Playworlds as an evidenced-based model of practice for the intentional teaching of executive functions

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ABSTRACT
Expectations for increased conceptual outcomes in the early childhood education sector have foregrounded a need for more evidenced-based practice in support of children's play. One such avenue for researching models of play practices that support cognitive outcomes is to study the implementation of Playworlds. Grounded in cultural-historical theory, Playworlds is a model of play pedagogy where children and educators recreate a narrative through dramatization. However, this approach has not traditionally been linked with enhanced academic outcomes. In this study, the researchers used executive functions (EFs) as a pre and post measure for studying the potential development of the learner. As a potential evidenced-based model of practice, we examined the effect of incorporating EF tasks into early childhood programs through Playworlds. Specifically, EFs were incorporated into everyday practices within eight play-based preschool programs in Victoria, Australia, through Playworlds and associated activities. Ninety-one preschool aged children (50% male, M = 54.7 months, SD = 3.94) participated. Video observations and interviews documented teaching practices related to the incorporation of EFs into play-based programs. Findings document gains in EF skills in the context of the Playworld practices. Snapshots of teaching practices provide guidelines for incorporating EFs into early childhood play-based programs.

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Introduction
As societies become more complex and values and expectations change, so does the need for ongoing research into the development of evidence-based models of practice in early childhood settings. Increasingly, many countries are expecting greater outcomes for schooling, and this appears to translate into more formal models of practice in early childhood (see Fleer and van Oers 2018).

Executive functions are a set of cognitive processes that assist with organisation and self-regulation (Blair, Zelazo, and Greenberg 2005). They include the ability to plan, shift
and sustain attention toward a goal, inhibit natural responses, and hold and retrieve information from the working memory. These are vital skills in the classroom, assisting children to retain information (including instructions), focus their attention, and resist distractions. Thought to be regulated in the prefrontal cortex (Luria 1973), EFs are now recognised by some researchers for their ability to predict life chances (Diamond and Ling 2016), including enhanced academic or cognitive outcomes (Bull, Espy, and Wiebe 2008; Cantin et al. 2016). Interventions targeting EFs in educational contexts focus on the development of skills which assist children’s capacity to learn (Bierman and Torres 2016), which can perhaps explain why the preschool setting has been a focal context for such interventions. This may also be due, in part, to our increased understanding of EF development, and its rapid growth during early childhood (Blair, Zelazo, and Greenberg 2005). Furthermore, increased expectations for greater cognitive outcomes within early childhood programs create a new research context for the incorporation of EF activities into early childhood settings.

Interestingly, although studies of EF interventions document gains in EFs, sustainability is generally poor, as educators struggle to integrate EF tasks into their regular program. Mostly, teachers have noted EF activities within such programs are not meaningful to children or themselves, in that the activities vary greatly from their regular teaching; they are time consuming and challenging to use in whole group sessions (Rothlisberger et al. 2011). Consequently, this study explores the possibility of enhancing children’s EFs through imaginary play, specifically by bringing together the play pedagogy of Playworlds (Lindqvist 1995) with games taken from common EF tasks.

**Overview of what is known about the development of executive functions**

In recent times, researchers have studied EF skills introduced in preschool settings for their immediate and longer-term impact on school achievement scores, and their ability to increase children’s school readiness. These studies suggest that enhancing pre-schoolers’ EF skills results in gains in both pre-academic skills and school readiness (Blakey and Carroll 2015; Fitzpatrick et al. 2014; Raver et al. 2011), and enhanced academic school results (Sasser, Bierman, and Heinrichs 2015). Studies have shown that it is lower SES children who appear to benefit the most from the EF programs. This has attracted policy makers to the possibility of developing children’s EF through early childhood education to increase later school performance (Bierman and Torres 2016; Ursache et al. 2011).

Whilst early EF skills appear to translate directly into cognitive outcomes (Visu-Petraa et al. 2011), implementation and sustainability of preschool interventions targeting EF skills are often poor after intervention. Teachers have reported difficulties with integrating programs into their regular early childhood curriculum (Rothlisberger et al. 2011). Expectations for high levels of task intensity and supervision have been presented as drawbacks. Tasks within interventions tend to be overly structured. This might account for educators’ diminishing implementation during the course of the intervention. It may also explain why there is limited evidence of generalisation of EF interventions with a focus on direct training and practice and leading to substantial increases in school achievement (Bierman and Torres 2016). Both explanations are concerning, suggesting that EF activities
should be incorporated into early childhood settings in meaningful ways. Playworlds may provide one model of how to achieve this because they bring the collective and individual play of children together in a productive way to support their development, and also have the potential for the development of EF.

