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Astrobook Booklet and Its Impact on The Sixth Graders' Scientific Literacy

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ABSTRACT

According to the 2018 PISA research, pupils' scientific literacy during science sessions was deficient. A practical approach to address this issue is using printed educational materials like booklets. The current study aimed to create a booklet called Astrobook as an educational tool to enhance sixth-grade students' scientific literacy, specifically in comprehending the solar system. We used a Research and Development (R&D) method with the ADDIE development model. The study instruments comprised validation sheets given to specialists in instructional media, content, technique, and language. We also administered surveys to educators and 19 students in the sixth grade to assess the book's feasibility. The expert validation yielded an average score of 87.54 (highly feasible). The field trial showed a student response score of 100%. As determined by the effectiveness test, the N-Gain score met the criteria for a medium level of effectiveness, with a mean score of 0.54. The results of this study suggest that the Astrobook booklet effectively facilitates the learning process and enhances students' scientific literacy.

Keywords: scientific literacy, booklet, learning media

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INTRODUCTION

The learning experience should be participatory at the elementary school level, allowing students to actively engage in hands-on activities and discussions to enhance their understanding of concepts. By incorporating enjoyable and inspiring elements into the curriculum, educators can create a positive and motivating environment that fosters a love for learning and encourages students to explore new ideas enthusiastically (Irshad, 2024). The school serves as a platform for pupils to cultivate several facets of their being, encompassing cognitive aptitude, attitudes, and conduct (Libayao et al., 2024). To produce exceptional and high-quality students, it is imperative to establish a robust education system and implement necessary changes that can foster dynamic, imaginative, groundbreaking, and pleasurable learning experiences for students (Dey, 2019). However, the education system in Indonesia continues to face several challenges, particularly at the primary school level (Jhon et al., 2021). This

issue also impacts students' inadequate scientific literacy, attitudes, and competency and the subpar quality of material and context in learning (Fuadi et al., 2020).

Scientific literacy encompasses the ability to read, interpret, and write about science and technology, as suggested by (Norris & Phillips, 2003). This definition highlights the importance of understanding scientific concepts and effectively communicating and engaging with scientific information (Norris & Phillips, 2003). Combining literacy instruction for students across many areas, including science, is essential to achieve an excellent education. The PISA ranking of Indonesia has shown a consistently low level of scientific literacy since 2012, with Indonesian students scoring 382 in 2012, ranking 64th out of 65 nations, and improving to a score of 403 in 2015, ranking 62 out of 72 participants in the PISA assessment (Ramli et al., 2022). These results indicate the ongoing challenges in scientific literacy faced by Indonesian students, highlighting the need for targeted interventions and improvements in science education to enhance students' scientific knowledge and skills. Efforts to address the scientific literacy levels in Indonesia should focus on implementing effective strategies to elevate student performance and foster a deeper understanding of scientific concepts, aligning with global standards and best practices in science education (Ramli et al., 2022).

The inadequate scientific literacy among students in Indonesia can be attributed to the conventional approach to science education, which is teacher-centered, hindering active student engagement and critical thinking (Paños & Ruiz-Gallardo, 2020). Furthermore, science education's content, processes, and contexts have failed to engage students effectively in developing their scientific literacy (Fuadi et al., 2020). In addition, the scarcity of science teaching resources available to students, the absence of scientific literacy incorporated into science education, unengaging science materials, and the absence of comprehensive material displays negatively impact student scientific literacy development (Riyana, 2018), especially in learning the solar system. The solar system has been known to be a complex scientific subject. The subject frequently leads to misunderstandings among primary school pupils.

The findings from interviews conducted with sixth-grade educators at a primary school indicated the challenges encountered by both instructors and pupils in comprehending the solar system. The consideration for choosing this grade is that students at this grade are cognitively mature enough to provide feedback. According to the teachers, pupils showed a strong interest in studying the solar system, although they struggled with comprehending abstract and intricate concepts. Hence, educators must offer frequent clarifications to ensure pupils' comprehension (Jumadi & Hamdani, 2018). In addition, the availability of instructional tools and media for understanding the solar system was limited. Grade VI students exhibited more enthusiasm when engaging in media-based learning than learning that did not involve media use. The scarcity of science-related reading materials has hindered the efficacy of the

scientific literacy initiative in schools. These findings contradict the idea that pupils are enthusiastic about reading books and science.

