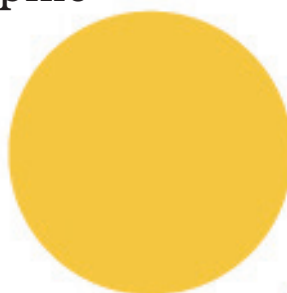


The exploration of children's
educational picture books for
learning informal mathematical
knowledge



from the perspective of graphic
and typographic design

Deniz Kaya



A Thesis submitted to PXL-MAD *School Of Arts*,
for the Degree of Master of Reading Type & Typography.

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This master's thesis came about (in part) during the period in which higher education was subjected to a lockdown and protective measures to prevent the spread of the COVID-19 virus. The process of collection information, the design research method and/or other design research work could therefore not always be carried out in the usual manner. The reader should bear this context in mind when reading this Master's thesis, and also in the event that some conclusions are taken on board.

Thesis / Research Article originally submitted in partial fulfilment of the requirements for the MA Reading Type and Typography (READSEARCH), University College PXL-MAD (Media, Arts & Design) School of Arts, 2020.

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This design study determines how an innovative approach on teaching math for preschoolers by means of graphic design — illustrative and typographic design — can contribute to unconventional methods for urgent educational mathematical needs. Starting from existing research in educational children’s pictures books, this design study built further upon how to innovate in a designerly way but also, more specifically the intended theory about math behind it. On top the new design should have the potential to be more effective, appealing and even how to awake more curiosity by means of different narratives. In this design study the presented series of picture books offer fresh insights and a more functional approach to innovative design due to the determination of a specific illustrative style, the use of tactility and interactivity, the harmonized use of illustration and typography and by the use of spot colours in a strict scheme to make colour meaningful. By implementing informal mathematical knowledge into picture books, children experience an early introduction to math, which they later will benefit from. The series of books form a bridge between preschool and primary education, a tool to introduce an innovative approach to materials based on the transformation of traditional graphic design, book design and layout. This way the book design contributes to a deeper understanding and insight in the (design) research field, in reference to unconventional methods based on research parameters) for children and educators.

Keywords

innovative design; visual narrative; typography; wordless picture book; transmitting information; illustration; informal mathematical knowledge; children’s literature; picture books; educational books; wordless picture books

10	Introduction
16	Problem statement in educational picture books
20	Design research in educational picture books The influence of teachers and educators Parameters based on suitability
24	State of the art
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34	Innovative design of educational picture books Determining an illustrative style Use of tacility Harmonized typography Meaning making with colour
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Book design covers a wide spectrum in its field of study. There are many different categories within book design and therefore also many different methods for tackling design. In 1896 Louis H. Sullivan formulated ‘form follows functions’, a principle that is widely used among (typo)graphic designers and in design in general. In 1930 Stanley Morrison wrote:

*Typography is the efficient means to an essentially utilitarian and only accidentally aesthetic end, for the enjoyment of patterns is rarely the reader's chief aim. Therefore, any disposition of printing material which, whatever the intention, has the effect of coming between the author and the reader is wrong.*¹

I have always had a specific interest in picture books and its refinement of illustrations, among others the balance between visuals and text and convenient visuals that explains, clarifies, illuminates, visually represents a written text. Many times, I came across the most beautiful illustrated children's books, but I often felt that the relation between the illustration and typography the was left out (fig. 1). Referring to the limited use of illustration to serve as an ancillary aid rather than the primary purpose of the possibility of exploration by providing visual clues.

During my internship at READSEARCH I worked on a project dealing with the tactility of children's books. We surveyed children's preferences of design decisions, such as page format, margins, line spacing and font size. After this survey, which was strictly on typographic design features, I broadened the search to find an equal relation between illustration and the structure of the book which resulted in an interesting exploration in design experiments on the tactility of the book. To be effective, a tactile illustration should provide the child with a tactual experience that, along with the book's words, triggers a connection with the child's own experience of the object in everyday life.² Tactility in books can be implemented by means of texture and is related to the sense of touch.

Books have for many years been a learning and teaching tool. Early children's literature consisted of spoken stories, songs, and poems, used to educate, instruct, and entertain children.³ It was only in the eighteenth century, with the development of the concept of childhood, that a separate genre of children's literature began to emerge, with its own divisions, expectations, and canon.⁴ The earliest of these books were educational books, books on conduct, and simple ABCs—often decorated with animals, plants, and anthropomorphic letters (fig. 2).⁵

During the Renaissance, teaching of subjects and the reading of books were often intended for the children of merchants sent to reckoning or abacus schools, where they learned the skills



"Ho, ho, ho!" riep de Reuzenkrokodil. "Wachten dat, als jij nu op dit ogenblik een lekker maaltje, vet jongetje in het water zag spatelen, je 'm dan in één hap op zou slok-ken?"

"Helemaal niet," zei de Nietzogrote. "Jongetjes zijn me te taai en kauwerig. Ze zijn taai en kauwerig en vies en bitter!"

"Daai en kauwerig!" riep de Reuzenkrokodil. "Vies en bitter! Wat een lareikoek! Jongetjes zijn maaltje en amikke-lij!"

"Ze smaken bitter," zei de Nietzogrote. "Je moet er een hoop saai-er op doen om ze naar binnen te krijgen."

"Jongetjes zijn groter dan vis," zei de Reuzenkrokodil. "Daar krijg je grotere porties van."

"Wat ben jij gauzig," zei de Nietzogrote. "Je bent de gul-igste krook van de hele rivier."

"Ik ben de dapperste krook van de hele rivier," zei de Reuzenkrokodil. "Ik ben de enige die uit het water durft te komen en door het oerwoud naar de stad durft om jongetjes te vangen."

"Dat heb je maar één keer gedaan," snooft de Nietzogrote. "In wat gebuurtje er toen? Ze zagen je allemaal aankomen en renden weg."

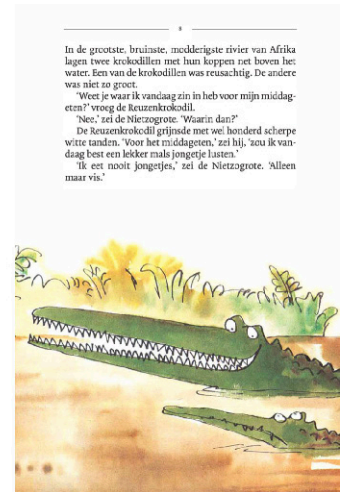


Figure 1. Roald Dahl, 2016. *De Reuzenkrokodil*. Illustrator: Quentin Blake. Age: 5-12

1. Morrison, Stanley (1929). *First principles of typography, originally written as the entry on 'typography' for the Encyclopaedia Britannica*
2. Wright, Suzette & Stratton, Josephine M. (2007). *On the way to literacy: Early experiences for children with visual impairments (2nd ed.)*. Louisville, KY: American Printing House for the Blind
3. Random History (2012). *To Instruct and Delight A History of Children's Literature*
4. Nikolajeva, Maria (1995). *Aspects and Issues in the History of Children's Literature*. Conn: Greenwood Press
5. Lyons, Martyn (2011). *Books: a living history*. Los Angeles: J. Paul Getty Museum

useful for trade and commerce. Complex exchange operations of compound interest calculation required a basic understanding of arithmetic and knowledge of algebra was very helpful. The counting books for preschoolers are more recent, little of this can be found in history. Nowadays books for toddlers often contain a mathematical topic like counting, values and opposites. Although science studies “mathematics at toddler level”,⁷ there seems to be no clear description. Some of the terms used are: “including basic number skills”,⁸ “preparatory arithmetic skills”,⁹ “concepts of numbers and counting”,¹⁰ “informal mathematical knowledge”,¹¹ “number module”,¹² “number sense”,¹³ It is therefore remarkable that different concepts apply in scientific literature. Preparatory arithmetic skill is mainly used when viewed from the child’s perspective. Informal mathematical knowledge is what the educator offers to stimulate the child on a pre-school level. Therefore, I keep ‘informal mathematical knowledge’ mainly throughout this article.

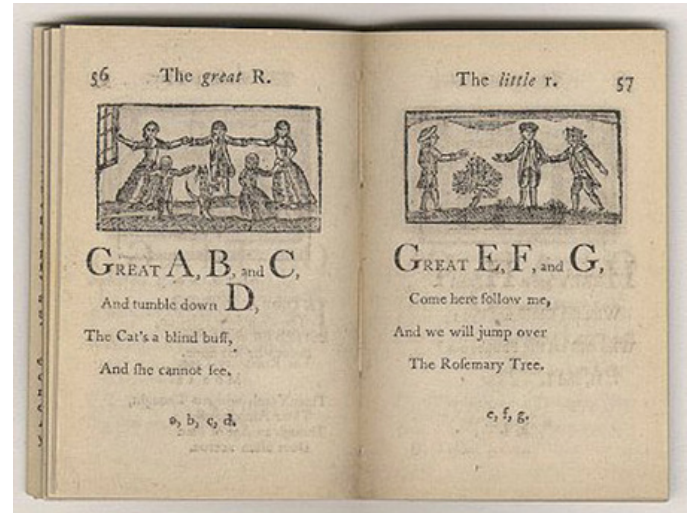
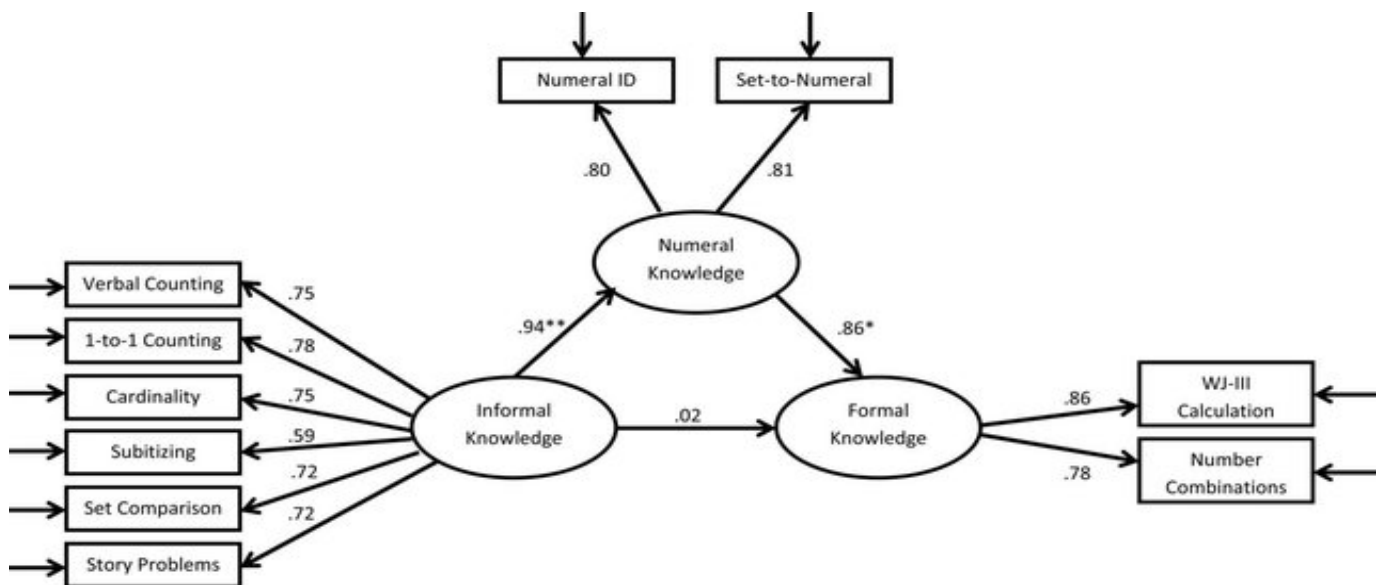


Figure 2. From Newbery’s *A Little Pretty Pocketbook*, 1744

This figure (3) shows the mediation of numeral knowledge in the relation between informal and formal mathematical knowledge. *WJ-III Woodcock-Johnson Tests of Achievement (3rd ed.; Woodcock, McGrew, & Mather, 2001). P. 05. p. 01*



6. Wikipedia (2020). *History of mathematics*. https://en.wikipedia.org/wiki/History_of_mathematics

7. Aunio, Ee, Lim, Hautamäki, & Van Luit (2004). *Numeracy of Young Children in Singapore, Beijing & Helsinki*. Helsinki research. pp. 195

8. Geary C. David, (1994). *Children’s mathematical development: Research and practical applications*. American Psychological Association

9. A.M. Schopman, Esther and E.H. Van Luit, Johannes (1996). *Improving Early Numeracy of Young Children with Special Educational Needs*

10. Fuson, Karen (1988). *Children’s Counting and Concepts of Number*. ISBN 978-1-4612-3754-9

11. Ginsburg, Herbert P. (1997). *Mathematics learning disabilities: a view from developmental psychology*

12. Butterworth, Brain (1999). *An Appraisal of Sciences and Mathematics Dyslexia and Dyscalculia Syndrome among Secondary Schools Students*. Ekiti State University, Ado-Ekiti, Nigeria

13. Dehaene, Stanislas (1997). *The Number Sense: How the Mind Creates Mathematics*. New York; Oxford University Press

In kindergarten, pre-school children are immersed in informal mathematical knowledge. As they play, they discover numbers, they are allowed to weigh and measure, and look for solutions to straightforward spatial issues. Mathematics is a learning area within pre-primary education. In order to function appropriately later in society, it is vital to have sufficient knowledge of elementary mathematics. Developmental psychologist Ewald Vervaeet said:

In our society, there is a need for mathematically educated people, math plays a critical role in science, technology, economics [...] [and moreover logical thinking]. Primary education wants to prepare children for this.¹⁴

In the first place, children learn to master mathematical skills to be able to solve all kinds of simple and practical problems in daily life. Preparatory arithmetic skill in kindergarten wants to connect with the need of pre-school children to get a grip on themselves and their surrounding world.¹⁵ According to the theory of Ewald Vervaeet¹⁶ it is desirable that children have developed the following skills before going to primary school, it does not impede if a child misses one or two skills:

- Open ordinary boxes and drums
- Count from 1 to 10
- Recognize at least a few letters
- Have basic motor skills. Children in this age group must be able to hold a pencil or a piece of chalk, climb stairs, open and close doors and cut with scissors under supervision.
- Etc.