**Playworlds**

The foundations of a Playworld began with the research of Lindqvist (1995) in Sweden as an educational experiment (Hedegaard 2008). Since then, studies of teacher development (Ferholt 2010; Fleer 2018a), narrative knowledge (Hakkarainen and Bredikyte 2008), drama pedagogy (Ferholt and Lecusay 2009), executive functions (Fleer, Veresov, and Walker 2017) and the development of concepts through Scientific Playworlds (Fleer 2019) have all emerged through the research undertaken in different countries.

Lindqvist (1995) invented the concept of *play pedagogy* and specifically discussed the role of the teacher in children’s play. The central assumption underpinning *play pedagogy* is that the teacher takes an active role in changing the conditions of children’s play. For instance, Lindqvist (1995) said, ‘the pedagogue needs to inspire the child to play, in order to develop the dramatic nature of the play’ (p. 35). The teacher creates a drama with the children, through collectively playing out the plot found in storytelling, fairy tales, folk tales or children’s books. Together the children live the experiences of the characters through the narrative as they play out the story. They feel the emotions of the character as they become frightened or are happy or take risks. Lindqvist (1995) argued that, ‘... the interplay between emotions and intellect gives rise to the development of imagination in play’ (p. 49). The play is not just an intellectual act but is also an emotionally charged experience. Children can imagine new actions and possible play scripts and become conscious of the meeting of inner ideas and external actions that arises during play. The aesthetics of the play emerge through the Playworld created jointly by teachers and children together.

In a Playworld, the child is seeking to *reproduce* in play the reality that they experience or imagine in the storybook, whilst at the same time *producing* their own play scripts during the process of coming to understand the roles and rules of the society in which they live. Lindqvist (1995) argued that in play, ‘children are expressing their feelings and asserting themselves in relation to adults’ but at the same time the adult senses that children also wish to ‘move closer to the adult world. This is neither

| Table 1. Theoretical foundations of Playworlds. |
|-----------------------------------------------|
| **Key characteristics of Playworlds**          |
| 1. Selecting a story for the conceptual Playworld: A story that is complex and dramatic creates an emotional tension that motivates children and teachers to engage with the story narrative. |
| 2. Designing a conceptual Playworld space: An area in designated as the imaginary space where children and teachers role play the narrative of the story. |
| 3. Entering and exiting the conceptual Playworld space: A routine or structure is used to signal that the children and teachers are entering/exiting the playworld area as a whole group. |
| 4. Planning the play inquiry or problem scenario: Teachers introduce additional problems that fit with the characters or plot, and this motivates children to want to solve the problem situation so that the play can progress. |
| 5. Planning teacher interactions to build conceptual learning in role: Teachers plan the roles they will take and the EF and games that will be introduced. |
dualism nor harmony – this is dialectics’ (p. 50). Playworlds in this way support the cultural development of the child. These theoretical assumptions are summarised in Table 1.

Bringing together a Playworlds approach with the development of children’s EFs offers the potential of an evidence-based model of practice that can speak directly into the Australian context (Fleer et al. 2017; Fleer, Veresov, and Walker 2017) but can also support practices more broadly in international contexts. This may present the possibility of enhancing outcomes for children by supporting the practice of intentional teaching (Early Childhood Australia 2014). Educators who engage in intentional teaching actively promote children’s learning and development through deliberate, purposeful and thoughtful means, in both experiences and interactions (Department of Education and Training 2009). This includes strategies which foster high-level thinking skills, such as open-ended questions, demonstrations, problem solving, and engagement in shared thinking. We know from our previous research that teachers and children productively engage in activities that are associated with EFs when using a Playworlds approach (Fleer et al. 2017; Fleer, Veresov, and Walker 2017). We also know about the implementation challenges of introducing a Playworlds approach (Rainio 2008). We do not yet know, however, whether a Playworlds approach makes a difference to children’s EFs. Research is needed to investigate whether children’s EFs develop during their involvement in Playworlds, a model of practice that has been shown to be engaging and meaningful for children and educators alike (Fleer et al. 2017; Fleer, Veresov, and Walker 2017). This might improve sustainability and meaningful engagement in EF programs, which have been identified as problematic in the EF literature (Rothlisberger et al. 2011).