Presently, there is a significant emphasis on creating educational resources or instructional materials grounded on scientific literacy, as exemplified by the study undertaken by Maslahatul et al. (2018). The study's primary objective was to create educational materials that utilize scientific literacy principles to instruct pupils about light waves. According to the feasibility test, the scientific literacy-based learning medium was highly suited for use, scoring 88.64. This research further substantiated that educational tools might enhance students' scientific literacy. Experts in Indonesia regard educational media, such as booklets, as suitable and reliable for instructing primary school learners in science (nizam & sukmawarti, 2022).

The urgency to develop media like Astro book to enhance scientific literacy has become increasingly evident. Scientific literacy is crucial for navigating complex scientific information, making informed decisions, and actively participating in societal discussions. Various studies have highlighted the significance of utilizing different forms of media to improve scientific literacy (Arifin & Kholiq, 2022; Ayu et al., 2021; Rosidah et al., 2021; Setiawan et al., 2022; Twiningsih & Elisanti, 2021; Widiyana et al., 2021). For instance, the development of 3D e-books, STEAM-based media, Android-based mobile learning, animated media, and augmented reality applications have shown promising results in enhancing scientific literacy skills among students. Moreover, media use in educational settings has been linked to improvements in critical thinking skills, positively impacting scientific literacy (Twiningsih & Elisanti, 2021). Research has also emphasized the importance of appropriate learning resources and media in enhancing scientific literacy.

Furthermore, the role of media literacy in combating scientific misinformation and enhancing public understanding of science has been underscored (Rosenthal, 2020; Vraga et al., 2020). Media literacy education is essential in empowering individuals to evaluate information critically, distinguish between reliable and misleading sources, and engage effectively with scientific content (Rosenthal, 2020; Vraga et al., 2020). The urgency to promote media literacy alongside scientific literacy is crucial in fostering a well-informed society capable of addressing contemporary challenges (Rosenthal, 2020; Vraga et al., 2020). In the current study, we also examined the validity and feasibility of the media in the science classroom where students learned about the solar system.

METHOD

The present study adopted a Research and Development (R & D) method called ADDIE. The ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (R. Yudi & sugiyanti, 2020). The Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model is a systematic instructional design process that involves five key steps. The Analysis

phase focuses on identifying learning needs and goals (Meuthia, 2019). The Design phase consists of creating a blueprint for the learning experience, incorporating content, activities, and assessments (Canlas & Guevarra, 2020). The Development phase involves making learning materials and resources based on the design (Bae & Lai, 2020). The Implementation phase consists of delivering the instructional materials to learners, ensuring that the designed learning experience is implemented (Selvi & Çoşan, 2018). Finally, the Evaluation phase assesses the process and learning outcomes from the analysis, design, development, and implementation phases (Taş & Gülen, 2019). The research data was gathered using product assessment sheets used in the expert validation process. We invited four professionals to validate the product, including an expert in the science learning material, a language expert, a learning expert, and a media expert. Experts in science learning materials, a language expert, a learning expert, and a media expert. Expert input on the product is considered as a revision before field trials. The experts' product feedback was considered revisions before the field trial.

The field trial was done using a one-group pretest-posttest experimental study design. The experiment was conducted on 19 sixth-grade students. During the field trial, responses to the Astrobook booklet were collected from the homeroom teacher and students. The data were analyzed qualitatively and quantitatively. The qualitative data analysis entailed presenting a detailed account of the outcomes of the product evaluation, which was conducted by distributing a questionnaire to experts, the homeroom teacher, and students. The quantitative examination of product validation findings by specialists was performed using a Likert scale, which assigns numerical values to assess the data. The criteria for evaluating the quality of the Astrobook booklet using the Likert scale are outlined in Table 1 (Sugiyono, 2019).

