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Development and Validation of the "Redi: *Sang Sel Pelayar*" Storybook Series for Pediatric Cancer Patients

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Abstract

This study aimed to develop and validate the "Redi: *Sang Sel Pelayar*" storybook series as an educational tool for pediatric cancer patients, enhancing their understanding of cancer and improving treatment adherence with age-appropriate content. Using Sugiyono's R&D method, the study progressed through defining, designing, developing, and disseminating stages. Five types of childhood cancers were addressed: leukemia, retinoblastoma, osteosarcoma, neuroblastoma, and nephroblastoma. This study demonstrates that illustrated storybooks are effective in helping children understand cancer and related medical processes. The storybooks, tailored to specific cancer types and age groups with adapted characters, make it easier for children to grasp their condition. The overall average score of our readability questionnaire was 3.9, which means that our book is categorized as readable (3.4 < Mean > 4.2 = Readable). There was also a significant increase in post-test scores after the children underwent intervention by reading storybooks (P: 0.015; 95% CI 0.013–0.018). Evaluations showed significant increases in children's knowledge after reading the books, along with positive changes in their behavior and understanding of cancer. The implications for pediatric oncology care are significant, suggesting that culturally relevant educational tools can reduce anxiety and improve adherence. Despite the promising findings, the study was limited by a small sample size and a lack of long-term effect measurements. Future research should focus on larger samples and longitudinal studies to better assess the impact on adherence and well-being. Overall, the "Redi: *Sang Sel Pelayar*" series offers a novel approach to pediatric oncology education, with potential applications for other chronic illnesses, proposing a valuable addition to standard pediatric care practices.

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Introduction

Cancer is a significant global health challenge, affecting approximately 400,000 children aged 0-19 years annually (Ward et al., 2019). This burden is particularly pronounced in low- and middle-income countries, where access to early diagnosis and treatment is often limited, exacerbating the disparities in health outcomes (World Health Organization, 2021). In Indonesia, the GLOBOCAN 2020 report revealed 11,156 new pediatric cancer cases, underscoring an urgent need for effective therapeutic and supportive interventions (The Global Cancer Observatory, 2021). Pediatric patients must endure lengthy and intensive treatments, such as chemotherapy, which can span several years and result in significant physical and emotional strain (Sisk et al., 2021). Addressing the informational and emotional needs of these young patients is crucial for improving their quality of life and ensuring adherence to treatment protocols, which are essential for successful outcomes (Kowalska-Duplaga et al., 2021; van der Laan et al., 2023; Vernon-Roberts et al., 2021).

Despite the critical need for information, many pediatric cancer patients lack a fundamental understanding of their disease and treatment processes. Research indicates that a

substantial proportion of childhood cancer survivors are unable to name their specific type of cancer or comprehend their treatment regimens, with a large percentage unaware of the potential effects of chemotherapy (Syed et al., 2016). Additionally, relying on parental knowledge is not always effective, particularly in low-income regions where parents themselves often lack adequate information (Shaima et al., 2020). This knowledge gap can hinder a child's ability to cope with their illness and participate actively in their treatment process (Bruce & Cowan, 2020; Miyoshi et al., 2021; Ayanto et al., 2022). Effective communication and educational strategies are essential to bridge this gap, as disease-specific knowledge has been shown to enhance treatment adherence and reduce psychological distress among pediatric patients (Doering, 2021; Conrad et al., 2020). However, existing educational materials frequently fail to address the unique needs of young children, who require simplified explanations and engaging content to facilitate comprehension.

Interactive and engaging educational materials, such as storybooks, have proven successful in other contexts by facilitating comprehension and fostering a positive self-image among children (Palacios et al., 2023; Al-Hosni et al., 2023; Tercyak et al., 2024). Storytelling, in particular, can be an effective medium for conveying complex medical information, given the unique perceptual and cognitive needs of children. Numerous studies have demonstrated that interactive reading materials can significantly improve children's understanding and emotional well-being (Er et al., 2022; Alabi et al., 2020). Despite these findings, an extensive review of available storybooks for cancer patients revealed a lack of materials that adequately address the specific symptoms and mechanisms of different cancer types (Yamaji et al., 2020). This shortfall highlights the necessity of developing tailored educational resources that are both informative and engaging for young cancer patients.

While the benefits of educational interventions are well-documented, there remains a notable absence of resources specifically designed to meet the diverse educational needs of pediatric cancer patients. Most existing storybooks fail to address the distinct symptoms and pathophysiology associated with different types of cancer, resulting in a significant gap in patient education (Krishnan et al., 2023). Furthermore, many educational materials are not age-appropriate, potentially limiting their effectiveness for younger children who require simpler explanations and more engaging content (Shaima et al., 2020; Kowalska-Duplaga et al., 2021). This issue is further compounded in low-resource settings, where educational disparities are more pronounced, and there is an urgent need for culturally relevant materials that resonate with children from different backgrounds (Abugri et al., 2020; Armin et al., 2022).

Previous studies have underscored the importance of integrating comprehensive medical information with engaging narratives to enhance the educational resources available to pediatric cancer patients. Interactive storybooks have been shown to foster resilience and hope among young patients by providing age-appropriate explanations of their illness and treatment (Palacios et al., 2023; Al-Hosni et al., 2023; Tercyak et al., 2024). However, there is a paucity of educational resources that address the specific needs of pediatric cancer patients, particularly those that are tailored to different types of cancer and designed to be engaging for children (Yamaji et al., 2020). The development of culturally relevant educational materials that resonate with children from diverse backgrounds is essential for improving health literacy and treatment outcomes in this vulnerable population (Krishnan et al., 2023; Abugri et al., 2020).

