



Title of Issue/section Teachers and Curriculum, Volume 18, Issue 1, 2018

Editor/s Carolyn Swanson, Kerry Earl Rinehart and Judith Mills

To cite this article: Perger, P., & Major, K. (2018). Counting in children's picture books: Digging deeper. *Teachers and Curriculum*, 18(1), 27-32.

To link to this article: <http://dx.doi.org/10.15663/tandc.v18i1.316>

To link to this volume <http://tandc.ac.nz/tandc/issue/view/43>

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COUNTING IN CHILDREN'S PICTURE BOOKS: DIGGING DEEPER

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Abstract

Learning to count is a significant achievement. Counting requires the learner to co-ordinate a number of key principles to make sense of the various contexts in which counting is used. Learning to count takes time to master. Children need a range of opportunities to hear the language associated with counting and engage in everyday activities to develop an understanding of how counting works in the various situations it is used. Reading a story with others or reading a picture book for themselves can provide children with an opportunity to practice their counting in a meaningful way. Through describing the counting opportunities evident in specific picture books, this article aims to demonstrate how parents and/or teachers can use picture books to support children in understanding the contexts and principles of counting.

Keywords

Counting principles; children's literature; picture books

Introduction

In terms of mathematics, the Oxford Dictionary defines counting as the ability to “recite the numbers in ascending order” and to “determine the total number of a collection of items”(Counting, 2018, n.p.). Counting is often learnt when young and once achieved forms the foundation for future mathematical learning. As adults, we take counting for granted. We no longer think about the complex processes involved to effectively use counting in our everyday life. We don't think about the underpinning principles such as one-one, stable order or cardinality (Gelman & Gallistel, 1978) when we count. We know that we are able to count almost everything and when we count objects they do not all have to be the same which is known as the abstraction principle, (Gelman & Gallistel, 1978). We understand that we can start counting at any point and that counting left to right or right to left will give us the same total as long as all objects are counted only once, known as order irrelevance, and the one-one principles, (Gelman & Gallistel, 1978). We confidently use counting in a range of contexts, such as ordinal, measure, cardinal, counting, and non-numerical (Fuson & Hall, 1983) without thinking about how we are adjusting the counting process to address the different settings. To successfully count in the range of everyday situations requires more than just the knowledge of the counting words. Developing an understanding of numbers, how they work and what they mean when counting is so subtle that it often escapes notice (Johnson, Tipps, & Kennedy, 2016). Although as adults the knowledge associated with counting is embedded in our cognitive practice, we rarely remember learning how to count.

Counting principles

Learning to count involves understanding not only a number of principles but also how these principles are applied in the various contexts where counting is used. An early counting behaviour, reciting the counting words – one, two, three, four, etc. is often praised by parents. Counting in this way is referred to as the sequence count where the counting words are said in order but there is no evidence that they are linked to anything being counted (MacLellan, 1997). The extent to which young children can recite the counting words is largely an indication of how important that particular ‘song’ is within the environment the child lives (Willis, 2002). Johnson, Tipps, and Kennedy (2016) note that although being able to produce a chain of counting words in the correct order is an important milestone for children, and worth celebrating, it is just the first step in learning to count. Many

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ISSN: 2382-0349

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everyday experiences that provide children with opportunities to hear and/or say words in the correct order also exposes them to more than just the sequence count. For example, the counting of each step as it is taken when climbing the stairs exposes children to the one-one principle as one counting word is linked to each step taken. Here, children are developing an understanding of the one-to-one correspondence that occurs when counting - one word is assigned to each action or object (MacLellan, 1997). The use of the phrase ‘one arm, two arms’ as a child is being dressed also supports the development of the one-one principle - ‘one’ is linked to the first arm, ‘two’ is linked to the second arm. The idea of quantity (two) is also introduced as children come to understand that the word two is related to their two arms, and reinforced when connected to ‘one foot, two feet’ as shoes or socks are put on. This also introduces children to the counting context where they begin to understand that the counting words are applied to objects in their everyday world (MacLellan, 1997). Initially, children may perform taught behaviours (copy adult actions) rather than show an understanding of the numbers when they engage in actions alongside reciting counting rhymes or using counting in their play. This early engagement with numbers will eventually support a more comprehensive understanding of counting as “the numbers, their uses and the words and symbols that represent them” (Johnson, Tipps, & Kennedy, 2016, p 146). Children need many opportunities to engage with counting if they are to develop an understanding of numbers that will allow them to effectively use this knowledge in their everyday lives.

