

# A Multitier Open-Ended Momentum And Impulse (MOMI) Instrument: Developing And Assessing Quality Of Conception Of 11<sup>th</sup> 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 eneng 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

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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

5.1 Observe Table 1 below!

Table 1. Vehicle Transportation

No.	Object Name
1	Sedan
2	Bicycles
3	Motor
4	Trains
5	Bus

In Table 1, when the four objects move at the same speed, the object that has the greatest momentum is ...

- Sedan
- Bicycles
- Motor
- Trains
- Bus

5.2 Are you sure of the answers to questions 5.1?

- Sure
- Not Sure

5.3 The best explanation of your answer to question 5.1 above is ....

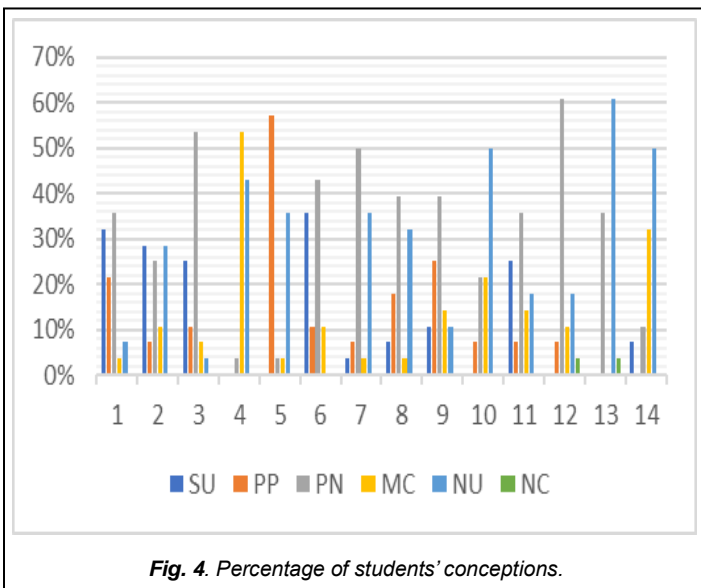
- The momentum is larger than the others because has the constantly speeds
- All object has to balance the biggest masses.
- The mass of the object is inversely proportional to the momentum
- All of the five objects have equal momentum because has the same speed
- The object that has the greater mass will have a larger momentum

5.4 Are you sure of the answers to questions 5.3?

- Sure
- Not Sure

**Fig. 3. Design multitier closed-ended momentum and impulse instrument**

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

INPUT: 28 Person 14 Item REPORTED: 28 Person 14 Item 5 CATS MINISTEP 3.75.

SUMMARY OF 28 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	ZSTD	OUTFIT MNSQ	ZSTD
MEAN	20.5	13.9	-.35	.25	.99	.1	.99	.1
S.D.	7.4	.3	.44	.04	.26	.7	.29	.6
MAX.	35.0	14.0	.42	.38	1.70	1.8	1.79	1.4
MIN.	8.0	13.0	-1.29	.22	.56	-1.6	.50	-1.4

REAL RMSE .27 TRUE SD .35 SEPARATION 1.33 Person RELIABILITY .64  
 MODEL RMSE .25 TRUE SD .36 SEPARATION 1.42 Person RELIABILITY .67  
 S.E. OF Person MEAN = .09

Person RAW SCORE-TO-MEASURE CORRELATION = .99  
 CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .66

SUMMARY OF 14 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	ZSTD	OUTFIT MNSQ	ZSTD
MEAN	41.0	27.9	.00	.18	1.00	.0	.99	.0
S.D.	16.0	.3	.48	.04	.29	1.2	.29	1.0
MAX.	64.0	28.0	.87	.26	1.38	1.8	1.39	1.3
MIN.	17.0	27.0	-.62	.15	.48	-2.4	.47	-1.5

REAL RMSE .20 TRUE SD .43 SEPARATION 2.22 Item RELIABILITY .83  
 MODEL RMSE .18 TRUE SD .44 SEPARATION 2.39 Item RELIABILITY .85  
 S.E. OF Item MEAN = .13

**Fig. 5. Person reliability, item reliability and Cronbach Alpha.**

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. Meanwhile, other analysis related to instrument about student conception can be shown in Fig 6 as follow:

