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PHYSICAL EDUCATION LEARNING MEDIA BASED ON TRADITIONAL SURAKARTA CHESS FOR CHARACTER EDUCATION AND NUMERACY IN ELEMENTARY SCHOOLS

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ABSTRACT

This study aims to develop a physical education instructional medium in the form of a board game based on the traditional game Catur Surakarta to strengthen character education and numeracy literacy among elementary school students. The research subjects were fifth and sixth grade students at MIN 1 Pesawaran. In addition, this study also seeks to evaluate the quality of the developed board game in terms of its validity and practicality. The research method refers to the ADDIE development model, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation. The results of the study indicate that: (1) the board game instructional medium demonstrates a high level of validity, as evidenced by an average score of 0.91 for content feasibility (high category), 0.85 for media feasibility (high category), and 0.70 for game feasibility (valid category); and (2) the practicality based on teacher and student response questionnaires is classified as very practical, with an average score of 96%. Overall, the board game instructional medium based on the traditional game Catur Surakarta is declared valid and practical for use in Physical Education learning at the elementary school level.

INTRODUCTION

Physical education in elementary schools plays a strategic role in developing students' potential holistically, encompassing physical, social, emotional, and intellectual aspects (Apriyano et al., 2022; Mandelid, 2023). Beyond physical activity, it serves as a medium for character formation, instilling values such as cooperation, responsibility, and sportsmanship (Miratunnisah, 2024). However, in practice, physical education in many elementary schools remains predominantly oriented toward physical activities, without

sufficient integration of cognitive aspects such as numeracy literacy or systematic character development (Anastasya et al., 2023; Greenberg et al., 2024).

Character education and numeracy literacy are two key competencies in Indonesia's national curriculum (Hidayat et al., 2025). Character values such as mutual cooperation, discipline, and sportsmanship can be cultivated through contextual learning, including physical education (Nolte & Roux, 2023), while numeracy literacy the ability to understand and apply numbers and mathematical concepts is equally essential (Hussein et al., 2022). Both aspects can be developed in an integrated manner through innovative learning approaches.

Indonesia's numeracy literacy achievement remains critically low. Based on PISA 2022, Indonesia ranked 69th out of 81 countries with an average mathematics score of 366, far below the OECD average of 472, with only 18% of students reaching minimum proficiency compared to the OECD average of 69%(OECD, 2023; Hafizha & Rakhmania, 2024; Reflina & Rahma P, 2023). This is further compounded by physical education practices that emphasize motor skills alone, neglecting cognitive and character dimensions (Widiantari et al., 2022)

One promising solution is integrating traditional games into physical education. Traditional games are rich in values of togetherness, sportsmanship, and strategic thinking (Maryanti et al., 2021). Surakarta Chess, for instance, requires critical thinking, problem-solving, and move planning skills aligned with numeracy literacy principles (Rachman et al., 2024). Adapting it into a board-game-based learning medium is expected to create an engaging and contextual physical education experience that simultaneously develops students' cognitive and affective dimensions (Sesrita et al., 2023; Sousa et al., 2023).

Several prior studies have demonstrated the effectiveness of games as learning media. Alotaibi (2024), in a systematic review and meta-analysis, confirmed that game-based learning promotes cognitive, social, and emotional development in young children, including in areas of numeracy and problem-solving. Hui & Mahmud, (2023) further found that game-based learning in mathematics education positively influences both cognitive and affective outcomes in students. Debrenti, (2024) showed that both digital and non-digital game-based learning experiences are effective for supporting mathematical understanding in elementary school students. At the level of board games specifically, (Sousa et al., 2023), in a systematic literature review covering 2012–2022, confirmed that analog games including board games are effective in promoting learning outcomes, engagement, and collaborative skills across educational contexts. Maryanti et al., (2021)

found that a board game developed from the traditional *egrang batok* game was valid and practical for elementary school mathematics learning. Wulansari & Dwiyanti, (2021) similarly confirmed that the traditional *dakon* game effectively builds basic mathematical concepts, particularly arithmetic skills. (Aliriad et al., 2024; Hidayat et al., 2025) established that traditional games can enhance students' fundamental movement skills locomotor, non locomotor, and manipulative and are effective media for improving psychomotor competencies.

