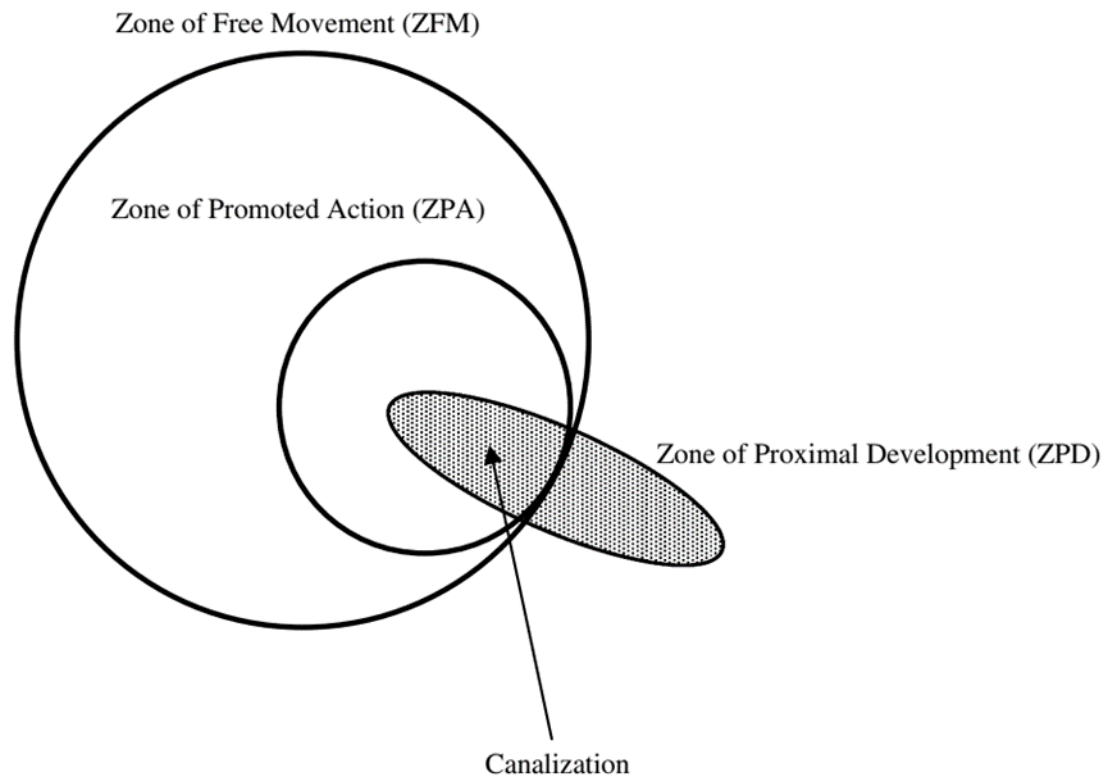


Figure 1.

The Interconnection between Zones (Blanton et al., 2005)