Despite the promising potential of educational interventions, existing literature highlights significant gaps and limitations in the resources available for pediatric cancer patients. Many current materials do not cater specifically to the diverse types of pediatric cancers, nor do they provide age-appropriate content that is engaging and comprehensible for children (Yamaji et al., 2020). Additionally, there is a lack of culturally relevant materials that resonate with children from different backgrounds, potentially limiting the effectiveness of these educational tools (Krishnan et al., 2023). Furthermore, many studies have identified a discrepancy between the need for detailed disease-specific information and the resources available to meet this need, highlighting an urgent requirement for tailored educational

interventions (Abugri et al., 2020; Armin et al., 2022; Mburu et al., 2022). Addressing these gaps is essential for improving the educational support available to pediatric cancer patients and ensuring that they have the necessary knowledge to understand and manage their illness effectively.

This study aims to develop and validate a series of child storybooks, "Redi: *Sang Sel Pelayar*," designed to educate pediatric cancer patients about their disease in an age-appropriate and engaging manner. Each book in the series focuses on a different type of cancer, providing specific information about the disease's mechanism, symptoms, and treatment using a relatable storyline and culturally relevant elements. By enhancing children's understanding of their illness and treatment, these storybooks aim to improve their emotional well-being and treatment adherence. This innovative approach not only fills a critical gap in patient education but also leverages the power of storytelling to foster resilience and hope among young cancer patients. By integrating comprehensive medical information with engaging narratives, these storybooks have the potential to significantly enhance the educational resources available to pediatric cancer patients and contribute to better treatment outcomes and quality of life.

Methods

This research employed the research and development (R&D) method, as described by Sugiyono (2016), which is utilized to develop and test products to produce an effective storybook media to enhance cancer awareness among children. The study was conducted through the four stages of Sugiyono's R&D model: defining, designing, developing, and disseminating. In the defining stage, the selection of cancer types for the book series "Redi: *Sang Sel Pelayar*" was based on the prevalence of childhood cancers in Indonesia. The target age range for the readers was identified according to the age most commonly affected by each cancer type. This age range influenced the complexity of the storyline, language style, and vocabulary to ensure comprehensibility for the children. Detailed research into the pathophysiology of each cancer type was conducted to ensure accuracy and relevance in the storytelling, with character names reflecting the involved cells to maintain the disease's natural history. A team of writers and physicians collaboratively adapted the story to align with the actual pathomechanism of cancer, while a clinical psychologist ensured that the language was appropriate for the cognitive development stage of the target age group. Illustrations were created using Procreate, starting from initial concepts to final refined images.

During the development stage, the book design underwent qualitative and quantitative validation. Expert evaluations were conducted by psychologists from Hasanuddin University and kindergarten teachers from RA Mardhati Makassar. Quantitative readability testing involved 10 first and second-grade students from SDN Inpres 1 Mamajang Makassar, who completed a Likert scale-based questionnaire adapted from Yusuf et al. (2021) (see Table 1). These students were selected as they could communicate effectively and provide unbiased feedback. The readability questionnaire assessed various aspects such as interest in the story, comprehension, memory retention, language simplicity, and independent reading capability. The responses were analyzed by calculating the mean scores for each item, with interpretations ranging from "Very Readable" to "Very Not Readable" based on predefined thresholds. Feedback from both qualitative and quantitative validations was used to revise the book series iteratively before finalizing and printing.

Table 1. Readability Questionnaire Checklist

Questions	**Scale**				
The child is interested in the story being read.	1	2	3	4	5
Children easily understand each storyline that is read.					
The child asks several questions while being read a storybook.					
The child easily remembers the storyline that was read.					
The storybook uses simple words and sentences.					
The child can answer some questions asked by the reader.					

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The child can read the storybook independently.
The child can maintain his/her attention to the story being read.
The child can recognize each character in the story.
The child can understand new terms used in the story.

Interpretation: 5 = Fully agree, 4= agree, 3=neither agree nor disagree, 2=disagree, and 1=fully disagree.

In the dissemination phase, the storybooks were trialed with children with cancer at YKAKI Makassar to evaluate the effectiveness of the media. Data collection involved pre-test and post-test surveys based on the book's storyline, administered to the children to measure their understanding of cancer before and after the intervention. The mean scores of correct answers pre- and post-intervention were calculated. The significance of score changes was analyzed using the Wilcoxon signed-rank test to determine whether the differences were statistically significant. The results provided insights into the book's efficacy in improving children's understanding of cancer. Detailed attachments of the pre-test and post-test questions, as well as interview sheets, are provided in the appendix. To assess the appropriateness of "Redi: *Sang Sel Pelayar*" for use, the media trial followed a structured formula: the qualitative feedback from experts and quantitative data from readability tests were integrated to refine the book. The final validation with cancer patients employed statistical analysis to confirm its effectiveness, ensuring the book met educational and psychological standards.

Result

3.1. Defining Stage

The author decided to make books for the 5 most common types of childhood cancer in Indonesia, namely Blood Cancer (Leukemia), Eye Cancer (Retinoblastoma), Bone Cancer (Osteosarcoma), Nerve Cancer (Neuroblastoma), and Kidney Cancer (Nephroblastoma) (Fithriyah et al., 2020; Veerman et al., 2022). Because Leukemia is the most common type, the author makes 2 age ranges, namely Leukemia books for children over 4 years and Leukemia books for children over 8 years. The other series are retinoblastoma books made for 3-4-year-olds, osteosarcoma books for children over 8 years old, and neuroblastoma and nephroblastoma books made for children 3-4 years old. The age range was adjusted to the highest prevalence of ages suffering from each type of cancer (Bray et al., 2018). Research into the pathophysiology of the five selected cancers resulted in character names adapted from the cells involved in each cancer course and the symptoms they cause (Table 2).