The researchers Hannula and Lehtinen found that young children differ greatly in the extent to which they spontaneously pay attention to quantities in their daily environment.¹⁷ In addition, they also found that children who did pay attention to quantities at a young age were more convenient in math at the end of primary school. A possible explanation is that children who spontaneously focus more on amounts in everyday situations create more opportunities for themselves to expand and practice their math skills. This larger range of learning and practice opportunities has a positive influence on the further calculation development and ensures that these children become more convenient in math at a later age.¹⁸

Pre-schoolers, similar to years ago, still have to master early childhood education principles before they can go to primary education, namely, according to Scandihub.com, children's brains are designed to be stimulated and challenged and to carefully examine and interpret their environment and when children are able to interact with different disciplines in different ways, they are able to experience the dynamism and interactivity of intelligence and the brain. Supporting and encouraging adults enhance this process leading to curious children able to imagine numerous possibilities in any scenario and come up with ideas

14. Vervaeet, Ewald. (2017). *Van schootkind tot schoolkind*, Delft: Elmar, pp. 182-208

15. Vandebroucke, H. (n.d.). 5.2. *Algemene doelstellingen*

16. Vervaeet, Ewald. (2017). *Van schootkind tot schoolkind*, Delft: Elmar, pp. 182-208

17. Hannula, Minna. and Lehtinen, Erno (2005). *Spontaneous Focusing on Numerosity in the Development of Early Mathematical Skills*. University of Turku

18. Hannula, Minna. and Lehtinen, Erno (2005). *Spontaneous Focusing on Numerosity in the Development of Early Mathematical Skills*. University of Turku

that have value.¹⁹ The transition from pre-primary education to first grade does not go smoothly for all children. Some children have a hard time keeping up; they cannot handle the rhythm of the other children [developmental delay] in the class.²⁰ Developmental delay can be due to various causes, such as behavioural problems, anxiety problems, learning problems, motor problems, writing problems, toilet training problems, nutrition and eating problems. The educator monitors each child individually and checks if they meet the educational goals. Belgian children will make two main transitions in learning [teaching] techniques during their studies. The first one is from kindergarten to primary education, which is equivalent to playful learning and free exploration to more controlled learning according to a timetable. The second one is the transition from primary education to secondary education, which equals; from general education to particular education. As a (typo)graphic designer I have chosen to base the book design research in the first transition period because children are still at an early stage of their school career and thus eager to discover what might push new designs in picture books. On top, research by McClellan in 2000 has shown that books as objects can add to transmit information in order to comprehend it better, namely, by effective visual narratives and provide more effective stimulation to independence and complex thinking. However, during this first phase, toddlers are still not adapted to reading and writing, meaning that they barely can read or write. So it is a challenge to rely solely on visual narratives, that I would like them to explore independently with little structure. The research of Tiedt, Iris McClellan (2000) pushes in the direction that young children love to explore vibrant, smart and interactive books, which could be great to introduce informal mathematical knowledge in picture books (fig. 4). This statement is also reinforced by:

*Typically, the best picture books – and certainly the ones that last – are those that have much more depth than might appear on first reading. Behind a very simple structure, brief text and beautiful illustrations can lie truths that are timeless.*²¹

Children are using early math skills throughout their daily routines and activities. Most children develop an understanding of addition and subtraction through everyday interaction before they start school. Numerous surveys and articles address the fact that it is vital to provide books to children at a young age, not only to stimulate vocabulary by means of illustrations, but also increases mathematical insight in social environments, namely numbers and quantities (number concept), height and weight (measurement) or figures and building structures (geometry). Initially, this

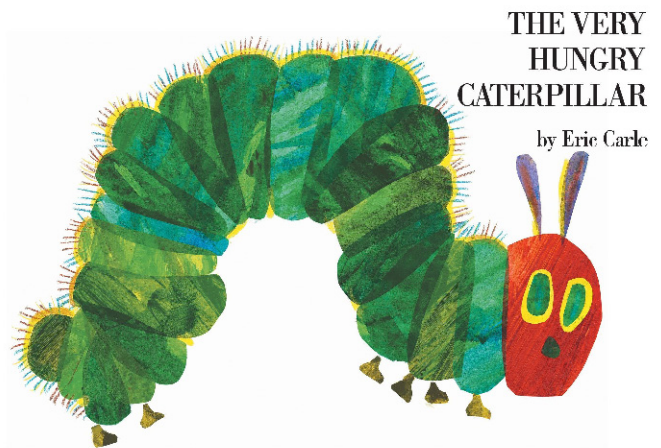


Figure 4. Eric Carle, 1969. *The very hungry caterpillar*. Publisher: World Publishing Company. Age: 3-6

19. Scandihub.com (2012). *Early childhood education principles*. Akasaka, Minato City, Tokyo, Japan

20. Lema, Helena (2016). *De overstap naar het eerst leerjaar: op welke manier beslist de klassenraad hierover?* University of Ghent

21. Eccleshare, Julia (2013). *What gives a picture book lasting appeal?* Retrieved from <https://www.theguardian.com/childrens-books-site/2013/mar/25/what-gives-picture-books-lasting-appeal>

happens unnoticed and incidentally, but at a certain point children start to recognize and use things in the world of arithmetic. The boundaries of a book as an object are explored to serve not only as a book, but also as an expendable toy. Addressing this, creativity, fantasy and curiosity are stimulated.

In the context of this thesis the term 'typography' constitutes all of the elements which represent language as it is presented on the 'graphic surface' of the page. This definition aligns itself with Sue Walker's wider definition of the term in *Typography and Language in Everyday Life: Prescriptions and Practices* (2001), in which she differentiates typography from more traditional definitions to include the production of writing in a more everyday sense. In reference to what Louise Gallagher has to say:

*Nevertheless, 'typography' is being used increasingly to refer to the visual organisation of written language however it is produced [...]. 'Typography' in this context is concerned with how letterforms are used: with how they are organised visually regardless of how the letters are produced. This approach emphasises the role of a typographer as someone who articulates the meaning of a text, making it easy for readers to understand, and that is the definition used in this book.*²²

22. Louise Gallagher (2018). *Typography and Narrative Voice in Children's Literature: Relationships, Interactions, and Symbiosis*. University of Dublin, Trinity College

This definition suits my purposes, as it allows for the broad spectrum of creativity which we find in the production of children's literature. Not all children's books worth investigating are mass-produced, and at least one created during this research was entirely handmade.

While attempting to analyse the often innovative and complex ways in which authors choose to present narratives to the adult reading public is no simple task, the task in relation to children's literature comes with an extra element of complexity.²³

A child reader is not static. When we discuss the child reader, we may be imagining anything from a pre-literate or inexperienced child reading alongside an adult, to a fully literate person in their late teens. The books we come across as very young readers provide our first experiences of creating meaning from the printed word and can leave a lasting impression on our perception of language and graphic symbols. A page comes much more vivid into a child's awareness, because children look at things adults don't. Therefore, within this project experiments are made upon the approach of typography in picture books.

*23. Louise Gallagher (2018).
Typography and Narrative
Voice in Children's Literature:
Relationships, Interactions, and
Symbiosis. University of Dublin,
Trinity College*

Every year changes are made to educational systems, but the basics such as illustration and navigation remain almost unaltered. Therefore, the approach to children's books has not drastically changed, namely, navigational systems and principles are the foundation of visual form. Many times, you can see a clear difference between educational and non-educational children's books. Meaning, almost all children's books are educational, they teach straightforward material, in other words, children's books that are specifically focused on educational systems and the order of learning and teaching. It is beyond dispute that a goal-oriented, meaningful and linguistic approach to pre-schoolers can yield a better educational result. Scientific research by Broecks, et al. (2015) shows that with regard to pre-schoolers and nursery schoolteachers, more scientific research has been carried out on a linguistic level than on an arithmetic level.²⁴

Educational goals are minimum goals that the government believes all students should reach. Minimum goals include a minimum of knowledge, insight, skills and attitudes. For pre-school and special education there are no final objectives, but developmental objectives: skills that a school must pursue among the pupils, but not necessarily achieve. In a curriculum, the school describes how it tries to achieve the final objectives. Books are a useful tool for preparing pre-schoolers, so here I see benefits for children who tend to be disadvantaged. The subject matter should not be forced but introduced in different and playful ways. Therefore, it seems helpful to design a tool that can be used both in the classroom and at home, in Belgium children are only obliged to attend school from the age of 6. By implying innovation in the design of these books by means of material and illustration, the subject matter will feel less educational and more as a subconscious lesson. Usually, schools from the same educational network share their curricula. Primary objectives specify the learning content and kindergarten behaviour. They are plotted on development lines that represent successive levels of development. They are intended as orientation points to which a kindergarten can consider its best efforts.²⁵ Pre-primary education is characterized by a very specific initial situation and is not a necessary form of education. Hence, at the end of it, one cannot expect that that all pre-school children have already achieved the development goals that have been pursued.

The learning process of toddlers — also referred to as pre-schoolers — differs fundamentally from that of children in primary school. Toddler's Learning processes are partly conscious and partly unconscious/incidentally. The first form is also called elaboration learning, the second form activation learning. Practicing (repeated execution) of certain cognitive tasks such as arithmetic, language, memory tasks and motor tasks is accompanied by a faster and more efficient execution of those tasks, whereby they are more automatic, so with less mental effort. Education is built on the conscious (activation) learning process. Activation learning, to learn by practice, gradually happens

24. Van Steenbrugge, Hendrik & Valcke, Martin & Desoete, Annemie (2015). *Mathematics learning difficulties in primary education: teachers' professional knowledge and the use of commercially available learning packages*. Department of Experimental clinical and health psychology & Department of Educational Studies

25. Onderwijs.vlaanderen. *be* (n.d.). *Eindtermen, ontwikkelingsdoelen en leerplannen in het basisonderwijs*. www.onderwijs.vlaanderen.be

through the imitation of others and is purposefully implemented in pre-primary education. This project is based on activation learning to make the transition from primary education gradual.

*Pre-schoolers mainly learn incidentally, and it is therefore important to provide rich play-learning effects. Primary school children also learn intentionally and can divide their skills into sub-skills. Age is not the determining factor, but his level of development. The pre-schoolers receive extra impulses in kindergarten for the preparation of reading, calculating and writing.*²⁶

During my MA, I have examined and studied different books and articles relating to my topic. According to the results of the Rideout survey in 2017, learning and bedtime were the most important reasons for use for picture books. Easily accessible children's books like most in libraries (fig. 5) only have one feature of what might be defined as a good children's picture book. Therefore, I refer to them as ordinary children's books. As an exploratory experiment I studied subjectively the reactions of a five-year-old boy when he was given five ordinary picture's books that I collected from the library, in order to understand where these books flaws. After the experiment with the five-year-old, conclusions are that there is a lack of suitable educational resources; namely, picture books to encourage children's creativity and complex thinking through fun experiments and visual stories. There is a wide range of refined educational children's books (fig. 6) with themes like the human body, atlases, experiment books, reading books, game books etc. On the other hand, specific educational books (fig. 7) with exercises for reading and math exist in abundance. The difference between these books is huge and can quickly feel like books for learning or books leisure time. By reducing the contrast between passive looking and active participation, this view changes and children can learn more playfully. Here the purpose raised to provide parameters of designing children's books that are able to offer children tactility and a fulfilling reading experience. Children can sense when a book is more educational compared to another. Children are incredibly observant and notice more often details in illustrations and interrelations

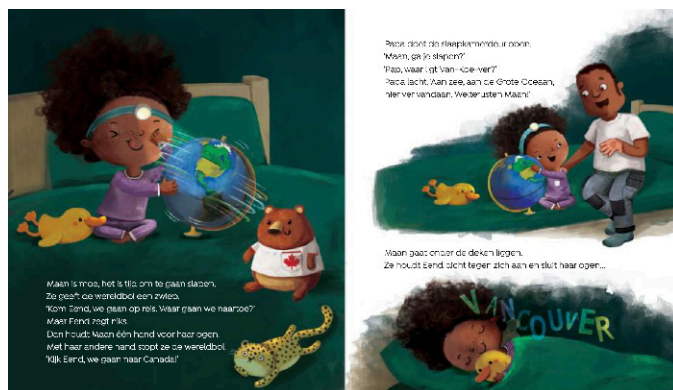


Figure 5. Femke Manger, 2019. *Maan in Canada*. Illustrator: Monika Suska. Age: 4-6

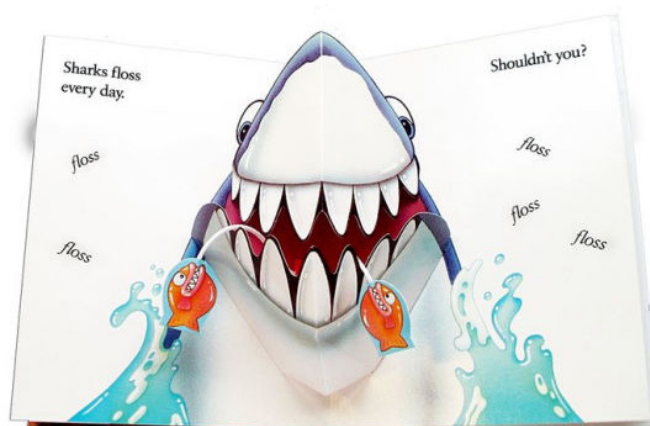


Figure 6. Leslie Mcquire, 2013. *Brush your teeth, please*. Illustrator: Jean Pidgeon. Age: 3-6

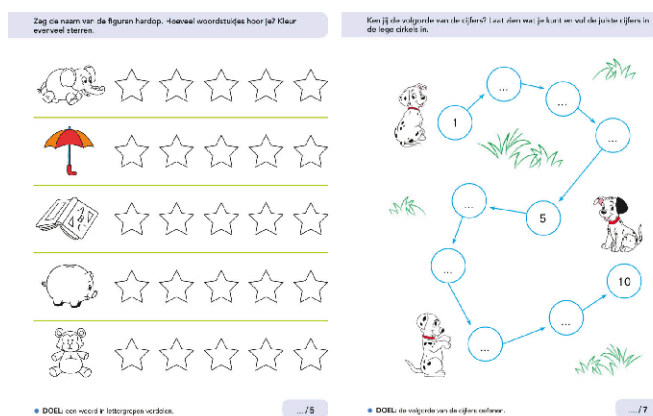


Figure 7. 2018. *Ik leer met Disney 0 - Eerste stappen naar schrijven, lezen en rekenen*. Age: 5-6

between different pages that adults don't, as a result of the wider imagination of a child. Therefore, a higher stimulus is needed to support their complex thinking.