Positioning counting in a meaningful context enables children to consolidate the number sequence as well as develop a deeper understanding of what numbers mean. If children are to become effective counters, they need opportunities to practice the ‘how to count principles’ (one-one, stable order, cardinal) as well as the ‘what to count principles’ (abstraction, order-irrelevance) within a range of contexts they can relate to (Gelman & Gallistel, 1978; Willis, 2002). Counting is seen as the knowledge that underpins future mathematics. Young children’s ability to use counting as a strategy for solving problems has been recognised as one factor in predicting success in future mathematical achievement (Geary, 2011). Before entering formal schooling, children begin to recognise and use the mathematical symbols and concepts associated with counting as they explore the world around them. They are encouraged to use their developing mathematical knowledge “with enjoyment, meaning and purpose” (Ministry of Education, 2017, p.26) as they solve everyday problems and communicate their mathematical ideas (Ministry of Education, 2017). By the time they have completed two years at school children are expected to have used meaningful contexts to learn the “forward and backward counting sequences of whole numbers to 100” (Ministry of Education, 2007, n.p.). Linking counting opportunities to something children can relate to or are interested in makes the process of counting more meaningful.

Alongside everyday experiences, picture-books can provide a meaningful context for children to practice and develop their counting knowledge. Picture-books are defined as those books where the text and illustrations work together to tell the story (Lee, Perger, Dunn, & Sullivan, 2014). The illustrations are seen as important for motivating children to use their mathematical understanding to unpack the story (Van den Heuvel-Panhuizen, Van den Boogaard & Doig, 2009). When skilfully presented, the storyline of a well-chosen picture book will engage children (Lee, Perger, Dunn, & Sullivan, 2014) so that they use their knowledge of counting to understand the story. In the remainder of this article, we will examine how eight picture-books can be used to support the development of the counting principles and counting contexts with children

Counting principles in picture-books

When using numbers to make sense of a story, children have a purpose for using them. In the book *While You Were Sleeping* (Butler, 2001), each page introduces a number of animals going about their everyday lives while the reader/listener was sleeping. Each double page starts with the same sentence starter – “While you were sleeping ...”. The illustrations clearly show the number of animals related to that sentence. For example, the first opening says “While you were sleeping, one tiger went hunting in the jungle”. Forefront in the illustration on this double page is a tiger cub standing on a rock. On the second opening it has “... two mice in a cosy nest of hay”, the third opening, “... three bears playing in the snow”, continuing in this pattern up to “... ten penguins jumped out of the icy sea.” On each page, the reader is provided with an opportunity to use their knowledge of counting to count the animals (counting context). As they count, they are linking one counting word to one animal on the

page (one-one principle). They are hearing the final counting word said (cardinal principle/context) used to describe the numerosity of the set that is used in the storyline to label the set of animals pictured on that page. Through reading the story a number of times, children are exposed to the stable order principle as the numbers are always presented in the same order. Therefore, predicting how many animals will be on the next page gives children the opportunity to consolidate their knowledge of the counting sequence for the numbers one to ten. After the ten penguins have jumped out of the water to meet their friends on the shore the last page in this book introduces a 'big' number (one hundred). The illustration provides the reader with an idea of how big one hundred is and the opportunity to count the 100 penguins.

The story *Five Wriggly Babies* (Smee, 2003) starts with five babies playing on the floor. Each time one leaves the group, part of the page is turned over leaving one fewer baby in the picture. Again, children are presented with the counting context as they are counting something they may see in everyday life – babies. The one-one principle is evident when one is removed by turning the page as the story progresses (one crawls away, one goes roly poly). As children count the babies to find out how many are left, they are also required to use the one-one principle. Being able to state how many are left (cardinal principle) is important, as this counting word is used to start the sentence on the next page. With each page having one fewer baby than the previous page, children are introduced to the backward counting sequence, and the idea of subtraction. The last page provides children with a reason to count to five – to check that all the babies have arrived for tea. In both the books discussed above, children need to be coordinating the use of all three of Gelman and Gallistel's (1978) 'how to count principles' (one-one, stable order and cardinality) as they use their knowledge of counting to make sense of the story and/or predict what comes next.