Table 2. General Concept of Each Series of The Childstorybook

No.	Cancer Type	Cast	Symptoms
1.	Leukemia series (4+)	Redi (modified from red blood cell), Lulu (modified from white blood cell), Bubu (modified from multipotential hematopoietic stem cell), Blast (modified from blastoma), Kemo (modified from chemotherapy)	The easy infection leads to fever, Fatigue caused by anemia, and Easy bleeding caused by thrombocytopenia.
2.	Leukemia series (8+)	Redi, Lulu, Tata (modified from thrombocyte), Bubu, Blast, and Kemo.	The easy infection leads to fever, Fatigue caused by anemia, and Easy bleeding caused by thrombocytopenia.
3.	Retinoblastoma (3+)	Redi, Kiki (modified from Cone cell), Blast, and Kemo.	Blindness.
4.	Osteosarcoma (8+)	Redi, Oca (modified from osteoclast), Ola (modified from osteoblast), and Kemo.	Bone pain.

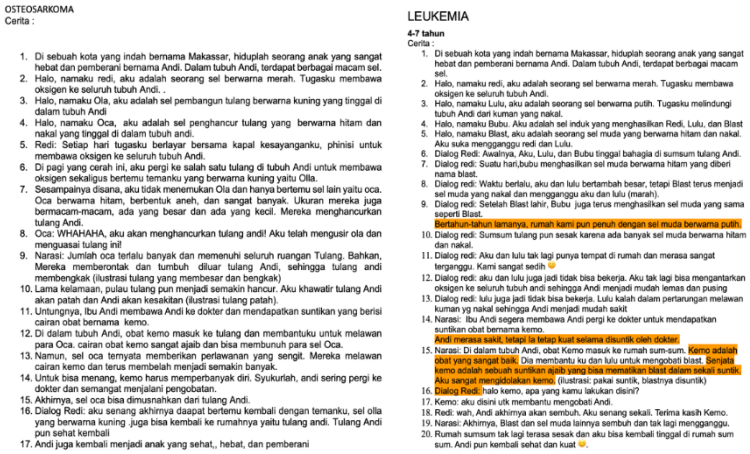
5.	Neuroblastoma	Redi, Neuro (modified from neuron), blast, and Kemo.	Lumps in Chest.
6.	Nephroblastoma	Redi, Nefo (modified from nephron), blast, and Kemo.	Lumps in abdomen.

Note: Generally, all types of cancer are related to repetitive infection, weight loss, and fatigue.

3.2. Designing Stage

This storybook series employs the Indonesian language and features simple illustrations to captivate children's interest in reading. The author utilizes straightforward sentences, avoiding confusing terms to ensure easy understanding. Throughout the book's compilation, initial sketches were created and then translated into illustrations, aligning with the author's preferences and the outcomes of consultation with experts

The preparation stages for the instrument for the storybook series "Redi: *Sang Sel Pelayar*" took two months (Figures 1 and 2). A main character named Redi was created. This character is depicted sailing to all parts of a child's body affected by cancer, utilizing a form of local wisdom from the people of South Sulawesi, the Phinisi Ship (Figure 4).



OSTEOSARKOMA
Cerita :

1. Di sebuah kota yang indah bernama Makassar, hiduplah seorang anak yang sangat hebat dan pemberani bernama Andi. Dalam tubuh Andi, terdapat berbagai macam sel.
2. Halo, namaku redi, aku adalah seorang sel berwarna merah. Tugasku membawa oksigen ke seluruh tubuh Andi. .
3. Halo, namaku Olla, aku adalah sel pembangun tulang berwarna kuning yang tinggal di dalam tubuh Andi
4. Halo, namaku Oca, aku adalah sel penghancur tulang yang berwarna hitam dan nakal yang tinggal di dalam tubuh andi.
5. Redi: Setiap hari tugasku berlayar bersama kapal kesayanganku, phinisi untuk membawa oksigen ke seluruh tubuh Andi.
6. Di pagi yang cerah ini, aku pergi ke salah satu tulang di tubuh Andi untuk membawa oksigen sekaligus bertemu temanku yang berwarna kuning yaitu Olla.
7. Sesampainya disana, aku tidak menemukan Ola dan hanya bertemu sel lain yaitu oca. Oca berwarna hitam, berbentuk aneh, dan sangat banyak. Ukuran mereka juga bermacam-macam, ada yang besar dan ada yang kecil. Mereka menghancurkan tulang Andi.
8. Oca: WHAHAHA, aku akan menghancurkan tulang andi! Aku telah mengusir ola dan menguasai tulang ini!
9. Narasi: Jumlah oca terlalu banyak dan memenuhi seluruh ruangan Tulang. Bahkan, Mereka memberontak dan tumbuh diluar tulang Andi, sehingga tulang andi membengkak (ilustrasi tulang yang membesar dan bengkak)
10. Lama kelamaan, pulau tulang pun menjadi semakin hancur. Aku khawatir tulang Andi akan patah dan Andi akan kesakitan (ilustrasi tulang patah).
11. Untungnya, Ibu Andi membawa Andi ke dokter dan mendapatkan suntikan yang berisi cairan obat bernama kemo.
12. Di dalam tubuh Andi, obat kemo masuk ke tulang dan membantuku untuk melawan para Oca. cairan obat kemo sangat ajaib dan bisa membunuh para sel Oca.
13. Namun, sel oca ternyata memberikan perlawanan yang sengit. Mereka melawan cairan kemo dan terus membelah menjadi semakin banyak.
14. Untuk bisa menang, kemo harus memperbanyak diri. Syukurlah, andi sering pergi ke dokter dan semangat menjalani pengobatan.
15. Akhirnya, sel oca bisa dimusnahkan dari tulang Andi.
16. Dialog Redi: aku senang akhirnya daapat bertemu kembali dengan temanku, sel olla yang berwarna kuning ,juga bisa kembali ke rumahnya yaitu tulang andi. Tulang Andi pun sehat kembali
17. Andi juga kembali menjadi anak yang sehat,, hebat, dan pemberani