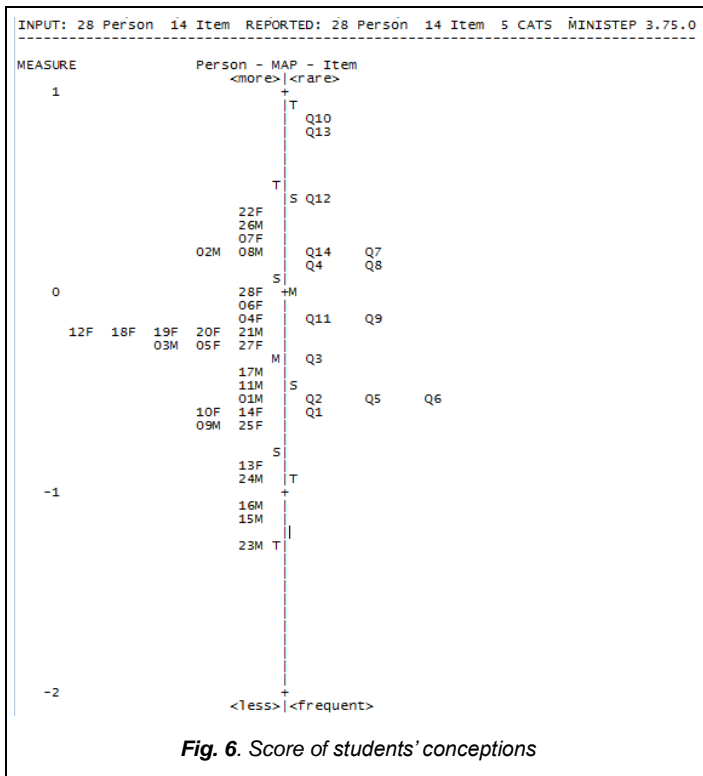


Fig. 6. Score of students' conceptions

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:

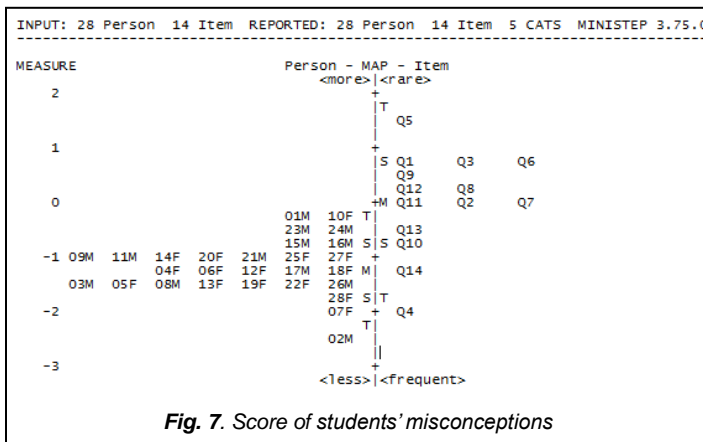


Fig. 7. Score of students' misconceptions

The score of students' misconceptions using analysis Rasch is same analysis as well as analysis students' conception. The highest potential for misconception in Figure 6 is students 01M and 10F, while student 02M has the lowest potential misconception. Students 01M and 10F have the highest potential below Q11, Q2, Q7 as same as the other students. Question 4 (Q4) has the most content of misconception while

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:

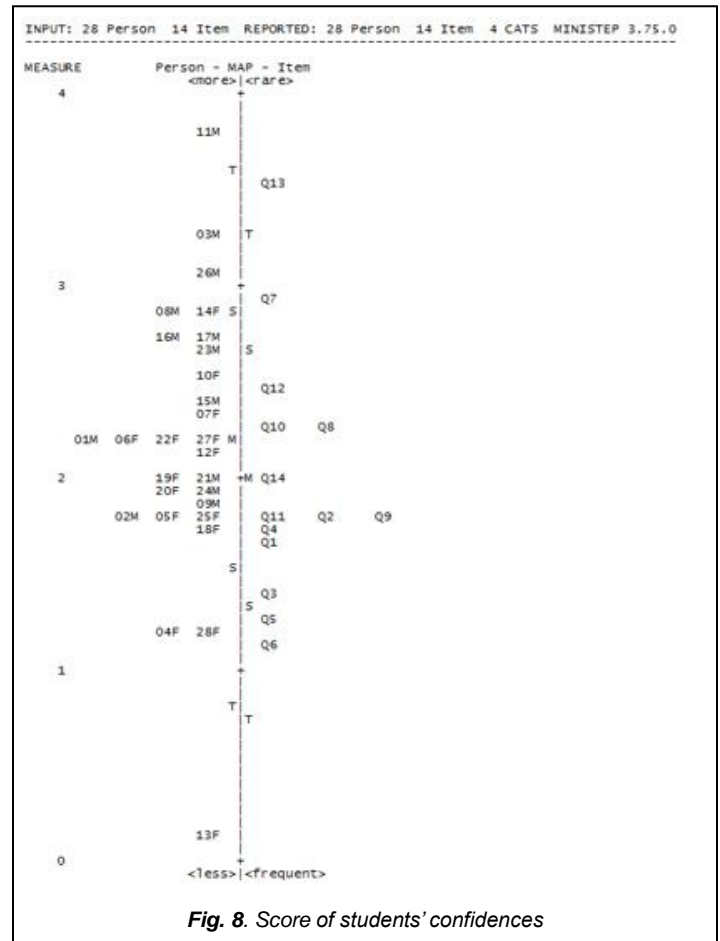


Fig. 8. Score of students' confidences

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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