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Development of Online Mechanics Concept Inventory (OMCI) Instrument Based on Local Wisdom

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Abstract

This study discusses the development of online mechanics concept inventory (OMCI) instrument based on local wisdom. The purpose of this study to determine the quality of the online mechanics concept inventory instrument based on local wisdom. The type of this research is Research and Development (R&D). The developed instrument is integrated with local wisdom, so that every item has literacy as a stimulus for the question. The concept inventory instrument is one of the test tools presented online which is used to measure students' conceptual understanding. The research model used is Borg and Gall. The instrument developed were validated by expert judgment. The results of the validation assessment are in the form of qualitative and quantitative content validity. The results of qualitative validity can be seen in terms of materials obtained on an average of 99.2%, construction is averaged 93.3%, and language is averaged 97.4%. While the quantitative analysis of validity is done using Aiken's v equations obtained an average of 0.841 of valored 0.841 is so high, it is worth being used to measure understanding the conception of learners.

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INTRODUCTION

Learning is an activity that involves students, educators, and learning resources. The learning process has a relationship with the achievement of curriculum goals (Suardi, 2018). The curriculum is a plan and arrangement that is used as a guide in the implementation of the learning process in accordance with the objectives to be achieved (Lismina, 2018). One of the goals of holding learning is to understand the science and solve the problems they face, so that they can be achieved. Achievement of knowledge that has been obtained by students during the learning process can be measured using instrument.

The instrument is an evaluation tool used to measure the ability of students (Widyoko, 2014). One of the evaluation tools is a diagnostic test that is used to identify the weaknesses and strengths of students. In addition, diagnostic tests can also be used to measure students' conceptual understanding. The evaluation tool used to measure students' conceptual understanding is the concept inventory instrument. Researchers conducted research on the development of concept inventory instrument due to several problems. The problem is that students have difficulty understanding the concept of physics and difficulties in interpreting problem solving related to physics. This is because during physics learning students only memorize formulas and do not understand the physics concepts (Cevik & Kurnaz, 2019). Of those issues, the research did research, a concept inventory instrument development that corresponded to previous studies.

Previous research on concept inventory has been carried out by Handhika et al. (2017) discussing the development of force concept inventory (FCI) instrument. The results of the study stated that the instrument was feasible to be used for testing. The results of the trial show that the majority of students do not understand the concepts contained in items number 23 and number 16. Item number 23 discusses kinematics, while item number 16 discusses Newton's third law. Based on the results of previous studies, the researchers were motivated to conduct research on the development of the online mechanics concept inventory instrument in the form of multiple choice to measure students' conceptual understanding. To make the instrument more contextual, the content of the questions is integrated with local wisdom (Kanhadilok & Watts, 2013). This is intended so that the local wisdom of the archipelago can be properly embedded by the nation's successors in order to maintain noble values (Husin & Billik, 2019).

Local wisdom is one of the activities often carried out by the local community. Local wisdom is also referred to as knowledge that is continuous with traditions that demand the character of the local community (Alfika et al., 2018). The local wisdom of the archipelago in developing the instrument is used as literacy for each item. Local wisdom used as literacy in instrument development is the rickshaw transportation tradition, the Care Free Day (CFD) tradition of riding a bicycle at Simpang Lima Semarang, the otok-otok boat game, baseball bat, catfish patil, marbles, boi-boian, lenggang rattan, and yoyo. Such local wisdom in order not to be forgotten by learners, it needs to be applied in learning, such as neonnem's local wisdom is linked with the concept of physics. The application of local wisdom in physics can train students in solving problems related to everyday life (Fadilah, 2019).

The application of local wisdom to the concept of physics is able to foster critical thinking, communication, collaboration, and creativity (4C) skills in students. The 4C skills are related to students' scientific literacy skills. Scientific literacy is a skill that students have in connecting problems with scientific knowledge, science-based technology, and scientific methods (OECD, 2018). With regard to scientific literacy issues, Indonesia is ranked 9th from the bottom among 71 countries with a score of 396 (Tohir, 2015). This states that the majority of students have less scientific literacy skills. The result of the Indonesian PISA ranting is in 2018, when compared with the 2015 result of PISA, the 2018 result is falling. The PISA study assessment in 2018 was attended by 600,000 15-year-old children, the majority of whom are Indonesian students in class X.

Based on the problem of scientific literacy in Indonesia, the researchers innovated to develop a concept inventory instrument. The concept inventory instrument is used to measure concept understanding however is associated with local wisdom. The instrument deals with the material of uniformly straight motion, uniformly changing straight motion, parabolic motion, circular motion, and Newton's laws. The developed instrument was presented online using a google form. This aims to anticipate conditions when learning is carried out online, such as the increasing condition of the COVID-19 outbreak in Indonesia.