Nevertheless, research that specifically develops physical education learning media based on Surakarta Chess with a focus on character education and numeracy literacy in elementary schools remains extremely limited. This study therefore offers a distinct novelty (*state of the art*) in connecting physical education, character education, numeracy literacy, and strategy-based traditional games within a single integrated learning medium. Accordingly, this study is expected to reposition physical education not merely as physical fitness training but also as a vehicle for character formation and cognitive development, while contributing to the quality of elementary school learning and the preservation of Indonesia's cultural heritage.

RESEARCH METHOD

This study employed a Research and Development (R&D) approach (Sugiyono, 2019), utilizing the ADDIE instructional design model, which consists of five systematic phases: needs Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected due to its structured and iterative nature, as well as its demonstrated effectiveness in developing game-based learning media at the elementary school level (Branch, 2009; Molenda, 2003). The product developed in this study takes the form of a board game-based learning medium grounded in the traditional Surakarta Chess (*Catur Surakarta*), specifically designed to reinforce character education and numeracy literacy among elementary school students. In its application, the instructional strategy integrates play-based methods, direct content presentation, and group discussion, with the aim of fostering an interactive and enjoyable learning environment that holistically supports students' competency attainment (Liberta Loviana Carolin et al., 2020; Rachma et al., 2023).

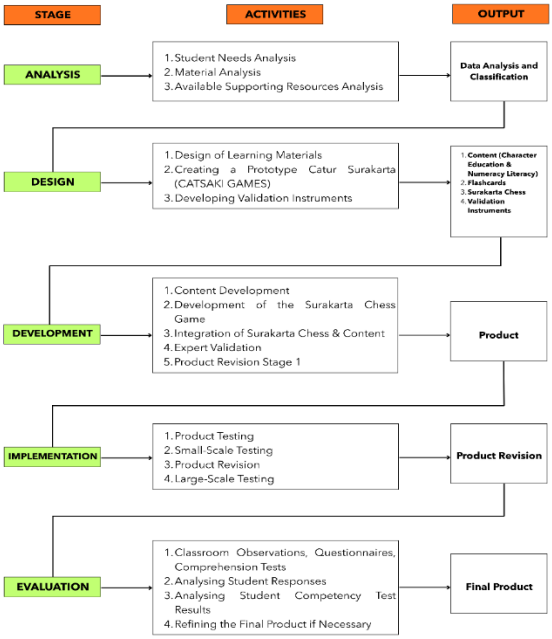

Figure 1. ADDIE Design and Its Implementation

This research was conducted at MIN 1 Pesawaran, Lampung, with fifth and sixth grade students selected through purposive sampling. These grade levels were selected because students at this stage are moving from concrete operational thinking toward formal operational reasoning (Inhelder & Piaget, 1958), a developmental shift that remains foundational in contemporary accounts of cognitive development (Siegler et al., 2020), their curriculum aligns with Surakarta Chess gameplay mechanics, and the school had not previously implemented traditional game-based learning in PJOK instruction. The inclusion criteria for participants were: (1) being actively enrolled in grade five or grade six at MIN 1 Pesawaran during the 2025/2026 academic year; (2) having received prior instruction in character education and numeracy literacy; and (3) having obtained parental consent to participate. Students who were absent during the data-collection sessions or whose parents did not grant consent were excluded. The individual trial (grade five) and the small-group trial (grade six) were conducted on separate days within the same week, with the individual trial preceding the small-group trial so that initial findings could inform the subsequent session. Expert validation involved three validators: a language expert, a content expert, and a media expert. This study also adhered to standard research ethics: the purpose and procedures of the study were explained to the school principal, teachers, and students; written informed consent was obtained from parents or guardians; participation was voluntary; and the identity of all participants was kept confidential and used solely for academic purposes.

Data were collected through three techniques: observation, interview, and questionnaire. Classroom observations focused on needs assessment related to existing PJOK learning media, teaching conditions, and students' character and numeracy development. Structured interviews with the PJOK teacher and school principal explored learning challenges and media needs. Two types of questionnaires were also administered: a media validation questionnaire for the three expert validators, assessing competency, language, visual presentation, and completeness; and a student response questionnaire measuring practicality across four indicators—attention, interest, confidence, and satisfaction.

