Developing Physics Comic Media a Local Wisdom: Sulamanda (Engklek) Traditional Game Chapter of Impulse and Momentum

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Abstract. Comics have output values and great influence on the entertainment market in accordance with the times. Comics can also be used in the field of education and are not only used as an entertainment media. This research aims to produce the local wisdom physics comics media: sulamanda or engklek traditional game impulse and momentum chapter and to know the feasibility of the product. Research and Development (R & D) research uses the Borg & Gall model. The research began with preliminary research, research design, developing initial products, limited trials, limited revised trials, initial field trials, revisions to the initial field trials. The research instruments used included product assessment sheets, student response questionnaires, and test questions. The results of the study show that the local wisdom physics comics media: sulamanda or engklek traditional game is assisted by an android impulse and momentum chapter containing impulse and momentum material, learning videos, examples and problem exercises and can be operated using a smartphone or computer. Products included in the feasible category are used in the learning process of physics for students based on good categories from the expert judgement and this media is can be implemented in the learning process inside and outside the classroom.

1. Introduction
Comics, games, and animations have a big influence and the value of output in the media market is in accordance with the development of today’s life [1]. Comics can be used in the field of education and are not only used as an entertainment tool [2]. Conversations in comics use language that can turn rigid science into simple science. Comics are very popular among teenagers because they feature humor, narrative, and visual imagery [3]. The benefits of comics today are not widely known including the effects on skills, and communication skills [4]. Students can experiment and make a comic to encourage the development of creativity and critical thinking [5]. Educators use comics to display students’ creativity and intelligence. The story in comics needs a good plot, a strong character of development, and writing techniques to convey the message clearly and accurately [6]. Scientific literacy products to study science are worthy of being used as learning media. Educators are advised to conduct extensive experiments to examine their effectiveness in improving scientific literacy and increasing students’ awareness of the problem of crisis in the environment [7]. The development of comics is needed to invite other students who have diverse abilities, because textbooks are less attractive
to middle-class students [8]. Readers prefer to read physics comics rather than reading physics textbooks [3].

Comics can be used as effective learning media at various levels of Education [9], [10]. Comics are introduced to elementary school students, high schools, and students to assess the ability of comics to increase their interest and understanding. Comics are expected to install curiosity and encourage students to learn more about their own subjects effectively [10]. Physics learning can balance the value of local wisdom to build the nation’s character with a scientific attitude in knowledge of physics [11], [12]. Educators feel physics looks difficult and abstract for students. Students must be able to understand that physics plays a role in real life, so they will be literate in physics [13].

The values of local wisdom are maintained so that they continue to exist following the times and remain a hallmark of every region in Indonesia [14]. Local culture used in learning physics can change the rigid view of physics into “science for the future”, “science for daily living”, dan “science for all” [15]–[17]. Sulamanda or engklek traditional game contain problem solving values consisting of understanding problems, compiling problem solving strategies, and exploring solutions. These results can be followed up by compiling modules and applying them to students to improve children’s problem solving skills through Sulamanda traditional games [18]. Physics includes learning that is important in various professions and fields regardless of gender [19], [20].

Local wisdom is important for connecting scientific theories and local conditions, so science can be accessed by the public. Local wisdom is used as a science learning model to build contextual learning, so the learning process becomes meaningful and easily accessible to students [15]. Engklek or also called sunda manda, sulamanda, sondah, ingkling, jong jing, lempeng, or dampu are games commonly found in Sumatra, Java, Bali, Kalimantan and Sulawesi. Sulamanda traditional game is a traditional game that emerged during the Dutch era and is now rarely played. This game is played by 2 to 5 people and is played individually not a team. Sulamanda or engklek traditional game has the content of problem solving values [18]. Sulamanda traditional game contain several physics concepts, including: Motion Dynamics (parabolic motion and displacement), Sound Waves, Equilibrium of Tegar Objects (center of gravity), and Impulses and Momentum. Educators can use the media in the learning process in the classroom [21].

![Figure 1. Sulamanda Traditional Game Plots](image)

Based on the background that has been explained, there is a need for research on developing physics comics media of the local wisdom: sulamanda (engklek) traditional game in the chapter of impulse and momentum. These products can later be used in the learning process in the classroom or outside the classroom by the teacher to students.