The hope of this research is to produce quality physics instrument, so that they can detect students' understanding of concept. In addition, with an instrument that connects with local wisdom, students can be trained to solve problems in everyday life correctly, thus training students' scientific literacy.

METHODS

The type of research used is R&D (Research and Development) which is oriented to product development. The resulting product is an online mechanical concept inventory instrument based on local wisdom. The development of the instrument

uses the Borg and Gall model type. The model has 10 stages, namely: 1) potential and problems, 2) gathering information, 3) planning the product to be developed (instrument product design), 4) design validation, 5) design revision, 6) product trial, 7) revision I instrument product, 8) product implementation, 9) revision II instrument product, and 10) mass production (Sugiyono, 2009). However, this research only reached the 9th stage.

The data collection technique in this study used a questionnaire for the assessment of the OMCI instrument. The instrument was validated by 5 physics lecturers as material experts and 4 physics teachers as practitioners. The validation process is carried out to collect the results of the instrument assessment by experts. In order to determine the feasibility of the developed instrument, the researchers conducted a content validity test analysis. The analysis was carried out using the Aiken's v equation. Aiken's v equation is written as follows (Suryani & Hendryadi, 2015).

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (1)$$

description:

V : Rater agreement index
n : Number of raters
s : Score assigned to each rater
l_o : The lowest validity rating score
c : The highest validity rating score
r : Number given by an expert

The results of the content validity analysis with the Aiken's v equation obtained refer to the validity classification category. The level of content validity categories is shown in Table 1.

Table 1. Category of Instrument Content Validity

Content Validity Range (%)	Category
0.81 – 1.00	Very high validity
0.61 – 0.80	high validity
0.41 – 0.60	Medium validity
0.20 – 0.40	Low validity

Sources: (Syarif & Kuswanto, 2019)

Content validity, apart from being analyzed quantitatively, was also analyzed qualitatively. The analysis was carried out in accordance with the results of the assessment of these experts. Qualitative analysis was carried out with the following equation (Riduwan & Sunarto, 2011).

$$P = \frac{f}{n} \times 100\% \quad (2)$$

description:

P : percentage of instrument eligibility
f : total score of the average aspect of the assessment instrument
n : the maximum score for the assessment aspect of the instrument

The criteria for the results of the qualitative content validity analysis are in Table 2.

Table 2. Expert Assessment Criteria

Percentage Range	Criteria
85% < score ≤ 100%	Very valid
70% < score ≤ 85%	Sufficiently valid
50% < score ≤ 70%	Less valid
10% < score ≤ 50%	Invalid

Sources: (Akbar, 2013)

RESULTS AND DISCUSSION

The instrument developed in this study is the online mechanics concept inventory instrument. The online mechanics concept inventory instrument includes a modification of the force concept inventory instrument. The the force concept inventory instrument has been applied in the United States by Hestenes & Halloun (1995) in the form of multiple choice. The force concept inventory instrument developed only discusses the concepts of Newtonian mechanics (Wells et al., 1995). The instrument was developed with the aim of evaluating students' conceptual understanding.

With the force concept inventory research, the researchers were motivated to develop an online mechanics concept inventory (OMCI) instrument. The differences between FCI and OMCI instrument are shown in Figure 1.

