

The Digital Short Stories Engineering (D2SE) Framework in Creating Stories on Computational Thinking Theme for Children Aged 3-4 Years

Azniah Ismail^{1*}, Suliana Sulaiman¹, Haslinda Hashim¹, Noor Anida Zaria¹,
Nordiana Zakir², Juppri Bacotang³, Cheok Voon See⁴

¹*Jabatan Komputeran, Universiti Pendidikan Sultan Idris; {azniah, suliana, haslinda, anidazaria}@fskik.upsi.edu.my*

²*Sultan Hassanah Bolkiah Institute of Education, Universiti Brunei Darussalam; nordiana.zakir@ubd.edu.bn*

³*Fakulti Psikologi dan Pendidikan, Universiti Malaysia Sabah; juppri@ums.edu.my*

⁴*Millennium Software Sdn Bhd, Kepong Kuala Lumpur; cheokvoonsee@yahoo.com*

* *correspondence author*

To cite this article (APA): Azniah, I., Sulaiman, S., Hashim, H., Zaria, N.A., Zakir, N., Bacotang, J., & See, C.V. (2022). The digital short stories engineering (D2SE) framework in creating stories on computational thinking theme for children aged 3-4 years. *Journal of ICT in Education*, 9(1), 154-161. <https://doi.org/10.37134/jictie.vol9.1.13.2022>

To link to this article: <https://doi.org/10.37134/jictie.vol9.1.13.2022>

Abstract

This paper presents a framework that can be used to guide digital short stories development that focuses on the computational thinking theme suitable for young children, aged between 3-4 years old. Stories can be used to convey information and send messages to their listeners, or readers. Digital short stories are very commonly used for children's learning. However, to effectively send the right messages, any stories including digital stories will require story engineering that helps produce a thoughtful story structure design. Meanwhile, computational thinking is considered a valuable ability for reasoning and problem-solving. With consideration of nurturing computational thinking among the young listeners or readers, the structure design of a story can be engineered to fulfil the objective, and later it can be reused to create new and different stories with similar objectives. Thus, in this study, the Digital Short Stories Engineering (D2SE) framework was derived, and a checklist to support the framework was developed and tested using expert review. Only four experts were involved to validate the items which must be deemed suitable for young children, from several perspectives including linguistic, content and storyline, visualization, and computational thinking aspects. Several examples of digital stories that were derived based on the framework were sent to another three experts who evaluated the stories using the checklist. The results showed that all of the aspects of the framework have been successfully implemented. In conclusion, the framework can be used not only to guide story creators in creating suitable stories for young children in general but also can be used to assist people in engineering stories that can expose children to computational thinking at young ages. In addition, the framework may also be used by nursery teachers or parents when choosing suitable reading materials for their children.

Keywords: Digital Short Stories Engineering (D2SE) framework, story structure design, computational thinking, young children.

INTRODUCTION

Computational thinking skills can be nurtured among children from very young ages by stimulating senses through their surroundings, either physically, socially, or cognitively (Ergül, 2018). However, according to Hsu et al. (2018) and Shute et al. (2017), unlike in mathematics and sciences, researchers and educators may still have problems finding the best way to teach computational thinking to very young children. Most of them only encourages young children to use computers and start learning to code. They put their focus on digital programming applications and robotics applications for children such as ScratchJr, LightBot, Hopscotch, Kodable, Lego Mindstorm dan TangibleK as reported in Baroutsis et al. (2019), Rose et al. (2017), and Bers (2010). This method might not be feasible for children at a very young age. Higher screen time is also associated with poorer young children's development, including limiting children's opportunities for verbal and nonverbal social exchanges with caregivers (Madigan et al., 2019).

Young Children and Stories

Telling a story is an interesting technique to educate young children. This technique has been used to teach mathematics and science concepts to school children and showed a good impact on the listeners (Lemonidis & Kaiafa, 2019; McGrath, 2014; Ayop, 2012; Griffith, 2007). According to Lemonidis and Kaiafa (2019), the listeners or readers may be able to visualize the concepts when they listened to the stories or read the stories. Stories with visual elements might have also helped them develop meaning and understanding, especially when the stories were all related to their local surroundings. Stories are also highly portable, easily disseminated, and can be used repetitively. Moreover, narratives have contributed a lot to early childhood development (Kerry-Moran & Aerila, 2019).