LEUKEMIA
4-7 tahun
Cerita :

1. Di sebuah kota yang indah bernama Makassar, hiduplah seorang anak yang sangat hebat dan pemberani bernama Andi. Dalam tubuh Andi, terdapat berbagai macam sel.
2. Halo, namaku redi, aku adalah seorang sel berwarna merah. Tugasku membawa oksigen ke seluruh tubuh Andi.
3. Halo, namaku Lulu, aku adalah seorang sel berwarna putih. Tugasku melindungi tubuh Andi dari kuman yang nakal.
4. Halo, namaku Bubu. Aku adalah sel induk yang menghasilkan Redi, Lulu, dan Blast
5. Halo, namaku Blast, aku adalah seorang sel muda yang berwarna hitam dan nakal. Aku suka mengganggu redi dan Lulu.
6. Dialog Redi: Awalnya, Aku, Lulu, dan Bubu tinggal bahagia di sumsum tulang Andi.
7. Dialog redi: Suatu hari,bubu menghasilkan sel muda berwarna hitam yang diberi nama blast.
8. Dialog redi: Waktu berlalu, aku dan lulu bertambah besar, tetapi Blast terus menjadi sel muda yang nakal dan mengganggu aku dan lulu (marah).
9. Dialog redi: Setelah Blast lahir, Bubu juga terus menghasilkan sel muda yang sama seperti Blast.
Bertahun-tahun lamanya, rumah kami pun penuh dengan sel muda berwarna putih.
10. Dialog redi: Sumsum tulang pun sesak karena ada banyak sel muda berwarna hitam dan nakal.
11. Dialog redi: Aku dan lulu tak lagi punya tempat di rumah dan merasa sangat terganggu. Kami sangat sedih
12. Dialog redi: aku dan lulu juga jadi tidak bisa bekerja. Aku tak lagi bisa mengantarkan oksigen ke seluruh tubuh andi sehingga Andi menjadi mudah lemas dan pusing
13. Dialog redi: lulu juga jadi tidak bisa bekerja. Lulu kalah dalam pertarungan melawan kuman yg nakal sehingga Andi menjadi mudah sakit
14. Narasi: Ibu Andi segera membawa Andi pergi ke dokter untuk mendapatkan suntikan obat bernama kemo.
Andi merasa sakit, tetapi ia tetap kuat selama disuntik oleh dokter.
15. Narasi: Di dalam tubuh Andi, obat Kemo masuk ke rumah sum-sum. Kemo adalah obat yang sangat baik. Dia membantu ku dan lulu untuk mengobati blast. Senjata kemo adalah sebuah suntikan ajaib yang bisa menatikan blast dalam sekali suntik. Aku sangat menjidolakan kemo. (ilustrasi: pakai suntik, blastnya disuntik)
16. Dialog Redi: halo kemo, apa yang kamu lakukan disini?
17. Kemo: aku disini utk membantu mengobati Andi.
18. Redi: wah, Andi akhirnya akan sembuh. Aku senang sekali. Terima kasih Kemo.
19. Narasi: Akhirnya, Blast dan sel muda lainnya sembuh dan tak lagi mengganggu.
20. Rumah sumsum tak lagi terasa sesak dan aku bisa kembali tinggal di rumah sum sum. Andi pun kembali sehat dan kuat

Figure 1. Initial Concepts of Creating The Storyline

The findings of this study indicate that the use of storybooks for children can be effective in explaining and educating them about cancer diseases such as osteosarcoma and leukemia. The first story about osteosarcoma tells the tale of Andi, a boy who fights against bone cancer, emphasizing the process of disease identification, treatment, and recovery. Through simple yet detailed characters and storylines, children can understand the disease's progression, the importance of early detection, and how medical treatments like chemotherapy play a crucial role in healing. The use of red and white blood cell characters helps personify complex biological processes, making them more comprehensible to young readers.

In the second story, which focuses on leukemia, the study highlights how Andi deals with blood cancer, depicting symptoms, diagnosis, and the stages of treatment required to combat the disease. This story also demonstrates the essential role of family support and medical professionals in the healing process. By narrating Andi's experience battling leukemia, children can learn about resilience, bravery, and the importance of social support in facing serious illnesses. The study underscores that through touching and educational narratives, storybooks can be an effective tool for enhancing children's understanding of serious diseases and the associated medical processes.