Through counting in both a range of picture-books and everyday experiences, children develop an understanding that the 'how to count principles' can be applied to anything they need to count, both physical objects in the real world or the non-physical ideas/illustrations in a book (abstraction principle). When counting objects in the real world children can often move them to ensure each is only counted once. This is not possible when counting objects in illustrations. Some books such as *Five Wriggly Babies* (Smee, 2003) present the objects for counting in a straight line making it easier for children to ensure they have counted all the objects. Other books, such as *Dora's Chicks* (Sykes, 2002), require children to search the illustrations to find the objects to be counted. Here, there is no structured arrangement - children can count from top to bottom or left to right or in any order they find the objects (order-irrelevance principle). In *Dora's Chicks* (Sykes, 2002), Dora, a hen, loses her six baby chicks and wanders the farm looking for them. As she finds them, they appear in the illustrations although not always together. On some pages, the chicks can be counted left to right, but on others, they might be counted top to bottom. Each time children read the story they may count the chicks in a different order, providing them with experiences that will support the development of the order irrelevance principle – developing an understanding that no matter which order objects are counted, you will get the same total. Through engaging in the story, children help Dora identify how many chicks she has and how many she still needs to find (counting context). Using their knowledge of the cardinal principle/context, readers are able to realise that Dora is returning home before finding all her chicks and rejoice with her when the final chick appears.

In many counting books, the objects to be counted are presented as a distinct set, with all members of the set being counted the same: a set of two mice, a set of five babies. As children's understanding of counting develops, they come to understand that the 'how to count principles' can be applied to both heterogeneous and homogeneous collections which MacIellan (1997) refers to as the abstraction principle. At the beginning of the story *Crash, Bang, Thud! A Noisy Story About Being Quiet* (Apperley, 2001), the groups of animals are introduced with all elements the same; for example, two cows, five rabbits, or eight bees. As the story progresses, the illustrations provide children with an opportunity to count all the animals and insects as one group - the animals on the farm. Counting this group as one set requires children to realise that a big cow and a small bee are each one element of the same set regardless of their size difference and appearance (abstraction principle). As the animals arrive and ask Mr Macdonald if they can live on his farm, they are pictured in various arrays; some in structured groups, such as the sheep pictured as two sets of two, and some in unstructured groups, such as the eight bees that fly across the page in a zig-zag line. The six hens are shown in a circle requiring children to identify a beginning and end point to ensure each is counted only once. After all

the animals have arrived on the farm, a double page shows Mr Macdonald surrounded by all the animals. The animal groupings are scattered; for example, the set of seven ducks can be found as one group of four, another group of three, and the final duck is sitting on top of the haystack. To successfully count the ducks, children need to search the illustration to find them, understanding that regardless of the order in which they are counted, there will be seven ducks somewhere (order-irrelevance principle). When they have counted the seventh duck, they will have found them all (cardinal principle/context) and will, of course, use their knowledge of the one-one and stable order principles to ensure the count is correct. The page following this peaceful farmyard scene is one of chaos, further challenging children to use their knowledge of counting to find all the animals. This story, like *While You Were Sleeping* (Butler, 2001), ends by introducing children to a larger number. Peace is restored to the farmyard when Mr Macdonald builds each group of animals its own special home; that is until ten spaceships each carrying ten aliens spy the farm and think it would be a nice place to live.

Another story that supports children's understanding of cardinality is *Six Dinner Sid* (Moore, 2000). As the title suggests, an understanding of six is important to the storyline. Sid is a black cat that lives in Aristotle Street where six people each believe he is their cat. As well as having six dinners every day, Sid has six different names, expected to behave in six different ways, is scratched in six different places, and sleeps in six different beds. Each of these aspects is supported with illustrations encouraging children to count to six. Using the one-one, stable order and cardinal principles along with the counting context children develop an understanding of how many six is. With these repeated opportunities to count to six, by the time Sid catches a cold and is taken to the vet six times, children have developed an understanding of how many six is and sympathise with him as he is given six spoons of medicine. Poor Sid is found out when the vet rings six different people living in the same street. This story, based on an experience many children may be able to relate to, such as owning a cat and/or taking medicine, gives children a reason to practice their counting.

Counting contexts in picture-books

As well as providing children with opportunities to practice the counting principles, picture-books can be used to introduce the counting contexts: ordinal, measure and non-numerical. Picture-books have the potential to introduce the language and motivate children to extend the context presented in the story, requiring them to adjust the counting process to address different settings. *Olwen - Twelve Pockets* (McKay, 1993) is a story about a girl who has twelve pockets in her favourite overalls. In each pocket, she carries something that supports her everyday activities but in her twelfth pocket, her biggest pocket, she keeps something very special. This story explores what is in each of Olwen's twelve pockets. Each pocket is introduced in turn from the first to the twelfth, introducing children to the language of ordinal numbers. Each illustration also includes the numbers 1 to 12. As each pocket is presented in the sequence of first, second, third ..., known as the ordinal context (MacIellan, 1997), the associated numeral is highlighted.