Although narratives and storytelling have been commonly used in teaching children values, cultures, sciences, mathematics, and many others, stories related to computational thinking are very limited. Although there were some books available that seem to be related to computational thinking, these books are either for older children (above five years old) or were categorized under the logical thinking or mathematics category. See examples in Zainuddin and Ismail (2020), McGrath (2014), and Griffith (2007). "Hello Ruby" and MathsThroughStories.org are among popular book collection sites. Sources related to developing stories for very young children based on computational thinking theme is considered scarce. Nonetheless, creating digital stories seems more fascinating than physical books due to the cost and the multimedia elements that they can offer. We need to take advantage of digital technology while keeping screen time low.

Hence, we were keen to develop a framework that can help create local content in form of digital stories on the computational thinking theme suitable for three to five years old children.

The research objectives include:

- (i) To develop a framework that can guide story creators in creating digital stories on the computational thinking theme suitable to be read for young aged children.
- (ii) To create examples of stories that follow the framework.
- (iii) To evaluate the stories.

LITERATURE REVIEW

Research studies in creating children's stories are not new. Whilst some studies focused on children's engagements such as in Kucirkova et al. (2016), others focused on the linguistic and the story structures aspects such as in Zainiah (2013), Jalongo (2014), Machado (2016), and Anida (2020).

Zainiah (2013) stated that in terms of linguistic, related items to be considered when creating stories for three to four years old children must include those that are lexically related such as using simple words (or root words), familiar words, and meaningful words. It is also related to sentences that commonly are of single sentences, use simple and correct punctuations (Zainiah, 2013), and are encouraged to use a repetitive form of sentences for emphasizing purposes (Jalongo, 2014).

The story structure for very young children must be simple, easy to understand, readable, and have expected endings (Jalongo, 2014; Machado, 2016). According to Anida (2020), a children's story must embed children's interests, curiosity, behaviors, or actions, and also shows affective emotions through guidance or praise from older people. It must also be able to inspire the children and help them gain confidence (Anida, 2020).

In addition, the digital book's key element is also an important element to be considered. It is about the quality of items provided in the book such as cover page, text, audio, video or animation, and interactivity (Roskos, 2009). Visualization key element is different compared to digital book key element although they have quite similar items. Whilst visualization involves items related to texts, illustrations, animation, and audio, it also focuses on the relationships among them (Anida, 2020). The visual elements of characters, background, colors, and texts play a huge role to create an interesting-looking page (Mak, 2011) and can stimulate the senses (Leinonen et al., 2000).

RESEARCH METHODOLOGY

The research was based on a qualitative design that heavily depended on expert reviews.

Expert Participants

There were two different activities where experts were involved: (i) four (4) experts were involved during the expert review of the framework, and (ii) another three (3) different experts were involved during the story evaluation. All from different backgrounds that contributed to the context of our study

area, which were: linguistic (1), early child development (2), education (1), multimedia (1), IT (1), and computer science (1). These experts were all lecturers and teachers, and at the same time, some of them were also parents to children aged 3 to 4 years old. Both IT and Computer Science lecturers also had experience in some other computational thinking related projects.

Research Flow

Literature Synthesis

In this study, the initial draft of the framework was first derived based on a synthesis of the literature from different aspects related to the digital book, storybook structure, and computational thinking related to young children. We searched the literature and identified key elements that were related to our study area before they were all organized into an initial draft of the framework.

Building a Checklist and a Story Prototype

A checklist to support the framework was then developed by decomposing each key element into several criterion items. To assist the experts during their review, a story prototype was also built.

Reviewing by Experts

The checklist was first given during the expert review. Once the experts had gone through the items and made comments or suggestions, we gave the story prototype for them to try evaluating the story using their checklist. The story prototype shall help the experts in simulating the story evaluation process and might help them give better suggestions to improve the checklist further.

Setting Criteria in the Framework

Once the checklist items have been improved based on comments and suggestions from the four experts, we used the items to expand the initial draft of the framework. We set the criterion items for each key element and named the Digital Short Stories Engineering (D2SE) framework.

Building and Evaluating Several Short Stories Based on the Framework

For usability evaluation purposes, we create another two short stories (*see Figure 1*) following the criteria in the framework. Then, different experts used our checklist to evaluate the stories.



Let's Go to the Zoo Tomorrow!



Let's Tidy Up the Toys

Figure 1: The two stories that were created based on the D2SE Framework for evaluation purposes.

FINDINGS & DISCUSSION

Based on the expert review, the structure of a children's storybook can be divided into several key elements including linguistics, content and storyline, theme, visualization, and digital book elements. Therefore, the D2SE Framework was divided into five key elements as shown in Figure 2, and further divided into several criterion items.