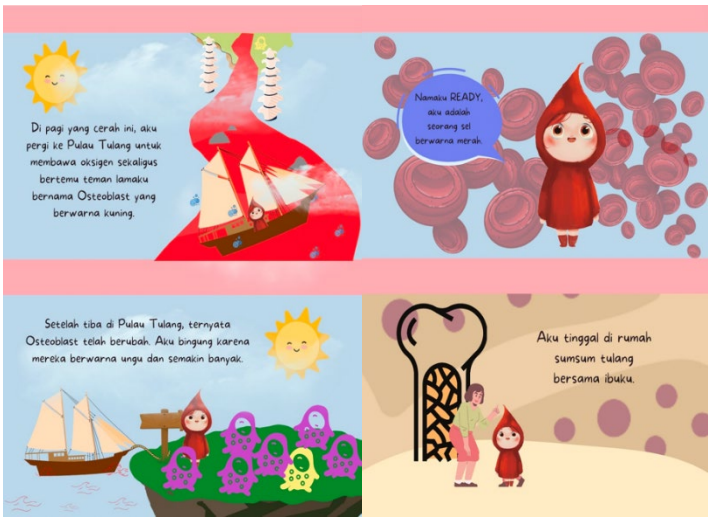


Figure 2. Initial Illustrations using Canva

This research highlights the effectiveness of illustrated storybooks in helping children understand complex medical concepts such as bone cancer (osteosarcoma). Through simple illustrations and narratives, the story depicts the journey of a red blood cell named Ready, who is responsible for transporting oxygen throughout the body and visits his friend, a yellow osteoblast cell, on Bone Island. The story then shows changes in the osteoblast, which turns purple and increases in number, indicating the presence of osteosarcoma. This visualization and personification of the cells help children grasp the biological processes and changes caused by the disease in an engaging and comprehensible manner.

The storybook also depicts the internal environment of the body as the home of the blood cell characters, with Ready living in the bone marrow with his mother. The use of friendly characters and familiar settings allows children to relate the story to real-life situations they might encounter if they or someone they know is diagnosed with a similar illness. Additionally, explaining the roles and functions of each cell, along with the changes occurring in the osteoblast, provides important information about the diagnosis and progression of osteosarcoma in a way that is accessible and understandable for children. This research demonstrates that illustrated storybooks can be an effective educational tool for introducing and explaining serious diseases to children.

Based on our findings, six series of child storybooks were developed for each type of cancer, tailored to the appropriate age group for children with cancer, including two series of storybooks for leukemia patients, each for children aged 4 years plus and children aged 8 years plus, as well as a series of storybooks for osteosarcoma (bone cancer), retinoblastoma (eye cancer), neuroblastoma (nerve cell cancer), and nephroblastoma (kidney cancer) (Figure 3.2).

On the last page of this storybook, there is also a coloring sheet featuring the characters from each story (Figure 4). After children have read the book, it is hoped that this will make it easier for them to understand and remember the contents of the story. The various stages involved in creating this storybook until its completion are illustrated in the following pictures.

The first character, Redi, is a red blood cell. He introduces himself by saying, "Hello, my name is Redi. I am a red cell. My task is to transport oxygen throughout Andi's body along with my beloved ship, Phinisi." This narrative effectively personifies Redi, making the complex function of red blood cells relatable and understandable for children. The illustration shows Redi standing on a ship, symbolizing his journey through the bloodstream to deliver oxygen, which visually reinforces the educational message.

The second character, Lulu, is a white blood cell. She introduced herself by saying, "Hello, my name is Lulu. I am a white cell. My task is to protect Andi's body from naughty germs." This personification of Lulu helps children understand the role of white blood cells in fighting infections. The illustration depicts Lulu with a shield and helmet, defending against germs, visually representing the protective function of white blood cells. Together, these characters and their narratives provide a simplified yet accurate explanation of the roles of red and white blood cells, making it easier for children to comprehend their importance in maintaining health.

Figure 4. Final Illustration using Procreate (Introduction Section of Book's Main Character; Redi)

Figure 5. Final Illustrations using Procreate (All Series of Redi: *Sang Sel Pelayar* Childstorybook's Cover)

The image showcases a series of educational storybooks titled "ReDi" focusing on various types of childhood cancers. Each book features characters representing different cells and functions within the body, tailored to explain specific cancers: leukemia, osteosarcoma, neuroblastoma, nephroblastoma, and retinoblastoma. The consistent visual theme includes Redi, the red blood cell, along with other characters who help narrate the biological processes and impacts of these diseases in an engaging and child-friendly manner. The series aims to educate young readers about serious medical conditions through relatable storytelling and vivid illustrations, making complex medical information accessible and understandable.

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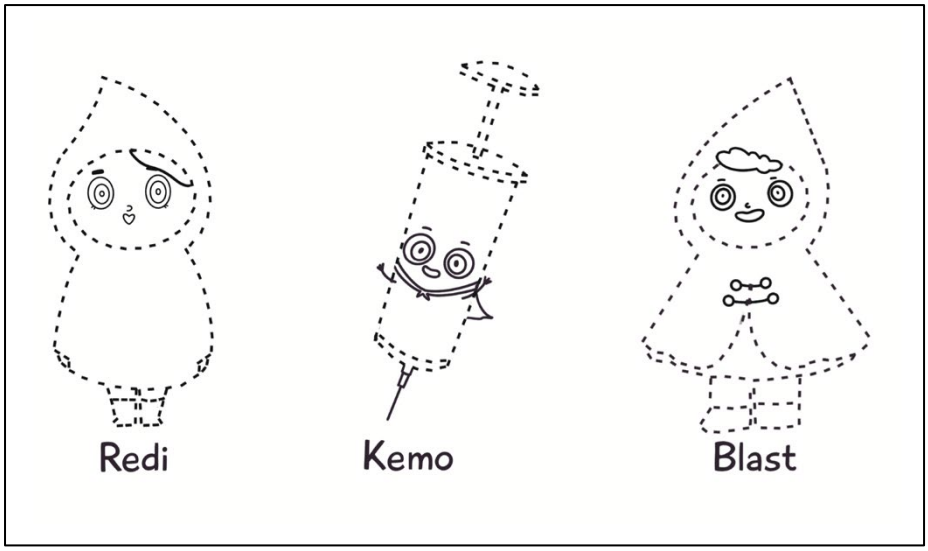