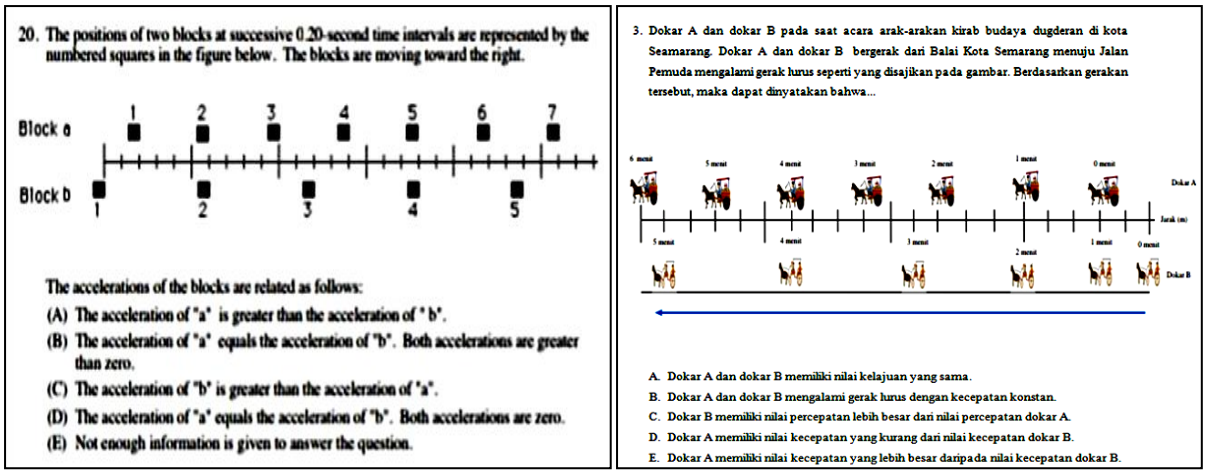

Figure 1. Differences between FCI and OMCI questions

Figure 1 shows the differences and similarities between the FCI and OMCI instrument. The similarity between the FCI and OMCI instrument is that they have the same goal of measuring concept understanding in class X according to the revised 2013 curriculum. In addition, the two instrument are in the form of multiple choice. While the difference is the content of the questions used as literacy for each item. The content of the questions in the force concept inventory instrument has not been linked to local wisdom, while the online mechanics concept inventory instrument has been linked to local wisdom. Local wisdom used as content or literacy for each item is shown in Table 3.

Table 3. Local wisdom in the OMCI instrument

Local Wisdom	Origin	Physics Concept
Rickshaw transportation	Semarang Old Town tourism culture	Uniform straight motion (GLB) and Uniformly altered motion (GLBB)
Dugderan	Semarang City, Central Java	Uniform straight motion (GLB) and Uniformly altered motion (GLBB)
Otok-otok ship game	Cirebon, Jawa Barat	Motion and force
Karapan cow tradition	Madura, Jawa Timur	Uniform Straight Motion
CFD tradition of riding a bicycle at Simpang Lima	Semarang City, Central Java	Uniform straight motion (GLB) and Uniformly altered motion (GLBB)
Traditional game of marbles	Starting from Roman times	Uniform Straight Motion Object friction
Traditional baseball game	Jawa	parabolic motion
Patil catfish traditional game	Nusa Tenggara Timur (NTT)	
Traditional game of rattan lenggang Yo-yo traditional game	Yunani Kuno	Circular Motion
Boi-boian traditional game	Sunda, Jawa Barat	Newton's I Law Newton's third law
The procession of the circumcised	Demak, Jawa Tengah	Newton's third law

Table 3 shows some of the traditional games and customs in Indonesia called local wisdom of the archipelago. The local wisdom is used as literacy for each item. The local wisdom used is that there are several traditional games that have been done by students, but the majority of students do not know the history or origins of the game. This is used as the basic reason for linking local wisdom into the developed instrument. With the integration of local wisdom, it is hoped that students will be able to know the history and origin of the local wisdom of the archipelago. One of the local wisdoms that is integrated with the OMCI question is the dugderan tradition in the city of Semarang. The tradition is associated with the material of straight motion. Dugderan is one of the traditions in the city of Semarang which is held every time before the holy month of Ramadan. The existence of the dugderan

ceremony began in 1881. The dugderan ceremony is usually also held a procession celebration as a form of cultural carnival using decorative gigs. The celebration started from the courtyard of the Semarang city hall. In addition, the OMCI instrument that has been developed also uses local wisdom in the form of traditional games. According to Agustina et al. (2019), traditional games are one of knowledge passed down from generation to generation. The function of traditional games is to be able to teach students to live socially, skillfully, and politely.

Research discussing local wisdom has been carried out by Hartini et al. (2018). This research has resulted in a module product based on local wisdom. The results of this study stated that the modules that had been developed obtained a high validity value, so they were suitable for use in the teaching and learning process. This research has differences with research conducted by researchers. This difference is the result of the product of research. The resulting product is an instrument.

The instrument that has been developed is judged by the expert judgment before the assessment of learners. The assessment was carried out by 9 experts, namely 5 physics lecturers and 4 physics teachers, which was carried out by looking at 3 aspects, namely material, construction, and language aspects. It aims to determine the content validity of the developed instrument. Content validity analysis was carried out qualitatively and quantitatively. The results of the qualitative content validity analysis are shown in Table 4.

Table 4. Results of Instrument Content Validation

Expert judgement	**Theory**		**Construction**		**Language**	
	Score	**%**	**Score**	**%**	**Score**	**%**
V-1	96	96%	94.3	94.3%	95.3	95.3%
V-2	99	99%	97	97%	98.4	98.4%
V-3	100	100%	67	67%	100	100%
V-4	100	100%	90.2	90.2%	96	96%
V-5	100	100%	100	100%	100	100%
V-6	99	99%	98	98%	100	100%
V-7	99	99%	99.4	99.4%	99.3	99.3%
V-8	100	100%	97	97%	100	100%
V-9	100	100%	97	97%	88	88%
Average	99.2	99.2%	93.3	93.3%	97.4	97.4%
Category	Very Valid		Very Valid		Very Valid	

Table 4 shows that content validity is analyzed qualitatively which is assessed from the aspects of material, construction, and language. Based on the material aspect, it obtained an average of 99.2%, construction obtained an average of 93.3%, and language obtained an average of 97.4%. The results of the instrument assessment of the three aspects indicate that the material aspect has the lowest average compared to the construction and language aspects. This is because, the expert appraiser stated that the instrument that had been developed had some unclear images, so revisions were needed. Judging from the results of a qualitative assessment, the online mechanics concept inventory instrument has a very valid category. Qualitative analysis of content validity is in line with research conducted by Sukmafitriani & Munjariyati (2021). The results of this study stated that the PAS questions were assessed by expert assessors by looking at 3 aspects, namely in terms of material, construction, and language. Based on the results of the analysis, it shows that the PAS questions have a valid content validity category.