The study

This paper presents the findings of a study that sought to introduce EFs into play-based settings, and in which both the introduction of EF games in everyday practice and the intentional teaching of EF in Playworlds were studied. This paper is concerned with the dual goal of 1) case study of teacher practices of introducing EFs into play-based settings, and 2) assessing whether children’s EFs changed as a result of participating in a play-based program that featured the intentional teaching of EF skills.

Method

This study was an Australian Research Council (ARC) funded research project. It was a linkage project between Monash University (Victoria), Queensland University of Technology, Lady Gowrie (Queensland), and the Department of Education and Training (DET) Victoria. This paper presents the participants, data collection procedure, and analysis for the Victorian section of the research. Consent was obtained from the Queensland University of Technology Ethic Committee and the DET prior to data collection. Interested centres were provided with an information briefing, along with explanatory statements and consent forms. Upon obtaining consent from educators involved in the intervention, centres were provided with explanatory statements and
consent forms for families. To accommodate the ethnic diversity within the centres’ locality, information letters in simplified language.

**Participants**

The participants were 91 preschool-aged children (50% male, M = 54.7 months, SD = 3.94) in three preschool centres in Melbourne, Australia. Eight teachers who were positioned as co-collaborators with the researchers participated in the study along with their teaching assistants.

**Procedure**

The study adopted a primarily qualitative design with the addition of quantitative techniques. The procedure is summarized below:

1. EF pre-testing was undertaken by the third-named author.
2. Intervention: the intervention was implemented over 10 weeks during Terms 2 and 3 in 2017, across eight preschool groups in three stand-alone preschool centres, and formed part of the usual teaching program. Prior to implementation, participating educators took part in professional learning about EFs and Playworlds with the main investigators. This was a collaborative process. Here, educators formed an idea of how they would begin the intervention, tailoring it to the needs, interests, and dynamics of their group. Specifically, they followed a five-step approach developed in previous research (Fleer 2019):
   1. Selecting a story for the conceptual Playworld
   2. Designing a conceptual Playworld space
   3. Entering and exiting the conceptual Playworld space
   4. Planning the play inquiry or problem scenario
   5. Planning teacher interactions to build conceptual learning in role
3. Digital video data gathering of Playworld practices at two key points in the implementation; at the beginning of the intervention and at the end of the intervention. These were undertaken by the first, third, fourth and fifth authors.
4. EF post-testing was undertaken by the third-named author.
5. Structured phone interviews on implementation of the Playworld.

Qualitative data were collected during video data gathering at two key points, and also during structured phone interviews. These interviews, with the focal preschool educator or teaching assistant, occurred post-intervention and consisted of nine key questions. These centred on exploring educators’ practices and engagement with the intervention and identifying barriers and facilitators. For example, ‘Can you give me examples of how you embedded EFs into the Playworlds? What worked for you? What was challenging?’

**Executive function measures**

In line with the standard pre- and post-testing approach on EF tasks published in the literature, we used three direct assessments for our pre and post intervention instruments,
measuring inhibition, shifting, and planning. Individual assessments were conducted in a quiet section of the preschool and were 15–20 minutes in duration for all 91 children (pre) and 81 children (post – 9 children had left the centre and one was away ill).

**Day/night stroop.** Inhibitory control was assessed by the day/night Stroop test (Gerstadt, Hong, and Diamond 1994). Sixteen cards portraying day and night are shown to children. The task requires children to say the opposite of what is depicted on the card. Each correct turn results in a score of 1. The test consists of 16 turns, with a possible total score of 16.