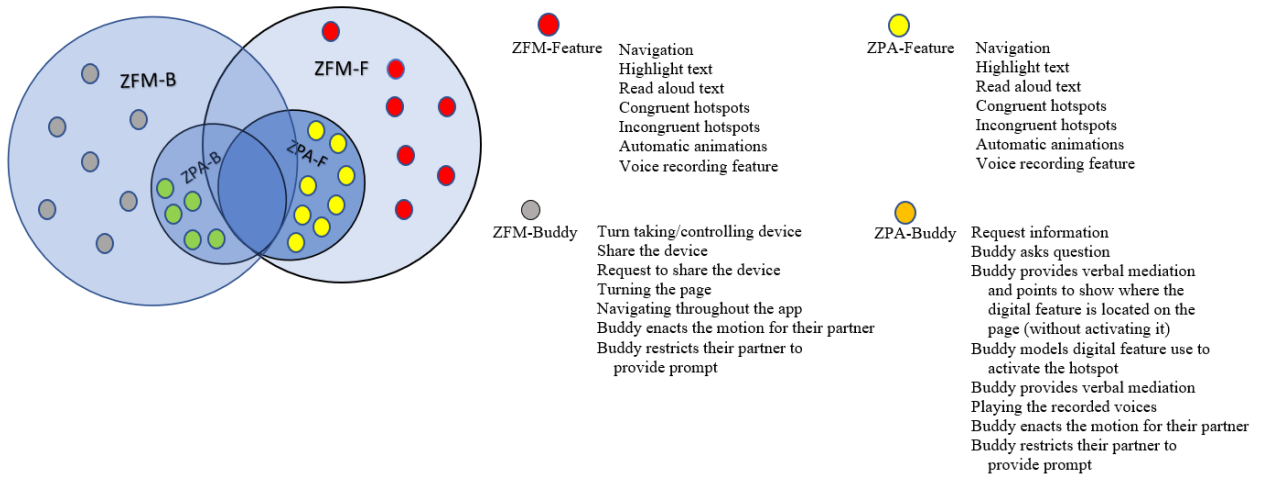


Figure 2.