*Objects have always played a role in educating children, but the concept of an educational device or toy to introduce specific lessons is only about only three hundred years old. While the concept of the educational toy has shifted over time to encompass a wide variety of objects and toys, it has maintained an emphasis on early learning as a form of social and societal improvement.*²⁷

Only a few children's books prove to be an effective preparation for kindergarten; this shows a shortage of educational children's books. An example of an effective book for teaching math in kindergarten is *Mouse Shapes* (2007) from Ellen Stoll Walsh (fig. 8), another example is *Shape by Shape* (2009) from author Suse MacDonald (fig. 9). Furthermore, it targets the right age category, linked to the educational objectives. I would like to address the matter of shortage of educational picture books targeting math based on the Belgian education system. Insight of language and math develops at a young age mainly in interaction with the environment, so with parents, teachers, classmates, brothers and sisters. In kindergarten pre-schoolers firstly come into contact with letters and math in different ways and forms, called informal knowledge of mathematics and literacy. A stimulating playing and learning environment contribute to the development of this knowledge. A school determines the content of the lessons and the teaching method. Furthermore, a school imposes some primary rules that ensure the quality of education. *"The government outlines what the students should know in terms of educational goals and developmental goals."*²⁸ The books can be functional for teachers to use during their class or at home with some guidance of a parent. For example, learning objective that need to be discussed can be visualized. The books are functional for other development domains and not only language consider development. Motor skills are one of them; they learn to handle the book consciously and function as contemporary tools besides books and pedagogical tools or materials for children. Toddlers become detached from

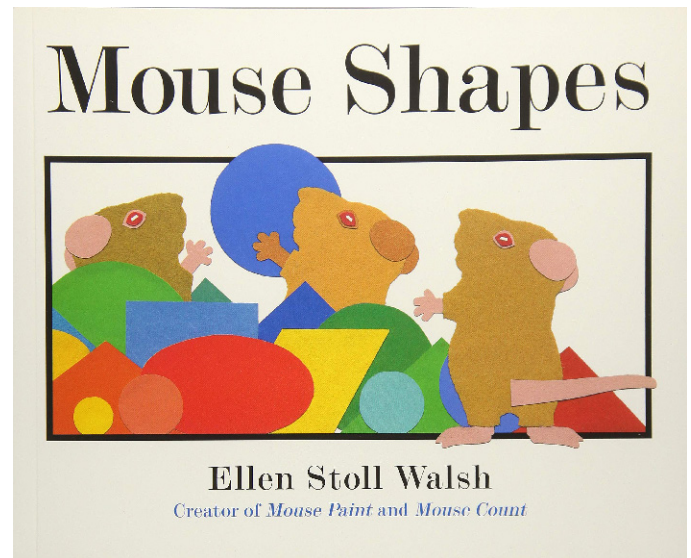


Figure 8. Ellen Stoll Walsh, 2007. *Mouse Shapes*. Publisher: Hmh Books For Young Readers. Age: 4-7



Figure 9. Suse MacDonald, 2009. *Shape by Shape*. Publisher: Simon & Schuster. Age: 2-4

26. Buggenhout (2018). *Hoe groot is de stap van kleuter- naar lagere school?* www.buggenhout.be

27. Amy F. Ogata (2004). *Creative Playthings: Educational Toys and Postwar American Culture*. Henry Francis du Pont Winterthur Museum. P. 130

28. Onderwijs.vlaanderen.be (n.d.). *Eindtermen, ontwikkelingsdoelen en leerplannen in het basisonderwijs*. www.onderwijs.vlaanderen.be

schemes they have developed; in this way, the visual language is broadened.

Children's books are often directed to a certain age group, an interesting but often overlooked insight is to have a narrative that will captivate and intrigue different age groups at the same time. The benefits of having a multiple age appropriate book is on the one hand to use the same book over the years while a child matures, and discovering different details depending on their maturation, while on the other, to provide a book to different aged children at the same time, which is positive for usage in families with more than one child.

*It's a strange idea that picture books should stop when you reach a certain age because they're such a wonderful way to relate and share ideas*²⁹

29. Ager, Charlotte (2020). Charlotte Ager discusses the wonder of familiarity and her new book *Child of Galaxies*. <https://www.itsnicethat.com/articles/charlotte-ager-child-of-galaxies-illustration-240420>

Over the years, I have often thought about what the term ‘book’ means and what its limits are. In the strict sense, a book is a number of pieces of paper, usually with words printed on them, which are fastened together and fixed inside a cover of stronger paper or cardboard. Books contain information, stories, or poetry, for example.³⁰ However, a book is a medium to transmit information, by testing its limits and innovating the notorious definition, a book can cross disciplinary functions.

The influence of teachers and educators

There are many different types of fascinating educational books. This master project and theoretical work focuses on the educational objectives within picture books used in the primary stages. Over the years, teachers and educationists have had an influence on the look and feel of children’s books. Therefore, I am interested in adding to this development and discussion a more child-friendly approach to book design for children. By means of a more independent use of books by toddler’s and the enhancement of tactility. But also, the use of books by children and in their school or home environment. Duke and Pearson (2002) argue that children can enhance their meaning making when they create mental images of what is being read, because “a visual display helps readers understand, organize, and remember some of those thousand words”.³¹ Encouraging children to visualize the text using their five senses can support their comprehension of the text. When being read to, using an illustrated text, children are already provided rich visual and verbal information.³² Teachers can encourage children to think about other senses while the text is being read. Namely, sounds they can hear in their mind, associated smells and tastes, and imagine touching and feeling. In early childhood, educators can help children to develop reading comprehension behaviours, like visualization, before independent reading emerges. Later, readers can use this visualization strategy, with some describing it as like “having a movie going on in your mind while you read”.³³ The curriculum contains basic guidelines that every pre-schoolers should master at the end of kindergarten.³⁴ Namely minimum goals in terms of knowledge, insight, skills and attitudes.

I have opted to only discuss informal mathematical knowledge for this project, as they are both inherently linked through verbal communication of learned or acquired knowledge. It is an entirely different subject with different learning techniques. To tackle the entire curriculum during this research period is overwhelming and not fully needed in achieving the first objectives for this project. However, my goal is to process most of the general objectives of measure for math within my picture books. These general objectives of measuring within informal mathematical knowledge established by the government are in the online pdf <https://pro.go.be/blog/Documents/KO%20Wiskundige%20initiatie.pdf>. The themes of my chapter books are based on the learning objectives set by the government and its curricula. Three general topics within

30. Collins. (n.d.). Definition of ‘book’. www.collinsdictionary.com

31. Duke, N.K. & Pearson, P.D. (2002). *Effective reading practices for developing comprehension (Chapter 10)*, In A.E. Farstrup & S.Ĵ. Samuels (Eds.), *What research has to say about reading instruction Third Ed (pp. 205-242)*, Newark, DE: International Reading Association. P218

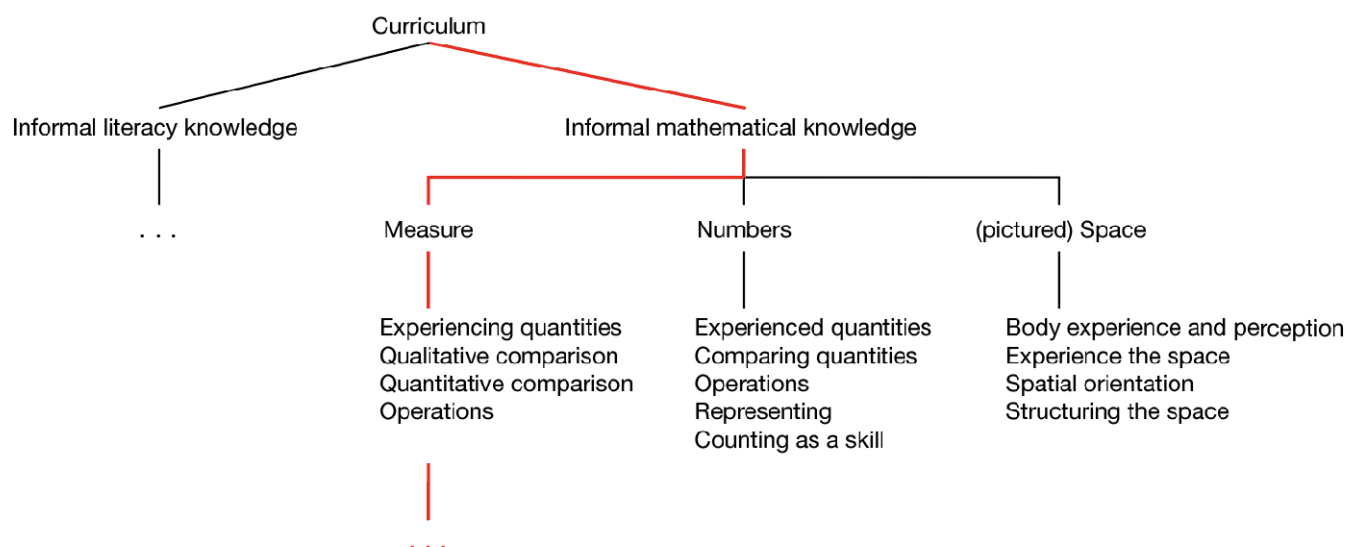
32. Victoria state government (2018). *Reading with children*. www.education.vic.gov.au

33. Davis, A. (2015). *Building comprehension strategies for the primary years*. Hong Kong: Eleanor Curtin Publishing. P:61

34. Zin in leren! Zin in leven! (n.d.) *Developmental objectives of pre-primary education from 2.5 to 6 years old for Catholic education; philosophical development, [...], mathematical development*. By, ZILL (2018). *Katholiek onderwijs leerplan*. www.zill.katholiekonderwijs.vlaanderen

informal mathematical knowledge are; measurement, numbers and (picture) space. Where within the topic Measure following themes are addressed; experiencing quantities, qualitative comparison, quantitative comparison, operations. Other topics are at least as interesting to serve as an extension of the project. Below is a framework with a visualisation of the system for more clarity;

Figure 10. Below is a framework with a visualisation of the Belgian curriculum system for more clarity;



Parameters based on suitability

Research by Nisbett³⁵ and Kühnen³⁶ (2003) showed that in different cultures there are basic differences in viewing things - in western cultures by dissecting objects into components (i.e. Westerners pay more attention to the objects and see the environment in terms of unconnected entities) and in Asian cultures viewing objects in holistic terms (i.e. Asians focus on the relationships of the objects and see the environment in terms of inter-connected entities). Picture books didn't fully blossom until late the 19th century (fig.11) when new developments in printing technology, changing attitudes towards childhood, and a new class of exceptional artists catapulted it into a golden age.³⁷



Figure 11. 19th century French children's books about dolls. Printed on stock paper with self covers. *La jolie Bebe* and *Honorine ou L'Institutrice d'Une poupee*. Publisher: Imagerie d'Epinal, Pellerin

35. Nisbett, Richard E. (2003). *The geography of thought: How Asians and Westerners think differently – and Why*. New York: The Free Press

36. Kühnen, Ulrich (2003). *Denken auf asiatisch. Gehirn und Geist*, 3 International University of Bremen. pp.10-15

37. Popova, Maria (n.d.). *A Brief History of Children's Picture Books and the Art of Visual Storytelling*. brainpickings.org

Still, it remains a rigorously researched and compellingly curated survey of a tremendously important storytelling medium, one that equips young minds with a fundamental understanding not only of the world but also of its visual language.³⁹ For example, Italian artist Bruno Munari groundbreakingly designed picture books in which touch became a key sense for reading and understanding.⁴⁰ For this design research, innovative design specialized in children's pictures books are used for introducing mathematical concepts, by exploring the following notions that are critical when designing these series of books. While new educational models are on the raise. Namely, the function of interactive play, a sense of time and perception and fascinating creativity for a book as a toy-object. This need supports Munari's response to the urgent educational needs of that time [late 20th century], to introduce children and adults to a different perspective and place them before the vastness of possibility using unconventional methods.⁴¹ This need is the leading element for this project; reflecting an innovative approach on teaching maths for pre-schoolers by means of illustration and graphic design, depending on unconventional methods and education policy. Based on this (design)research new parameters emerged to transmit information in order to comprehend it better. Namely, engage children emotionally, invite involvement, provide opportunities for interaction by educators to increase children's understanding of the book and be aesthetically pleasing.