2. Methodology

The type of research and development (R & D) research uses the development method of Borg & Gall. Research on the development of local wisdom physics comics media: Sulamanda traditional game of impulse and momentum chapter using the Borg & Gall model. Development of physics comics media of local wisdom: Sulamanda traditional game of impulse and momentum chapter starts from (1)
preliminary research, (2) research design, (3) developing initial products, (4) limited trials, (5) limited revised trials, (6) initial field trials, (7) revision of the initial field trials. The first stage of product development is to analyze the physical aspects of local wisdom: *Sulamanda* traditional game. The first stage is finished, then draw characters, make a plot, storyboard, and combine stories with pictures for comics. Images are made manually using paper and pencil, the results of the description are scanned, the editing process uses Adobe Photoshop CS5 software. The finishing stage uses Sigil software in the form of *.epub* files and the file can be accessed on Android using the Himawari Reader/Reasily-EPUB Reader application.

| Table 1. Physics Concept of Local Wisdom: *Sulamanda* Traditional Game |
|-------------------------------------------------|
| Activities | Theory |
| When the gaco is motionless or moving | 1) **Momentum**  
When the gaco has mass m in stationary condition \((v = 0)\) or moves \((v \neq 0)\). Gaco has momentum that indicates the state of motion of the engine. Momentum is a measure of difficulty in stopping the motion of an object. Momentum is influenced by mass and speed, these equations can be written like Equation 1.  
\[ p = mv \] |
| When the gaco comes in contact with another gaco or sulamanda game plot within a certain interval of time | 2) **Impulses**  
Force when the gaco touch each other with another gaco or Sulamanda traditional game plot in a short period of time. Players give an average impulsive force \((F)\) to another gaco or game plot in a short interval of time \((\Delta t)\). So that the impulse can be written like Equation 2.  
\[ I = F\Delta t \] |
| When there is a gaco pounding another gaco or about another player. | 3) **Collision**  
When the gaco hits another gaco, there will be a collision process between the gaco. In any collision process, momentum is always eternal as long as there is no external force acting (total zero external force). So as written in Equation 4.  
\[ m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \] |

Here we consider the gaco to experience collisions each does not change. In the collision process, in addition to speed, the mass of each object before and after the impact can change. For example, after the collision, the two gaco join, or after the collision there is a broken gaco. The collision process is divided into 3 types, namely:

a) perfectly resilient collision \((e = 1)\),
b) partial resilient collisions \((0 < e < 1)\), and
c) collisions are not resilient at all \((e = 0)\).

Where, \(e\) is the value of the restitution coefficient obtained from Equation 5.

\[
e = \frac{-(v_1' - v_2')}{v_1 - v_2}
\]  

\[\text{[22]}\]
The product to be validated is analyzed using Aiken’s V and calculated using the Aiken’s V formula with product criteria such as Table 2.

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

\( s \) = number given by the assessor
\( r \) = number given by the assessor
\( lo \) = lowest validity rating
\( n \) = number of assessors
\( c \) = highest validity rating

### Table 2. Criteria for Assessment of Aiken’s V Products

| Score Range   | Quality Category |
|---------------|------------------|
| 0.75 < V ≤ 1.00 | Very Good        |
| 0.50 < V ≤ 0.75 | Good             |
| 0.25 < V ≤ 0.50 | Pretty Good      |
| 0.00 < V ≤ 0.25 | Not Good         |

Limited testing is the product validation stage to experts. The finished products are then validated by expert lecturers, namely media experts and theory experts, physics teachers, and peer reviewers. The task of the expert lecturer, physics teacher, and peer reviewer is to assess the product from the theory feasibility and presentation of the media. Products that have been validated receive an assessment and input to be used as a comic repair before the initial field trial is carried out. The initial field trial uses assessment tests and non-tests. Validation is done by using a validation sheet that has been validated by an expert lecturer.

### 3. Result and Discussion

#### 3.1. Result

The product trial in this study consisted of 2 stages, namely: limited trials (expert validation and practitioners) and initial field trials. This stage aims to produce a viable product. The data obtained consisted of data from the results of the validator’s assessment and data from the results of the trial responses to students. Limited trials were carried out by material expert lecturers, media experts, physics teachers, and peer reviewers.

