Analysis of Physics Aspects of Local Wisdom: Long Bumbung (Bamboo Cannon) in Media Development for Android-Based Physics Comics in Sound Wave Chapter

Rahmad Hudan Ramadhan*, Latifah Ratnaningtyas, Heru Kuswanto, Ratna Wardani
Physics Education, Graduate School, Yogyakarta State University
Colombo Street 1, DI Yogyakarta 55281, Indonesia

*Corresponding author e-mail: hudenrr@gmail.com

Abstract. Local wisdom in Indonesia is a property that should be maintained. One way to instill local wisdom in students is to link physics learning. This study aims to develop a learning media for android physics comics based on local wisdom, android-assisted long bumbung. This article presents how researchers develop physics comics by exploring physical aspects that exist in local wisdom long bumbung. Android is used as a basis for using comics so that it can be used to learn physics whenever and wherever. This physics comic is also sought as enrichment material to strengthen the concepts and material students learn in class. The method in the development of physics comics is R & D (Educational Research and Development) with 4-D models. The process of developing comic physics media is through stages (1) Define consisting of Introduction, Analysis of students, Concept Analysis, and Analysis of learning objectives. (2) Design consists of Material Determination Study and Making Comic Media Component Specifications. Comic Media Physics in the form of electronic digital Book (EPUB) that can be read on the Android system with the help of Reader Reasily, Lithium, Himawari Reader, and others

1. Introduction
The failure of students in solving problems is more due to failure to activate the relevant knowledge that they already have, not because they do not have the right knowledge related to the problem [1] [2]. Therefore there is a need for direction for students to activate knowledge quickly and precisely when solving physics problems. Learning physics has a good meaning if the physical concept is studied in depth. Physics learning more often applies mathematical mindset than deep concept, this brings the atmosphere of learning physics which leads to the memorization of formulas only, so that conceptual and high-level thinking abilities of students are poorly trained [3] [4]. So it is important for teachers to provide high-level thinking stimuli in learning
Local wisdom in each region in Indonesia is an asset or hidden asset for the Indonesian nation that must be maintained. One way to instill local wisdom in students is by linking integrated physics learning. In addition, physics learning can easily be done by using the surrounding items as teaching materials [5] [6]. Utilization of local culture is still rarely noticed by teachers in exploring related physics. Local wisdom as a model for learning science enables students to build contextual learning, and can be easily accessed by local communities [7] [10]. With all the many local cultures in
Indonesia, teachers should be able to apply local culture in learning, thus providing good contextual learning among students.

Comics or manga are so close to teenagers, especially students. Manga is a Japanese comic that is spread throughout the world. Comics become an opium for most students in various countries, especially Asia. The instructor is also not looking at comics for studying science [10]. In addition to print media, comics in this era can easily be read through mobile devices in web content [11]. Comic strips and the internet are one of the most accessible materials that can be used in science classes as learning tools. Developing physics comics to learn gives a good contribution to the concept of sound in lower middle school students.

2. Literature Review

The comic contains a unique narrative code consisting of a mixture of images and text in telling a story. Comics have the potential to be good teaching materials by paying attention to aspects that are relevant to the topic of learning. In addition, comics can also be used for learning media that are proven to be able to convey incoming information in a clear, coherent, and fun way [12] [13]. In addition to presenting information, comic books have a strong appeal to provoke reading interest through features of humor, narrative, and visual representation [14] [15]. In addition, comic books have advantages over textbooks in general, which can lead to many perspectives from visual and verbal readers' thoughts, predict the beginning and end of the storyline, find climax moments, and feel the complexity of complex stories [17]. Comics in the form of mobile applications also allow paper savings, especially comics in the form of applications can have more than one feature, which is available online tests, animations, and material [18]. So the development of physics comics that are tailored to the context of the material in learning can provide good learning and increase student motivation and attractiveness.