To promote the independence of a child, visualizations are used that provide clarity and meaning making of a linear storyline. This gives them spatial insight and illustrations depict reality by only visualizing most of the necessary characteristics of the concept or situation to which they refer. Reference can be made to concrete situations in which different steps are proposed. Through a visual character set, the meaning of a situation or concept becomes clear. Clues can also be given to a next or previous situation or activity, which emphasizes awareness of time. In this way, a child can also make a connection between the object and the situation.

38. Salisbury, Martin and Styles Morag (n.d.). Via interview: Popova, Maria (n.d.). *A Brief History of Children's Picture Books and the Art of Visual Storytelling*. braimpickings.org

39. De Rijdt, Chris. (2012). *Werken met visualisaties*. www.klascement.net

40. Campagnaro, Marnie. (2019). *Do touch! How Bruno Munari's picture books work*. Università di Padova. Retrieved from abstract

41. Campagnaro, Marnie. (2019). *Do touch! How Bruno Munari's picture books work*. Università di Padova. P.82

Salisbury and Styles (2012) point out:

*“Many publishers and commentators’ express views about the suitability or otherwise of artworks for children, yet there is no definitive research that can tell us what kind of imagery is most appealing or communicative to the young eye. The perceived wisdom is that bright, primary colours are most effective for the very young.”*³⁸

Bruno Munari has designed a large number of books dedicated to children. This selection of Munari's vast array of picture books are the basis of this paper: *L'uomo del camion* (The Lorry Driver, 1945), *Nella Notte Buia* (In the Darkness of the Night, 1956) and *I Prelibri* (Prebooks, 1980). Quote by Marnie Campagnaro:

Munari's picture books open up imaginary worlds in everyday settings that draw the reader into the action and push them to be challenged by limits rather than bow to them, even those books published to be understood and handled by toddlers.⁴²

Munari's books were not only objects to behold, but to experience through different materials, types of binding, experimental typography, illustrations, and colours, cited by Diana Budds.⁴³ His vision is at the base of this project, his way of working matches this research perspective. Bruno Munari stated for his book *Nella Notte Buia* (fig. 12), that a good book for children aged three to nine should have a simple story and coloured images showing whole figures drawn with clarity and precision.⁴⁴ The book must be as straightforward as the child's world to promote independency. It is evident that design is an act of visual communication, but it also needs to be objective and universal and thus human being regardless of age or social context.

We [designers], Bruno Munari stated, perform visual operations, that is, visual communication [...] design has nothing to do with art except for its aesthetic aspects, which are not 'applied art' but a 'logical aesthetics' born in the solutions to the various problems to be found within a given project.⁴⁵

Besides the children's books by Bruno Munari, one of the books that triggered me most for this project was *Blokje om* (fig. 13), a book created by Belgian illustrator Judith Vanistendael. This is a wordless visual book with mainly basic shapes and primary colours. Picture books teach children to create things starting with basic shapes, for example; how to create a caterpillar from multiple circles. Jürgen Peeters said that Vanistendael knows how to combine a variety of rudimentary, geometric shapes in different constellations into surprising figures.⁴⁶ The book is a fascinating visual narrative with a dynamic process, in which



Figure 12. Bruno Munari, 1956. *Nella Notte Buia*. Publisher: Opera Munari (1996)

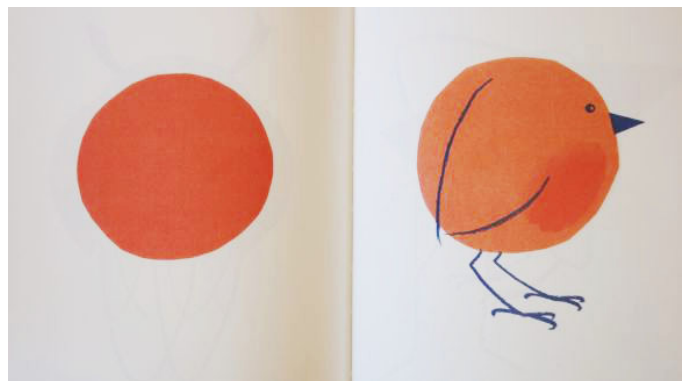


Figure 13. Judith Vanistendael, 2018. *Blokje om*. Publisher: Querido Kinderboek. Age: 3-12

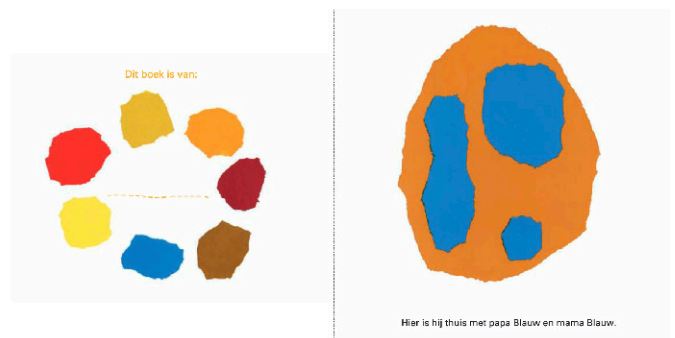


Figure 14. L. Lionni, R. van Lint, 1959. *Blauwtje en Geeltje*. Publisher: Ankhhermes. Age: 4-6

42. Campagnaro, Marnie. (2019). *Do touch! How Bruno Munari's picture books work*. Università di Padova. Retrieved from abstract

43. Budds, Diana. (2015). *Bruno Munari Will Make You Fall In Love With Books All Over Again*. www.fastcompany.com

novelties and surprising twists can be discovered again and again. *Blauwtje en Geeltje* (fig. 14), is a book about colours and learning to look at things differently; about friendship and the fact that you both bring in your own colour in a relationship, so that you make a new colour together, this also refers to colour theories. All this is presented in a very simple way, which leaves the child enough space for his own input. Next, *Round and Round and Square* (fig. 15), is a book by Fredun Shapur which was published in 1965.

As historian Amy F. Ogata writes in the new book *Fredun Shapur: Playing with Design* (2013), “*Shapur produced toys that highlighted and challenged the child’s agency while appealing to the parents’ tastes.*”⁴⁷ Shapur has the same refinement and illustration approach as Vanustendael, he also starts with basic shapes to create objects, but unlike Vanustendael he explains what is happening in the frame, which I find an added value. He provides an introduction to the possibilities of visual expression.

Last, a book by Marion Bataille called *10* (fig. 16), is a sensationally attractive package that sets the stage for an inventive exploration of counting simultaneously. The numbers unfold and transform with breath taking ingenuity. *10* is the exact example for a book for children that is equally as interesting for adults, Bataille made this pop-up book in which numbers appear, but she also released an alphabetical version called *ABC3D* (fig. 17). These picture books have certain equal graphical peculiarities, these characteristics are one by one parameters for this design research. Determining an illustrative style is far one of the most important for designing a picture book, referring to the subvention of visual communication. Harmonized use of typography is equal to the use of visuals -or solved in an innovative way with a well-thought-out approach-addressing a visual representation of oral speech. By an additional use of tactility, layers of interest take different forms on each detail. Furthermore, use of colour can contribute an especially important part of learning for

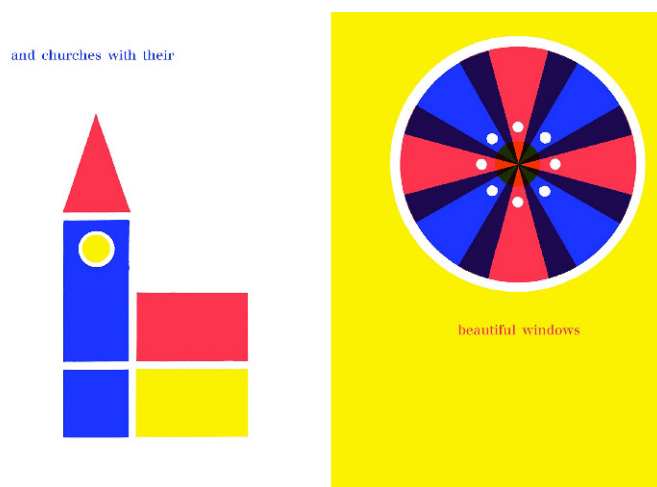


Figure 15. Fredun Shapur, 1965. *Round Round and Square*. Publisher: Tate publishing. Age: 3-5

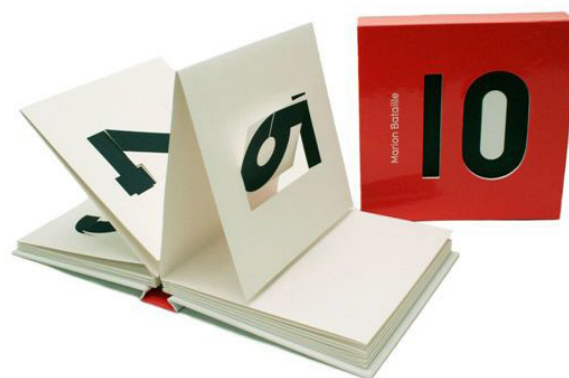


Figure 16. Marion Bataille, 2011. *10*. Publisher: Roaring Book Press. Age: 2-4



Figure 17. Marion Bataille, 2011. *ABC3D*. Publisher: The Millbrook Press Inc. Age: 2-4

44. Serrano, María. (2013). Bruno Munari & his book *Nella Note Buia*. www.the-publishing-lab.com

45. Barberis, Alfredo. (1978). BRUNO MUNARI intervista di Alfredo Barberis. www.munarg.org

46. Peeters, Jürgen (2018). Judith Vanistendael, ‘Blokje om’: Geometrische vormen in transitie. www.cuttingedge.com

47. Ogata, Amy F. (2013). *Fredun Shapur: Playing with Design*. Editions Pipopq

small children. According to Sarah Leigh Wills when colour is used right in children's books, it draws them into the visual aspect of the various colours on the pages and helps provide stimulation for their developing minds.⁴⁸

Marie Neurath made dozens of illustrated books (fig. 18) for children on scientific topics ranging from nuclear physics to reproduction. "From the 1940s to the 1970s she transformed complex science into striking infographics and diagrams to be easily understood by those of all ages"⁴⁹ (house of illustration, 2019). She was particularly good in making things visual in an order and a systematic way. The multiple age-appropriate approach transitions from cute illustrations for toddlers to more 'grown up' use of insights and patterns for older kids. These different levels focus on making an emotional connection and recreating the feeling readers had when they were playing with the books as children, and to feel okay to keep reading them now and forever. Atelier Bingo, composed of Maxime Prou and Adèle Favreau, has illustrated a new children's storybook *Dans le Ciel* (2018) (fig. 19) for publishing house Amaterra. It is the perfect example for a book that is both interesting for children and adults. "Using its signature cut-out style, Atelier Bingo's images are colourful, expressive and have stolen our imagination".⁵⁰

Research by Sue Walker shows that

*At the end of the nineteenth century psychologists and medical practitioners began to be interested in the effect of reading and writing upon eyesight.*⁵¹

This research led to recommendations for the use of particular kinds of typefaces, type size and spacing in books for beginner readers. Books for teaching reading have also been the subject of legibility and linguistic research and this, to a greater or lesser extent, has had an impact on their visual organization. Different treatment of features like texts, pictures, headings, captions reflects, among other things, the printing technology of the time, the way teachers may have used the books in the classroom, national educational policy and publishers' ambitions to sell books. Each of these examples typifies the visual characteristics of books produced around the time each was published. Descriptions of graphic language remain relatively rare compared

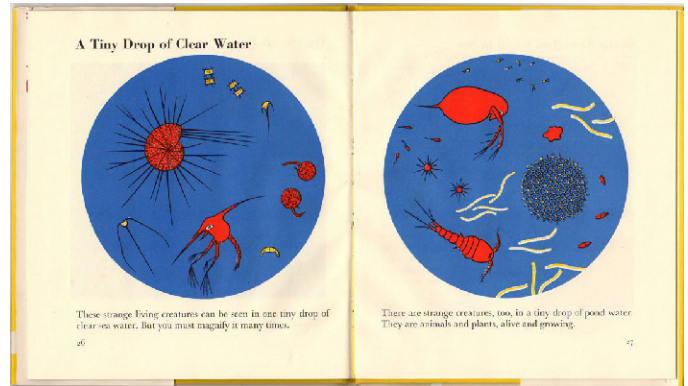


Figure 18. Marie Neurath, 1955. *The wonder world of the deep sea.*



Figure 19. Atelier Bingo, 2018. *Dans le Ciel*

48. Leigh Wills, Sarah (2015). *The Importance of Colour in Children's Books*. Happydesigner.co.uk

49. House of illustration (2019). Marie Neurath:

Picturing Science. <https://www.houseofillustration.org.uk/whats-on/current-future-events/marie-neurath-picturing-science/calendar/07-2019>

50. Emma Latham Phillips (2018). *Atelier Bingo's new storybook features "pure, expressive images" inspired by nature*. <https://www.itsnicethat.com/articles/atelier-bingo-dans-le-ciel-publication-040718>