### Table 3. Results of Product Assessment from Media Aspects

| No | Rated Aspect             | Aiken V | Information |
|----|--------------------------|---------|-------------|
| 1  | Comic Design             | 1.00    | Very Good   |
| 2  | Visual Quality           | 0.88    | Very Good   |
| 3  | Content                  | 0.83    | Very Good   |
| 4  | Organization, Language, and Readability | 0.92 | Very Good |

### Table 4. Results of Product Assessment from Material Aspects

| No | Rated Aspect  | Aiken V | Information |
|----|---------------|---------|-------------|
| 1  | Presentation  | 0.88    | Very Good   |
2 Coverage of Material 0.96 Very Good

| No | Rated Aspect                  | Aiken V | Information |
|----|-------------------------------|---------|-------------|
| 1  | Perception of Ease of Use     | 0.90    | Very Good   |
| 2  | Usability felt                | 0.95    | Very Good   |
| 3  | Attitude                      | 0.90    | Very Good   |
| 4  | Use of the actual product     | 0.90    | Very Good   |

The results of data analysis are based on evaluations by media experts, material experts, physics teachers, and peer reviewers. Table 3, Table 4, Table 5 shows the results of the assessment of physics comics media of local wisdom: Sulamanda traditional game based on the aspects of media, learning materials, and practicality so that they are expressed in very good categories.

The initial field test was carried out to see and measure the implementation of local wisdom physics comics media: Sulamanda traditional game developed in the learning process, in the form of clarity, readability, effectiveness and usability in the impulse and momentum chapters.

### Table 6. Results of Product Appraisal at Initial Field Trials

| Theory | Media    | Mean  |
|--------|----------|-------|
| 3.75   | 4.71     | 4.07  |
| Good   | Very Good| Good  |

Evaluation of the feasibility of the local wisdom physics comics media: Sulamanda traditional games assisted by Android, obtained an average rating of 4.07 in the good category. Media of local wisdom physics comics: Sulamanda traditional games are concluded to be feasible to be used and continued in the main field trials. Media on local wisdom physics comics: Sulamanda traditional games produced can be seen in Figure 5.
3.2. Discussion

The product manufacturing phase starts from analyzing the physical aspects of local wisdom: Sulamanda or Engklek traditional game. Next draw characters, make grooves, storyboards, and combine stories with pictures for comics. Stories in comics need good plot, strong development character, and writing techniques to convey messages clearly and accurately [6]. Images are made manually using paper and pencil, the results of picture on paper are scanned, the editing process uses Adobe Photoshop CS5 software. The finishing stage uses Sigil software and produces the output of *.epub file. The file can be accessed on a smartphone using the Himawari Reader or Reasily-EPUB Reader or other EPUB Reader application or using a computer with an internet browser.

The physics comics media of local wisdom: Sulamanda or Engklek traditional game of impulse and momentum chapter has been said to be valid after going through a limited trial process with validation processes from expert lecturers, physics teachers, and peer reviewers. The Aiken V value from the media aspect includes comic design 1.00; visual quality 0.88; content 0.83; organization, language, and readability of 0.92. The results of the Aiken V assessment of material aspects include presentation and material coverage of 0.88 and 0.96. Whereas the results of the product assessment from the practical aspects include perceptions of ease, perceived usefulness, attitude, and product usage of 0.90; 0.95; 0.90; 0.90. So, the assessment category is very good. Assessments produced from the validation process by expert lecturers, physics teachers, and peer reviewers were generated to proceed to the field trial stage in high school students.

The physics comics media of local wisdom: Sulamanda or Engklek traditional game of impulse and momentum is said to be feasible after being applied to the initial field testing process for high school students. The results of product assessment in the initial field trial amounted to 4.07 from standard scale 1-5 with categories both in terms of material and media. Products included in the feasible category are used in the learning process of physics for students. This is in accordance with the results of previous studies from [10] that comic science education is an educational tool that is feasible to use in the field of education. The physics comics media of local wisdom: Sulamanda or Engklek traditional game of impulse and momentum
chapter can be used on smartphones with the Reasily-EPUB Reader application or using a computer with internet browser application. Comics can be used as effective learning media at various levels of Education [9], [10]. Scientific literacy products to study science are worthy of being used as learning media [7]. The development of Android-based physics comic media is appropriate to be used in physics learning in class [23]. Conversations in comics use language that can turn rigid science into simple science so students can understand it [3]. Physics comics media is can be implemented in the learning process inside and outside the classroom.

4. Conclusion
The results showed that the physics comics media of local wisdom: Sulamanda (Engklek) traditional game of impulse and momentum chapter is a media that is operated using a smartphone with the application EPUB Reader or by using a computer with an internet browser. Products included in the feasible category are used in the learning process of physics for students based on good categories and this media is can be implemented in the learning process inside and outside the classroom.

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