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Hydraulic Carica as A Local Commodity Potential Based Natural Scientific Instrument

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ABSTRACT

This research aimed to develop a local commodity potential based natural, scientific instrument called Hydraulic Carica (Hydrocar). It belonged to research and development studies. The instrument was developed through several stages: information acquisition, planning, development, validation and limited testing. It was validated by experts, practitioners and students during the limited testing stage. The product of research was a natural, scientific instrument based on local potential commodity in Wonosobo regency called Hydrocar (Hydraulic Carica). The instrument was developed according to the criteria with ”very good” scores on media, material and method aspects. Hydrocar is a suitable media for natural, sciences learning because it overcomes time and space limitation, improves students’ motivation and understanding and allows them to be more actively engaged in classroom.

Keywords: Hydraulic Carica, Natural Scientific Instrument, Local Commodity Potential.

INTRODUCTION

Natural sciences is a rational, systematic subject capable of training students to solve problems in their lives. Since its materials are closely related to life and able to develop students’ potentials and capabilities, improvement in its learning for a better quality is mandatory.

In reality, students have little interest in natural sciences subject despite its importance because they assume most of materials are abstract and difficult to comprehend. Therefore, real actions are needed to solve the issue. One of them is to employ interesting, creative and innovative instruments or media in natural sciences learning. It will create a more alive learning situation where students would understand materials easily. Instrument can also stimulate students’ thinking capability and improve their learning outcome (Firdaus, 2016; 46-54) and problem solving skills (Firdaus, 2017: 17-19).

The initial observation and interviews conducted in 16 Elementary Schools and *Madrasah Ibtidaiyah* in Wonosobo regency showed that almost 90% of them did not have natural, scientific instruments developed by their teachers. Although each teacher agreed that instruments were vital in learning because they could improve students’ learning motivation and engagement in classroom, the availability of such instruments was scarce.

Learning instrument/media serve important roles i.e. 1) to encourage students’ interest towards materials, thus improving their learning motivation, 2) to stimulate students to think critically and imaginatively, increasing their creativity in producing innovations (Arsyad, 2013), 3) to improve their understanding, 4) to stimulate their thinking and refine learning environment, 5) to improve their academic performance and engagement in learning activities (Lapada, 2017; 139-156) and 6) to help demonstrating something in learning process (Notoatmojo, 2009) or serve as a learning medium (Sitanggang, 2013).

Cuban (2001) investigated students' learning psychology when using instruments, showing that 1% of what is learned is learned via taste, 1,5% of what is learned is learned via touch, 3,5% of what is learned is learned via smell, 11% of what is learned is learned via hearing and 83% of what is learned is learned via sight. Therefore, sight sense has the biggest role in students' learning towards object learning, enforcing the importance of instrument usage in natural sciences.

Dale (1969) describes the experience values which underlie students' learning, namely 10% from what is read, 20% from what is heard, 30% from what is seen, 50% from what is heard and seen, 70% from what is said and written and 90% from what is performed. Greatest learning experience will be acquired by students who are actively engaged in learning activities. Instruments could be designed not only to demonstrate abstract concepts but also provide real experience for students when they use them in their learning activities.

Integrating instruments in classroom learning begins with teachers preparing instruments relevant to materials which will be presented (Ranasinghe & Leisher, 2009: 1955-1961). The instruments should support learning activities, not dominate them. Furthermore, the instruments must be able to create condusive, collaborative learning environment. Koc (2005) also explains that technology integration in curriculum means using media or tools to teach certain concept to students. It aims to improve students' high thinking skills. Technology development may allow innovation and advancement for natural, scientific instruments.

Based on the importance of natural, scientific instruments in learning process and the fact that no such instrument was available, a development of new instrument was needed. To make new instrument innovative, creative and different from existing ones, it would be developed based on local commodity potential in Wonosobo regency.

The instrument developed in this research was called Hydrocar (Hydraulic Carica). It was created to support natural sciences learning. Hydrocar is able to move and lift goods like an excavator. It has a movement system consisting of four movers made of ice cream sticks. Each mover has different function. For instance, the first mover moves the claw, the second mover moves goods vertically, the third mover moves goods forward and backward, and the last mover moves goods horizontally. The local commodity potential used in Hydrocar was carica, a special fruit from Dieng highland in Wonosobo regency.