51. Walker, Sue. (2001). *Typography and Language in Everyday Life: Prescriptions and Practices*. London; Longman P.194

to, for example, description of varieties of spoken language. She created a checklist (fig. 20 & 21) which considers constraints of the design, like attributes that are relevant to children's reading. So, after working out this checklist, one would be left with an artefact description of designs for the needs of a child.⁵²

*52. Walker, Sue. (2001).
Typography and Language in
Everyday Life: Prescriptions and
Practices. London; Longman.
P.182*

Checklist for recording the visual attributes of childrens' books, as used in the Typographic Design for Children Project

IDENTIFICATION INFORMATION

category

- reading book
- information book

author

editor

series editor

illustrator

title

series title

publisher

place of publication

date

- approximate date
- supplied date

..... to
(single year, decade, or date range)

edition

printer

place of printing

location

reference

ARTEFACT DESCRIPTION

page size height mm width mm

orientation

- portrait
- landscape

no. of pages pp.

paper

- matt
- shiny
- coloured paper
- different kinds of paper in book
- other

binding

- single-section sewn
- single-section saddle-stitched
- section-sewn
- side-stitched
- perfect binding

type of cover

- hard cover
- soft cover
- self cover

cover material

- board
- cloth
- cloth-covered board
- paper-covered board
- cloth-covered paper

colour of cover material

cover printed in

- full-colour
- more than one spot-colour
- single colour

printing process (text)

- letterpress
 - offset litho
 - other:
- printing process (images)

DOCUMENT STRUCTURE AND ARTICULATION

Extra matter

- presence / absence of
 - frontispiece
 - title page
 - back of title / imprint page
 - contents page
 - notes for teachers
 - list of references
 - list of illustrations
 - glossary
 - index
 - acknowledgements
 - advertisements
 - other:

Navigation

- presence / absence of
 - contents page
 - index
 - page numbers
 - section heading
 - heading level 1
 - heading level 2
 - heading level 3
 - running head
 - key words in text
 - graphic devices (such as arrows, bullets to direct attention)
 - other:

heading distinction

- no headings
- no obvious hierarchy

heading 1

- size
- boldness
- italic
- typeface
- capitalisation
- indentation
- colour
- space
- underlining
- other:

heading 2 [with attributes as above]

heading 3 [with attributes as above]

Information units

- chapter/section
- double-page spread
- page
- other:

graphic components

- main text
- supplementary text
- heading(s)
- picture(s)
- picture(s) with labels
- captions to pictures
- exercise
- other:

MAIN TEXT TYPOGRAPHY (reading books only)

typeface

- serif
 - old style
 - modern
 - transitional
 - slab
- sanserif
 - grot
 - humanist
 - geometric
- script typeform
- handdrawn/stencilled

infant characters

- yes
- no
- x-height mm
- cap height mm
- point size (based on [eg type specimen]
- line feed mm
- line length mm

word spacing

- normal
- narrow
- wide
- variable

letter spacing

- normal
- narrow
- wide
- variable

average no. of characters per line

alignment

- ranged left
- justified
- centred

hyphenation

- yes
- no

no. of columns

treatment of the start of paragraphs

- indented
- indented plus space
- full out
- full out plus space
- first line extended to the left
- first line extended to the left plus space
- numbered and indented
- numbered and indented plus space
- numbered and full out plus space
- numbered and first line extended to the left
- numbered and first line extended to the left and space
- other paragraph treatment

differentiation of key words:

- no differentiation
- bold
- italic
- caps
- colour
- typeface
- type size
- underlining
- other:

Colour use in text

colour used for

- heading(s)
- main text
- supplementary text
- captions
- labels
- other

distinction of

- letter
- word
- phrase
- sentence
- paragraph
- other:

function

- decorative
- articulation of structure
- articulation of content

ILLUSTRATION

type of picture

- line drawing
- simple shaded drawing
- detailed shaded drawing
- photograph
- map
- plan
- diagram
- bar chart
- pie chart
- other
- diagram

position of picture in relation to text

- above text that refers to it
- below text that refers to it
- integrated across spread
- to right of text that refers to it
- to left of text that refers to it
- surrounded by text that refers to it (as text runaround)
- between text that refers to it
- no visual relationship to text
- text on verso, picture on recto
- text on recto, picture on verso

treatment of picture

- squared up or boxed
- bled off
- no boundary / vignetted / cut out
- plate
- other

colour or not

- black and white
- single colour
- quite colourful
- very colourful

colours applied to

- all foreground elements
- some foreground elements
- all of background
- some of background

function of colour

- decorative
- articulation of structure
- articulation of content

basis for colour choice

- realistic/associative
- other:

position

- on same page that refers to it
- on same spread that refers to it
- on different pages

As a preparation for primary school, three books were designed concerning mathematical concepts provided by the Belgian curriculum. The books are divided based on three subdivisions of the mathematical concepts of measure; experiencing quantities, qualitative comparison and quantitative comparison. Each chapter contains mathematical knowledge that children would need to understand to make the transfer from kindergarten to primary school easier. As an overview for the project I'm implying the following key ideas on what a book can represent;

- Transmitting (educational: mathematical knowledge) information
- Plaything
- Exploring tactility
- Multiple age-appropriate approach
- Promote children's independence

Traditional children's books are built upon reductionist principles which ended up mutilating creativity and training children in linear thinking and learning-by-repetition.⁵³ In order to counteract this trend, these picture books are based on the concept of touch (fig. 22), which is an advantage of paper books compared to digital books. As a book designer, the awareness of tactility also factors in our appreciation of books as aesthetic objects. The combination of author, designer and printer is a craft tradition that results in the development of typical visual attributes that are closely related to (the perceptions of) usage, mixing visual communication with textual and sensory communication. I do not want to teach children how to 'read' a book but to help them understand how combinations of pages and its tactile, visual and formal elements allow us to express things, such as mathematical concepts (to support informal mathematical knowledge).

This project on children's picture books focusses on effective visual narratives to provide visual stimulation and according to María Nikolajeva; pictures amplify more fully the meaning of the words, or the words expand the picture so that different information in the two modes of communication produces a more complex dynamic,⁵⁴ but also to generate interesting results out of the design process, such as different layers of illustration and commutation; interaction between the three volumes and various reading directions through surprising navigations, also for

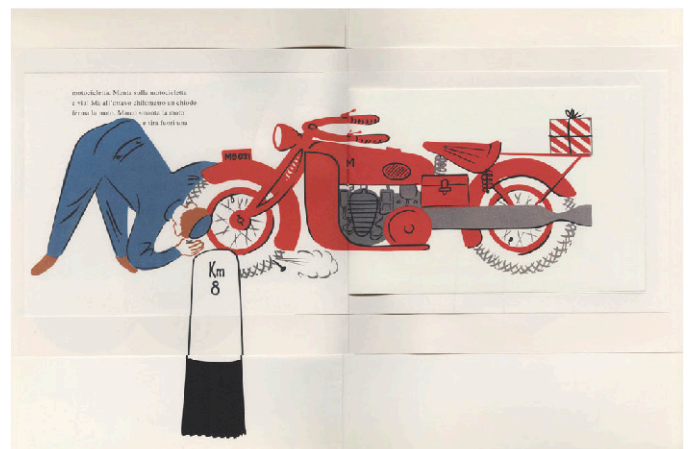
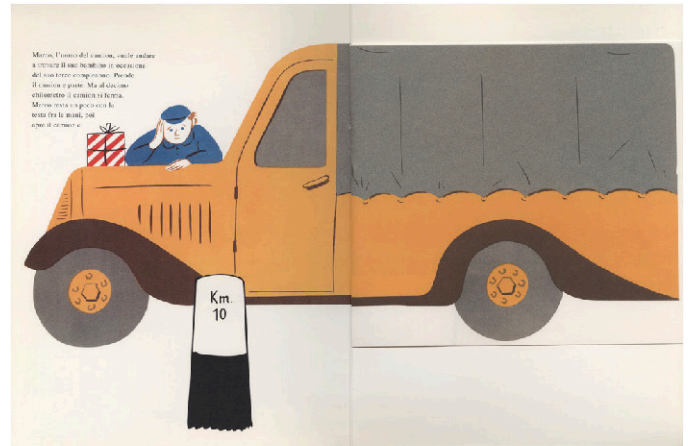


Figure 22. Bruno Munari, 1945. *L'uomo del camion*. Publisher: Mantova: Corraini (2008)

53. Serrano, María (2013, March). Bruno Munari & his book *Nella Note Buia*.

54. Nikolajeva, María (2000). *The Dynamics of Picture book Communication*. Human Sciences Press, Inc. P.225

the tactility of books for children; more than a classic touch & feel book with added textures of textile, among other things. Tactility design analysis by means of design features, such as paper weight, binding and printing techniques and navigation. For the enhancement of visual communication, narrative conceptions rely on design, simplicity and functionality; illustrations are created in a thoughtful and functional manner. Too often too much emphasis is placed on durable materials or cute fonts, which take the upper hand over tactile and visual information which the children are dealing with. Contemporary picture book maker Paul Cox uses strategies to incorporate codes and conventions into texts, so that readers become aware of the amount of visual interpretations that occur daily through codes. Using these codes, he creates texts that encourage readers to think differently about books, narrative, and culture.⁵⁵ In his book *An Animal ABC* (fig. 23) he arouses curiosity for experienced readers and commemorate the concept of reading in a provocative alphabet. He remains true to form in his signature style; a thoughtful combination of painting and graphics in a mix of design.⁵⁶

This MA design approach of educational children's books in relation to informal mathematical knowledge, by playing with its navigation, enhancing the tactile experience and playing with the lack of language as words, I implied by using different levels in my picture books. Navigation, in other words, is the foundation of visual form; composition, principles, harmony, the dialogue between pages. As Gautier said: "A layout is always presented to the viewer, who may or may not begin a "conversation" with the piece." Visual navigation of images leads to the fundamentals of symbol recognition (shape, color, negative/positive forms) leading to letter forms. In order to distinguish letters, it is vital to recognize similar and different letter shapes, referring to the cognitive ability to separate elements based upon contrast. Understanding the representation of both positive and negative space and learning to "see" negative space [counter shape] helps children to unconsciously think in balance and depth. A strong development of visual perception makes it possible to recognize differences and similarities in letters. Marc Litière said:

*This perception therefore has to do with seeing and it is not only about looking and being able to see well, but a child must also be able to recognize what he sees, and he must be able to distinguish details, similarities and differences.*⁵⁷



Figure 23. Paul Cox, 2001. *Abstract Alphabet: An animal ABC*. Publisher: Cahners Business Information, Inc

55. Reynolds, Kimberley (2007). *Radical Children's Literature: Future Visions and Aesthetic Transformations in Juvenile Fiction*, London: Palgrave Macmillan, p. 64
56. *Publishers Weekly* (2007,

July). *Abstract Alphabet: A book of animals*
57. Litière, Marc, (2008). *Ʒuf, mag ik overvaren*. Tiel, Belgium: Lanmoo. ISBN 9789020978148. P.80

The pursuit of visual learning objectives of the Belgian education system, to facilitate the transition from nursery education to primary education, seems possible. It is vital to create a balanced visual image without changing characteristics. The approach itself of the pure visual narratives in picture books can be seen as small-scale worlds children are being introduced to. Going deeper into the visualization techniques, used to create this aesthetic and tactile identity for the book, the process (fig. 24 & 25) helped to create a visual style that's interesting but also very educational in that I can tweak the design and tweak the forms so that they make sense and represent the learning objective accurately.

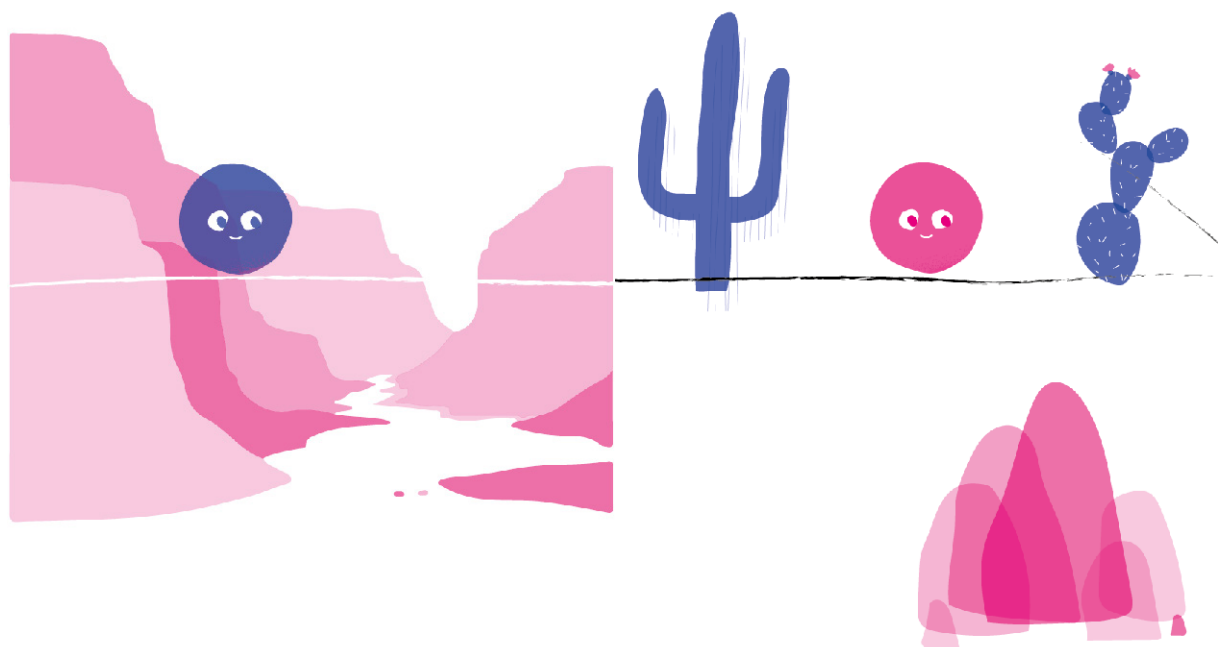


Figure 24. First sketches. Defining illustrative style, by means of colour and character.