**Truck planning task.** Planning was assessed by the Truck Loading task, adapted from Fagot and Gauvain (1997). In this task, children pretend they are postal officers delivering different coloured party invitations to similarly coloured houses on a poster of a road map. Children use a toy truck to deliver the invitations. The truck must follow the direction of the arrows on the map, it must deliver the invitations within one lap of the block, and invitations must be taken from the top of the truck. In order to meet these requirements, children need to plan the order in which the invitations are placed onto the truck. The researcher demonstrated the task with two invitations before the child began a trial run, delivering two invitations with prompts. The task requires children to deliver two invitations on their first turn, with four levels of difficulty. Additional invitations are added at each level. Children progress to the next level when they have successfully completed the delivery within two turns. When children successfully complete the level within one turn, they are scored 2. When children successfully complete the level within two turns, they are scored 1. There is a total possible score of 8.

**Dimensional card change sort.** Shifting was assessed by the Dimensional Card Change Sort ([DCCS] Frye, Zelazo, and Palfai 1995; Zelazo 2006). Here, children are presented with cards with illustrations of either a red boat, blue boat, red rabbit, or blue rabbit. Children begin by sorting the card by shape, then by colour. Children score 1 for each correct turn, with each task lasting for a duration of 8 turns. There is a possible total score of 16.

**Analysis**

Qualitative analysis through the five characteristics of conceptual Playworlds is summarised in supplemental file S1 and further details can be found at https://www.monash.edu/conceptual-playworld (see Fleer 2018b) as a five-step planning process. Both the text of the interviews and the digital video observations were analysed in relation to each of the five steps in the process for planning a Playworld and which have been identified in previous research as relevant for an effective model of Playworld (see Fleer 2019, 2017).

**Results**

Of the eight participating groups, seven had continued, or were planning to continue, intentionally teaching EFs through a play-based program. This included Playworlds and associated activities, such as games. One group had ceased using Playworlds and executive function practices, as she had ‘quite challenging behaviour in [her] room this year’.
The results of the study are reported through a series of examples of practices for each of the characteristics of the Playworld and supporting tables. Specifically, the vignettes illustrate how EF tasks were being considered by the educators when planning their Playworld and associated activities.

**Selecting a story for the conceptual Playworld**

Teachers selected a story for their Playworld based on the children’s interests or popular children’s books/fairy tales, with the rationale to encourage engagement and meaningful practice.

Kelly: *We did ours from the book, ‘Aliens Love Underpants’ [sic]. It came from the kids being very excited about the book.*

Donna: *We did space and pirate treasure maps. We used children’s interest rather than books.*

Deanna: *There was no book behind our Playworld. It was free based. Our Playworlds were based around Leo the lion. He was a toy lion we had in the room that the kids played with all the time.*

Bec: *We used the book, ‘Magic Hat’ [sic] by Mem Fox. Originally, we copied the book … I wanted the children to have a say in what the children were doing; I asked whether they would like to change the book or what they turned into, and they choose dinosaurs. I used it as a learning opportunity to learn about dinosaurs. We researched lots of stuff about dinosaurs. It tied in well as we had been doing a lot of stuff about eggs and hatching, due to another student bringing something in from home … It was a toy egg that hatched and a toy hatched out of it. We had been guessing what would come out of the egg. There had been a lot of discussion about what hatches out of eggs. There were a lot of boys in that group so they wanted to become dinosaurs in the Playworld.*

Story plots often involved opportunities to create problems. Teachers developed problems for the children to solve, as a means of incorporating EF into the Playworld (See Table 2 Groups 1, 3, & 8).

Kelly: *We would present a problem. Like [the children] would bounce off a few planets, get to earth, and there would be no undies on the line ‘cause it was raining. The kids were a bit stumped with that. Then they’d have to try to work out what they could do. At first, they just wanted to go back to kinder, but then we threw out some suggestions, and got them thinking. We did a rain dance party and waited for the washing to get hung out later when the rain stopped, or we’d steal the washing out of the basket before it was hung on the line. Stuff like that.*

Others changed the story plot through the Playworld, drawing upon children’s working memory and ability to shift attention (See Table 2 Groups 5 & 6). Consistent with role play at group time, teachers generally spent time developing the play plot as a collaborative process with the children before entering the Playworld, or spent time supporting the children with remembering the plot and how to play the EF games. For example, the EF of inhibition is shown below; the children inhibited their natural responses in the free-play
### Table 2. Extracts of intentional teaching of EFs.