The validity of the learning media was assessed using Aiken's V formula, which was selected on the grounds that it yields an objective and reliable content validity coefficient for instruments grounded in expert judgment (Aiken, 1985; Kania et al., 2024; Ventura-León et al., 2025). The Aiken's V formula is presented as follows:

$$V = \sum \frac{S}{[n(c-1)]}$$

(Kania et al., 2024)

Notes :
S = the adjusted score (r − lo)
lo = the minimum validity rating score (set at 1)
c = the maximum validity rating score (set at 4)
r = the rating given by an expert evaluator

The resulting Aiken's V coefficients were interpreted according to the criteria outlined in Table 1 as follows:

Table 1. Media Validity Criteria Using Aiken's V Coefficient

Correlation Coefficient (V)	Validity Interpretation
$\geq \mathbf{0,80}$	Very Valid
$\mathbf{0,60 \leq V < 0,80}$	Valid
$\mathbf{0,40 \leq V < 0,60}$	Moderately Valid
$\mathbf{0 \leq V < 0,40}$	Not Valid

(Kania et al., 2024)

The practicality test was conducted to determine whether the PJOK learning media based on the traditional Surakarta Chess board game, developed for fifth- and sixth-grade elementary school students, is suitable for use in strengthening character education and numeracy literacy. The data obtained from the practicality assessment sheet were analyzed by calculating the practicality of the media through the percentage of teacher and student response scores using the following formula:

$$\text{Percentage (\%)} = \frac{\text{total score obtained}}{\text{criterion score}} x100\%$$

(Maryanti et al., 2021)

The resulting percentage scores were subsequently interpreted based on the criteria presented in Table 2.

Table 2. Criteria for Levels of Practicality

Mean Score Interval	Criteria
81%–100%	Very Practical
61%–80%	Practical
41%–60%	Moderately Practical
21%–40%	Less Practical
0%–20%	Not Practical

(Maryanti et al., 2021)

RESULTS AND DISCUSSION

Results

The development of a PJOK (Physical Education, Sports, and Health) learning media based on the Surakarta chess board game is carried out using the ADDIE model, which consists of the stages of analysis, design, development, implementation, and evaluation. This section presents the results from each stage of development, along with assessments of the validity and practicality of the resulting media.

In the Analysis stage, field analysis at MIN 1 Pesawaran shows that PJOK learning, which has relied on thematic books, Student Worksheets (LKS), and conventional practices, leads to student boredom and low engagement. The characteristics analysis of fifth and sixth grade students (ages 9-12) reveals that they tend to be active and enjoy playing. Hence, game-based media are deemed relevant to stimulate learning involvement. On the other hand, students' high dependence on gadgets necessitates the need for alternative media based on traditional games that can revive local cultural values.

In the Design stage, the aim is to draft the initial version of the PJOK learning media based on the traditional game Surakarta chess. The first step involves creating benchmark tests in the form of questions related to character education and numeracy literacy, which serve as the foundation for developing game components. Next, the game design is formulated by blending the concept of abstract strategy games, manifested through the movement of pieces from one point to another, and trivia games in the form of question cards. A player is declared the winner when they can answer questions correctly while also capturing the opponent's pieces. Based on this mechanism, the board game and question

cards are then developed using Photoshop, Canva, and Microsoft Word, with the design adjusted to fit the characteristics of the students, learning objectives, and feedback from expert validators.

In the Product Development stage, the development results in the Surakarta chess board game, which consists of three main components. First, the game board measures 42 × 59.4 cm (A2) with a thickness of 5 mm, printed using acrylic material layered with sandblast stickers for durability, allowing it to be used directly in the field (Figure 2).