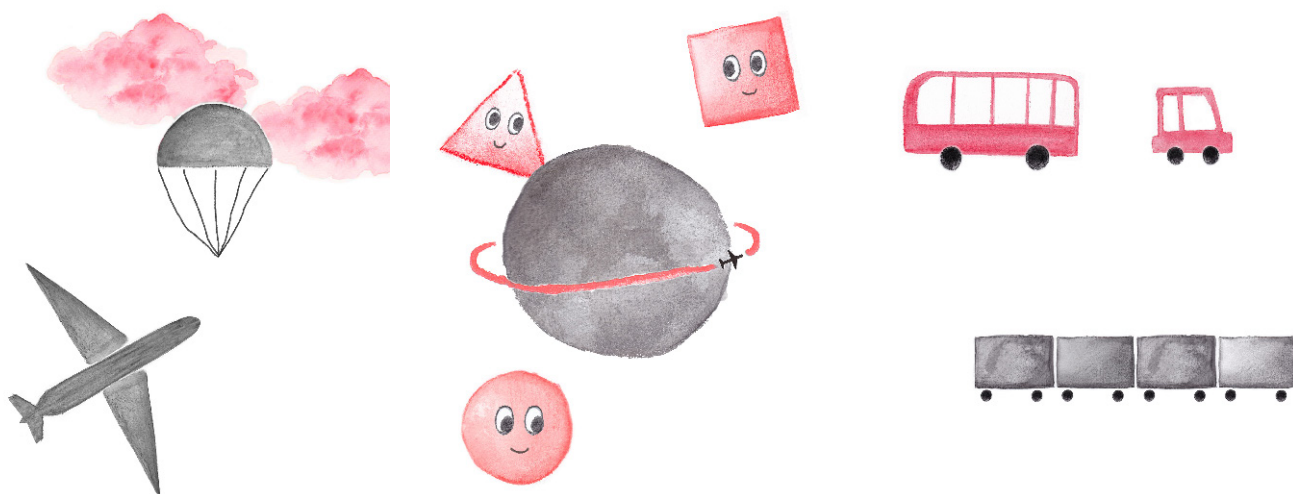
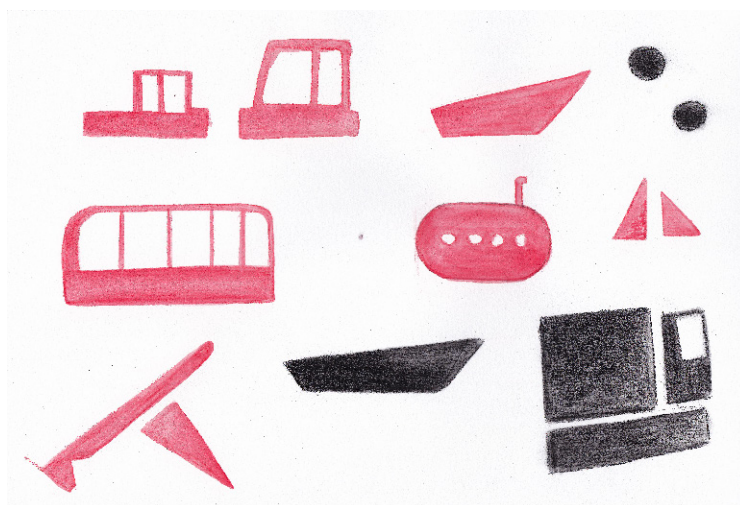


Figure 25. More sketching, Watercolour. Setting up a character set, starting from basic shapes.

The following assumptions are determined (and clarifications) in my design approach for the series of picture books and the additional narrative manual created during this project. By means of graphic and typographic design the following matters Determining an illustrative style, Use of Tactility, Harmonized typography and Meaning making with colour are being addressed. To rely solely on scientific articles and other findings discussed in this thesis.

Determining an illustrative style

The book market, although the emergence of e-books, continuously evaluates. More than ever, books are published for children, each of which is a bit grander and more expressive due to new printing techniques and technologies. Inspired by the possibilities of the ways of traveling, the storybook is about preparing for primary education, and a ground-breaking way of experiencing a book.

Wordless books are always addressing to a community that share common visual alphabets and collaborate to build this international and collective sharing of images and imagination. [...] Silence is not only a pedagogical possibility offered by this kind of narration, which breaks the chain of too many words of scholastic habits and reviews the educational hierarchies by facing with a text which does not necessarily need to be said by a literate reader in words in a loud voice but rather seen and read with the eyes and retold in new words for every reader. In pedagogical terms, it turns the traditional roles of reading upside down: the adult is no longer the first reader, the initiated side that knows the written sign and acts as a go-between, at times with a rather hurried approach, dulled by normative obsession or cognitive control, and loses the plot, while children are the dynamic readers of pictures.⁵⁸

I wanted to develop a signature illustrative style, with illustrations that are as simple as a child's world, the moon and the sun, a boat, a leaf, a tree, a car, a train, an elephant, water, time. Forming a small-scale world that takes a child through complex dynamic educational objectives. Therefore, drawn with clarity and precision, but with hidden details and clues. The picture books (fig. 26) focus on special characteristics, i.e. those wordless, pure, visual storytelling in the shape of picture books, by providing the written narrative in a separate manual. I am pioneering for a form of education that carries impact and influence for children. Through picture books, I believe that children can be encouraged to achieve their objectives in an innovative way. Wordless books mean listening to other languages, those of signs, colours, visual ranges and shapes, also, a space where multiple narratives are possible. The



Figure 26. Part of illustration, Amerika.

58. Marcella Terrusi (2018). *Silent Books. Wonder, Silence and Other Metamorphosis in Wordless Picture Books*. University of Bologna

approach is one by process and order, by tackling illustration similar to graphic design by means of a pattern of concepts, with a regimented colour palette and visual consistency across the board too. It is not just about depicting something but also trying to let the pre-school children understand the described objective. This understanding is fundamental for my project and is focusing on the supporting role that a clear illustration can offer. The best illustrations contain a message and convey this message in a well-founded manner, no different from that of design.

The images in my project are colourful, expressive and moreover might add to a child's imagination. The general theme of the book tells the story of a number of primary shapes. I show typical features of all continents - animals, means of transport, world cuisine, etc. By presenting themes through different concepts, I wanted to create a book that surprises young readers and develop their curiosity in relation to the tactility of books. The idea was to create clear expressive images while including some figurative elements to make a link with the text and give some landmarks to the readers. When I started illustrating, I thought of a way to repurpose them. The creative process began by setting up a library of illustrations consisting of reusable basic objects. Armed with an alphabet of shapes / character set (fig. 27), I could now easily start creating the visuals for narrative. The set is a tool which allowed me, as a designer, to create consistency in my design process and outcome. Therefore, I could focus on the visualization of the narrative and stylization, instead of having trouble with different illustrations and trying to fit them together as a whole. Parameters were set to reference back to the three leading topics; mathematical concepts of measure. These topics are set by the Belgian government, (1) experiencing quantities, (2) qualitative comparison and (3) quantitative comparison. Triangle, square and circle are the three shapes that divined the three leading topics above, each shape, and thus mathematical concept were indicated by a character.

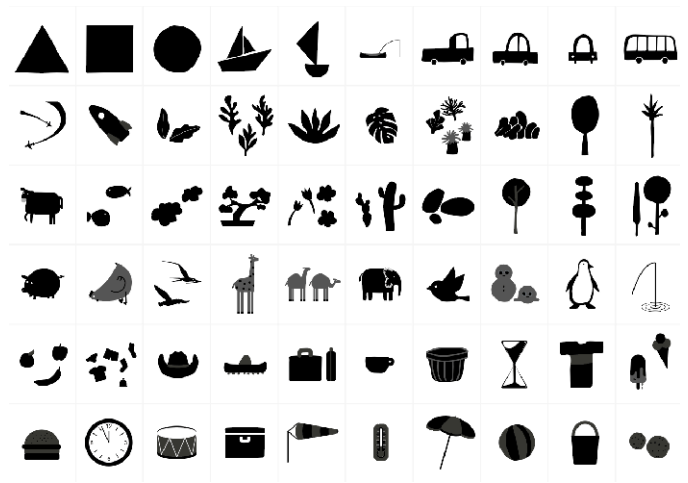


Figure 27. Alphabet of shapes / character set

Use of Tactility

Piaget's theories and revolutionary study on the cognitive development of children, proving children-centered activities that facilitate trial-and-error experiences are very helpful for early literacy and may help develop children a keen eye for imagination and creativity,⁵⁹ deeply influenced this project. Therefore, the picture books are designed as appropriate educational tools, based on tactility and navigation of a book. I started by creating a poster per continent (fig. 28), by analyzing multiple ways of reading and seeing pictures in a book, carefully working out the

59. Campagnaro, Marnie (2019). *Do touch! How Bruno Munari's picture books work.* Università di Padova. ISSN 2384-8294. P. 229

relationship between pictures and text. Later, I chopped the posters into pages per learning objectives; available in the online pdf <https://pro.go.be/blog/Documents/KO%20Wiskundige%20initiatie.pdf>. Then I divided them into three books funded on the three leading topics; mathematical concepts of measure, referring to the three main characters, shapes. The three books are in a constant interplay to each other, narrative, page arrangement, positioning of the books are all contributing to one big puzzle. I wanted to create a series of books that was able to alter as an attribute to be used as a plaything. Therefore, I used different types of folding (fig. 29). The layer of interest takes different forms on each detail. The children experience different views but still remain consistent every time, one folding can function as the base for another. The intercommunication of the book versus its reader plays a big role in the processes to learn from discovery in functions of the book. By innovating navigation systems, the children experience 'reading' in other ways. Also, there are a lot of books on the market within this topic of structuring books, such as navigation, but the part of tactility is often left out. Not only for young children I wanted to create an awareness for tactility that could factor into appreciation for books as aesthetic objects and playthings. The binding is also critical. I wanted different kinds of folding's addressing to the possibilities of traveling. For example, with a Japanese binding (fig. 30) I was able to visualize the inside and outside of a vehicle. With a pop-up a could visualize the sails of a boat. By folding pages, I could extend a passenger car into a bus. These are fun little hind-and-go-seek interactions for children to discover. To promote motor skill and unconventional navigational systems.

Harmonized typography

We often overlook that written language can also be a form of visualization. Anyone who can read and write or recognize certain letters does not always need drawings, photos or pictograms.⁶⁰ Naturally, visualization and interpretation evolve as the child grows older, so in secondary education more written language is used than visualized language. Often while reviewing children's books,



Figure 28. Posters of continents



Figure 29. Fold out; expand from small to large boat

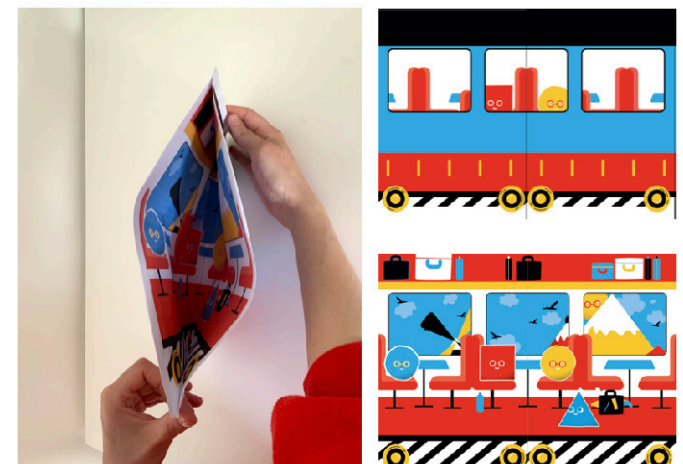


Figure 30. Japanese binding Outside: train outside. Inside: train inside

60. De Rijdt, Chris. (2012). *Werken met visualisaties*. www.klascement.net

you can see demarcation between typography and illustration. To breach the gap between these two, which for years has been two different disciplines, I have searched for a harmonious relationship of text and visuals. It is vital that there is smooth communication between text and image in a structured way. Therefore, I opted to add a fourth pictureless book that contains the narrative in only written text, to serve as a narrative manual. Introducing clues in positioning of the text and adding a colour code in a smart way.

By using the same colour structure in the written narrative [separate manual] as for defining the topics, the sentences can refer to the underlying educational objectives. Both the written and the visualized language support each other. A commonly used serif font in children's books is Plantin Infant (fig. 31), which is designed for maximum legibility and Prof. dr. Ann Bessemans PhD showed that children with normal vision made less mistakes with a serif typeface, an admirable contrast as they were more familiarised with a sans serif. Studies have shown that having a serif makes the text more legible. It is round, open, and sturdy, with its surprising contrasts Plantin Infant comes near the top of the list of no-nonsense text fonts. Roethlein (in collaboration with Benton, M.F.) showed that young readers more quickly identified letterforms with contrasting weight, but with the lighter strokes maintaining presence. Tests also revealed the importance of maintaining counter-form (the white space around the black letterform) in recognizing the face at smaller sizes.⁶¹ I've been looking for a way out of the classic use of text and be more experimental, by introducing new ways of typography, referring to harmonious cooperation of type and illustration. This communication method took a new meaning by letters, words and sentences defined by colour and positioning in the page space that become a visual set of their own.