Table 1. The Likert's Scale

Scale	Criteria
1.	Poor
2.	Fair
3.	Good
4.	Excellent

The validity of the Astrobook booklet was determined using the following formula:

$$n = \frac{a}{\sum a} \; x \; 100 \text{ (Purwanto, 2012)}$$

Description:

n = validity score

a = total score

∑a = maximum score

The score was then converted into a qualitative criterium. Table 2 presents the category of product validity score.

Table 2. Category of Product Validity

Score/ Percentage	Criteria
75 - 100	Extremely Valid
50 - 75	Valid
25 - 50	Moderately Valid
< 20	Less Valid

Source (Benny, 2014)

Meanwhile, the effectiveness of the booklet in enhancing students' scientific literacy was calculated using the following formula

(g) = ((post)-(pre))/(100-(pre))

Source: (G. Yudi, 2020)

description:
(g) = N-Gain Score
Post = Post-test Mean Score
Pre= Pretest Mean Score

The result of the N-Gain score calculation was interpreted based on the effectiveness category depicted in Table 3.

Table 3. Category of N-Gain Score for Product Effectiveness

N-gain	Category
g > 0.7	High
0.3< g>0.7	Medium
g<0.3	Low

Source (G. Yudi, 2020)

RESULTS & DISCUSSION

Analysis

The Astrobook booklet was explicitly crafted to showcase captivating visuals and compelling written content, stimulating students' curiosity and eagerness to acquire knowledge. The booklet was designed to be appealing, efficient, and inspiring. According to Intika (Intika, 2018), well-crafted booklets can pique students' attention and facilitate their comprehension of the educational content. The Astrobook booklet is included in traditional print media. Print-based media refers to forms of media that communicate messages primarily through words accompanied by illustrations or pictures (Maharani et al., 2019). Print-based media is advantageous for pupils since it allows them to study depending on their abilities. Print-based media enables pupils to acquire knowledge independently. Further, this form of media includes detailed explanations and concrete illustrations (Kustandi & Sutjipto, 2016). Using booklets as instructional media has several benefits, including enhancing the allure and interactivity of learning, elevating the quality of education, transcending the constraints of place and time, and fostering captivating learning experiences.

Design

The Astrobook booklet covers the solar system's comprehension and its constituents' characteristics. In addition, the booklet also includes supplementary material conveyed through visual aids, facilitating pupils' comprehension of the solar system. Studying the solar system is intertwined with elements of scientific literacy. The essence of scientific literacy in the booklet rests in enhancing the aspects of scientific literacy that are incorporated into the media. The booklet discusses four critical components of scientific literacy: content, context, competence, and attitude (Arlis et al., 2020).

The Astrobook booklet includes scientific knowledge about the solar system and aligns with the 2013 curriculum, including the Core Competencies, Basic Competencies, and learning objectives for sixth-grade elementary school pupils. The solar system is inherently abstract and encompasses a vast range of concepts. Hence, the booklet was designed to deliver the subject and facilitate students' comprehension. Consistent with the reference (Yuyu, 2017), the curriculum incorporates scientific literacy content and educational resources that prioritize comprehension of concepts and their practical application in daily life.

Direct translation:
INSTRUCTIONS
1. Pray before studying
2. Choose a comfortable place to study
3. Understand learning outcomes and learning objectives
4. Read the solar system material in order
5. Do competency test questions

COMPETENCE
Learning Outcomes: Students demonstrate how the solar system works and relates to the earth's rotation and revolution.
Learning Objective: 6.6. Students can identify the solar system's planets.

Figure 1. The "science content" aspect in the Astrobook booklet

The "science knowledge" aspect is shown by students' comprehension of ongoing natural occurrences. Research undertaken by (Narut & Supriadi, 2019) demonstrates that science knowledge pertains to students' engagement in comprehending scientific topics. The Astrobook booklet has incorporated the "knowledge" element by employing various illuminating questions to stimulate pupils' curiosity about the solar system.