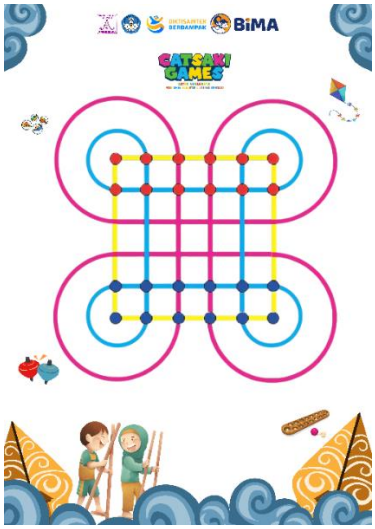

Figure 2. Board Game Design

Second, there are 24 circular pieces made of wood with a diameter of 14 mm and a height of 3 cm. Third, there are 24 question cards made of ivory paper (7.26 × 12.7 cm) divided into 12 character education cards covering values such as cooperation, honesty, tolerance, integrity, religiosity, discipline, mutual respect, and curiosity, as well as 12 numeracy literacy cards that include aspects of problem-solving, the use of numbers and symbols, information analysis, critical-logical thinking, and decision-making (Figure 3). All components are packaged in a compact acrylic box designed for easy carrying and storage.

Figure 3. Question Cards for Character Education and Numeracy Literacy

This game is played in teams (5 members per team) with rules that are structured simply and systematically. Each team member has a distinct role, which simultaneously trains cooperation and group responsibility. The complete rules of the game are presented in Figure 4. After the product has been developed, validation was conducted by three experts: a material expert, a media expert, and a traditional game consultant, to assess the media's feasibility before it is tested.

1. Setiap pemain menyiapkan 12 buah bidak dan sebuah papan permainan. Giliran bermain ditentukan melalui suit.
2. Bidak disusun pada setiap titik di dua garis horizontal pertama yang berada di hadapan masing-masing pemain.
3. Pemain bergerak secara bergantian dengan memindahkan satu bidak ke titik kosong yang terdekat. Bidak dapat bergerak ke depan, belakang, kiri, atau kanan. Pola pergerakan bidak mengikuti cara bergerak raja dalam permainan catur.
4. Tujuan permainan adalah menangkap seluruh bidak lawan. Penangkapan bidak lawan dilakukan dengan melewati sedikitnya satu lintasan melingkar yang terdapat pada setiap sudut papan permainan.
5. Apabila seorang pemain berhasil memutari lintasan melingkar dan kemudian mengenai bidak lawan, pemain tersebut harus mengambil satu kartu pertanyaan dan menjawabnya. Jika jawaban yang diberikan benar, maka bidak lawan yang terkena menjadi milik pemain. Sebaliknya, jika jawaban salah, bidak tersebut tetap menjadi milik lawan. Berbeda dengan permainan Dam-Daman, pada permainan Surakarta bidak tidak dapat ditangkap dengan cara melompati bidak lawan.
6. Pemain yang terlebih dahulu berhasil menguasai atau menangkap seluruh bidak lawan dinyatakan sebagai pemenang.

Figure 4. Rules and Gameplay Procedures of the Board Game Based on the Traditional Surakarta Chess Game

Implementation Stage. Before being tested, the media was validated by three expert validators: a content expert (Ida Sopiana, S.Pd.), a media expert (Ayi Rahmat, M.Pd.), and a traditional games expert (Chairul Umam, M.Pd., Vice Secretary General of KPOTI Central Board). The validity assessment employed Aiken's V formula, where a coefficient of ≥ 0.80 is categorized as High. The summary of the validation results is presented in Table 3.

Table 3. Summary of Media Validation Results

Validator	Aspect	Aiken's V	Category
Content Expert	Content Coverage & Accuracy	0.91	High
Media Expert	Design & Visual Communication	0.85	High
Game Expert	Language & Game Rules	0.70	Valid
Average		0.82	High

Overall, the average Aiken's V coefficient across the three validators reached 0.82, which falls into the High category (V ≥ 0.80). The validation scores for content (0.91) and media (0.85) indicate that both the instructional material and the physical design of the media are aligned with the basic competencies of Physical Education (PJOK) and meet appropriate visual communication standards. The validation of the game aspect yielded a coefficient of 0.70 (Valid), which still falls within the valid range and suggests that the game

rules and language used in the media are well understood by students. Therefore, the media can be considered valid and appropriate for trial implementation.

The practicality test was conducted at MIN 1 Pesawaran in two stages: an individual trial (n = 4 fifth-grade students) and a small group trial (n = 10 sixth-grade students). The two trials were carried out sequentially on different days, with the individual trial preceding the small group trial so that input from the first stage could inform the second. The participants were selected to represent a range of ability levels, including high, moderate, and low achievers. Teacher evaluations were measured using a 1–4 scale, while student responses were collected through a 25 item Guttman-scale questionnaire (Yes/No), covering four aspects: attention, interest, confidence, and satisfaction. The results of the individual test are presented in Table 4.