61. *Webtype (n.d.). Century Schoolbook Family. <https://www.webtype.com/font/century-schoolbook-family/>*

Aa

Plantin Infant

Aa

Baskerville

Aa

Georgia

Aa

Times New Roman

Aa

Century Schoolbook

Figure 31. Commonly Used serif Font Types

Meaning making with colour

I explored the children's books from the 50s and 60s, where they use fewer colours and returning shapes, allowing the power of dreams to take shape in the mind of the reader. Offset was a commonly used printing technique during the second half of the twentieth century. Artist Dieter Roth mastered the limited availability of colour and print during the 50's and 60's. He only used a circle and a square for his *Kinderbuch* (1957) (fig. 32) with three primary colours. By using transparency and opacity there is a complex interplay between each page and shape. As a subject of his time, he was innovative with the materials and techniques of his era. Marie Neurath's (fig. 33) books are an example of books created under the influence of restrictions of printing techniques. Later on, the first digital presses are making their way to the market, desktop publishing revolution is taking place. The Komori press was first to perform a four-colour print in 1975, but options were still limited.⁶² Slowly, techniques are evolving to what we know today.

Colour is a visual element of art and design, meaning making with colour in picture books is a semiotic mode that is used strategically by sign-makers to communicate meaning. Understanding the meaning making potential of colour can enhance children's understanding, appreciation, interpretation and composition of multimodal texts.⁶³ The picture books and the additional narrative manual created for this project are printed in spot colours: blue, red, yellow and black, creating a powerful but straightforward image that imprints itself clearly on the mind. Each colour has been assigned a mathematical concept of measure (fig. 34); blue represents triangle ▲; experiencing quantities, yellow represents circle ●; qualitative comparisons and red stands for square ■; quantitative comparisons. Colour is conceived as an integral feature to enhance meaning and engage readers. Pure colour is used within a functional

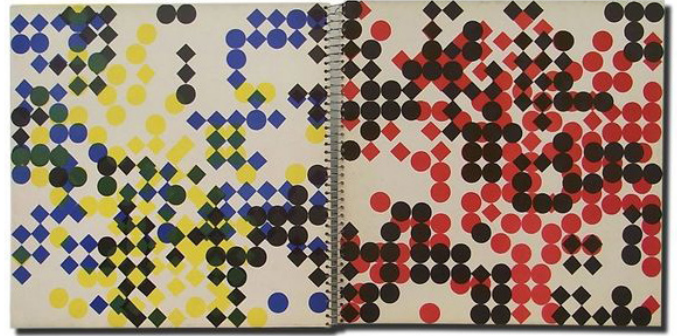


Figure 32. Dieter Roth, 1957. *Kinderbuch*. Linocut



Figure 33. Marie Neurath, 1955. *Picture Science*

62. Reppure (n.d.). *The history of print from 1950 to 1999*. www.preppure.com

63. Sylvia Pantaleo. (2012). *Meaning-making with colour in multimodal texts: an 11-year-old student's purposeful 'doing'* United Kingdom Lubricants Association, Published by Blackwell Publishing

context rather than as decoration. Clean and refreshing brilliance in drawings never fails to appeal and to capture children's enthusiasm, where items can appear in unnatural colours but remain recognizable. I am convinced that children have a strong imagination, and I want to give them an image where they can use it.



Figure 34. Three characters representing mathematical concepts of measure

In this MA thesis, an innovative approach on children's educational picture books for learning informal mathematical knowledge is being explored, by introducing design and typographic parameters that are connected to instructional experiences that integrate the study of mathematics with children literature. In addition, this project provides a tool -for parents and educators- for the preparation of children on the introduction of pre-primary education. Relationships between mathematical concepts and children's literature are being explored. This innovative approach on educational picture books provides new insight into imaginary situations in relation to everyday events that fill the gap between comprehending concepts that differ in age. With this library of illustrations, I was able to create a multicultural language, visual symbols, that would make sense to everyone. I wanted the book to be interesting for children at different ages, pre-schoolers and primary school students, favouring books that you can keep for life. Over time, different triggers are being addressed.

These picture books and the additional narrative manual aimed to provide effective unconventional methods for urgent educational needs, namely informal mathematical knowledge. An innovative approach to picture books aimed to promote children's intellectual independence through an active, sensorial and playful problem- solving exercise by using the book page as a laboratory unit. This indicates that appropriate educational tools encourage children's creativity, complex thinking and independence. I used comparisons and simplified schematic images, and techniques such as cross-section and magnification to engage the learning objectives of pre-schoolers. Each educational objective is clearly explained by means of basic but accurate drawings in bright colours and a supportive narrative manual.

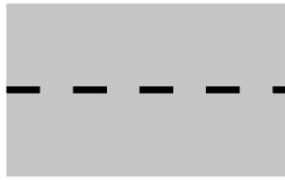
The illustrations are based on reality, but which slip into the fantastical. It's a book with illustrations, but it also tells a story at different levels. The purpose of the books highlights a return to a playful sense of fun. In terms of design, I strongly believe that my diversity of key ideas forced me to reject having a single visual style or a one-dimensional 'writing system', this project is all about context. With the writing system, I refer to underlying meanings of text and visuals. Like, the concept of 'space' can be depicted. Toddlers become detached from schemes they have developed; in this way, the visual language is broadened. The narrative can be read in multiple sequences, by the organization of the books and the ability to link the books together, which provide several reading directions. A blue, yellow and red thread form three separate chapters but can be read perfectly alternately, there is no set reading direction, nor permanent book sequence. In addition, more equality between illustration and text -the signature illustrative style that is harmonically reflected in typography- can be obtained.

The relationship between design and childhood can be found in numerous settings throughout the book, to evoke adventures which are unreal, imaginary or fictional places, they plunge the

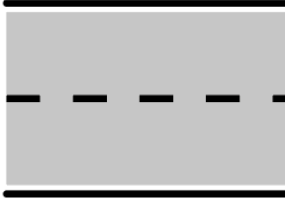
character into everyday situations. Based on the surprising effect of the unexpected, unforeseen and fantastic aspects of reality, the aim was to combine the visually stunning playfulness of a story with the formal linearity of the narrative. Offering children an innovative retelling of a classic everyday events, but above all a real and touching experience. This design research about educational picture books clarifies combining education with play, involving educational objectives, but it also raises the question of contemporary (educational) book design. For example, is a more innovative design approach to book design also more effective? The parameters in this design research are set on personal findings and findings by others through research and surveys. Another question is; Does a contemporary approach to book design as a result of educational changes contribute to improving education? These questions remain mostly unanswered. Based on findings by looking back in history is that the navigation remains unadjusted.

The experimental research based on the theory is limited. This design research about educational picture books is further applicable for other divisions of the educational system in different series of books. Especially, for testing the design factors in a qualitative scientific way and investigating them more in-depth. Also, for the typographical aspect there will be additional experiments needed to clarify the results' interpretations and investigate them more in-depth as they quote informal literacy knowledge. Research is already done on design parameters for children's books. However, the study of an innovative way for educational features as a tool for primary education is never tested on this level.

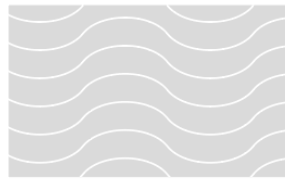
Legend



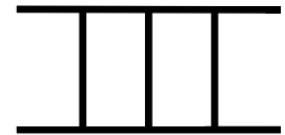
Street



Street + Bridge



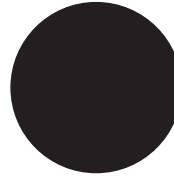
Water



Train Track



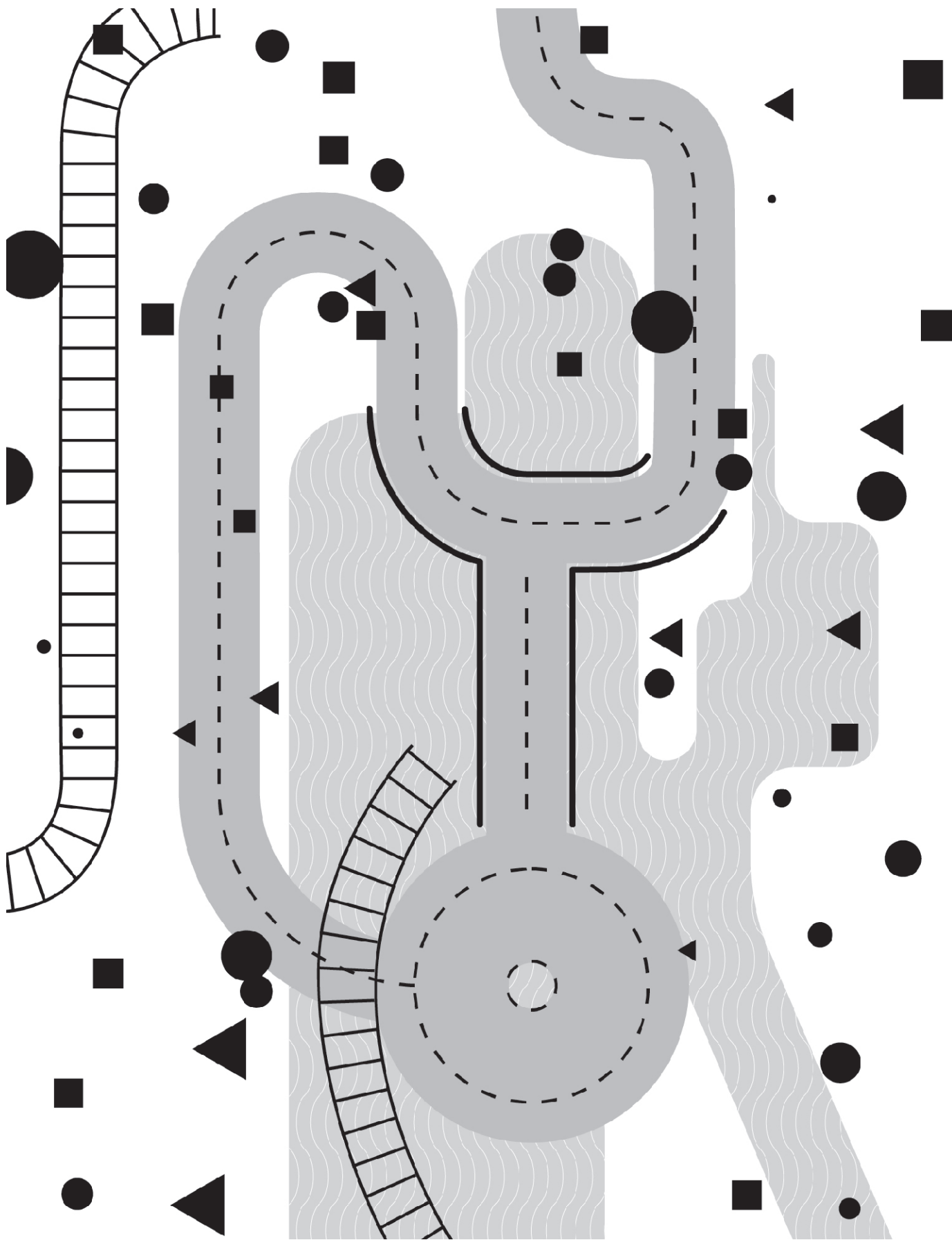
**Experiencing
quantities
Character: Triangle**



**Qualitative
comparison
Character: Circle**



**Quantitative
comparison
Character: Square**



1. Can articulate change, movement, (speed) that they experience with their own body or that they perceive with objects, phenomena or with other people.

