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Development of Student Worksheet Based on Discovery Learning Models and Circular Motion Practicum Tools Based on Digital Technology: Design, Validity, and Practicality

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Abstract

This article discusses the student worksheet and circular motion practicum tools based on digital technology. Due to the unavailability of both student worksheet and circular motion practicum tool that matched the student's characteristics and 2013 curriculum demands, this article proved the validity and practicality of student worksheets based on discovery learning models and circular motion of practicum tools in learning. The development model used was a 4-D model consisting of define, design, develop, and disseminate stages. The data was obtained by using a validity, practicality and effectiveness questionnaire validated by the validators. Five validators validated student worksheet based in the discovery learning and one validator validated the circular motion practicum tool. The result showed that the student worksheet based on the discovery learning model and the circular motion practicum tool was valid and parctical.

Keywords*: Student worksheet, discovery learning, practicum tools, circular motion and digital technology.*

1. Introduction

The change from the high school curriculum to the 2013 curriculum with a scientific approach by the Ministry of Education and Culture (Kemendikbud) requires the development of learning models and supporting equipment, one of which is the discovery learning model. This model shows a great influence in various subject areas in improving student learning outcome. (Kadri & Rahmawati, 2015; Kristin, 2016; Putrayasa, Syahruddin, & Margunayasa, 2014), skil pembelajaran (Balım, 2009), berfikir kreatif (Balım, 2009; Kusumawardhani, Mulya, & Faizah, 2019; Ningsih, Riyanto, & Suyanto, 2019; Wahyudi, Rukmini, & Bharati, 2019), keaktifan siswa (Prasetya & Harjanto, 2020; Syarif, Syamsunardi, & Saputro, 2020).

In the field of physics education, previous studies have shown that this discovery learning model has a major influence on the development of physics lessons (Raya, 2019), student learning outcomes in physics subjects (E. Putri, 2020), problem solving in physics subjects (Wartono, Batlolona, & Sholikhan, 2018), student learning activities in physics subjects (IS Putri, Juliani, & Lestari, 2017), student skills in physics subjects (Kurniawati,

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Wangguway, & Hayyu, 2020; Ramadoni, 2019).

The reality is that those studies haven't resolved the digital ttechnology circular motion Practicum Tool that the author developed and then tested it on the learning outcomes of State Senior High School (SMAN) 3 Sungai Penuh, tenth grade students. Meanwhile, the digital technology circular motion practicum tool, this is very useful to increase the student's competence.

Beside that, the school like senior high school 3 Sungai Penuh Kerinci still used old practical tool, so it can detain student practice (Virmani, 2016).

Based on writer's observasition, September 2015, in SMA 3 Kerinci, the student had difficulty in physic learning 55,5%, practical activity 66,67%, an inappropriate use of student worksheet in practical activity 40%, and the use of student worksheet to find the concept 43,33% (Virmani,2016).

The observations were also done by interviewing physic teacher at school. According to the interview result, the students were seldom to use the student worksheet in learning process. The student worksheet bought from the publisher was inappropriate with the student characteristic and student development, so it did not make and teach the students to be active and able to find the student's concept (Virmani, 2016).

Not only at SMA 3 Kerinci, some schools in Indonesia also experienced the same thing (For example, see, Abdjul, Ntobuo, & Payu, 2019; Anggereni & Ikbal, 2018; Bancong & Song, 2018; Ekosari, Prihandono, & Lesmono, 2018; Katili, Sadia, & Suma, 2013; Pasaribu, Gultom, & Pasaribu, 2020; Purwandari, 2015; Yanti, Subiki, & Yushardi, 2017).

This article intends to develop digital technology-based practicum tools equipped with practical instructions in the form of student worksheet. So that the use of student worksheet in learning can improve the student's competence, with a great quality of student workshet which has been developed where it is effective, practice and has a high level of validity.

In addition, the article describes the results of the validation of the development of digital practicum tools for circular motion material and worksheets using the discovery learning model.