Table 4. Media Practicality Test Results Individual Test

Aspect	Individual Trial	Category
Attention	92%	Very Practical
Relevance (Interest)	100%	Very Practical
Confidence	94%	Very Practical
Satisfaction	98%	Very Practical
Average	96%	Very Practical

Based on Table 4, the results of the individual trials show an average of 96%, falling into the 'very practical' category. The relevance aspect received the highest score (100%), followed by satisfaction (98%), self-confidence (94%), and attention (92%). These findings indicate that the medium can be used effectively in the initial stage. Furthermore, the results from the small-group trial stage are presented in Table 5.

Table 5. Media Practicality Test Results Small Group Test

Aspect	Small Group Trial	Category
Attention	98%	Very Practical
Relevance (Interest)	94%	Very Practical
Confidence	92%	Very Practical
Satisfaction	90%	Very Practical
Average	94%	Very Practical

As shown in Table 5, the small-group trial produced an average practicality score of 94%, indicating a very practical level of usability. The attention aspect increased to 98%, whereas the other assessed aspects remained within the very practical category, ranging from 90% to 94%. The stability of these results across both the individual and small-group trials suggests that the developed learning media is highly practical, user-friendly, and suitable for implementation in Physical Education and Health instruction

The Surakarta Chess-based physical education learning media was trialed with students who had previously received instruction in character education and numeracy literacy. During the trial, students demonstrated active engagement raising questions, seeking peer and teacher assistance when faced with difficulties, and expressing opinions with growing confidence. Notably, higher-achieving students spontaneously assisted struggling peers, fostering group solidarity throughout the gameplay. Question cards and challenge cards were answered with highly satisfactory results overall. These observations were substantiated through a practicality questionnaire, the results of which are presented in Table 5.

Table 6. Analysis of Students' Responses Toward the Surakarta Chess-Based Physical Education Learning Media

No	Aspect	Indicator	Items	Percentage
1	Attention	Interest in board game media; ease of understanding material	4	98%
2	Relevance	Not boring; differs from common media; suits students' ability	6	94%
3	Confidence	Motivated to learn; enhances activities; constructs knowledge and understanding	8	92%
4	Satisfaction	Courage to express opinions	2	90%
	Overall Average			**94%**

As shown in Table 6, all four assessed aspects attention, relevance, confidence, and satisfaction achieved scores within the very practical category, yielding an overall average of 94%. No suggestions for improvement were raised by students during the small-group trial, indicating that the media adequately met their learning needs and expectations. Accordingly, the Surakarta Chess board game media is classified as highly practical and feasible for use in physical education learning.

Discussion

Expert validation by three specialists produced a mean Aiken's V of 0.82, categorized as Highly Valid ($V \geq 0.80$). Individual scores comprised content validity (0.91), media validity (0.85), and gameplay validity (0.70, Valid). These values exceed the minimum content-validity threshold defined by Aiken, (1985) and confirm that a multi-panel Aiken's V yields a more objective and reliable estimate than single-validator approaches (Kania et al., 2024)

The content score of 0.91 reflects strong alignment between the question-card content and the core PJOK competencies targeted in this study, particularly character education and numeracy literacy. The media score of 0.85 indicates that the board game's physical design satisfies key visual-communication principles legibility, visual appeal, and

appropriate sizing elements known to shape student interest and active participation (Kamid et al., 2022). The comparatively lower gameplay score of 0.70, though still valid, signals that instructional clarity requires refinement, especially for students with varying reading proficiency. This echoes Sousa et al., (2023), whose systematic review of 2,741 articles on analog game-based learning identified language accessibility as a persistent design challenge in educational board games.

Practicality results were similarly strong: teachers rated the media at 100% across both assessed dimensions, while students scored it 96% in the individual trial and 94% in the small-group trial both Highly Practical. Attention peaked at 98% in the small-group trial, indicating that the board-game format effectively captures and sustains focus, whereas interest reached a perfect 100% in the individual trial, reflecting the media's relevance to students' cultural backgrounds and learning needs.

