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DEVELOPMENT OF IPAS WORKSHEET BASED ON UNPLUGGED CODING FOR SECOND GRADE ELEMENTARY SCHOOL STUDENTS

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Abstract. IPAS is an essential subject for elementary school students. The teaching of Natural and Social Sciences (IPAS) at the elementary level plays a crucial role in instilling fundamental concepts of environmental awareness among learners. Environmental cleanliness is a primary focus to ensure students understand the importance of maintaining a clean environment for collective health and well-being. However, in practice, students often struggle to apply these concepts because instruction has predominantly relied on government-provided teaching materials without incorporating innovative approaches aligned with current technological developments. Additionally, the limited availability of facilities and infrastructure in elementary schools serves as a further obstacle. This study aims to develop an IPAS worksheet based on unplugged coding for second-grade elementary students in Tulungagung Regency that is both valid and practical. The research adopts a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The results indicate that the validity score from material and media experts reached 93%, classified as "Highly Valid." Practicality, based on feedback from students and teachers during small- and large-scale trials, achieved 94%, categorized as "Highly Practical." Therefore, the IPAS worksheet integrating unplugged coding is valid, practical, engaging, and suitable for classroom learning activities, with the potential for further development to meet educational needs.

Keywords: Worksheet, Unplugged Coding, IPAS, Elementary School

I. INTRODUCTION

Science and Environment Studies (IPAS) is essential to be introduced at the elementary school level as it enables students to observe and explore nature, distinguish relationships between facts and phenomena, and understand environmental integrity [1]. One of the IPAS subtopics for Grade 2 students is the ability to differentiate between clean and dirty environments and recognize objects in their home, school, and community surroundings [2]. Understanding environmental cleanliness is crucial for maintaining health and preventing diseases [3]. However, field observations indicate that students' awareness of environmental cleanliness remains low due to conventional teaching methods that rely solely on government-issued textbooks. In fact, this material can be taught by leveraging digital technology in the current era. igital-age learning requires elementary students to acquire coding skills [4]. his aligns with the statement of the Indonesian Ministry of Education, which plans to introduce coding as an elective subject in primary and lower secondary schools starting in the 2025/2026 academic year. Limited technological facilities in some elementary schools, however, pose a challenge to implementing technology-based learning. As an alternative, unplugged coding worksheets can be used to teach and introduce coding without digital devices. Through these activities, students can learn problem-solving, systematic thinking, and algorithmic sequencing to achieve specific goals [5].

Worksheets are structured guides that help students perform programmed activities [6]. Incorporating unplugged coding worksheets into IPAS lessons on environmental cleanliness offers an innovative solution. These worksheets enable students to design simple algorithms in the form of step-by-step instructions for maintaining cleanliness, such as sorting waste or organizing cleaning tasks at home and school [7]. This approach not only enhances IPAS comprehension but also fosters environmental awareness through engaging and interactive methods. Needs analysis in elementary schools

shows that instruction remains lecture-based, and worksheets are limited to government-provided materials, leading to monotonous and less engaging learning. This lack of variety does not meet students' needs, especially since second graders are still in the concrete operational stage and require engaging, tangible experiences [8]. Consistent with previous research, unplugged coding is well-suited for early learners because it is concrete and interactive, allowing students to learn through manipulation of real objects. This method is both enjoyable and effective in developing students' cognitive skills [9]. Coding and unplugged coding approaches are particularly suitable for elementary students as they are visual, interactive, and fun [10]. onsequently, integrating unplugged coding-based worksheets into IPAS lessons not only strengthens subject mastery but also instills sustainable environmental habits through an enjoyable and interactive approach.

II. RESEARCH METHODS

This research is a type of development research, also known as Research and Development (R&D). The model employed in this study is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

The main focus of this research lies in the development stage, which involves the creation and validation of the product [11]. The selection of the ADDIE model is based on its advantages, namely being systematic, iterative, and flexible [12]. The population in this study consists of all second-grade elementary school students. The research sample comprises 12 students. Additional subjects for product validation include one material expert and one media expert. In addition, one classroom teacher was involved in the product implementation process and interviews. The data used in this study are qualitative and quantitative. Qualitative data consist of feedback and suggestions from the media expert, material expert, teacher, and students, obtained through interviews, questionnaires, and observations. Quantitative data are used to assess the feasibility of the learning media product, which the researcher collected from the media expert, material expert, teacher, and students.