The development of Hydrocar consisted of several stages. One of them involved validation through several criteria. Criteria are used to assess the quality of new learning instrument/media before being used (Chee & Wong, 2003; 136-140); Newby, 2000; 116-117); (Winarno, 2009; 74-80). The criteria used to assess our natural scientific instrument were categorised into three aspects: media, material and method.

Based on the explanation above, we therefore intended to develop a natural, scientific instrument Hydrocar (Hydraulic Carica) based on local commodity potential in Wonosobo regency.

RESEARCH METHOD

This research belonged to research and development category. It would develop a natural, scientific instrument based on local commodity potential called Hydrocar.

The research method employed was based on a model developed by Brog & Gall (1983: 775) namely 1) information acquisition, 2) planning, 3) initial product development, 4) limited testing and 5) product revision.

The information acquisition stage is the first stage, also called preparation for development. This stage consisted of literature review and field survey. The literature review was performed to collect information necessary for the development of natural, scientific instrument. The field survey was performed to directly observe the environment situation, potentials, learning process and document students' capabilities.

The planning stage was performed by designing natural, scientific instrument based on local commodity potential. The design was created as solution for the problem identified during the first stage. The planning stage also consisted of selecting certain individuals who were qualified as experts, practitioners and students. A procedure would be designed and adopted in order to make the research run effectively and efficiently.

The initial product development was performed based on the plan. The stage was started with developing Hydrocar based on local commodity potential. A prototype was created and complemented with student worksheet and operational manual. The next step was the instrument was tested for its validity by experts and practitioners, resulting in initial qualitative and quantitative evaluations on the prototype. The results of test were analysed qualitatively and quantitatively.

The first revision on product was performed based on the validation test by experts and practitioners towards the development of Hydrocar, resulting in several considerations for improvement.

Limited testing was performed by a small group consisting of 10 students to produce scores and suggestions for improvement concerning the revised instrument.

The second revision on product was performed based on the suggestions from students as users. It was to improve the instrument in order to become more usable.

The instruments used to collect data in this research were: validation, interview and questionnaire sheets. The research data were experts and practitioners' validation recorded in the validation sheet. The data on teachers' preliminary research on natural, scientific instrument were recorded on the observation sheet. The data on instrument assessment by students were recorded on the questionairre sheet.

The validation sheets were organised based on aspects presented in Table 1 below.

Table 1. Aspects of Validation Sheet on Learning Instrument

No.	Aspects	Items
1.	Media	11
2.	Materials	7
3.	Method	9

The data were analysed using the following steps: 1) Tabulate all acquired data from validators for each component and sub component of items in instrument assessment, 2) Calculate average scores from a sub-aspect of each aspect, 3) Data in form of comments and suggestions are analysed descriptively and qualitatively, 4) Scores acquired from the Likert Scale are analysed and converted into four criteria derived from Department of National Education (Depdiknas) as presented in Table 2.

Table 2. Converting the Likert Scale into four criteria (Depdiknas, 2010: 60)

No	Score Intervals	Categories
1	$Mi + 1,5SDi \le \overline{M} \le Mi + 3,0SDi$	Very Good
2	$Mi + 0SDi \le \overline{M} < Mi + 1,5SDi$	Good
3	$Mi - 1,5SDi \le \overline{M} < Mi + 0SDi$	Fair
4	$Mi - 3,0SDi \le \overline{M} < Mi - 1,5SDi$	Poor

Notes

$Mi = \frac{1}{2}$ (Maximum Score + Minimum Score)

$SDi = \frac{1}{6}$ (Maximum Score – Minimum Score)

$\overline{M}$ = Average Scores acquired

The results of the scores conversion into four scales can be viewed in Table 3.

Table 3. The Scores Conversion into Four Scales

Aspects	Score Intervals	Categories
Media	$35,75 \leq M \leq 44$	Very Good
	$27,5 \leq M < 35,75$	Good
	$19,25 \leq M < 27,5$	Fair
	$11 \leq M < 19,25$	Poor
Material	$22,75 \leq M \leq 28$	Very Good
	$17,5 \leq M < 22,75$	Good
	$12,25 \leq M < 17,75$	Fair
	$7 \leq M < 12,25$	Poor
Method	$29,25 \leq M \leq 36$	Very Good
	$22,5 \leq M < 29,25$	Good
	$15,75 \leq M < 25$	Fair
	$9 \leq M < 15,75$	Poor

RESULTS AND DISCUSSION

The instrument developed in this research was Hydraulic Carica, based on local commodity potential. It was developed based on the information acquisition through interview. According to the result of interview with teachers, it can be concluded that 1) the existing instruments were related to natural sciences and provided by government, 2) the instruments which were created by teachers were scarce, 3) the instruments available in schools generally were torso, graphics, lups, thermometers, globe, galaxy miniature model and human heart model. There were no local commodity potential based instruments made by teachers.