The Adapted Version of Valsiner's Zone Theory

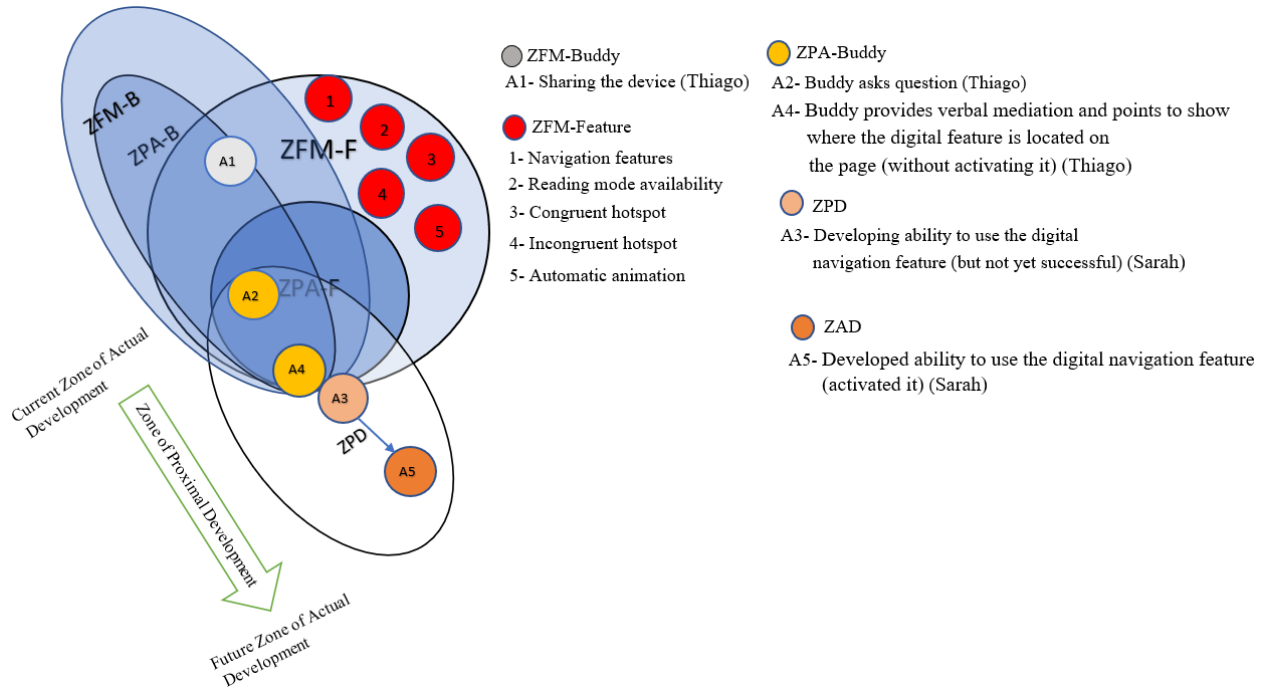


Figure 3

Visualization of Zones for Verbal Modeling in Transcript A

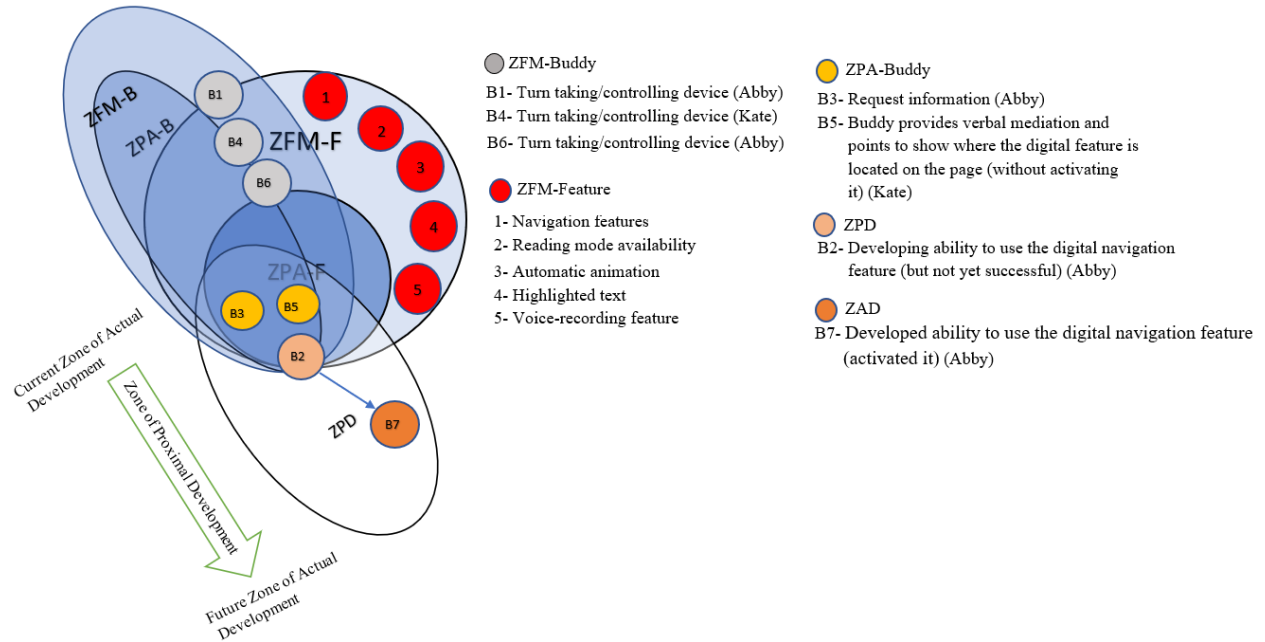