In addition, the instrument that have been developed are also analyzed quantitatively using the Aiken's v equation. The results of the content validity analysis are shown in Figure 2.

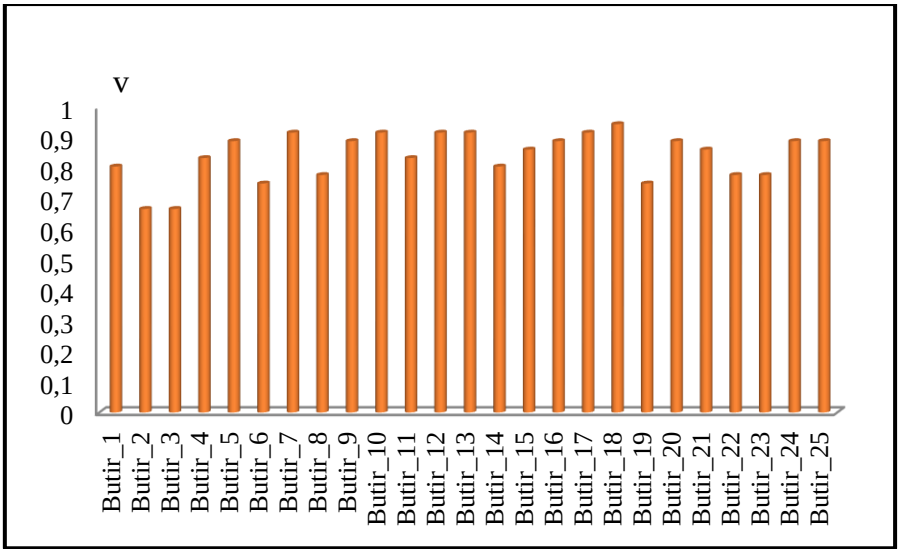

Figure 2. Validity Results of Aiken's v

Figure 2 shows that as many as 25 questions were analyzed using Aiken's validity with a value range of 0 to 1. The results of the analysis which had the highest score were found in item number 18 of 0.944 with the "very high" category. This is because item number 18 contains clear question content, the material is adapted to the class X syllabus, and local wisdom is used as the content of the question according to the circular motion material. The local wisdom is related to the traditional yo-yo game originating from the Greeks. Item number 8 relates to the motion of objects that experience circular motion, so that it can affect the magnitude of the angular acceleration and linear velocity. Meanwhile, the item with the lowest content validity value is found in item number 2 and 3 of 0.667 with the "high" category. This is because according to expert judges, the local wisdom of the traditional stilt game which is integrated with the material of straight motion is not appropriate, so improvements need to be made. Thus, the straight motion material is associated with local wisdom in the city of Semarang, such as the rickshaw transportation used during the Dugderan Cultural Carnival tradition which is carried out before the arrival of the holy month of Ramadan. In addition, the results of the content validity analysis using the Aiken's v equation obtained an average of 0.841 with a very high category. Therefore, the developed instrument has a decent quality so that it can be tested on students.

Content validity analysis using Aiken's v equation is in line with previous studies. The results of the previous research were obtained at 0.857, so that the evaluation tool was stated to have adequate content validation (Hendryadi, 2017). In addition, the validity analysis of Aiken's v was also carried out by other researchers. The results of this study stated that the 78 items from the developed instrument had an Aiken's validity result of 0.93 so that they were declared valid (Khotimah & Mindyarto, 2021).

CONCLUSION

The online mechanics concept inventory instrument is one of the instrument developed in the form of multiple choice. The instrument is associated with local wisdom on the island of Java. The objective of the instrument development research was to determine the quality of the online mechanics concept inventory instrument based on local wisdom. The quality of the instrument can be done by analyzing qualitative and quantitative content validity. The results of qualitative validity are seen in terms of material, construction, and language. The results of the validity in terms of material obtained an average of 99.2%, in terms of construction obtained an average of 93.3%, and in terms of language obtained an average of 97.4%. Quantitative content validity analysis, the results of which were obtained from expert appraisers using the Aiken's v equation, obtained an average of 0.841 in the very high category. This shows that the developed instrument has a quality that is suitable for use.

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