The instruments used in developing this product include interview sheets, observation sheets, and questionnaires. The questionnaire is used to determine the extent to which this unplugged coding-based worksheet is valid and practical for second-grade elementary school students. The IPAS worksheet based on unplugged coding can be considered of high quality if it meets the criteria of validity and practicality.

The validity of this worksheet is obtained from the validation results of experts, both material and media experts. Meanwhile, the practicality of this worksheet is obtained from the results of student and teacher response questionnaires, both on a small and large scale.

Table 1. Percentage of Validity and Practicality

No	Persentase (%)	Keterangan
1.	0%-20%	Very Invalid / Very Impractical
2.	21%-40%	Less Valid and Less Practical
3.	41%-60%	Fairly Valid and Fairly Practical
4.	61%-80%	Valid and Practical
5.	81-100%	Highly Valid and Highly Practical

Resource: [13]

III. RESULTS AND DISCUSSION

The research and development process employed the ADDIE model, with results outlined as follows.

A. Analysis

The first stage of the ADDIE model is analysis. This stage began with identifying the needs of both teachers and students. A needs assessment was conducted with teachers and second-grade students at SDN Karangtalun to determine the actual conditions prior to the study. Based on interviews with teachers, it was found that they had not received comprehensive training or information related to coding-based learning or unplugged coding. Learning resources in the classroom were limited to government-issued textbooks and worksheets from the *Cerdas Tangkas* book. Teachers faced time constraints in developing innovative worksheets or other instructional materials, which hindered the implementation of varied learning strategies. Additionally, technological facilities at SDN Karangtalun were limited, making computer-based coding implementation difficult.

Interviews with students revealed that they were entirely unfamiliar with coding or unplugged coding. They expressed boredom with worksheets, materials, and media that relied solely on textbooks. These findings indicate the need for varied learning resources, as teachers had not been able to provide sufficient instructional tools. To address this issue, the researcher proposed developing unplugged coding-based worksheets focused on the theme of environmental cleanliness. This topic aligns with the learning outcomes for Phase A (Grade 2) and aims to instill habits of maintaining cleanliness at school, home, and in the community.

B. Design

The second stage in the ADDIE development model is the design phase. In this stage, the researcher creates a blueprint for the unplugged coding worksheet as follows.

1. The worksheet is planned to consist of five pages, including a title page, worksheet identity, and activity/content pages.
2. The coding elements in the worksheet include directional arrows (→ ↓ ↑), instruction boxes, mazes, and repetition symbols.
3. The design incorporates colorful images and visuals that align with the characteristics of second-grade elementary school students.

C. Development

The third stage in the ADDIE development model is development. At this stage, the researcher divides the process into two sub-stages: the creation of the worksheet and its validation. The creation and development of the unplugged coding-based worksheet can be illustrated through the diagram below.

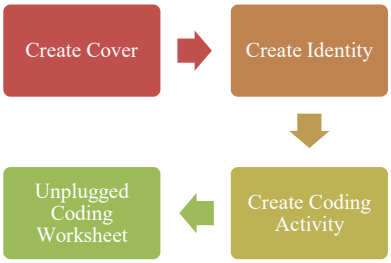

Figure 1. Flowchart of Worksheet

The completed worksheet was then validated by both subject matter experts and media experts. Validation was carried out by professionals who are highly skilled and competent in their respective fields. This process ensures that the developed worksheet receives feedback and suggestions for improvement from experts. The validation results from the two validators-media expert and material expert-for the unplugged coding-based worksheet development are presented as follows.

Table 2. Expert Validation Results for the Unplugged Coding Worksheet

No.	Expert	Score	Category
1.	Media Expert	92%	Highly Valid
2.	Material Expert	94%	Highly Valid
	Total	**186**	
	Average	**93%**	**Highly Valid**

Based on the data presented above, the media expert provided a score of 92% with the criterion "Highly Valid," while the material expert assigned a score of 94% with the same criterion. Overall, the average score was 93%, categorized as "Highly Valid." Both experts provided no suggestions or revisions regarding the unplugged coding-based worksheet. Based on these criteria, the unplugged coding-based worksheet meets the "Highly Valid" standard, making it suitable for use as an innovative learning resource.