2. Method

The method used in the development of a circular motion practicum tool based on digital technology and student worksheet was research and development with 4-D model. (define, design, develop and disseminate). Research and ddevelopment are a process or step to develop a new product or improve an existing product that can be accounted for in order to produce a product. The products produced were student worksheet with practicum and digital laboratory equipment.

This study begun by defining needs using a needs analysis, then designing a circular motion practicum tool and instructions for its use by students. Next, it was continued with validation and field trials.

Instructions for the use of practicum tools were made in the form of a Student Worksheet. The design and manufacture of digital technology-based practicum tools were assisted by a team of S1 Physics students, Faculty of Mathematics and Natural Sciences, UNP. While the design and development of student worksheet was made by the author.

The validity test was at the Develop stage. Validation was carried out by five validators, three lecturers of UNP and two teachers of SMA 3. The validity test was carried out on March 26, 2015. Validation was done to determine the validity of student worksheet and circular motion practicum tools. Data were collected using a validation sheet. Quantitative

data used from the validation results were using a Likert scale.

Based on the validation sheet, the steps used to validate include: Gave a score for each item with alternative answers: (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). 2) validation results were analyzed on a scale (0 - 100) using Equation 1

$$\mathbf{v = \frac{x}{y}\ x\ 100\%}$$

Description:
V : validity score
X : Obtained Score
Y : Maximum score
To determine the level of validity of the developed student worksheet could be seen in Table 1

Table 1. Validity Category

No	Score	Category
1	80% < x ≤ 100%	Strongly valid
2	60% < x ≤ 80 %	Valid
3	40% < x ≤ 60 %	Valid enough
4	20% < x ≤ 40 %	Low valid
5	0% < x ≤ 20 %	invalid

Based on Table 1, it can be seen that the validity consists of invalid categories with a range of 0-20, less valid with a range of 21-40, quite valid with a range of 41-60, valid with a range of 61-80, and very valid with a range of 81- 100.

3. Results and Discussion

a. Circular Motion Practicum Equipment Design

Circular motion practicum equipment consisted of a mechanical system and an electronic system. The mechanical system consisted of geared wheels, static, circular rubber, meters. While the electronic system consisted of a sensor as a measuring instrument for angular velocity, poser supply, microcontroller and a digital display in the form of an LCD. The circular motion data display was read directly on the LCD. The results of the design and manufacture of digital technology-based practicum tools can be seen in Figures 1 and 2.

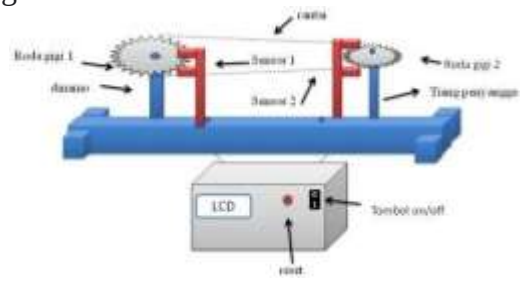

Figure 1. Design of Circular Motion Tool

Figure 2. The Results of The Circular Motion Practicum Equipment.

The numbering information in the figure is: (1) LCD to display the output of the system. (2) button to turn on and off the dynamo. (3) Reset button to repeat measurement. (4) ON/OFF switch to turn the appliance on and off. (5) and (6) Push button buttons for variations in wheel radius 1 and wheel spokes 2. (7) button for varying the number of turns in the system [8].

Table 2. Data on Tool System Accuracy Compared to Theoritical Calculations on Wheels with One Chain.