Local wisdom is important to stay close to school and interact with learners in the local context in the development of knowledge that can be adapted to school potential [5] [19]. Local wisdom as a model for learning science enables students to build contextual learning, which makes learning more meaningful and becomes more accessible for students in local communities [7] [20]. Product development and media based on local wisdom must pay attention to the core part which consists of: media explanation intro; making local wisdom (products); concept maps; chapter title; keywords; material description; product character; worksheets, and summaries; and the closing section in the form of practice questions, competency tests, bibliography, key answers [21] [8]. Through contextual specifications with physical aspects, learning media can be a good source of information for learning physics concepts.

*Long Bumbung* (bamboo cannon) is one of the traditional Malay traditional games that was popular in its time and is almost known throughout the archipelago. Various regions recognize the game of bamboo cannons with different names. In Java, especially around Yogyakarta and Central Java, bamboo cannons are commonly known as “Long Bumbung”. In addition, in other places this game is known as bamboo rifle, mercon bumbung, and others. This *long bumbung* game is usually played by boys when commemorating religious / customary holidays and enlivening the month of Ramadhan (fasting) before the feast day.

*Long bumbung* requires fuel that can help produce a boom that is in the form of kerosene or carbide mixed with water with a certain dose. Bamboo cannons are played by pouring kerosene or carbide liquid into the hole where the ignition is made on the bamboo ends. A piece of wood wrapped in a cloth dampened using kerosene is used as an ignition cannon (long bumbung). Until finally the ignition is directed towards the hollow hole of a bamboo cannon which will produce a thumping sound.
Students often avoid difficult questions posed by the teacher. Though deep questions can facilitate good learning, even leading to high level of knowledge [3] [22]. The use of conceptual questions can help students learn to verify the concepts they understand [23]. Questions and dialogues that have been arranged in order to make it easier in the practice of making comics have good advantages in delivering physics material. Memdalam learning can be done by introducing general concepts and bringing on more specific concepts, and qualitative learning [3]. As an effort to stimulate the thinking of students to train HOTS in deep learning, it can be done by means of free and structured interviews. The form of free interviews can be adapted into writing in the form of structured questions. So that structured interviews can be expressed in a deep question in the physics comics media.

3. Methodology
This research is included in development research. The final product of this research is learning media in the form of physics wisdom based on local wisdom: Long Bumbung on contextual sound material. The method of this research is the development of R & D education (Educational Research and Development) with the Thiagajaran 4-D (Four-D Models) model (in 1974).

The product development procedure with a 4-D model in this study consists of 4 stages, namely: Define (Definition), Design (Develop), Develop (Development) and Disseminate (Distribution). This article presents the design of physics comics through the Define and Design stage. This study presents how the physics comics media are developed based on local wisdom Long Bumbung with the subject matter of sound wave chapter.

3.1 Define
The definition process is carried out to determine the terms and components of the physics comics media so that they can be used in the learning process to the fullest. The definition phase is carried out through the following stages: Preliminary Study, Learner Analysis, Analysis of Learning Objectives, Analysis of Physics Concepts, and Task Analysis.

3.2 Design
The design phase is the stage of designing product media, namely the physics-based comics based on formulating indicators of student achievement in accordance with the physics material in Long Bumbung's local wisdom. The indicators are then pinned into the basis of making a prototype design or initial product design consisting of the following stages: Determination of Material and Making Specifications of Media Components Comics. The next step is developing is product realization, preparation of instruments for validation, product validation, and product testing. Products are developed using the Photoshop application. Comic images that have been finished are then arranged into several chapters using the sigil application and will produce comic files in .EPUB format that can be opened using the upub reader on an android smartphone.
4. Result
The development of comic physics is done through the following steps:

1.1. Preliminary Study
The preliminary study was conducted to detect problems in learning in an effort to improve the quality of learning through android-based comic physics media, namely the low level of physical representation ability and high-level thinking ability (HOTS): analysis among high school students. A preliminary study was also conducted to see the curriculum being implemented at school, as well as the selection of Long Bumbung as Yogyakarta's local wisdom integrated in the teaching media.