| Centre | Playworld | Games or activities |
|--------|-----------|---------------------|
| **Kelly from Group 1** | When they first did [the Playworld], it was done exactly as it was in the book [Aliens Love Underpants]. Then it changed a bit. When they arrived, the underpants were missing cause it was raining that day. So involving problems for them. The other one was that they had to stop and wait because the mum had to come and hang the washing up. The children had to hide and watch the mum hang up the underpants, which was hard because at the beginning they just ran straight over to get the underpants. The child who was pretending to be the dog had to wait to chase the aliens. Then the next one was changing the trip to the planet Earth. At first we just went straight from Shanou [the planet we lived on] to planet Earth, but then we mixed it up so that they would land on different planets along the way, and they had to guess which planet they had landed on based on whether it was really, really hot and close to the sun, or really, really cold and far away from the sun. The kids took turns driving the ship, and deciding where we would go along the way. We took a map of the solar system with us. We’d get to a planet and say, ‘Oh it’s so hot, ouch, ouch, we must be on Mercury or Venus, should we stay here?’ The kids didn’t want to stay on the hot planet because the undies would get burnt. | During [the intervention] we played a lot of memory. We had one set up on the tables but they liked the one I did as a group. It was a big ‘on the mat memory game’. I made big A4 cards from Disney characters that I knew they liked. They loved that. If someone had their turn and they turned over a card that they knew where the pair was, they would start shouting, ‘Oh I know where it is!’ But they had to keep it to themselves and wait for their turn. They couldn’t peep under the cards. It worked really well. |
| **Bec from Group 2** | We kept changing the stop sign, it was a green stop sign, a red go, etc. There were lots of changes to the stop sign. The password was regularly changed. The children took turns at the role they were playing. They all wanted to be the wizard, they had to wait their turn. When we were doing the dinosaurs we used cards. The cards had different dinosaurs on them. If all the cards were handed out for the dinosaur they wanted then they had to choose a different dinosaur. This took a lot of impulse control. | We were doing a lot of games, and we were working on waiting your turn, impulse control, and memory. Like we had a game where we would have 10 items on a tray, and I’d take items away, and the children would have to guess which was missing. We also played the Memory card game. The games were available every day as table top activities. We had a lot of staff in the room. The staff had a discussion that if kids went to the table a staff member would facilitate the game, talking about the rules, etc. The games were available for 1–2 weeks at a time. Some of the games like the memory object game, we did as a whole group. ‘Simon says’, and ‘What’s the time Mr. Wolf?’ were more random, and usually played outside. Sometimes the children would ask to play those games. Once the kids knew the rules the children played it themselves with their friends. |
| **Eva from Group 3** | We did a little brainstorm about some of the problems e.g. where might Tiddalick be? We even did a walk around the centre looking for him. There was flexible thinking and impulse control with Tiddalick going missing. | We used a large mat and created our own games... A red circle for stop, green for go, we would show the children two pictures of animals and they had to choose one to be, when magic lips were on, the children had to make the sound of the animal, and when magic lips were off, there was no sound just the action of the animal. If there was red circle on the card there was no sound and no action. It was played with music. Cards were displayed when the music stopped. Sometimes to confuse the children we’d hold up 2 cards to assess where they were at. |

(Continued)
### Table 2. (Continued).

