A Multitier Open-Ended Momentum And Impulse (MOMI) Instrument: Developing And Assessing Quality Of Conception Of 11th Grade Sundanese Students With Rasch Analysis

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Abstract: Physics education scholars have revealed that students have some difficulties and misconceptions in basic physics concepts in mechanics including momentum and impulse. The purpose of this study was to develop a valid and dependable Multitier open-ended momentum and impulse (MOMI) diagnostic test to evaluate students’ understanding. For developing this test, 14 multiple-choice with open-ended questions were administered to high school students with 28 participant of 11-grade students (13 male students called “ujang” and 15 female students called “eneng”). The MOMI instrument contain of 14 question which analyzed by Rasch. Students’ conceptions have already been considered regarding to six categories; Sound Understanding (SU), Partial Positive (PP), Partial Negative (PN), Misconception (MC), No Understanding (NU), and No Coding (NC). Category student’s conception with the highest percentage is 36% (SU) and the highest student’s misconception is 54% (MC) as the result of this research.

Index Terms: Multitier Open-ended Momentum and Impulse (MOMI), physics, assessment, momentum, impulse, Rasch analysis

1. INTRODUCTION
Two-tier test and three-tier test has been improved to be multitier test according to evolving education now. The Multitier open-ended momentum and impulse (MOMI) is four-tier instrument with multiple-choice question to determine students’ alternative conceptions and whether a student gives a correct response. Multiple-choice tests are frequently more necessary in science classes since they are easy to apply and evaluate students’ understanding of the related subject. However, multiple-choice tests have some limitations in applying such as determining whether a student gives a correct response to a test consciously or just by a chance. Total of 273 articles have been published until 2014 in many journals through their analysis method [1]. The assessment that has been made as the most utilized diagnostic tools such as planned and interactive formative assessment [2], interviews [3], open-ended question [4], [5] and multiple-choice questions [6]. Most interactive test development use multiple choice question. This familiar instrument utilized by teachers in testing all the levels of knowledge because its efficiency for student to answer quickly [7]. In additional, coaching is one of the best approaches being used by teachers in education to improve student outcomes [8]. With the result, teachers can focus on assessing the student’s conception to be analyzed. Many studies show that students have a specific initial conception. Anderson [9] show that there are many researchers report in students reasoning in science education that students have specific conceptions and these specific conceptions affect their initial understanding. Student understanding has been documented, investigated and studied that students indicated serious misconceptions about many concepts of physics [10], [11]. Therefore, as a teacher, we should take an opportunity to improve the quality of all system learning in education, especially in science education. From that statement, there should be an appropriate alternative assessment to identify and explore students’ misconceptions in science education [12], [13], [14]. Science education has been a concern in recent years, especially in Indonesia. Indonesia is known as well as one of the most populations in the world with various religions, races, cultures, and tribes. These differences of religions, races, cultures, and tribes issue in most of the Indonesian citizen easily influenced by negative assumptions so that affected on their educations [15]. On the other side, Indonesia has been classified in 15 tribes, with the most tribes are Javanese and Sundanese. Most of Sundanese tribe is located in West Java Indonesia. In Sundanese tribes, a boy is called “ujang” and a girl is called “neng”. Therefore, we have purpose to know quality of conception on momentum and impulse concept, specifically in this Sundanese tribes. This conception of ujang and neng will be included with Rasch Analysis to know their knowledge of momentum and impulse concept. Rasch analysis was made by George Rasch in 1960 to identify two parameters on psychology test which contains the ability of individual and difficulties of instrument test [16], [17], [18]. Rasch analysis is one of statistic method to examine the ability each individual and its interaction and the difficulties of item instrument that utilized mostly research especially in social and science education [16], [19], [20], [21], [22], [23], [24]. The various research in many fields of education was using Rasch analysis such as in engineering [25], [26], [27], mathematics [28], [29], chemistry [30], [31], physics [32], [33], [34]. Sumintono [20] reveal that Rasch analysis can be utilized by all the teachers in many fields of education to develop instrument test and to identify relevant information regarding student’s assessment. The assessment was carried to find out student’s ability of conception and their initial knowledge. Therefore, as a teacher and researcher, we should take the opportunity to create a development instrument test. This research aims to develop multitier open-ended instrument to show the quality of conception.
Sundanese students with Rasch analysis on momentum and impulse concept.

2 METHODOLOGY
This research utilizes by 3D + 1I model (Defining, Designing, Developing and Implementing). The author’s use this model because of its complexity in learning. The first phase is defining, its purpose to know student’s initial misconceptions on momentum and impulse concept. The designing phase is to make the instrument test Multitier Open-ended Momentum and Impulse (MOMI) concept from student misconception. The third phase is developing, its purpose is to develop MOMI instrument into multitier closed-ended Momentum and Impulse (MOMI) concept from student misconception. The last phase is implementation, this phase is to test multitier open-ended on Momentum and Impulse concept then will be analyzed by Rasch. There are 28 participants of 11th-grade students who involve in this research (13 male students, called “ujang” and 15 female students, called “eneng”). This student is a majority of 17 years old with most of them is a Sundanese tribe. The Sundanese tribe has the most people in West Java, Indonesia. This research is located in Ciamis, one of districts in West Java. Map of Ciamis can be shown in Fig 1 as a follow:

3 RESULTS AND DISCUSSION
3.1 Define
The defining phase is a literature study with desires to know student’s initial conception of momentum and impulse concept. In this phase, the authors collected references from any research that dependable and trustable.