1.2. Analysis of students
This stage is done to find out the background of students related to the learning process, which consists of: academic abilities, cognitive, psychological, and social development of students in classroom learning. The target of media products is 11th grade high school students in the Physics class.

1.3. Physics Concept Analysis
The physics concept analysis is carried out by balancing the reality and workings of Long Bumbung. The appropriate concept of physics is then explored based on the existing context. Sound wave concept analysis is carried out by formulating facts/physical phenomena, physical concepts, physical principles, physical laws, and physical theories based on local cultural games long bumbung.

1.4. Task Analysis
Analysis of learning objectives is the result of task analysis and analysis of concepts which are summarized as indicators of student learning outcomes that refer to KI and KD in related physics material. In addition, this study focuses on honing HOTS skills and the physical representation of students on sound material. Table 1 presents the learning objectives with the physics comics media based on the 2013 curriculum applicable in Indonesia.

1.5. Material Determination
The process of identifying physical concepts is carried out on the phenomenon of Long Bumbung's local wisdom. The process of determining the material is also carried out by analyzing physics concepts that are in accordance with the problem of research variables. So that there will be a suitability of the case or plot of the story in the comic physics media relating to the achievement of learning objectives. The material of physics that is set in comics is sound waves which consist of sub chapters of sound characteristics, hearing and seeing sounds; sound propagation; sound intensity; and sound intensity level. In this study, the focus of variable achievement focuses on sound material.

1.6. Making Media Component Specifications for Comics
The making of comic physics media specifications is done through the following stages: 1) the process of making characters and characters; 2) determine the storyline; 3) design illustration images and conversation dialogue; 4) designing problems and solving physical phenomena; 5) designing sound material questions.

1.7. Product Making: Media Physics Comics
Media Physics Comics consists of 4 parts, where each activity conveys sub topics. In addition, 4 parts of the story in the comics of physics are arranged systematically through the most basic phenomena, events, dialogues and sub-questions. It aims to make the learning process through 5M (observing, asking, trying, associating, and communicating) and carried out well, and directs learning that is coherent so that the material can be easily digested by students. In addition, dialogue in physical phenomena is arranged on the basic (factual and procedural) questions that are proposed, which include the nature of teaching and emerge "astonishment" (understanding, prediction, detecting anomalies, applications, and planning) that can lead to deep learning [22 ] An in-depth question can be
arranged by introducing the concept of "key" which is accompanied by an explanation that will make learning facilities good in the general learning environment [3]. The developer integrates deep questions in the comic physics media to help students gain the depth of learning. The following is a sequence of chapters in comic physics: Introduction: local wisdom-*Long Bumbung* 1) Chapter I: Hearing & Seeing Sound; 2) Chapter II: Sound Fast propagate; 3) Chapter III: Sound phenomenon; 4) Chapter IV: Intensity and Sound Intensity Level.