Mr Wolf and the Three Bears (Fearnley, 2001) is a story about Mr Wolf who puts on a birthday party for Baby Bear. Of course, everything does not go to plan when Goldilocks arrives uninvited. She's not the mild girl found in the traditional story. Before everyone arrives, Grandma Wolf and Mr Wolf cook special recipes for the guests; cheesy snip snaps for Grandma Wolf, sandwiches for Mother Bear, huff puff cakes for Father Bear and, of course, a birthday cake for Baby Bear. All the recipes MrWolf and Grandma Wolf bake are provided on the inside cover of the book. Getting children to explore these recipes, or, even better, bake them, provides children with the opportunity to use their knowledge of counting to interpret the ingredients listed in the recipe. Counting in this form is referred to as the measure context (MacIellan, 1997). When using the measure context, children have to coordinate both the number of, and the unit measure for each ingredient. For example, one cup of flour is only one cup of flour if it is a full cup. Reading the story *Mr Wolf and the Three Bears* (Fearnley, 2001) could be the motivation to engage children in a cooking experience that would require them to use their counting knowledge in the measure context.

The use of numbers in a non-numerical context can be found in many aspects of everyday life. They are used as codes - for example, bankcard pin numbers or labels such as car license plate numbers (MacIellan, 1997). Children need to realise that numbers found in this context do not have a

numerical value and do not follow a sequence of counting numbers. The illustrations in children's picture-books such as *Grandma Joins the All Blacks* (Mc Kinlay, 2007) can be used to introduce children to the idea of numbers as labels. In this story Grandma makes marmalade on Monday then on Tuesday heads out on her skateboard to watch the All Blacks train (with a jar of her marmalade in her bag). When the All Blacks don't appear, she goes to investigate and finds them in need of her marvellous marmalade. During the following week, she supports them in their training and on test match day ends up having to stand in for the captain. The illustrations that support the story show the All Blacks in their jerseys when they train and play. On the back of each jersey is a number providing an opportunity to discuss the meaning of numbers as indicators of playing position rather than a numerical value.

Conclusion

Efficient counters automatically integrate their knowledge of the counting principles and easily adjust the counting processes to address various contexts where counting is required. Children are aware of what numbers mean and how they are used in everyday situations. Once children have developed a sound knowledge of counting, they have the foundations that will enable them to penetrate the tasks of addition and subtraction (MacIellan, 1997). It takes time to master the complexities of counting and children need many and varied opportunities to engage with and to practice their counting. They need experiences that allow them to physically manipulate sets as well as opportunities to realise that counting can involve more abstract ideas. More than that, they need experiences that will engage them so that they automatically see counting as a strategy to solve problems and to help them make sense of the world around them.

Two learning outcomes in the New Zealand early childhood curriculum, Te Whāriki (Ministry of Education, 2017) are that children will "enjoy hearing and retelling stories" and "recognise and use mathematical concepts with enjoyment" (p.42). The New Zealand primary curriculum states that children should be engaged in thinking mathematically through a range of meaningful contexts (Ministry of Education, 2007). Using picture-books where the story provides an opportunity for children to use their knowledge of counting to make sense of the story gives children the chance to engage with experiences that address these learning outcomes. As they help Dora find all her chicks, explore the magnitude of farmer Brown's problem or sympathise with Sid, who wants six dinners every night, they use their knowledge of counting to access a deeper meaning of the story. *Owen - Twelve Pockets* (Mckay, 1993), *Mr Wolf and the Three Bears* (Fearnley, 2001) and *Grandma Joins the All Blacks* (Mc Kinlay, 2007) expose children to counting in other contexts. While *Crash, Bang, Thud! A Noisy Story About Being Quiet* (Apperley, 2001) and *While You Were Sleeping* (Butler, 2001) challenge children to count to 100. Children's picture-books are able to provide a meaningful context for children to practice their counting skills.

Children's picture-books are one tool that can provide children with a reason to practice their counting. They can be used to support children moving from working with concrete objects that can be seen and manipulated, to situations where the counting involves more abstract ideas. As they use their knowledge of counting to make sense of the story they consolidate their understanding of the processes involved. Picture-books have much to offer as a resource that provides children with opportunities to practice counting but before any mathematical learning can take place, children need to want to engage with the story. The mathematics [counting] needs to add to the story and not spoil the enjoyment of it (Perger, 2007). If they enjoy the story, children will return to it. Revisiting the story and illustrations provides further opportunities for them to consolidate their counting knowledge. When a story is carefully chosen and the opportunities to count are thoughtfully scaffolded so as to ensure they add to the understanding of the story, picture-books can be a powerful tool to support the development of counting.

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