*Triangle is on the beach with his ball,
he has to be careful or it will get lost in the sea.*

2. Experience that there are different quantities that we can measure, namely length, content, weight, area and time.

*In the summer it is very hot.
Triangles' ice cream slowly melts because of the heat.*



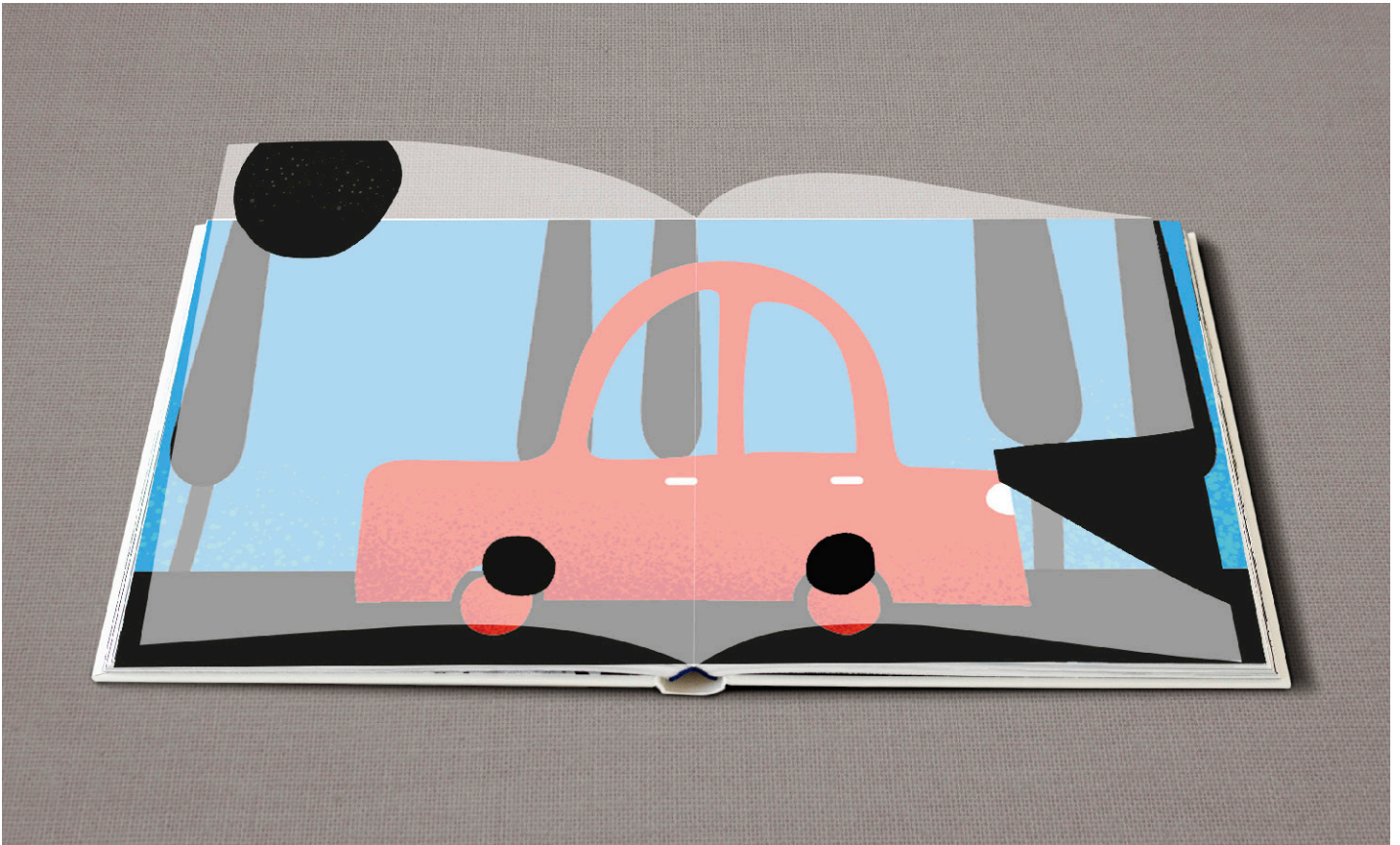
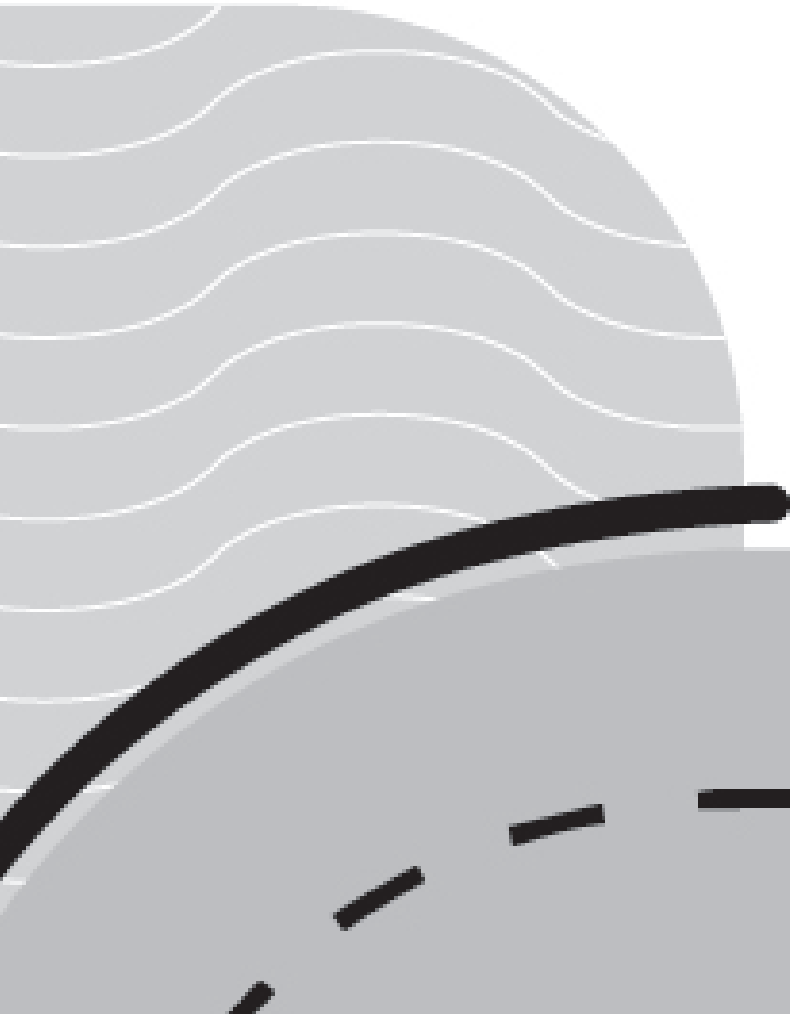
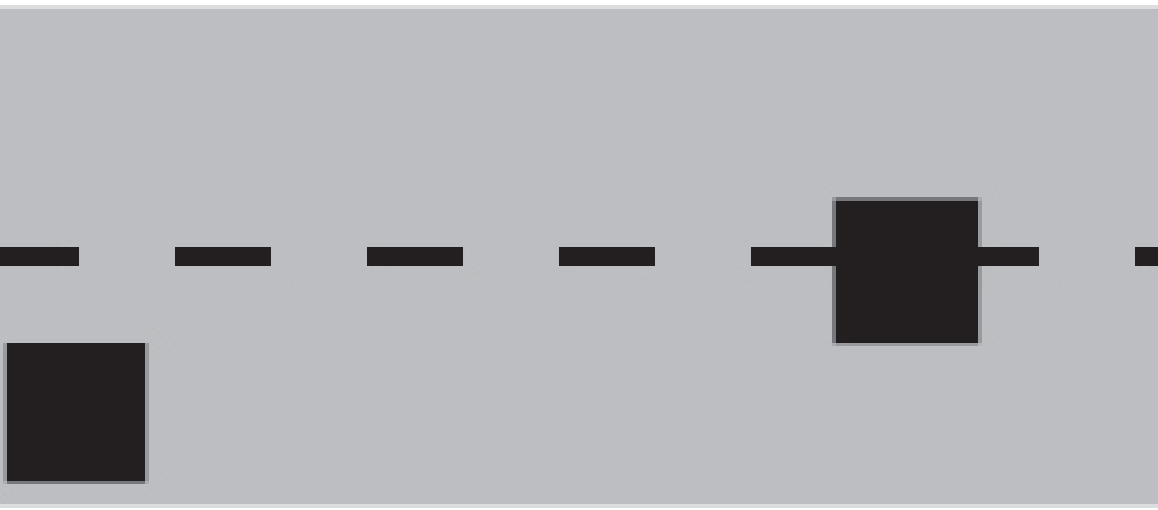


Figure 38. Spread of vehicle, fold-out boat. When folded open, will discover more details.









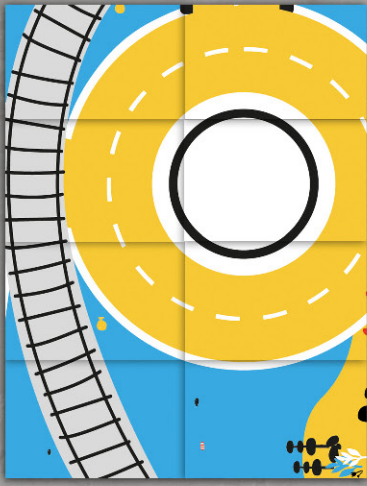
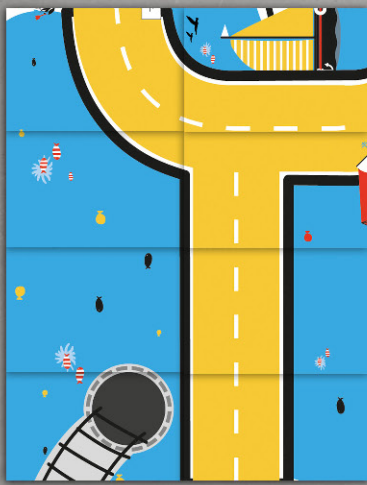


Figure 1. Roald Dahl, 2016. *De Reuzenkrokodil*. Book, 21,5 x 14 cm, 64 pages, language: Dutch, age: 5-12. Illustrator: Quentin Blake. Publisher: De Fontein Jeugd. ISBN 9789026140747. Source: www.bol.com

Figure 2. Newbery's *A Little Pretty Pocket-Book*, 1744. Source: www.18thbritischchildreosliterature.weebly.com

Figure 3. This figure 3. shows the mediation of numeral knowledge in the relation between informal and formal mathematical knowledge. WJ-III Woodcock-Johnson Tests of Achievement (3rd ed.; Woodcock, McGrew, & Mather, 2001). P .05. p .01

Figure 4. Figure 4. Eric Carle, 1969. *The very hungry caterpillar*. Publisher: World Publishing Company. Age: 3-6

Figure 5. Femke Manger, 2019. *Maan in Canada*. Book, 20,2 x 17,5 cm, 28 pages, language: Dutch, age: 4-6. Illustrator: Monika Suska. Publisher: Mo'S Daughters. ISBN 9789493145061. Source: www.bol.com

Figure 6. Leslie Mcquire, 2013. *Brush your teeth, please*. Book, 21,6 x 16,3 cm, 12 pages, language: English, age: 3-6. Illustrator: Jean Pidgeon. Publisher: Sfi Readerlink Dist. ISBN 9780794430405. Source: www.bol.com

Figure 7. 2018. *Ik leer met Disney 0 - Eerste stappen naar schrijven, lezen en rekenen*. Book, 24,8 x 19,2 cm, 96 pages, language: Dutch, age: 5-6. Publisher: Deltas/Chantecler. ISBN 9789044747201. Source: www.bol.com

Figure 8. Ellen Stoll Walsh, 2007. *Mouse Shapes*. Publisher: Hmh Books For Young Readers. Age: 4-7

Figure 9. Suse MacDonald, 2009. *Shape by Shape*. Publisher: Simon & Schuster. Age: 2-4

Figure 10. Deniz Kaya, 2020. Below is a framework with a visualisation of the Belgian curriculum system for more clarity;

Figure 11. 19th century French children's books about dolls. Printed on stock paper with selfcovers. *La jolie Bebe and Honorine ou L'Institutrice d'Une poupee*. Publisher: Imagerie d'Epinal, Pellerin. Source: www.theriaults.com

Figure 12. Bruno Munari, 1957. *Nella Notta Biua*. Book, 24 x 17cm, 60 pages, language: Italian, age: 8-12. Publisher: Opera Munari (1996). ISBN 9781616896300. Source: www.amazon.com

Figure 13. Judith Vanistendael, 2018. *Blokje om*. Book, 22,7 x 17,5 cm, 80 pages, age: 3-12. Publisher: Querido Kinderboek. ISBN 9789045121734. Source: www.bol.com

Figure 14. L. Lionni, R. van Lint, 1959. *Blauwtje en Geeltje*. Book, 21,3 x 20,2 cm, 48 pages, language: Dutch, age: 4-6. Publisher: Ankhhermes (2020). ISBN 9789020216110. Source www.bol.com

Figure 15. Fredun Shapur, 1965. *Round Round and Square*. Book, 25 x 18 cm, 48 pages, language: English, age: 3-5. Publisher: Tate publishing. ISBN 9781849763639. Source: www.bol.com

Figure 16. Marion Bataille, 2011. *10*. Book, 15,2 x 15,2 cm, 22 pages, age: 2-4. Publisher: Roaring Book Press. ISBN 9781596436824. Source: www.bol.com

Figure 17. Marion Bataille, 2011. *ABC3D*. Book, 19,1 x 14,6 cm, 36 pages, age: 2-4. Publisher: The Millbrook Press Inc. ISBN 9781596434257. Source: www.bol.com

Figure 18. Marie Neurath, 1955. *The wonder world of the deep sea*. Book, 36 pages, language: English. Publisher: Max Parrish. Source: House of Illustration, via www.itsnicethat.com

Figure 19. Atelier Bingo, 2018. Dans le Ciel. Publisher: Amaterra. Source: www.lasuited-illustration.com

Figure 20 & 21. Sue Walker, 2001. Checklist for recording the visual attributes of children's books, as used in the Typographic Design for Children Project. Source: pdf: Sue Walker (2001). *Typography and Language in Everyday Life: Prescriptions and Practices*. London; Longman

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Figure 24. Deniz Kaya, 2020. First sketches. Defining illustrative style, by means of colour and character.

Figure 25. Deniz Kaya, 2020. More sketching, Watercolour. Setting up a character set, starting from basic shapes

Figure 26. Deniz Kaya, 2020. Part of illustration of Amerika.

Figure 27. Deniz Kaya, 2020. Alphabet of shapes / character set

Figure 28. Deniz Kaya, 2020. Posters of continents

Figure 29. Deniz Kaya, 2020. Fold out; expand from small to large boat

Figure 30. Deniz Kaya, 2020. Japanese binding Outside: train outside. Inside: train inside

Figure 31. Deniz Kaya, 2020. Commonly Used serif Font Types

Figure 32. Dieter Roth, 1957. Kinderbuch. Book, 32 x 32 cm, 28 pages, Linocut. Publisher: Reykjavik, Iceland: Forlag Ed. Source: www.artsy.net

Figure 33. Marie Neurath, 1957. The wonder world of Land and Water. Publisher: Max Parrish. Source: House of Illustration, via

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