Figure 4

Visualization of Zones for Verbal Modeling in Transcript B

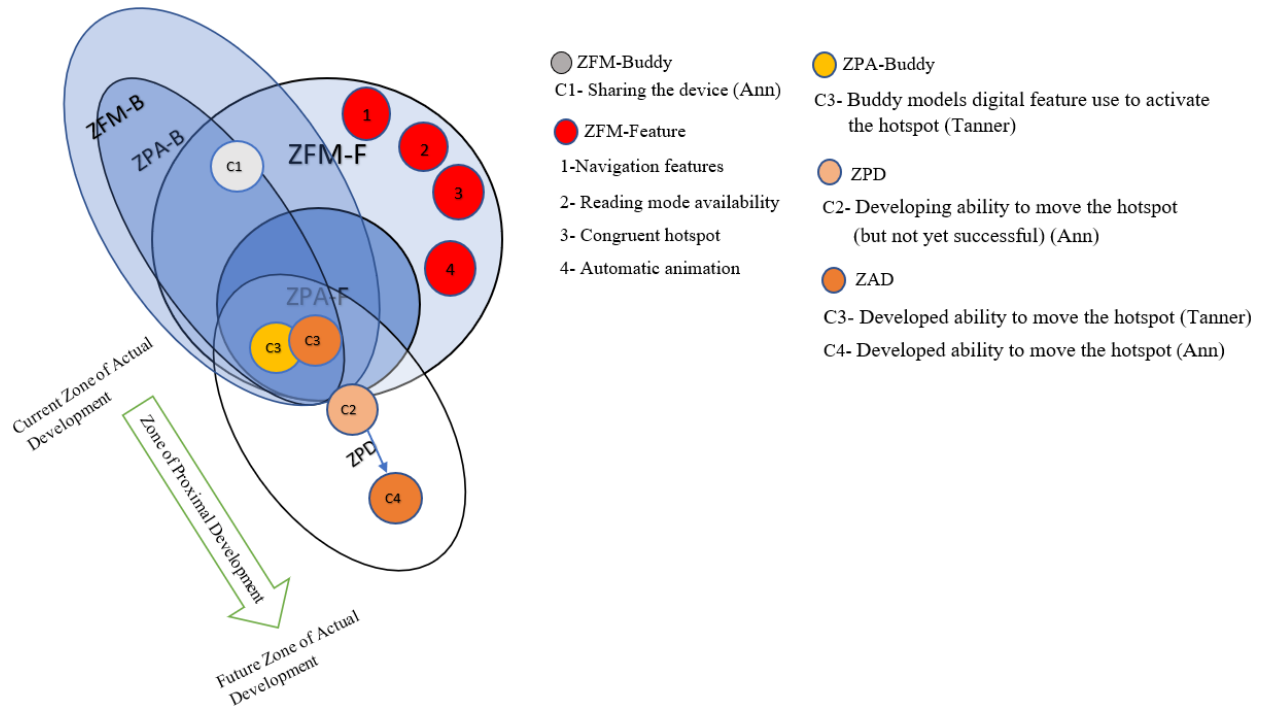


Figure 5
Visualization of Zones for Physical Modeling in Transcript C