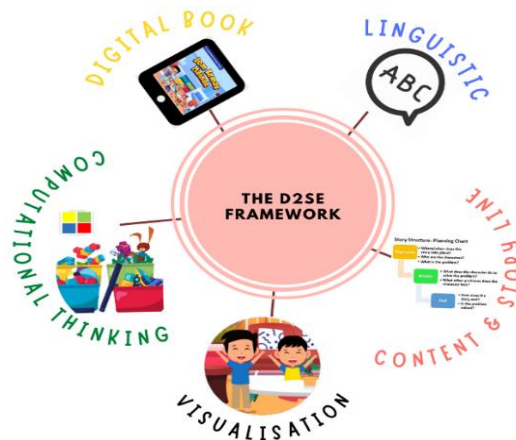


Figure 2: The FIVE key elements in the D2SE Framework.

In terms of theme, it shall depend on the criterion items of the theme. As we were developing content for the computational thinking theme, criterion items must include important aspects of computational thinking and be shown visibly clearly in the story. Commonly, it is considered as reasoning and problem-solving aspects. For example, if we were focusing on pattern recognition then such aspect must be visualized clearly in the digital storybook and become part of the story by showing how the main character solves a problem using some specific patterns. *See example in Figure 3.*



Figure 3: Example of pattern recognition introduced in *Let's Tidy Up the Toys*. In this story, children were shown how colored boxes can be used to sort different types of toys.

Evaluation Results

In general, the evaluation results in Table 1 and Table 2 showed that all-important key elements in the framework have been successfully implemented with just a minor adjustment required in both stories. For Story A, we followed the suggestion by Expert 1 to change one of the sentences. Changing a long sentence to a short sentence means we have to use a more straightforward sentence, avoid using prefixes and suffixes, and minimize the use of unneeded articles. We also have to re-do the audio that has some unclear pronunciations based on comments by Expert 2.

For Story B, we followed the suggestion by Expert 1 to change one of the terms into a more suitable vocabulary. We also make several changes to text sizes to make them more readable. For both stories, experts agreed that the computational thinking key element used in the stories were suitable. It means the key element has been successfully embedded in the story.

Table 1: Story A – Let's Go to the Zoo Tomorrow!

Key Element	Expert 1	Expert 2	Expert 3
1 - Linguistic	Item 1(b) – change the sentence on page 5 to a shorter sentence. Using lesser words in a sentence is preferable.	Suitable.	Suitable.
2 – Content & Story Line	Very nice story.	Suitable.	Suitable.
3 - Visualization	Suitable.	Suitable.	Suitable.
4 – Computational Thinking	Suitable.	Suitable for decomposition.	Suitable.
5 – Digital Book	Suitable.	Item 5 (c) – Audio for page 3 was not clear.	Suitable.

Table 2: Story B – Let’s Tidy Up the Toys

Key Element	Expert 1	Expert 2	Expert 3
1 - Linguistic	Item 1(a) – Suitable noun for toys in Malay is “ <i>mainan</i> ”.	Suitable.	Suitable.
2 – Content & Story Line	Very nice story.	Suitable.	Suitable.
3 - Visualization	Suitable.	Suitable.	Suitable.
4 – Computational Thinking	Suitable.	Suitable for pattern recognition.	Suitable.
5 – Digital Book	Suitable.	Item 4(c) - Font sizes were not standardized; some were too small. Toys should be labeled clearly.	Suitable.

Last but not least, we also like to emphasize the followings that have highly contributed to our success in this study:

1. Different contexts of the study area may require different experts with a related background.
2. A story prototype helps simulate the evaluation process during expert review.

CONCLUSION

In conclusion, we presented the D2SE framework that we developed based on literature synthesis and expert reviews. Only four experts were involved to validate the checklist items of the framework, in which all must be deemed suitable for young children of three to four years old, from several perspectives including linguistic, content and storyline, visualization, and computational thinking aspects. Feedback received was then used to improve the checklist items. We found out that providing a story prototype to the experts during expert review has helped them to provide good comments and suggestions as they can simulate using their checklist to evaluate the story prototype given. We also successfully created and evaluated two stories built based on the framework for usability evaluation purposes. In this process, another three different experts were involved. The framework can now be used to guide story creators in creating suitable stories for young children in general and also can be used to assist people in engineering stories that can expose children to computational thinking at young ages.

Last but not least, the framework may also be used by nursery teachers or parents when choosing suitable reading materials for their children. We are looking forward to evaluating the potential of the stories created based on this D2SE framework among children, aged three to four years.