D. Implementation

The fourth stage of the ADDIE model is implementation. After validation by experts, the next step is implementation. The implementation was carried out at SDN Karangtalun with a small-scale group of 4 students and a large-scale group of 8 students. The researcher did not provide a teaching module, as the classroom teacher conducted the lesson using their usual teaching methods. Questionnaires were administered to both students and teachers for both small-scale and large-scale implementations. The questionnaires were distributed after the learning activities were completed. Their purpose was to assess the extent to which students engaged in learning activities using the unplugged coding worksheet. The questionnaire consisted of 10 statements in a multiple-choice format with "Yes" and "No" response options. A teacher questionnaire was also provided to gather teacher feedback following the implementation on both scales. The results of the questionnaires can be presented and analyzed as follows.

Table 3. Practicality of the Unplugged Coding Worksheet

No.	Questionnaire	Score	Category
1	Students (Small Scale)	93%	Highly Practical
2	Teachers (Small Scale)	95%	Highly Practical
3	Students (Large Scale)	96.5%	Highly Practical
4	Teachers (Large Scale)	95%	Highly Practical
	Total	**283**	
	Average	**94%**	**Highly Practical**

Based on the presented data, the student response questionnaire on a small scale obtained a score of 93%, categorized as *Highly Practical*, while the teacher response on a small scale reached 95% (*Highly Practical*). On a large scale, the student response achieved 96.5% and the teacher response 95%, both classified as *Highly Practical*. Overall, the average score of student and teacher responses, for both small and large scales, was 94% with a total score of 283, indicating the *Highly Practical* category. These results suggest that the unplugged coding-based worksheet is considered highly practical for use in learning activities by both students and teachers.

E. Evaluation

The final stage in the ADDIE model is evaluation, which is used to generalize findings and make decisions based on the data obtained. Each stage of the process has been carried out meticulously and involved input from qualified experts. The worksheet was developed using the ADDIE model through a series of systematic steps, ensuring that it meets quality standards and is beneficial for SDN Karangtalun.

This is evident from the validity results of the worksheet, where the score given by the media expert was 92%, categorized as *Highly Valid*, and the material expert provided a score of 94%, also categorized as *Highly Valid*. Overall, the average score was 93%, falling under the *Highly Valid* category. These findings are consistent with previous studies on innovative learning media utilizing unplugged coding, which demonstrated that the product was classified as highly feasible, with respective scores of 96.43% and 93% [14].

Meanwhile, the practicality results of the unplugged coding worksheet show that the small-scale student responses obtained a score of 93%, categorized as *"Highly Practical,"* and the small-scale teacher responses achieved 95% with the same category. Furthermore, the large-scale student response questionnaire obtained a score of 96.5%, classified as *"Highly Practical,"* while the large-scale teacher responses reached 95% with the same classification. Overall, the average score from student and teacher response questionnaires, both at small and large scales, totaled 283 with an average of 94%, indicating the category of *"Highly Practical."*

This finding is consistent with previous research on unplugged coding e-modules, which reported that the validation analysis of the developed learning module reached 87%, categorized as *"Highly Valid."*

Additionally, the practicality test results for the developed learning module achieved 89.7%, falling into the *"Highly Practical"* category [15]. Unplugged coding learning emerges as an innovative method that introduces programming concepts without the use of electronic devices, making it suitable for implementation among elementary school students and in settings with limited infrastructure and resources [16].

IV. CONCLUSIONS

The unplugged coding-based worksheet was found to be both valid and practical. The validity was determined through expert evaluations, with the media expert assigning a score of 92%, categorized as "*Highly Valid*," and the material expert assigning a score of 94%, also categorized as "*Highly Valid*." On average, the validity score reached 93%, meeting the "*Highly Valid*" criterion.

In terms of practicality, the worksheet achieved a score of 93% from students in a small-scale trial, categorized as "*Highly Practical*," and 95% from teachers in the same scale, also classified as "*Highly Practical*." Furthermore, the large-scale student response questionnaire yielded a score of 96.5%, while the large-scale teacher response scored 95%, both categorized as "Highly Practical." Overall, the combined average score from student and teacher responses across both small-and large-scale trials totaled 283 points, with an average of 94%, meeting the "*Highly Practical*" criterion.

Based on these findings, it can be concluded that the unplugged coding-based worksheet for Grade 2 elementary school students, focusing on the theme of home, school, and community environments, is highly valid and highly practical for use in the learning process.

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