3.2 Design
The designing phase is a design instrument test of momentum and impulse concept for assessing students’ alternative conceptions. In this phase, an instrument test utilized four-tier open-ended instrument. The first tier is a multiple choice question with five choices, the second tier is student's confidence after answering the first tier with two choices "Sure" and "Not Sure", the third tier is open-ended question that students have to answer what they think about the reason of the first tier, and the last tier is the same choices as the second tier about student's confidence. The design of this instrument test can be shown in Fig 2 as a follow:

1.1 Question
Alternative answers:
  a. 
  b. 
  c. 
  d. 
  e.

1.2 Are you sure of the answers to questions 1.1?
  a. Sure     b. Not Sure

1.3 The best explanation of your answer to question 1.1 above is ….
  ..............................................................
  ..............................................................
  ..............................................................
  ..............................................................

1.4 Are you sure of the answers to questions 1.3?
  a. Sure     b. Not Sure

3.3 Develop
The development phase is to develop the instrument of multitier open-ended into a multitier closed-ended instrument test. In this phase, the authors use 14 items of Multitier Open-ended Momentum and Impulse (MOMI) instrument test. The open-ended instrument test was processed, calculated and
combined based on students’ answers to make a closed-ended question. The development instrument test into closed-ended question can be shown in Fig 3 as a follow:

3.4 Implementation
The collected data have been analyzed using percentage each item of MOMI instrument. This percentage was from the category of students’ conceptions that have been made before. The percentage of students’ conception can be shown in Fig 4 as follow:

As shown in Figure 4, we can see through the percentage of each item in category students’ conception. The category of Sound Understanding (SU) with the highest percentage is question no 6 (36%) while question no 4, 5, 10, 12, and 13 has the lowest percentage (0%). The category of Partial Positive (PP) with the highest percentage is question no 5 (57%) while question no 4, 13, and 14 has the lowest percentage (0%). The category of Partial Negative (PN) with the highest percentage is question no 12 (61%) while question no 4 and 5 has the lowest percentage (4%). The category of Misconceptions (MC) with the highest percentage is question no 4 (54%) while question no 13 has the lowest percentage (0%). The category of No Understanding (NU) with the highest percentage is question no 13 (61%) while question no 6 has the lowest percentage (0%). The category of No Coding (NC) with the highest percentage is question no 12 (4%) while the other question has the lowest percentage (0%). The data from three categories that collected (student conception, misconception, and level of student’s confidence) will be inputted into software namely “MINISTEP version 3.75.0” and analyzed using Rasch. The results showed that person reliability is 0.64 and 0.67, with item reliability 0.83 and 0.85, and test reliability Cronbach Alpha (KR-20) is 0.66 on Multitier Open-ended Momentum and Impulse (MOMI) Instrument. The reliability of this result is in sufficient categories. This result of reliability can be shown in Fig 5 as follows: In Fig 5, the meaning of person reliability is to show the stability of student answers and item reliability is to show the quality of MOMI instrument. Meanwhiles, other analysis related to instrument about student conception can be shown in Fig 6 as follow:
The score of conception using Rasch analysis as in Fig 6 show that 22F (Female) has the highest score of conception while the lowest score of conception is 23M (Male). These mean that student number 22 (22F) can answer all questions below Q12 (Question 12) from multitier open-ended momentum and impulse instrument test. Even if 22F has the highest score, she still can’t answer Q10 (Question 10) and Q13 (Question 13) as same as other students. As we know that Q10 and Q13 are difficult questions whereas Q1 (Question 1) is the easy one. The score of misconception using Rasch analysis of multitier open-ended momentum and impulse (MOMI) instrument test can be shown in Fig 7 as follow:

Q5 has the least content of misconception. Furthermore, an analysis score of students’ confidences to show their sense of answering multitier open-ended momentum and impulse instrument test can be shown in Fig 8 as follow:

As shown in Fig 8, Student 11M have the highest confidence of their ability and presume to answer multitier open-ended momentum and impulse instrument test. Whereas student 13 have the lowest confidence to answer MOMI instrument test. Moreover, Q13 is the question that has the least level of confidence except by student 11M. As the opposite of that, question 6 (Q6) has the greatest level of confidence and most believe by all students except by student 13F.

4 CONCLUSION
The quality conception of Sundanese student on Multitier Open-ended Momentum and Impulse (MOMI) instrument test using Rasch analysis showed that majority student has misconceptions than their conception. Moreover, analysis Rasch can identify a characteristic of student on their confidence level. Either a student with the highest conception or student with the highest potential of misconception has answer MOMI instrument test confidently on a sufficient level. Therefore, MOMI instrument in this research can utilize as an alternative instrument test to assess students' conceptions with sufficient level of reliability.

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