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Analyzing Students' Misconceptions about Newton's Laws through Four-Tier Newtonian Test (FTNT)

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ABSTRACT

This research aimed at analyzing student misconceptions about Newton's Laws through Four-Tier Newtonian Test (FTNT). The research involved 30 students (15 boys and 15 girls, whose ages were middling of 16 years-old) at one of Senior High School in Bandung, Indonesia. The data were analyzed through mixed methods. Based on the quantitative analysis, the highest percentage of student misconceptions through four-tier test was 66% and through two-tier test was 100%. According to qualitative analysis, it was found student misconceptions about Newton's Laws. From the research, it can be concluded that FTNT can be used in analyzing student misconceptions on Newton's Laws concepts and more effective than using the two-tier test. Teachers or researchers can expand the concepts of Newton's Laws that are used in designing diagnostic test and developed for other physics concepts.

Keywords: Misconceptions, Four-Tier Newtonian test (FTNT), Newton's laws

INTRODUCTION

Conception becomes one of the important aspects for students (Cepni et al., 2017). Students build the concepts in their mind from their experience in school education or daily activities (Gurel et al., 2015). Since students have different experience, they might have the right or wrong concept from scientific conceptions. Students convey their concepts independent from scientifically recognized concepts related to their science lesson (Unal et al., 2010). The difference between students' conceptions and scientific conceptions called as misconceptions (e.g. Samsudin et al., 2018; Solas & Wilson, 2017; Samsudin et al., 2017a; Fratiwi et al., 2017; Osman et al., 2017; Cataloglu & Ates, 2014; McLaughlin & MacFadden; 2014). Misconceptions is a basic problem for students and often creates misunderstanding and misconstruction. Modifying student misconceptions from incorrect to correct knowledge can be forceful and problematic (e.g. Liu & Fang, 2016; Samsudin et al., 2015; Costu, 2012;

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Eshach, 2010; Stein et al., 2008) since the misconceptions are thriving embedded in students' prior knowledge framework (e.g. Preston, 2017; Samsudin et al., 2016; Demirdogen et al., 2016; Reese, 2015; Calik et al., 2009). Therefore, student misconceptions must be recognized earlier.

Many scholars from various disciplines conducted research about student misconceptions. One of these disciplines was in physics education (e.g. Fratiwi et al., 2018; Liu & Fang, 2016; Wong et al., 2016; Samsudin et al., 2016; Kaniawati et al., 2016; Leppavirta, 2012; Eshach, 2010), especially in Newton's Laws (e.g. Samsudin et al., 2017a; Liu & Fang, 2016; Poutot & Blandin, 2015; Eshach, 2010; Bayraktar, 2009). Student misconceptions can be recognized through a diagnostic test (e.g. Fratiwi et al., 2017; Liampa et al., 2017; Chen et al., 2017). Many researchers around the world use diagnostic test (Purwanto et al., 2018; Mainali & Heck, 2017; Gurel et al., 2017; Gurel et al., 2015; Samsudin et al., 2015; Poutot & Blandin, 2015; Cataloglu & Ates, 2014; Chen et al., 2013; Bayraktar, 2009; Kaltakci & Didis, 2007). Gurel et al. (2015) defined that diagnostic tests are evaluation tools which are interfered by the repeated learning problems which seem hard to be not solved. By employing a diagnostic test in a lesson of a certain science topic, a science teacher can achieve pure ideas about the nature of the students' understanding and will more know the difficulty faced by the students. So that, the teachers can develop and utilize alternative teaching methods which discourse students' misconceptions (e.g. Gurel et al., 2015; Adams & Wieman, 2010; Kaltakci & Didis, 2007).

In recent years, there have been an urgent development in diagnostic tests related to students' misconceptions of science subjects (Adams & Wieman, 2010). The diagnostic tests use several techniques in diagnosing students' misconceptions such as interview, open-ended tests, ordinary multiple-choice, and multiple-tier tests (e.g. Gurel et al., 2017; Baran & Sozbilir, 2017; Gurel et al., 2015; Unal et al., 2010). The interview plays an important role since providing detailed investigation and opportunity to find comprehensive reports of a student's cognitive structures (Gurel et al., 2017). The interviews with the other influence can afford more comprehensive information about students' alternative conceptions and ideas of a specific concept (Saat et al., 2016). On the other hand, unfair or biased interviewer may fault the results because of several aspects. For example, testing data can be little bit problematic, students can think in different waysand it is time-consuming when the interview is used for a large number of students to simplify their alternative conceptions (e.g. Gurel et al., 2017; Saat et al., 2016; Gurel et al., 2015; Adams & Wieman, 2010).

Open-ended tests give participants more time to think and write about their own concepts, to observe the misconceptions potentially owned by students, to know the reason that students have such confusion when explaining specific complicated concepts, or additional questions about the way students can tackle their misconceptions (Zhou et al., 2016). Nevertheless, the open-ended tests have exposed shortcomings in practical usage to assess. One of these reasons is linguistic barrier. When students have problems but they cannot identify them, there are usually fewer students who eager to write their responses in full sentences and taking time to evaluate the product and scoring (e.g. Gurel et al., 2017; Gurel et al., 2015; Saat et al., 2016).