### Table 1. Analysis of Learning Objectives

| No | Analysis                  | Result                                                                 |
|----|---------------------------|------------------------------------------------------------------------|
| 1  | Core Competence           | Understand, apply, analyze factual, conceptual, procedural knowledge   |
| 3  | based on their curiosity about science, technology, art, culture, and |
|    | humanities with humanity, nationality, state and civilization insights |
|    | regarding the causes of phenomena and events, and apply procedural     |
|    | knowledge to the field of study specific ones according to their talents |
|    | and interests to solve problems.                                     |
| 2  | Basic Competencies        | 3.10. Applying the concepts and principles of sound and light waves in |
|    |                           | technology                                                             |
| 3  | Indicator                 | 3.10.1. Comparing sound strength (TI sound intensity level) that is heard |
|    |                           | by the human ear because of the difference in the distance of the listener |
|    |                           | from the sound source that arises in the explosion of the *long bumbung* |
|    |                           | 3.10.2. Large grouping of sound propagation based on propagation medium |
|    |                           | 3.10.3. Make a parable about the nature of sound and the process of sound |
|    |                           | propagation that occurs in the *long bumbung* to the sense of hearing   |
|    |                           | 3.10.4. Concludes the classification of sound waves based on pitch and sound |
|    |                           | strength                                                              |
|    |                           | 3.10.5. Sort out the variables that affect the speed of sound in the event |
|    |                           | of a bamboo cannon sound                                              |
|    |                           | 3.10.6. Choose the right way to manipulate large sound velocity         |
|    |                           | 3.10.7. Find methods for dealing with physical problems related to the  |
|    |                           | weakness of sound in *long bumbung*                                   |
|    |                           | 3.10.8. Make an outline about the intensity of sound waves (I) in *long* |
|    |                           | *bumbung* which is viewed from the size of bamboo material             |
|    |                           | 3.10.9. Describes the role of variable area (A) and power (P) on the sound |
|    |                           | wave intensity (I)                                                    |
|    |                           | 3.10.10. Deconstructing the arrangement of bamboo materials (in terms of |
|    |                           | length and magnitude) to show the truth of physical phenomena about the |
|    |                           | intensity of sound waves                                              |

The process of making physics comics with local wisdom *long bumbung* consists of several stages with the following steps:

1. **Draw self-contained comics with hand sketches**
   Drawing sketches made with hand painting with half-clear strokes. The researcher must adjust the right scene for each page of the comic. For maximum results, the story plot must be adjusted to the material analysis, learning objectives, and physical analysis that was made at the beginning. Figure 2 (left-side) is an example of a comic sketch that has been made.

2. **Physics Comic Editing Process**
   The results of the comic drawing sketch are then scanned in the form of an image (.png; jpeg). The scanned comic results are then imported into Adobe Photoshop software. In this stage, the results of comic sketches are processed through the process of coloring and tidying, as well as giving balloons to comic dialogue. Figure 2 (right-side) is an example of a comic sketch that has gone through the final editing process using Adobe Photoshop.
3. Compilation of comics in the form of EPUB using SIGIL software
Comics that have gone through the final editing phase will be ready to be packaged using SIGIL software. In this process, each comic part is arranged in a sequence that has been determined. The advantage, researchers can include video features that can support students' understanding of the sound concepts associated. So that the integrity of comic physics can be poured with the final product in the form of EPUB (digital book).

4. Product of Long Bumbung Local Wisdom Physics Comics
Final format physics comics are packaged in EPUB format (.epub), which is a digital book format. Comics can be read on mobile Android devices using the EPUB reader application such as: Reasily, Himawari Reader; lithium: Epub Reader, and others. Figure 3 shows the local wisdom physics comics long bumbung through the application Reasily.

5. Discussion
The product that will be developed by the author is an android-based physics comic with the utilization of local wisdom long bumbung. Comics are designed to attract students' interest in learning physics. In addition, the use of android as a learning medium can be used by students to study physics whenever and wherever. This physics comic is also sought as enrichment material to strengthen the concepts and material students learn in class. Here are the Android-based comic physics specifications designed by the author: 1) Physics comics are designed with the theme of local wisdom long bumbung in the form of an android application. 2) Physics comics are designed that focus on sound physics material. 3) Physics comics are designed as material for student learning enrichment. 4) Physics comics are designed with the theme of science fiction with interesting character characters that display humor and culture. 5) Each dialogue on the comic story plot is based on an approach to depth-questions about related material. 6) Physics comics are equipped with several physical support videos, sample questions, answer discussions, and practice questions in each event plot.