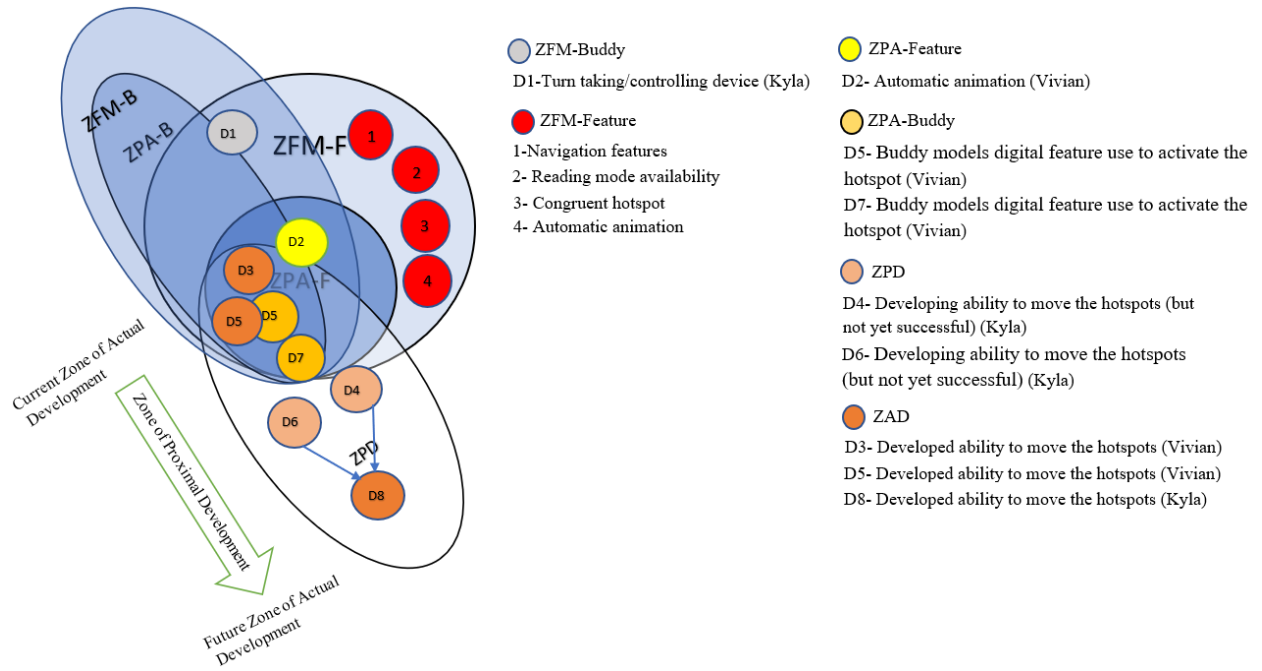


Figure 6

Visualization of Zones for Physical Modeling in Transcript D

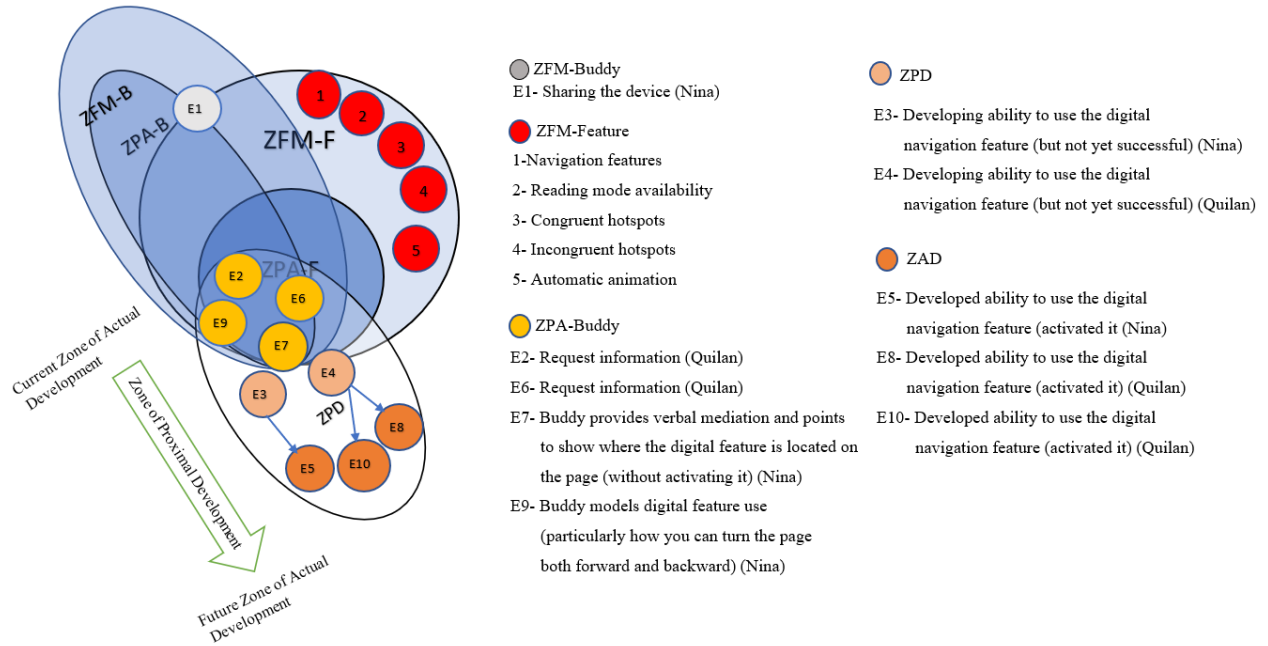


Figure 7

Visualization of Zones for Integrated Verbal-physical Mediation in Transcript E