ACKNOWLEDGEMENTS

This research was supported by the National Child Development Research Centre (NCDRC), Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia under the research grant code 2020-0020-107-04. We express our gratitude to the NCDRC, research team members, and experts who participated in the study.

REFERENCES

- Anida, S. (2020). Ulasan buku: “Engkaulah adiwiraku: bagaimana kanak-kanak boleh melawan Covid-19”, *Jurnal Pendidikan Awal Kanak-kanak Kebangsaan*, 9(1), 48-57. <https://doi.org/10.37134/jpak.vol9.1.5.2020>
- Ayop, N.W. (2012). Pembangunan Aplikasi Buku Cerita Interaktif Bercirikan Islam Untuk Platform iOS (iKids Stories). Master’s thesis. Universiti Teknologi Malaysia.
- Baroutsis, A., White, S. L., Ferdinands, E., Goldsmith, W., & Lambert, E. (2019). Computational thinking as a foundation for coding: Developing student engagement and learning. *Australian Primary Mathematics Classroom*, 24(2), 10-15. <https://search.informit.org/doi/10.3316/informit.523946223625912>
- Bers, M. U. (2010). The TangibleK Robotics program: Applied computational thinking for young children. *Early Childhood Research & Practice*, 12(2), 1-20.
- Ergül, A. (2018). Maybe, maybe not: Probabilistic reasoning in preschool period. *Erken Çocukluk Çalışmaları Dergisi*, 2(1), 68-85. <https://doi.org/10.24130/eccd-jecs.196720182149>
- Griffith, N. (2007). *Stories can be counted on: Ideas for developing mathematics through story*. UK: Red Robin Books
- Hsu, T. C., Chang, S. C., & Hung, Y. T. (2018). How to learn and how to teach computational thinking: Suggestions based on a review of the literature. *Computers & Education*, 126, 296-310. <https://doi.org/10.1016/j.compedu.2018.07.004>
- Jalongo, M. R. (2014). *Early childhood language arts*. Boston: Pearson.
- Kerry-Moran, K., Aerila, J. (2019). Introduction: The strength of stories. In Kerry-Moran, K, Aerila, J (eds) *Story in Children's Lives: Contributions of the Narrative Mode to Early Childhood Development, Literacy, and Learning*. Switzerland: Springer, pp.1-8.
- Kucirkova, N., Littleton, K. & Cremin, T. (2016) Young children’s reading for pleasure with digital books: six key facets of engagement, *Cambridge Journal of Education*, 47, 67-84. <https://doi.org/10.1080/0305764X.2015.1118441>
- Lemonidis, C., & Kaiafa, I. (2019). The effect of using storytelling strategy on students’ performance in fractions. *Journal of Education and Learning*, 8(2), pp 165-175. <https://doi.org/10.5539/jel.v8n2p165>
- Madigan, S., Browne, D., Racine, N., Mori, C., & Tough, S. (2019). Association between screen time and children’s performance on a developmental screening test. *JAMA Paediatrics*, 173(3), 244-250. <https://doi.org/10.1001/jamapediatrics.2018.5056>
- Machado, J. M. (2016). *Early childhood experiences in language arts: Early literacy*. Boston, MA: Cengage Learning.
- MathsThroughStories.org. (2017). 'How to' books, University of Reading’s Institute of Education (UK). Retrieved from <https://www.mathsthroughstories.org/how-to-books.html>
- McGrath, C. (2014). *Teaching Mathematics Through Story: A Creative Approach for The Early Years*. Oxon: Routledge
- Rose, S., Habgood, J., & Jay, T. (2017). An exploration of the role of visual programming tools in the development of young children’s computational thinking. *Electronic Journal of E-learning*, 15(4), 297-309.
- Roskos, K., Brueck, J., & Widman, S. (2009). Investigating analytic tools for e-book design in early literacy learning. *Journal of Interactive Online Learning*, 8(3), 218-240.
- Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational Research Review*, 22, 142-158. <https://doi.org/10.1016/j.edurev.2017.09.003>
- Zainiah, M.I. (2013). Kesan pembacaan buku cerita bertahap terhadap kemahiran pemunculan literasi kanak-kanak prasekolah. Tesis doktor falsafah yang tidak diterbitkan, Universiti Pendidikan sultan Idris, Tanjong Malim, Perak.
- Zainudin, N., & Ismail, A. (2020). Designing Storylines for Children’s Mathematics Digital Interactive Storybook using Software Engineering Approach. *Journal of ICT in Education*, 7(1), 43-51. <https://doi.org/10.37134/jictie.vol7.1.5.2020>