| Centre | Playworld | Games or activities |
|--------|-----------|---------------------|
| Deanna from Group 4 | [I incorporated EF into the Playworld by] planning what was going to happen next, keep the ideas in their mind with the den (remembering to collect leaves, branches, etc for the den when they were outside playing) | We did basic ‘Simon says’ and stuff, but we did a lot of story time and we’d incorporate what was in the story. Instead of the goat in the billy goat gruff we’d put a pig in there or a woof. We were always twisting the story all time, the kids loved it. |
| Abagail from Group 5 | A few of [the ways I incorporated EF into the Playworld] were to do with the narrative. The children were [using the EF skill called] shifting. In the book [Dunbi the Owl] the children grab the owl and torture the owl. I said, ‘This time Dunbi wants to be friends with the children, how can Dunbi be friends with the children?’ I would change the plot that they were so familiar with, like, ‘This time, what if Dunbi is a boy and the naughty children are owls?’ | We used memory, the card game, but I made the game. I made a resource of photographs of the children to make the card game. We did quite a few other games; board games and games to work on short term memory, such as Snail pace race, and snakes and ladders. We ended up making our own board game that ended up being its own learning experience. We played the covering the objects memory game frequently, where you show children all these objects, cover them, take one away, and have the children guess which one it is. The board game they built – it was a square board, with squares on it, each was numbered to move chronologically. The kids made cards. They drew the images and the teachers then wrote down the words to accompany the images. It was good for the children to remember what they had drawn, what it was they wanted to card to say. |
| Kelly from Group 6 | [We changed] the materials up. Instead of green for the grass, we’d put down blue glass. At first we changed the colour of the material, then we changed the order that you’d go. So instead of grass, water, forest, etc. we changed up the sequence. Then we changed the path, so they’d follow the sequence (grass, water, forest, etc.) but it was in a different section of the room instead of in a nice neat circle like it had previously been. We changed the password up a bit too. The kinder door was the entry in and out of the Playworld. To get into the door of kinder, there was a big paw print, each pad had a different colour. The password might be to touch red, yellow, blue, and then green. Well we changed the colours around, so that the colours were in different places but the password was the same colour sequence, and then we changed the coloured sequence. | We tried [incorporating EF activities into our daily activities]. I did the same games with them that I did with [Group 1]. The only one I didn’t do was the big A4 memory game. I didn’t do it with them for no particular reason. I showed them the cards, but they weren’t interested in them. They liked the little cards, but they weren’t interested in the big cards. It didn’t work too well with them. We did snap cards and memory games at the tables. We played snap with them. We did a maze worksheet for them, and a teacher worked one on one with them to get the mouse to the cheese, etc. We did memory as a whole group with objects, where you cover objects with a blanket and take stuff away and then have to remember what was there. |
| Donna from Group 7 | We used passwords to enter the worlds. That was the main [way we incorporated EF into the Playworld] | We tried an EF game where we play charades, where they got a card and couldn’t say the animal on the card but had to act out the animal. We played the 1,2,3, buzz game where you have to say buzz instead of the designated number. |
| Holly from Group 8 | [Our incorporation of EF into the Playworld was] mainly problem solving. The educators created the problem through the Playworld and dramatization, and the planning. | [We incorporated EF activities into our daily activities through] rhymes and songs, and mixing them up a little bit. Mixing the stories up, so the pigs were at the 3 bears house or the wolf was crossing the bridge, helped with flexible thinking. |
setting of the outdoor area and engage in sustained attention on the goal of finding an appropriate place for the lion's den.

Group 5 video data

0:58 & 3:27 It’s time for us to go on our adventure in the jungle. So, remember what we have to do when we go into the jungle, we must stay together, so that nobody gets lost, and it might be very dangerous in the jungle too. We might see some dangerous animals, or we might see some dangerous plants, or anything. That’s why we need to stay together. Miss [Deanna] is handing out your binoculars, because you need your binoculars for the jungle. Has everyone got their backpacks on … So remember, once we pass this door, we’re not at kinder anymore, we’re at the jungle, so we have to stay together. We’re going to go on our adventure, to find a nice place for Leo’s den

**Designing a conceptual Playworld space**

Teachers created spaces that provided children with the opportunity to use EFs and build social and emotional development. This was apparent when the story plot was changed, allowing children to shift attention, use their working memory, and build empathy through perspective taking (See Table 2 Group 5). Teachers designed opportunities for children to represent their ideas and understandings, and initiate play in ways that further developed the plot and were personally meaningful. For example, children in Group 1 created and named their own planet, situating it within the solar system. They designed alien masks to wear during the Playworld, and underwear to steal. Children took turns driving the spaceship and landing on planets, thus directing the plot within the Playworld.

Kelly: The kids wanted to vote for a name for the planet. One of them said Shanou and so we went with that … They made their own underpants. They made head-bands with aliens on them. They had a look in the book to choose which alien they’d like to be and then they made them. Same with the underpants, so that we could peg the underpants on the string that was the washing line … we bounced off each other’s ideas.