Figure 6. Coloring Sheet On The Last Page

3.3. Development Stage

3.3.1. Qualitative Assessment

Qualitative testing with experts from psychologists and kindergarten teachers resulted in plenty of advice that we grouped into some aspects of the book. This advice was then formulated and put into consideration by the authors to revise the existing draft into the final draft. Suggestions from experts and actions based on the suggestions are summarized in Table 3.

Table 3. Expert Suggestions on Book Development

No.	Advice	Action
1.	Cast naming: cast name should be short and easy to remember by children	All cast name is one word only and most of them consist of repeated syllables (Lulu, Kiki, Bubu), others are as short as 3 letters (Ola and Oca), but others remain original to the disease (blast, neuro, nefo, etc)
2.	Word and phrases: regarding the uncontrollable division of cells in cancer, the child will not understand the concept of cell division	Cell division is captured as a mom (bubu/ multipotential hematopoietic stem cell) gives birth to so many children (blast) that later will disrupt normal cells and result in symptoms of cancer.
3.	Storyline: - before the story begins, every cast should be introduced first so to the children - Determine the point of view of the story, who will be the narrator?	- Every character introduced in the first few pages of every book - The main character (Redi as red blood cell) will be the narrator and the story will be told from the Redi's point of view.
4.	Design: every face of the character should be the same and consistent, and the font must be enlarged.	Animation repair is done, and font text is enlarged.

3.3.2. Qualitative Assessment

The result of the quantitative testing of 10 elementary students was summarized in Table 4. The overall average accumulated at 3,9 which interprets that our book is Readable (3,4 < Mean > 4.2 = Readable). The lowest indicators are in question number 4 (The child easily remembers the storyline that was read), number 7 (The child can read the storybook independently), and number 8 (The child can maintain his/her attention to the story being read) which all of them either related to the complexity of storyline or the storytelling techniques that is boring.

Table 4. Readability Questionnaire Results

Question Item/ Child	1	2	3	4	5	6	7	8	9	10	Total Mean
1st child	5	4	5	5	5	4	3	3	5	4	
2nd child	5	4	5	4	4	4	3	3	5	4	
3rd child	5	5	5	4	4	4	2	3	5	4	
4th child	3	2	5	1	4	3	2	2	5	4	
5th child	4	2	5	1	5	3	3	2	5	3	
6th child	4	3	5	2	5	4	3	2	5	3	
7th child	4	4	5	2	4	4	3	3	5	4	
8th child	4	4	5	2	5	4	3	3	5	4	
9th child	5	4	5	4	5	4	3	4	5	4	
10th child	5	5	5	4	5	4	4	4	5	4	
Mean	4.4	3.7	5	2.9	4.6	3.8	2.9	2.9	5	3.8	**3.9**

Based on the result, the author generally eases the storyline and improves the storytelling techniques so that at the dissemination stage, the cancer child will understand the book better. Among all indicators, the mean values are always greater than 2.6 (2.6 < Mean > 3.4 = Readable enough), so only minor revisions were made by the authors to finish the final draft of this book series.

3.4. Dissemination Stage

3.4.1. Pre-test and Post-test Survey

The knowledge evaluation method employed in this research aimed to determine whether the subjects became more aware of the cancer they were experiencing after reading the storybook. The minimum score a child can get is 0 and the maximum score for all correct answers is 6. The pre-test and post-test mean scores of the ten children who attended the full storybook reading session are compared in the following graph. A total of 10 children with cancer were included in this assessment.

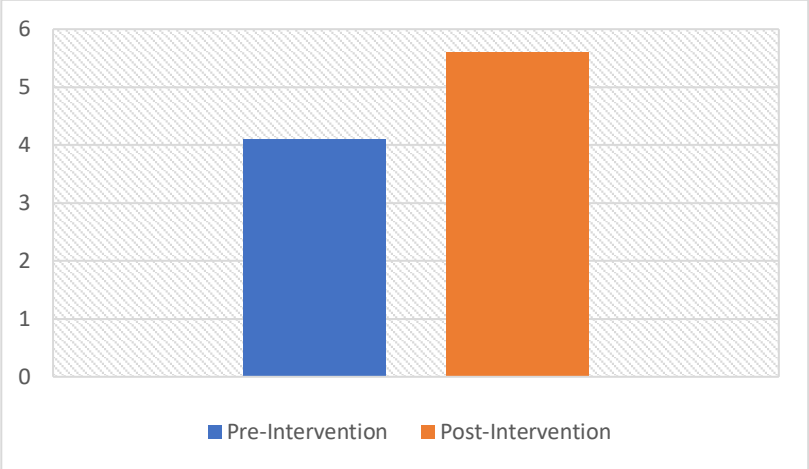

Figure 7. The average scores of the pre-test and post-test.