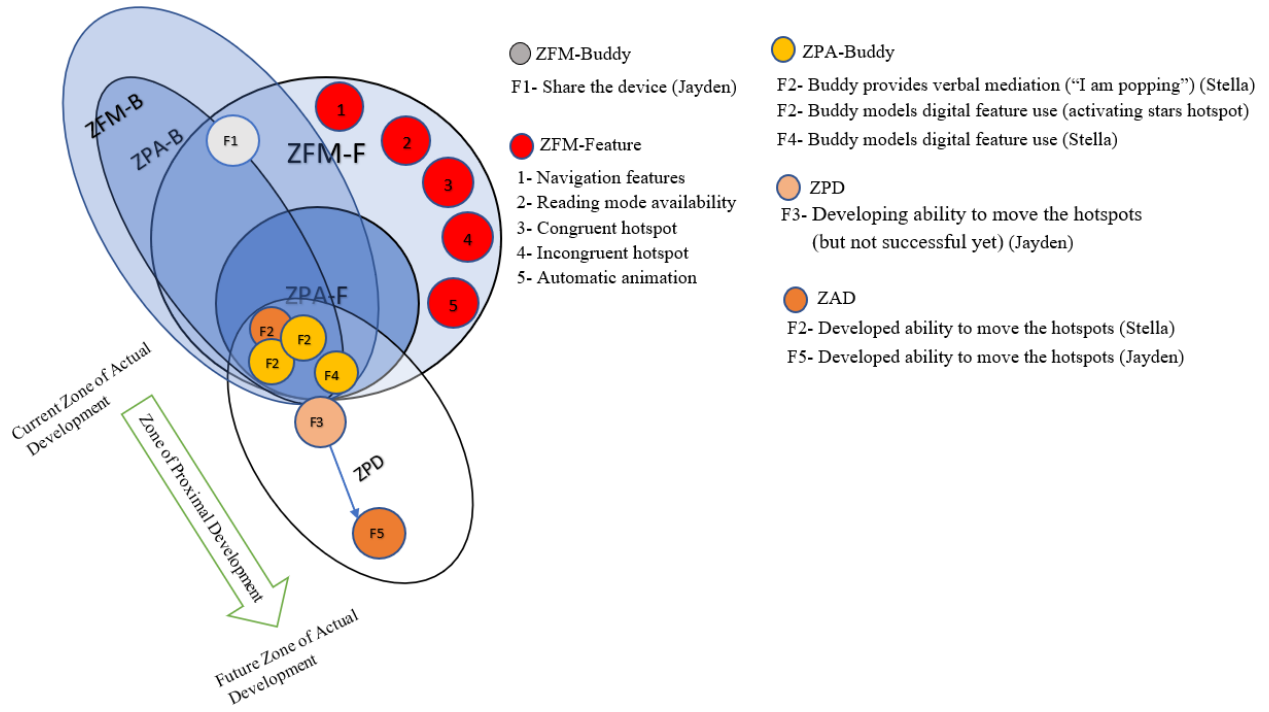


Figure 8

Visualization of Zones for Integrated Verbal-physical Mediation in Transcript F

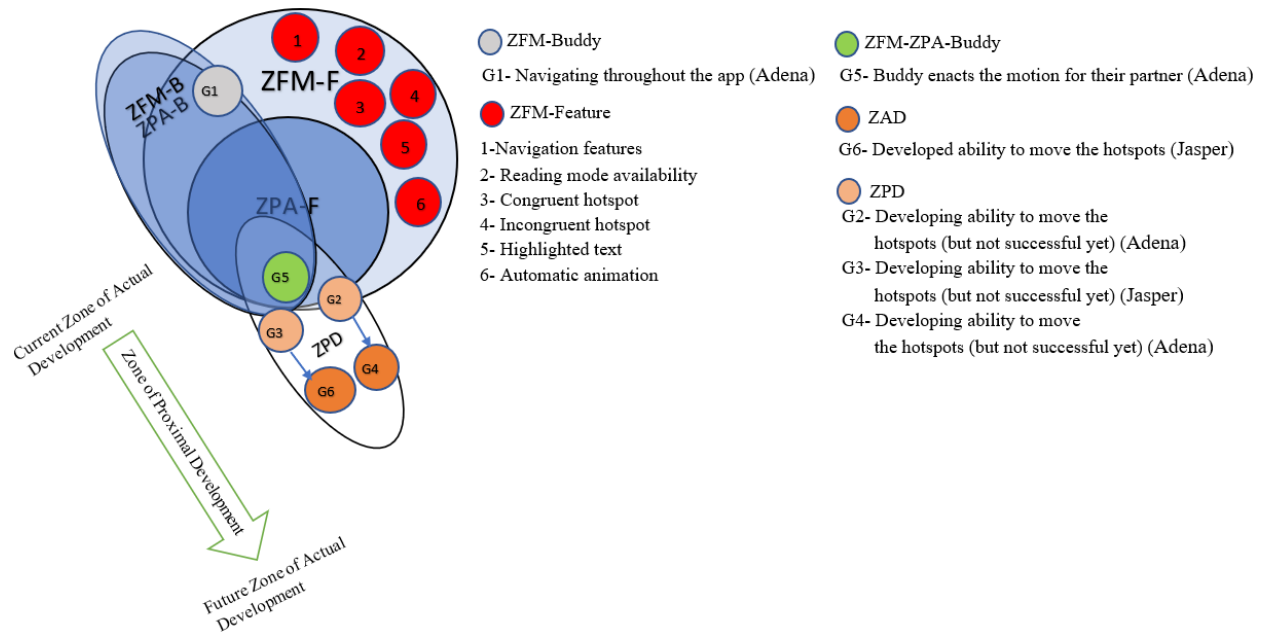