**Entering and exiting the conceptual Playworld space**

Playworlds as collective imaginary situations of the storybooks were entered and exited through a variety of means. These often incorporated EFs, such as the use of songs and passwords, which were changed throughout the intervention, requiring children to exercise their working memory and to shift, focus, and sustain attention. The whole group participated in the Playworld, including the teacher, who generally took the role of a director of the play or as a character which supported the organisation of imaginary situation. Children often chose the character they would embody during the Playworld before entering or took turns of popular roles. In Group 2 children selected the dinosaur they would become through a series of dinosaur cards (See Table 2). Children exercised inhibition during moments of disappointment when others were selected for a role they desired.
Planning the play inquiry or problem scenario

Planning for problems to arise in the play were varied among groups from scripts to general ideas of the problem under investigation, but always originated with the aim of engaging the children. Solving the problems often required children to exercise the EF skill of planning. Group 4, who designed their Playworld around Leo the Lion, had Leo leave a letter in the kindergarten room, asking the children to help him solve the problem of where to situate his den. The children of Group 7 arrived at mat time to find a treasure map to follow, with the teacher acting as lead pirate on their hunt. The teacher of Group 8 introduced problems whilst in the Playworld, posing questions such as, ‘Do you know who I can’t see? The big bad wolf? Where has he gone?’ (1:24 – video data). This dramatic inquiry engaged the children and directed the plot to a search for the wolf. Other groups also had hunts for characters in the book, such as the search for the missing Tiddalick by Group 3. Group 2’s challenge was to guess the dinosaur that the magic hat had turned each child into based on the behaviour of the child.

Planning teacher interactions to build conceptual learning in role

Overall, the adults maintained the role of the teacher when shifting in and out of the Playworld. This was particularly evident when teachers called children by their real names, rather than their character within the Playworld. Children’s and teachers’ characters were often parallel with their daily roles, such as acting as the children and teachers from Group 4 on their jungle adventure and acting as the children and teachers of Group 6 on their bear hunt. At times, the Playworld heavily reflected the sequence of the story in the book, leaving less room for child initiation in terms of plot direction.

Table 2 provides extracts from the structured phone interviews. These outline how the educators intentionally taught EFs during the intervention.

A summary of the implementation of executive functions using the 5 characteristics of Playworlds (Fleer 2018b) can be found in online supplement file S1.

Table 3. Means and standard deviations for EF measures and ANOVA results for gender differences.

| EF Measure        | Boys (n = 46) | Girls (n = 45) | F    | p   |
|-------------------|--------------|----------------|------|-----|
| Pre-test Stroop   | 9.17 (6.25)  | 10.82 (5.50)   | 1.77 | 0.18|
| Post-test Stroop  | 13.61 (5.31) | 15.00 (2.84)   | 2.07 | 0.15|
| Pre-test DCCS     | 11.80 (3.40) | 12.80 (2.80)   | 2.31 | 0.13|
| Post-test DCCS    | 14.00 (2.97) | 13.53 (2.64)   | 0.54 | 0.46|
| Pre-test Planning | 2.36 (1.95)  | 2.26 (1.91)    | 0.06 | 0.80|
| Post-test Planning| 4.00 (2.58)  | 3.61 (2.36)    | 0.48 | 0.48|

Table 4. Bivariate Pearson correlations between EF Measures.

|          | T1 DCCS | T1 Planning | T2 Stroop | T2 DCCS | T2 Planning |
|----------|---------|-------------|-----------|---------|-------------|
| T1 Stroop| .274**  | .223*       | .345**    | .260*   | .130        |
| T1 DCCS  | -       | .175        | .228*     | .131    | .345**      |
| T1 Planning | -     | -           | .110      | .159    | .445**      |
| T2 Stroop | -       | -           | -         | -.035   | .106        |
| T2 DCCS  | -       | -           | -         | -       | .443**      |

T1 refers to pre-test, T2 refers to post-test; * p <.05, **p <.01
Descriptive and inferential statistics
To indicate levels of performance and possible variations between boys and girls, descriptive statistics are presented in Table 3. One-way ANOVAs indicated there were no significant gender differences on any of the measures. Correlations among all the EF measures are presented in Table 4.

Pearson correlations were used to investigate consistency of performance over time and interrelatedness of the three measures. Correlations between pre-test at Time 1 and post-test at Time 2 were significant for Planning and Stroop but not for DCCS. The strongest correlation was for Planning at Time 1 and Time 2. EF measures at Time 1 were significantly correlated with the exception of the DCCS. At Time 2 the only significant correlation was between the DCCS and Planning. The Planning measure at Time 1 was unrelated to children’s scores on the Stroop task or the DCCS at Time 2.