During the planning stage, there were several things to be done such as deciding the type of instrument, collecting materials and tools and designing the shape of instrument.

The development stages of Hydrocar based on local community potential will be described as follows.

1. Designing the skeleton of hydrocar hand

First, draw a pattern of excavator hand on a cartoon. Cut the cartoon accordingly. Second, drill another cartoon from both sides according to the preset sizes. After that, combine both cartoons. Glue a small pad on each bamboo skewer to make it tight.

2. Install hydraulic system into the hydraulic hand

First, drill the bottom part of each plunger rod so it can be attached to a bamboo skewer in the hydrocar hand. Second, glue a cable tie on the bottom part of a syringe. After that, the syringe is glued on the hydrocar hand with Glue A.

3. Creating the claw of hydraulic hand

First, prepare a cartoon and some wires. Cut the cartoon in the shapes of triangle, letter C, and letter I. Bend the wires in shape of letter Z. Add a pair of pads on each tip of the claw using Glue A. After that, cut unneeded part of bamboo skewers. Add hot glue on the top side of the hydrocar hand. After that, connect the claw to the upper part of the hand. Leave them for a while until the glue is completely dry. Next, we create a hydraulic system for the claw. First, prepare a syringe. Cut the round part of its plunger rod. Attach it to the skeletal hand using a bamboo skewer. Connect the wires on the claw to the plunger rod. Apply glue on them.

4. Creating the pad for the hydraulic hand

First, prepare a large cartoon and a smaller one (10 cm X 10 cm). Combine them using glue. After that, drill the middle part of the combined cartoons and insert a used battery. Add some glue A on the battery. Next, we create additional layer on the pad. Create two rectangles (10 cm x 5 cm) and attach them to the pad of the skeletal hand. Add another layer on the pad and leave it for a while. Next, drill the middle part and insert a battery into the hole.

5. Creating mover of the bottom part of hydraulic hand

First of all, drill one tip of an ice cream stick. Fold a cartoon into a small square. Attach a syringe into it using a bamboo skewer. Aplly some glue A on the skewer. Next, attach the mover to the side of the robot hand.

6. Creating liquid fuel for moving the hydraulic hand

First, pour some water into a glass, add a pinch of color powder. Next, attach a

tube on each syringe. After that, put the water into the tube using one of the syringes.
7. Creating small trees and carica fruits miniatures

Carica is made from yellow plasticine material. Its shape is similar to pepaya's, only smaller.