Figure 9

Visualization of Zones for Physical Enacting Mediation in Transcript G

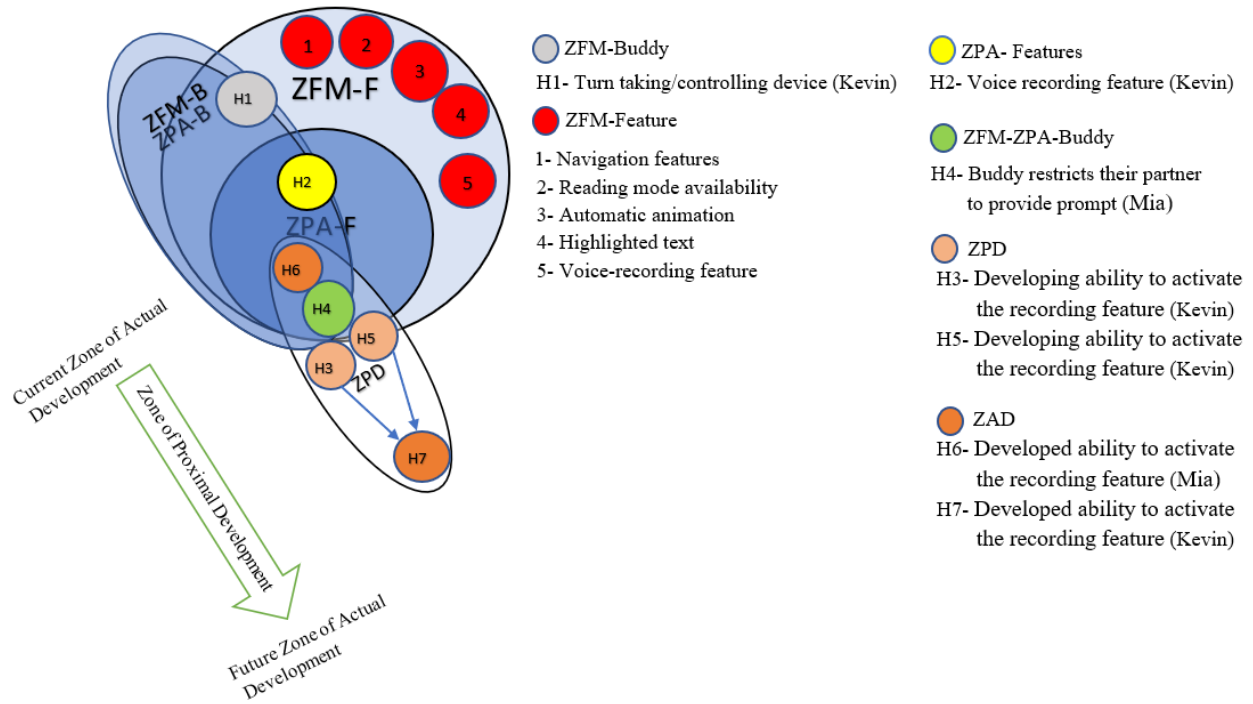


Figure 10

Visualization of Zones for Physical Enacting Mediation in Transcript H