6. Conclusion
Given the importance of local cultural values in Indonesia, educators must have a stake in preserving them. Physics learning by seeking local wisdom is very good to do. The development of android physics comics learning media based on local wisdom of long bumbung is one example of efforts to preserve local cultural values. Researchers developed physics comics by exploring physical aspects that exist in local wisdom long bumbung. The method in the development of physics comics is R & D (Educational Research and Development) with 4-D models. The manufacturing process through stages (1) Define consists of Introduction, Analysis of students, Concept Analysis, and Analysis of learning objectives. (2) Design consists of Material Determination Study and Making Comic Media Component Specifications. The content of comic physics contains a treatment that can facilitate students to hone the ability of physics representation and HOTS, comics present the phenomenon pysics sound waves, problems and examples of problems, supporting videos.

7. Reference
[1] L. Buteler and E. Coleoni, “Solving problems to learn concepts , how does it happen ? A case for buoyancy,” vol. 020144, pp. 1–12, 2016.
[2] J. L. Docktor, N. E. Strand, J. P. Mestre, and B. H. Ross, “Conceptual problem solving in high school physics,” vol. 020106, pp. 1–13, 2015.
[3] S. D. Craig, B. Gholson, J. K. Brittingham, J. L. Williams, and K. T. Shubeck, “Promoting vicarious learning of physics using deep questions with explanations,” Comput. Educ., vol. 58, no. 4, pp. 1042–1048, 2012.
[4] G. V. Madhuri, V. S. S. N. Kantamreddi, and L. N. S. Prakash Goteti, “Promoting higher order thinking skills using inquiry-based learning,” Eur. J. Eng. Educ., vol. 37, no. 2, pp. 117–123, 2012.
[5] C. Pornpimon, A. Wallapha, and C. Prayuth, “Strategy Challenges the Local Wisdom Applications Sustainability in Schools,” Procedia - Soc. Behav. Sci., vol. 112, pp. 626–634, 2014.
[6] A. Rusilowati, Supriyadi, and A. Widiyatmoko, “NATURAL DISASTER vision LEARNING SETS INTEGRATED IN SUBJECT OF PHYSICS-BASED LOCAL WISDOM,” J. Pendidik. Fis. Indones. J. Phys. Educ., vol. 11, no. 1, pp. 42–48, 2015.
[7] Anwari, M. S. Nandi, and E. Sulistyowati, “Biological Science Learning Model Based on Turgo’s Local Wisdom on Managing Biodiversity,” in PROCEEDINGS OF INTERNATIONAL SEMINAR ON MATHEMATICS, SCIENCE, AND COMPUTER SCIENCE EDUCATION
P. Z. Kun, “Pembelajaran Sains Berbasis Kearifan Lokal,” *Pros. Semin. Nas. Fis. dan Pendidik. Fis.*, vol. 2, no. 1, pp. 246–256, 2013.

B. Setiawan, D. K. Innatesari, W. B. Sabtiawan, and S. Sudarmin, “The development of local wisdom-based natural science module to improve science literation of students,” *J. Pendidik. IPA Indones.*, vol. 6, no. 1, pp. 49–54, 2017.

R. Egusa *et al.*, “Improving the usability of manga-on-a-tablet for collaborative learning,” in *CSEDU 2014 - Proceedings of the 6th International Conference on Computer Supported Education*, 2014, vol. 1, pp. 446–451.

H. Tolle and K. Arai, “Manga content extraction method for automatic mobile comic content creation,” in *2013 International Conference on Advanced Computer Science and Information Systems, ICACSI 2013*, 2013, pp. 321–328.

D. Yulianti, S. Khanafiyah, and S. Sulistyorini, “Inquiry-based science comic physics series integrated with character education,” *J. Pendidik. IPA Indones.*, vol. 5, no. 1, pp. 38–44, 2016.

B. Subali, A. Sopyan, and E. Pallianawati, “Developing local wisdom based science learning design to establish positive character in elementary school,” *J. Pendidik. Fis. Indones.*, vol. 11, no. 1, pp. 1–7, 2015.