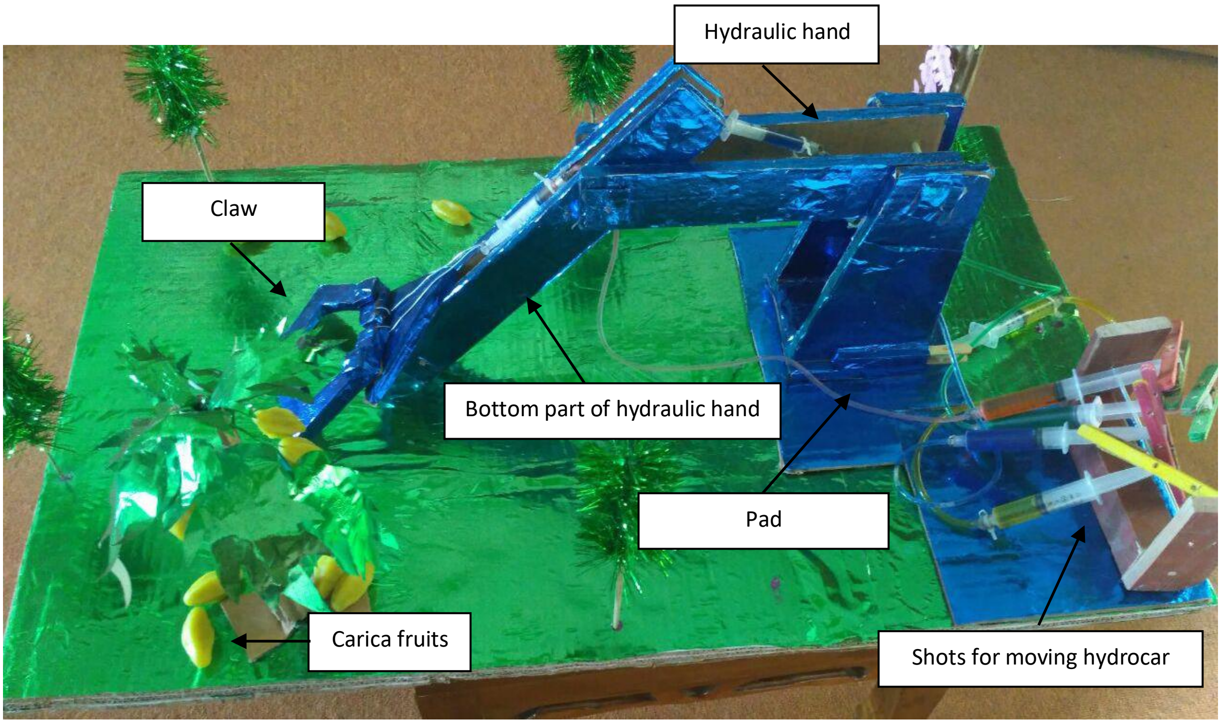

Figure 1. Instrument Hydrocar

The developed instrument was then validated by experts and practitioners. Students also evaluated it during the limited testing stage. The results of validation test on the instrument are presented in the following diagram.

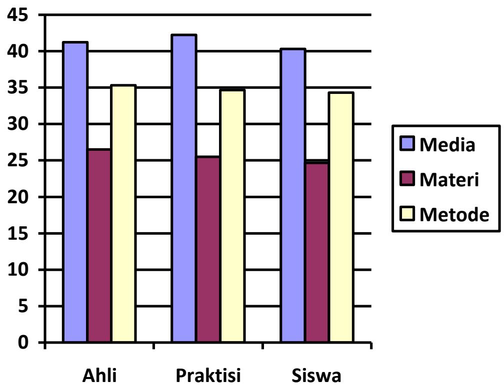

Figure 2. A diagram of the results of validation test and assessment on Hydrocar

The total scores of media aspect given by experts were 41,25, by practitioners were 42,25, and by students were 40,33. According to Table 3, it can be concluded that in media aspect, Hydrocar belongs to "very good" category. The total scores of material aspect given by experts were 26,5, by practitioners were 25,5, and by students were 24,67. According to Tabel 3, it can be concluded that in material aspect, Hydrocar belongs to "very good" category. The total scores of method aspect given by experts were 35,33, by practitioners were 34,67, and by students were 34,33. According to Tabel 3, it can be concluded that in method aspect, Hydrocar belongs to "very good" category.

Instrument developed in this research was Hydraulic Carica or Hydrocar. The instrument could be used to support natural sciences learning, reducing the space and time limitation. The newly developed instrument could enhance students' interest in natural sciences since it allows students to be actively engaged during learning process.

The instrument was developed based on the local commodity potential in Wonosobo regency. It is a miniature of excavator which is usually used to move carica fruits from high terrains in Dieng highland. By connecting learning media and local potential basis, hopefully students will understand and love more the culture and potentials in Wonosobo regency.

The research and development of natural, scientific instrument 'Hydrocar' consisted of information acquisition, planning, development and limited testing. These stages of development was necessary in determining the validity and usability of Hydrocar in natural sciences learning. The validation on Hydrocar was based on three aspects (media, material and method). The test score of Hydrocar in each aspect was 'very good', showing that the instrument could be used in natural science learning and provide insights to students. Students can be actively engaged in the learning process as they use the instrument.

CONCLUSION

The product of this research and development study is a natural, scientific instrument based on local commodity potential in Wonosobo regency called Hydrocar (Hydraulic Carica). The instrument was developed according to criteria which involved assessments on media, material and method aspects. Given the instrument's "very good" score in each aspect, it can be used in natural sciences learning since it may overcome space and time limitation and increase students' motivation, understanding, and active engagement in classroom.

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