No	Linear velocity		Error percentage	Relative velocity	Accuracy (%)
	v1	v2			

1	0,0321	0,0319	0,623	0,994	99,4
2	0,885	0,0866	2,147	0,978	97,8
3	0,1495	0,1460	2,341	0,976	97,6
average			1,704	0,982	98,2

Based on table 2, it can be seen that the circular motion measuring instrument for one chain has a fairly high accuracy. The relative angular accuracy is 0.98 and the accuracy is 98.2%. The results of these measurements with high accuracy ensure that the circular motion measuring instrument made can be used for circular motion practicum activities.

b. Student Worksheet Design and Creation with the Discovery Leraning Model

Student Worksheet design and development were made using the Discovery Learning model.

c. Validation of practicum equipment and Student Worksheet

The assessment instrument must first be validated before validating the circular motion practicum tool and student worksheet. The assessment of the validation instrument had indicators, namely clear and understandable instructions for filling in the validation sheet, simple and clear Indonesian language, the statements made on the validation sheet were in accordance with the assessment indicators, with the objectives to be achieved, namely knowing the validity of the circular motion practicum tool and the Student Worksheet based on the discovery learning model and a circular motion practicum tool based on digital technology and do not contain double meanings. Last, the validation sheet used a simple and understandable assessment format.

d. The initial stage of validation of the circular motion practicum tool and student worksheet

At this stage, the validator was asked to assess the circular motion practicum tool and the student worksheet that had been created. The assessment included content feasibility, construct feasibility, and language. In validating the circular motion practicum tool and student worksheet, validators were asked to provide assessments and suggestions for improvements to the lesson plan, student worksheet, and assessment. The results of the validator's assessment of the student worksheet stated that it was valid to be tested or not. The suggestions obtained from the validator will be revised in order to produce a valid student worksheet. From the suggestions given by the validator, revisions were made to the student worksheet before an assessment of the validation sheet was carried out. The validator's suggestions can be seen in Table 3.

Table 3. Summary of Validator Suggestions

The Student Worksheet	
Before revision	After revision
the cover student worksheet is not exist	The student worksheet is exist
The material should consist of core competency and based competency	The material has been added to support the student worksheet
Add the picture design work steps in the student worksheet	The picture of design work steps has added to the student worksheet

e. Final Stage Validation of Circular Motion Practicum and Student Worksheet

Student Worksheet's validation was carried out to find out whether the student worksheet was valid to be tested or not. Validation carried out by the validator was to provide an assessment by filling out a validation sheet. In validating, validators were asked to provide an assessment and opinion on the student worksheet which had been designed and revised. Validation was said to be complete if

the validator had stated that the developed student worksheet was valid. The results of the validation provided by the validator can be seen in table 4

Table 4. Student Validation Result

No	Validation Aspects of Student Worksheet	Validator rating (%)					Average
		1	2	3	4	5	
		RM	YH	YA	N	PE	
1	Content	91,66	91,66	-	87,50	87,50	89,58
2	Construct	90,62	80,20	-	82,29	83,33	84,11
3	Language	100	91,66	83,33	91,66	91,66	91,66
Overall Average							85, 32
Category							Strongly Valid

Based on Table 4, it can be concluded that the student worsheet developed is in the very valid category and can be used in learning. The validation of student worksheet was carried out to determine the results of content validation, construct validation and language validation. Tool validation was carried out to assess the purpose, objectives, operating techniques, accuracy of use, and working principles of practical tools. The results of the Analysis of the Validation Sheet for the Circular Motion Practicum Based on Digital Technology can be seen in Table 5.

No	Indicator	Score
1	The purpose	16
2	The technic operation	11
3	The using accuracy	12
4	The work principle	7
Total		46
The maximum total		48
Presentation		95,83
Category		Strongly valid

Based on Table 5, it is known that the validated circular motion practicum tool has an average of > 80, which means that the circular motion practicum tool developed is strongly valid.

4. Conclusion

Based on the results of data analysis on design validation and development, it can be concluded that the practical equipment based on digital technology and student worksheet based on the discovery learning model were very valid. The average validity test results of the assessment results of the student worksheet Validation Instrument and the Validation Instrument were 86.10 and 91.66 are in the strongly valid category. While the student worksheet's validation obtained an average of 86.77 and the validation of the circular motion practicum tool obtained an average of 95.83 with strongly valid criteria that can be used in learning

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