These outcomes align with Aliriad et al.,)2024), who found that integrating traditional games into physical education markedly improves motivation and motor-skill development relative to conventional methods. Sousa et al., (2023) likewise affirmed that analog games foster intrinsic motivation and cognitive engagement when mechanics balance challenge with accessibility, and Vita-Barrull et al., (2023), through a cluster-randomized controlled trial of 522 primary students, demonstrated significantly greater gains in executive function and academic skills among board-game participants competencies foundational to numeracy literacy. The high relevance scores further reflect the cultural embeddedness of Surakarta Chess as local heritage, consistent with Parhan & Dwiputra, (2023), who argue that traditional games in formal settings revive local-wisdom values through lived experience rather than verbal instruction alone.

Structurally, the game pairs inter-group competition with intra-group cooperation in teams of five, creating a pedagogical condition in which competition drives achievement motivation while team dynamics cultivate positive interdependence. Trial observations showed higher-ability students spontaneously mentoring struggling teammates behavior embodying gotong royong (mutual cooperation) and group solidarity, core dimensions of the Pancasila Student Profile. Alotaibi, (2024), in a systematic review and meta-analysis, confirmed that cooperative game-based learning strengthens social skills, empathy, collaboration, and prosocial behavior in young learners.

For numeracy, embedding five mathematical-competency dimensions problem-solving, use of numbers and symbols, information analysis, critical-logical reasoning, and decision-making into the question cards turns gameplay into an authentic vehicle for

mathematical reasoning. Hui & Mahmud, (2023) confirmed via systematic review that game-based learning significantly benefits both cognitive and affective dimensions of mathematics, including motivation, engagement, and conceptual understanding, while Debrenti, (2024) found that non-digital and digital approaches yield comparable mathematical gains among primary students, with teachers favoring non-digital formats in practice. Finally, the game functions as an instrument of cultural revitalization: Sakti et al., (2024), in a Scopus-indexed ethnopedagogy study in Heliyon, showed that embedding local wisdom into formal learning meaningfully enhances children's cultural awareness and character an outcome of growing strategic value given the Pancasila Student Profile emphasis within Indonesia's Kurikulum Merdeka (Parhan & Dwiputra, 2023).

Limitations

Three principal limitations of this study warrant transparent acknowledgment. First, empirical trials were conducted at a limited scale (n = 4 for the individual trial; n = 10 for the small group trial), and the generalizability of the practicality findings therefore requires confirmation through full-scale field implementation. Second, this study did not quantitatively measure the instructional effectiveness of the media in terms of character or numeracy achievement outcomes. Accordingly, future research employing quasi-experimental or randomized controlled trial designs following the methodological standards applied by (Vita-Barrull et al., 2023) in their board game studies is necessary to establish the causal relationship between use of the Surakarta Chess board game and improvements in student character and numeracy literacy. Third, the lower gameplay validity score of 0.70 signals the need for targeted revision of instructional language and rule clarity prior to broader-scale implementation.

CONCLUSION AND ADVICES

Conclusion

This study successfully developed a Physical Education (PJOK) learning media based on the traditional Surakarta Chess board game using the ADDIE model. The developed media proved to be both valid and practical, achieving an overall Aiken's V coefficient of 0.82 (Highly Valid) and practicality scores of 96% and 94% in the individual and small group trials respectively, both categorized as Very Practical. These results indicate that the media effectively engages students, strengthens character values such as cooperation and

mutual assistance, and supports the development of numeracy literacy competencies in an enjoyable and culturally meaningful learning environment.

However, this study has several limitations, including the small trial sample size and the absence of quantitative measurement of learning outcomes. Therefore, future research is recommended to conduct larger-scale field trials using experimental designs to confirm the effectiveness of this media in improving student character and numeracy literacy achievement more comprehensively.

Advices

Based on the findings of this study, several suggestions are proposed for relevant stakeholders. For teachers and school administrators, this media is recommended to be implemented more broadly as an engaging and meaningful learning variation within Physical Education subjects. For future researchers, it is necessary to conduct effectiveness testing through experimental research to measure the actual impact of this media on students' character development and numeracy literacy, and further development into a digital version is also encouraged to better adapt to technology-based learning environments. For education policymakers, the findings of this study can serve as a reference in developing locally-based instructional materials that are aligned with the strengthening of the Pancasila Student Profile.

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