The graph above illustrates a significant increase in post-test scores after the children underwent intervention by reading storybooks. The mean score in pre-intervention was 4.1 from a maximum score of 6 and increased to 5.6 after the intervention. The Wilcoxon signed-rank test analysis shows a significant difference with P-value: 0,015; 95% CI 0.013-0.018. This suggests that the utilization of storybooks effectively enhanced the children's knowledge of the cancer they were experiencing.

3.5. Structured Interview

To further support our child storybook intervention, we try to assess the point of view of child cancer parents towards our book, even though this step is not included in the original R&D method. In this interview, a combination of open-ended and closed questions is directed toward the child's parent who participated in the storybook intervention. The purpose of these questions is to confirm the results of the pre-test and post-test and to evaluate the child's behavior in their daily life after gaining a better understanding of their cancer through the storybook reading. Here the author includes several interview results submitted by the child's parents. Mother of N (6-year-old with leukemia) "Alhamdulillah, he enjoys having books read to him, and he already understands what chemotherapy means for him". Father of A (7-year-old with leukemia) "The storybook is interesting and easy to understand. Now, he knows that he has cancer and is aware of what actions are allowed and not allowed for children with cancer. He aspires to become a doctor". The teacher also stated after several visits, children are more inclined to adopt healthy living behaviors, such as washing their hands and eating fruits and vegetables.

Discussion

The primary objective of this study was to develop and validate the "Redi: *Sang Sel Pelayar*" storybook series as an educational tool for pediatric cancer patients. Pediatric cancer presents significant challenges, with approximately 400,000 children diagnosed annually worldwide, highlighting the need for effective educational interventions (Ward et al., 2019). In Indonesia, the prevalence of childhood cancer is particularly high, with leukemia being the most common, accounting for 35% of cases (The Global Cancer Observatory, 2021). Previous studies have shown that disease-specific knowledge is crucial for improving treatment compliance and emotional well-being in young patients (Kowalska-Duplaga et al., 2021; van der Laan et al., 2023). Moreover, children's understanding of their disease is often inadequate, as evidenced by research indicating that a significant number of child cancer survivors lacked sufficient knowledge about their condition and treatment (Syed et al., 2016). This lack of understanding can be attributed to the complexity of cancer and the difficulty of explaining it to young children (Shaima et al., 2020). This research builds on the existing literature by providing age-appropriate, cancer-specific information through a culturally relevant medium, addressing the gap identified in the current market for educational resources tailored to children's cognitive levels (Yamaji et al., 2020).

The development of the storybook series targeted the five most common childhood cancers in Indonesia: leukemia, retinoblastoma, osteosarcoma, neuroblastoma, and nephroblastoma (Fithriyah et al., 2020; Veerman et al., 2022). The series included two age-specific books for leukemia, reflecting the disease's prevalence across different age groups, with distinct versions for children over 4 and over 8 years old (Bray et al., 2018). The design stage involved creating simple illustrations and narratives that were validated by experts and pilot-tested among elementary school students. Feedback from psychologists and kindergarten teachers helped refine the storylines, characters, and illustrations, ensuring they were age-appropriate and engaging. Qualitative assessments indicated that the books were well-received, with suggestions for minor adjustments to enhance readability and engagement. The quantitative assessment showed that the storybooks were generally readable, although some areas, such as maintaining children's attention, required further refinement.

Our findings align with previous research indicating that visual storytelling and interactive reading significantly enhance children's understanding of complex medical concepts (Doering, 2021; Conrad et al., 2020). The pre-test and post-test evaluations demonstrated a notable increase in children's knowledge about their cancer, corroborating the efficacy of educational storybooks as reported in similar studies (Yabe et al., 2018). The significant improvement in post-test scores (mean increase from 4.1 to 5.6) suggests that the storybooks effectively conveyed critical information about cancer, supporting the hypothesis that age-appropriate educational

materials can improve disease-specific knowledge in pediatric patients (Santoso et al., 2023). Additionally, the use of relatable characters and culturally relevant elements, such as the Phinisi boat, likely contributed to the children's increased engagement and understanding, similar to findings in other studies utilizing culturally tailored educational interventions (Ratminingsih et al., 2020).

The positive feedback from parents and children aligns with the literature emphasizing the therapeutic and educational benefits of bibliotherapy for pediatric cancer patients (Weaver et al., 2022). Parents reported that their children better understood their treatment and exhibited improved health-related behaviors, such as adhering to medication schedules and adopting healthier lifestyles. This supports findings from other studies that highlight the role of educational interventions in enhancing treatment compliance and reducing anxiety in young patients (Kusuma & Nurhidayati, 2021). The incorporation of local cultural elements, such as the Phinisi boat, further reinforced the children's connection to the material, similar to findings in other culturally tailored educational programs (Ratminingsih et al., 2020). Additionally, the qualitative feedback from parents indicated that the storybooks helped their children develop a more positive outlook toward their treatment, emphasizing the importance of integrating emotional and psychological support within educational materials for young patients (Adrian & Christiani, 2021).

The significant improvements in children's understanding of cancer can be attributed to the storybooks' design, which utilized simple language, relatable characters, and engaging illustrations. These elements likely facilitated better comprehension and retention of information, as supported by cognitive learning theories (Vaahtoranta et al., 2019). Moreover, the interactive nature of the storybooks, including activities like coloring, likely contributed to sustained attention and engagement, as previous studies have shown that interactive features can enhance children's learning experiences (Zhang et al., 2020). However, it is essential to interpret these findings cautiously due to the small sample size and the limited scope of the pilot study. While the initial results are promising, further research with larger, more diverse populations is necessary to validate the effectiveness of these storybooks comprehensively. Additionally, the variability in children's responses suggests that individual differences in cognitive and emotional development must be considered when designing educational interventions (Santoso et al., 2023).