In order to understand the success or otherwise of the Playworld and EF practices that the educators sought to develop and implement across the settings, it was important to examine any change in EFs of the children. Paired sample t-tests were conducted to explore change over time in children’s EF scores between the pre-test and the post-test. There was a significant main effect of time for Planning (1, 80) t = −5.48, p < .001, Stroop (1, 80) t = −5.98, p < .001, and the DCCS (1, 80) t = −3.64, p < .001. These results are discussed below in the context of the qualitative findings.

Discussion
This study examined the possibility of using play as a means of intentionally teaching EFs in preschool, through the use of Playworlds. The study focused specifically on practice, and therefore the outcomes of the study have generated a set of Playworld practices which we offer as an alternative to decontextualized EF tasks, as has been the usual approach. The findings demonstrate a meaningful way of incorporating EF teaching into everyday preschool programs (see Table 2 and Supplemental file S1). Educators drew upon a range of contexts for the development of their Playworld, including children’s interests, stories, and materials within the kindergarten setting. Although Playworlds are based on co-construction, the Playworlds within this study were generally teacher-led in the first instance when introducing the Playworld, and for some groups the educators (Groups 1, 2 and 6) also used games at the tables, rather than always incorporating games into the Playworlds. This finding may be due to teachers’ developing use of Playworlds, and their familiarity with how to support children’s play from within the imaginary situation as play partners, rather than as teachers. Familiarity with EFs and the additional challenge of then incorporating EF games within a Playworld may offer another explanation. Educators who continued Playworlds in the following year post intervention demonstrated over time a greater density during the intervention, engaging in Playworlds every day or every two out of three sessions.

Previous studies (Rothlisberger et al. 2011) have documented that educators have difficulty integrating EF activities into their regular teaching programs. The use of play for intentional teaching of EFs in preschool can be related to both children’s development (Vygotsky 1966) and the teaching program. Meeting this combination of children’s needs and teachers’ plans is perhaps the most promising aspect of this intervention. Certainly, it provides a more sustainable basis than previous experimenter-designed EF interventions.
This supports results from the section of the study that took place in another state of Australia (Walker et al. 2020). Together, these findings suggest Playworlds are an effective and promising means for intentionally teaching EFs in preschool play-based programs. Previous studies targeting EFs have documented strong effects for children with poor EF skills (Bierman and Torres 2016). Integrating EFs through meaningful and sustainable intentional teaching practices may be a means to lessen inequalities between disadvantaged children and their peers that can become evident at school entry and beyond. Using pretend play, such as conceptual Playworlds, may present as a more engaging (for teachers and children alike) and effective context for the introduction of EFs for those interested to draw on this body of research (Barkley 2001).

Although the findings indicate differences on measures of EFs over time, there was no control group within this study. It is possible that effects were not solely the result of the intervention and this needs to be kept in mind when considering our research. Nevertheless, previous studies have documented gains in EFs for preschool children participating in EF interventions in preschool settings. Qualitative data have assisted with understanding the contexts of the Playworlds and the teachers’ roles, and the associated analysis has provided insight into the particular practices that educators find useful for intentionally teaching EFs through Playworlds and other activities in their everyday teaching programs. More research is needed to document the sustainability of effects and implementation over time.

**Conclusion**

This study empirically evaluated the effect of an intervention using Playworlds on children’s executive function development. The intervention took place in preschool settings and was constructed and administered by each of the participating preschool teachers. The findings reveal benefits of Playworlds for children’s executive function skills in the year prior to formal schooling. This has notable implications, particularly for disadvantaged children, as EFs play a role in school achievement. This low-cost, play-based intervention can be easily integrated into preschool teachers’ everyday programs through intentional teaching and meaningful practice. The research holds some promise for educators interested to introduce EFs in their existing play-based programs using examples like those shown in this paper to plan their practices. Incorporating such practices may potentially help to reduce the substantial school readiness and achievement gap between disadvantaged children and their peers. At the very least, it may offer a promising avenue for early childhood education in an era of increasing emphasis on cognitive/academic outcomes.

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