Direct translation:
MERCURIUS
The first planet we visit is Mercury. Let's get acquainted with the planet Mercury.
Do you know?
Rotation is the rotation of a planet on its axis. Revolution is the movement of planets around the sun.
The distance between Mercury and the Sun is around 58 million km. Due to its proximity to the sun, Mercury has almost no atmosphere. The hot solar wind always blows away its thin atmosphere, so Mercury's planetary atmosphere disappears, causing the air temperature on Mercury to increase.
The temperature on Mercury during the day is 427 ºC; at night, it is -171 ºC.

Figure 2. The "science knowledge" aspect in the Astrobook booklet

Science competence shows students' ability to explain the phenomena around them. The Astrobook booklet has allowed students to demonstrate and express their opinions regarding the process of a phenomenon. The booklet contains questions that evaluate students' understanding of the solar system by naming, describing, and matching the planets in the solar system. The questions were made excitingly and colorfully, giving the impression that the assessment was not complex or tedious. This finding aligns with research conducted by (Fitria & Dwisetia, 2021) that students' scientific competence refers to their ability to describe a phenomenon, draw conclusions based on existing evidence, apply scientific knowledge appropriately, and exchange opinions with other students.

Direct translation:

Correctly match the planet pictures with the planet names below!

Venus
Jupiter
Mars
Mercury
Earth
Uranus
Saturn
Neptune

Figure 3. The "science competence" aspect in the Astrobook booklet

	Direct translation: Friends, have you correctly used and cared for this book to prevent damage?

Figure 4. The "attitude" aspect in the Astrobook booklet

The different aspects of scientific literacy are interconnected and work together to enhance understanding. The final element of scientific literacy is attitude. Attitude is an action characterized by interest, curiosity, responsibility, and concern. In this Astrobook booklet, the "attitude" aspect is intricately connected to the previous elements, as they foster students' curiosity about the solar system. Colorful and conceptually appealing media is well-suited for elementary school students. Furthermore, students can be engaged and intrigued by presenting them with intriguing statements such as "Did you know?" In addition, the captivating shapes and vibrant colors of the booklet illustrations can potentially spark students' interest in reading.

Develop

The Astrobook booklet is a type of printed media that comes as a book. The brochure's cover says, "Have you taken care of this book?" This statement encourages students to demonstrate responsibility and care towards the booklet they utilize. The development of media like this aligns with research conducted by (Fatkhurrohman et al., 2021), which suggests that the "attitude" component of scientific literacy may be fostered through the use of practical and efficient books or media that provide an engaging, inquisitive, purposeful, and responsible learning environment.

Before its use, the Astrobook booklet had been tested for validity and feasibility by media, solar system, learning, and language expertise. The expert validation results showed that the media was ready for a field trial. Table 1 recorded the expert validation results.

Table 4. Expert Validation Results

Validated by	Score
Media Expert	90.38
Solar System Expert	90
Learning Expert	84.09
Language Expert	85
Total	349.47
Score	87.36
Category	Extremely valid

Table 1 shows the results of the media quality test carried out by media, solar system, learning, and language experts. The results of this analysis indicated that the Astrobook booklet received a total score of 349.47 out of a maximum score of 400, with an average of 87.36. This score falls into the "extremely valid" category for learning media. Thus, it can be inferred that the Astrobook booklet is very suitable as an educational tool for studying the solar system.

The field trial of the Astrobook booklet with 19 grade VI pupils yielded excellent responses. The booklet has received a rating of 100, indicating several desirable qualities. Firstly, it is user-friendly and can be efficiently utilized. Secondly, it is accessible for reading at any time and location. Thirdly, it is attention-grabbing and captures the interest of its readers. Fourthly, it aids students in comprehending the solar system by straightforwardly presenting information. Additionally, it employs easily understandable language.

Furthermore, it avoids monotony when read repeatedly. Moreover, it is a source of motivation and enhances students' curiosity. Lastly, it fosters an enjoyable learning experience for students. Therefore, it can be inferred that the Astrobook booklet garnered a favorable response from students due to its ability to enhance the appeal and enjoyment of the learning process.