The study's qualitative feedback also underscores the importance of iterative design and expert validation in developing educational tools for children. The revisions made based on expert suggestions likely contributed to the improved readability and engagement observed in the final versions of the storybooks. This iterative process aligns with best practices in educational material development, ensuring that the content is both accurate and accessible to the target audience (Zhang et al., 2020). Nonetheless, the complexity of cancer as a topic necessitates ongoing refinement and adaptation of the educational content to address any emerging challenges in comprehension and engagement. Moreover, considering the diverse educational and cultural backgrounds of children in Indonesia, future iterations of the storybooks should incorporate feedback from a broader range of stakeholders, including educators, healthcare professionals, and parents from different regions (Shaima et al., 2020).

The implications of this study are substantial for pediatric oncology care. By providing children with tailored, comprehensible information about their disease, these storybooks can enhance their understanding, reduce anxiety, and improve treatment adherence. The success of the "Redi: *Sang Sel Pelayar*" series demonstrates the potential of using culturally relevant, age-appropriate educational tools in healthcare settings to support young patients. Moreover, this approach can be extended to other chronic illnesses, offering a model for developing effective educational resources that empower children to manage their health proactively. Future research should focus on scaling the intervention and evaluating its long-term impact on children's health outcomes. Additionally, integrating these educational tools into routine pediatric oncology practice could foster better communication between healthcare providers,

patients, and their families, ultimately improving the overall quality of care for pediatric cancer patients (Er et al., 2022; Al-Hosni et al., 2023).

Conclusion

This study aimed to develop and validate the "Redi: *Sang Sel Pelayar*" storybook series as an educational tool for pediatric cancer patients, enhancing their understanding of cancer and improving treatment adherence with age-appropriate content. The storybooks effectively educate children about cancers such as osteosarcoma and leukemia using relatable characters like Redi and Lulu to simplify complex biological processes. Assessments confirmed the readability and engagement of the books, though minor revisions were needed for storyline complexity. The study's implications for pediatric oncology care are significant, offering a model for using culturally relevant, educational tools to reduce anxiety and improve adherence. This approach can extend to other chronic illnesses, suggesting broader applications for educational resources. However, the study's small sample size and lack of long-term effect measurement on adherence and well-being are limitations. Future research should address these with larger samples and longitudinal studies. Overall, the "Redi: *Sang Sel Pelayar*" series represents a promising step in pediatric oncology education, enhancing illness understanding and improving communication and support within healthcare. Future efforts should expand this approach to other chronic conditions and integrate it into standard pediatric care practices.

Declarations

Author contribution statement

RH is responsible for developing the research concept and design, as well as evaluating and monitoring the implementation of the study. MAA is tasked with implementing dissemination activities, processing research data, and participating in the editing phase of article writing. Author I participate in the printing preparation process and assist in both the dissemination of research results and the processing of data. FWA and AINH both play a role in testing the research instrumentation, validating it, and conducting preparatory tests. RM and SM provided supervision during the research implementation and guidance for enhancing manuscript writing.

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Declaration of Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Additional information

For reviewing processes, the reviewer may access the full version of the storybooks through https://bit.ly/bukuceritaredi. It's important to note that this storybook has not been published anywhere and is not allowed for online publication.

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Appendix

Example of Pre-test and Post-test Survey Items*

Type of Intervention	Items	Options
Book (Leukemia Series)	Andi is running and falls. His knee is injured and bleeding. However, the bleeding is difficult to stop. Andi has bruises on his body. Why is Andi experiencing this?	a. The number of platelets in Andi's body has decreased. b. The number of white blood cells in Andi's body has decreased. c. The number of red blood cells in Andi's body has decreased.
	When taken to the doctor, Andi is given a drug called Chemo. What is the role of Chemo in Andi's body?	a. To fight the increasing number of cancer cells. b. To fight the platelets in Andi's body. a. c. To fight the red blood cells in Andi's body.
	Lately, Andi has been frequently ill and in and out of the hospital. The doctor said Andi's immune system is weakened. Why does Andi get sick easily?	a. The number of platelets in Andi's body has decreased. b. The number of white blood cells in Andi's body has decreased. c. The number of red blood cells in Andi's body has decreased.
Book (Osteosarcoma Series)	If not treated immediately, what can happen to Andi's bones which are increasingly swollen and enlarged?	a. Andi's bone can break. b. Andi's bone becomes stronger. c. Andi's bone changes color.
	What does Andi usually feel when his bones swell and enlarge?	a. Andi feels pain in his bones. b. Andi feels sleepy easily. c. Andi sneezes.
	After being examined by the doctor, it turns out there is a cluster of abnormal cells growing in Andi's bone. What is the name of this cluster of bad cells?	a. Osteoblastoma. b. Osteosarcoma. c. Melanoma.

List of Interview Questions to Children's Parent

Close-ended Question	**Does this book encourage children to learn more about their cancer?**
	Does this medical toy make children want to learn more about the medical procedures they undergo?
	Does this book serve as an enjoyable and motivating learning medium about cancer?
	Does the medical toy serve as an enjoyable and motivating learning medium about cancer treatment?
	Do these books and medical toys motivate children to be more courageous in seeking treatment?
Open Ended Question	What are your impressions and messages after reading the book and playing with the medical toys?
	What is your response to the book "Redi the Sailing Cell"?
	What feedback and suggestions do you have for our future outreach efforts?