The effectiveness of the booklet in improving students' scientific literacy skills was examined using a one-group pretest-posttest experimental study. Figure 5 depicts the pretest and post-test obtained by 19 students during the experiment.

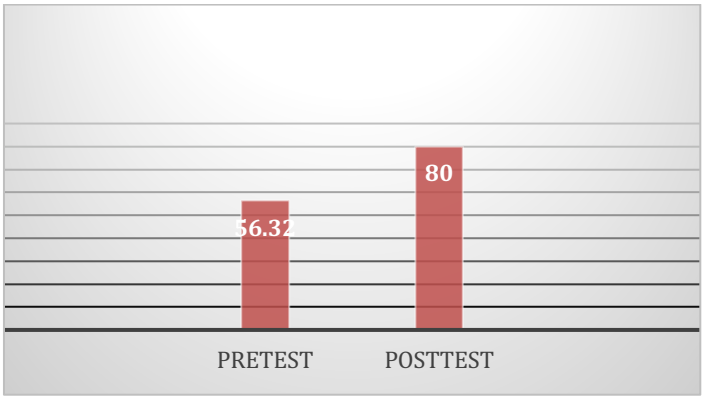

Figure 5. Students' Pre- and Post-test Mean

According to Figure 5, field trial participants achieved a mean pretest score of 56.32 and a mean post-test score of 80. This result indicated an increase of 23.68 in the students' scores. The pretest and post-test were followed by tests of normality and homogeneity, t-test, and N-Gain test.

1. Test of Normality

A normality test was done to evaluate whether the pretest and post-test data were distributed normally. The normality test was performed using the IBM SPSS Statistic application. The normality test results are presented in Table 5.

Table 5. Normality Test Results

Tests of Normality				
	Shapiro-Wilk			
	Statistic	**Df**	**Sig.**	**Description**
Pretest	0.930	19	0.177	Normal
Posttest	0.915	19	0.091	Normal

The significance levels for pretest (0.177) and post-test (0.091) were more significant than 0.05. Hence, the data had a normal distribution.

2. Test of Homogeneity

A homogeneity test was conducted to test whether the data had the same variance. Table 6 presents the results of the homogeneity test.

Table 6. Homogeneity Test Results

Levene Statistic	df1	df2	Sig.
.423	4	13	0.790

The homogeneity test results showed a significance level of 0.790 for the pretest and post-test, which was more significant than 0.05. Thus, it was concluded that the pretest and post-test data were homogeneous.

3. Paired Sample T-test

A paired sample t-test compares the conditions before and after the research intervention. The result of the paired sample t-test performed in this study is shown in Table 7.

Table 7. Hasil Uji Paired Sampe Test

Paired sample test				
		t	dt	Sig. Two-sided
Pair 1	Pretest-posttest	10.809	18	<0.01

Table 7 shows a significance level (p) smaller than 0.01. This finding indicated a significant difference between the student's pretest and post-test scores, as the significance level was smaller than 0.05. Meanwhile, the N-Gain score of 0.5422 suggested that the media was moderately effective (scores between 0.3-0.7) in enhancing students' scientific literacy. Past research has shown that booklets can foster the quality of learning (Maharani et al., 2019).

Implement

The Astrobook booklet is adaptable and portable, making it suitable for autonomous study at any time and in any location (Riyana, 2018). This aligns with the findings of a study by (Intika, 2018), which concluded that booklets offer several benefits as educational resources, as determined by validator assessments. Booklets as instructional media are user-friendly and portable, enabling students to enhance their comprehension anytime and from anywhere. Implementing educational media within the classroom facilitates students' comprehension of abstract concepts and reduces the prevalence of misconceptions among them. In addition, instructional media allows students to observe hazardous and difficult-to-locate objects. Instructional media facilitates comprehension of objects that are impracticably large, tiny, or beyond the visual range of the average person. Instructional media contributes significantly to educational activities. According to (Riyana, 2018), instructional media enhances the organization of instructional messages, makes learning more engaging, promotes interactive learning, and improves the overall quality of education.

Evaluate

The evaluation results at the ADDIE stage in research into the development of Astrobook to increase scientific literacy showed a significant impact on understanding scientific concepts in the target audience. Collecting quantitative and qualitative data revealed substantial improvements in Astrobook users' understanding of astronomy and science topics. Users' positive response to the user-friendly interface and engaging content confirms the ADDIE model's success in producing practical and valuable products to increase scientific literacy among users.

Discussion

Students frequently encounter misconceptions in the field of science. During science education, students are encouraged to enhance their curiosity, aptitude for inquiry, and capacity to investigate and comprehend the phenomena occurring in their surroundings. The pupils' limited scientific proficiency can be attributed to their struggle to generate effective learning responses. Science encompasses several foreign terminologies, and science content often exhibits high complexity and comprehensiveness. Science education in conventional classrooms typically necessitates pupils to engage in rote memorization. In addition, teachers seldom utilize instructional media, resulting in a predominantly teacher-focused and unvaried learning experience. Elementary school students sometimes encounter challenges in learning due to their limited proficiency in science courses. Indeed, students' conceptual knowledge of science frequently diverges significantly from the expertise scientists possess (Maryani, 2016). The challenge of grasping science concepts can also be affected by internal factors, including

students' intellectual level, motivation to learn, emotional stability, overall health, and the level of support they get from their environment.

The Astrobook booklet generated in this research provides scientific information about the solar system that incorporates elements of scientific literacy. The booklet has undergone rigorous testing by experts, teachers, and students to ensure its validity and feasibility. The booklet has also been proven effective in enhancing sixth-grade students' scientific literacy. Scientific literacy is derived from the word "literatus," which refers to a deep understanding and knowledge of scientific concepts. Scientific literacy can also be defined as the knowledge required to engage in activities related to scientific understanding (Aswita et al., 2021). Scientific literacy is demonstrated through engaging learning activities that empower students to fully utilize their skills in exploration, inquiry, problem-solving, decision-making, and caring for the environment. The Astrobook booklet incorporates four aspects of scientific literacy: context, knowledge, competence, and attitude.

The School Literacy Movement (GLS) is an obvious manifestation of the ongoing efforts to enhance student literacy. The School Literacy Movement (GLS) goes beyond simply reading books. It emphasizes the importance of reading with utmost attention, concentration, and a thorough understanding of the content. Additionally, it serves as a means of fostering character education and promoting values such as honesty, discipline, and responsibility. As part of the School Literacy Movement, students are guided in cultivating positive reading habits, fostering cognitive and emotional growth, and cultivating acceptable social etiquette. One of the challenges encountered in implementing the School Literacy Movement in Indonesia is the scarcity of books with attractive illustrations (Yulisa, 2017).

Considering these factors, we have generated the Astrobook booklet as educational media to enhance students' scientific literacy and contribute to the school literacy initiative. The Astrobook booklet has been crafted with a polished and appealing design, presenting knowledge in a manner that is effortlessly comprehensible for students. The booklet also features appealing illustrations to enhance the learning experience. Based on this research, it has been demonstrated that the use of booklets as a learning tool can improve students' scientific literacy. The Astrobook booklet has been shown to be valid and effective in increasing students' scientific literacy. The booklet also received positive feedback from elementary school students. In conclusion, the Astrobook booklet can promote a stimulating and engaging learning experience and foster a greater enthusiasm for reading among students.

CONCLUSION

The current study adopted the ADDIE research and development model, which consisted of four major stages: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation. The results of this study suggest that booklets can be used as innovative media to enhance students' scientific

literacy. The four aspects of scientific literacy integrated into the Astrobook booklet include context, content, competence, and attitude. The booklet has been deemed highly valid by media, material, learning, and language experts. The field trial results also indicated that the booklet was effective in improving elementary school students' scientific literacy of the solar system.

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