Ordinary multiple-choice questions have solid validity confirmation. From the view of teachers' practice, multiple choice has its own advantages such as being valid and reliable, easy to score, and easy to manage. Paper and pencil tools allow teachers to efficiently assess student consideration of science and get information about student understanding and misconceptions by using diagnostic tests. Understanding student answers are one of the main troubles in these tests, if the items have not been designed and multiple-choice tests do not provide enough understanding into student ideas on the subject and students may contribute true responses for mistaken aims. In other words, truthful answers may not in line with the presence of the truthful scientific conception. Thus, a mistaken answer assumed to be an old-style multiple-choice item which might not be owing to the detained misconception but might be a mistaken answer through truthful reasoning (Gurel et al., 2017).

The next method is multiple-tier tests. It consists of two-tier test, three-tier test, and four-tier test. The two-tier tests were designed as diagnostic instruments. The first tier is to comprise multiple-choice content problems, and the second tier includes the multiple-choice set of reasons for the answer to the first tier (e.g. Fratiwi et al., 2017; Adams & Wieman, 2010; Adadan & Savasci, 2012). The setup of the two-tier test has included problems, selecting response and selecting reasoning. The two-tier tests have returned over ordinary multiple-choice tests, because those tests afford students' reasoning behind their selected response. Though, these tests have certain boundaries in terms of lack of knowledge on misconceptions, mistakes, or scientific knowledge.

For this cause, the three-tier tests become essential in determining whether the answers assumed to the first two tiers are due to a misconception or a mistake due to lack of knowledge. In the three-tier tests, researchers assembled a multiple-choice test. The first tier is an ordinary multiple-choice test. The second tier is a multiple-choice test question asking for the reasoning. And. the third tier is a scale asking for the confidence level for the given answers to the above two (Pesman & Eryilmaz, 2010). The three-tier tests are measured to be more precisely determine the student misconceptions since they can detect the lack of knowledge percentages by means of confidence tiers. Although the three-tier tests are believed to assess misconceptions besides errors and lack of knowledge in a valid technique, they still have some boundaries due to the concealed rating of the confidence for the first and second tiers.

Since there is no connection between confidence rating that were requested for the content and reasoning tiers, the four-tier tests are presented more lately. This condition may affect in two difficulties which is lack of knowledge in quantities, and the overestimation of the student misconception and the truthful scores (Gurel et al., 2015). Although the four-tier tests look like to exclude many difficulties of the aforementioned instruments, they still own several boundaries such as necessity for a longer testing time, not worthwhile for spending in achievement purposes, and the probability of student choice of the answer in the first tier can result in their choice of the answer in the reasoning tier. Nevertheless, the four-tier tests effectively recovered to identify student misconceptions than the two-tier tests and three-tier tests. In the four-tier test, the first tier is a conventional multiple-choice test through its distractors including precise misconceptions. The second tier inquires the self-confidence of the response in the first tier. The third-tier requires the reasoning for the response in the first tier. The fourth-tier requires the self-confidence of the response in the third (reasoning) tier (e.g Gurel et al, 2017; Fratiwi et al, 2017). Kaltakci (2012) developed a four-tier diagnostic test for geometrical optics. In addition, the second tier performs confidence rating to the first tier and the fourth tier performs confidence rating to the third tier. As student selects incorrect choice in the first tier and choose "sure" on confidence rating (in the second tier) afterward he/she selects incorrect reasoning in the third tier and choose "sure" in the fourth tier, it could be categorized as the student hold misconception.

As understood from the previous studies on multiple-tier concept tests, the four-tier tests are the diagnostic tests which are widely used by researchers (e.g. Sreenivasulu & Subramaniam, 2014; Gurel et al., 2017; Caleon & Subramaniam, 2010) since the four-tier tests are more effective than any other diagnostic test. So, the purpose of this research was to analyze students' misconceptions about Newton's Laws through Four-Tier Newtonian Test (FTNT). The analyses of students' misconceptions are useful for teachers in developing and employing unconventional teaching methods particularly related to students' misconceptions.

METHODS

In this research, mixed method (quantitatively and qualitatively methods) was adopted as the research method. The mixed method is preferred since gathering both quantitative and qualitative data to minimize the weakness of the other methods (Creswell, 2014). In this research, the qualitative data were obtained during pre-test and post-test through quantitative data through analysis students' answer from four-tier test.

a) Participants

In this research, the participants were 30 students (15 boys and 15 girls, whose ages were in average 16 years-old) at a Senior High School in Bandung, Indonesia. Each of the participants was assigned a code as S1, S2, S3, etc. The participant selection was grounded on less score on the preliminary studies since students who got less score have many misconceptions. The two-tier test was used at preliminary studies. And then, the participants implemented the FTNT as pre-test and post-test. Before the post-test, the Dual-Situated Learning Model (DSLM) was applied as teaching methods when studying Newton's Laws.

b) The Instruments

The instruments were developed in this research. In the development, the phases of the FTNT were shown in Figure 1.

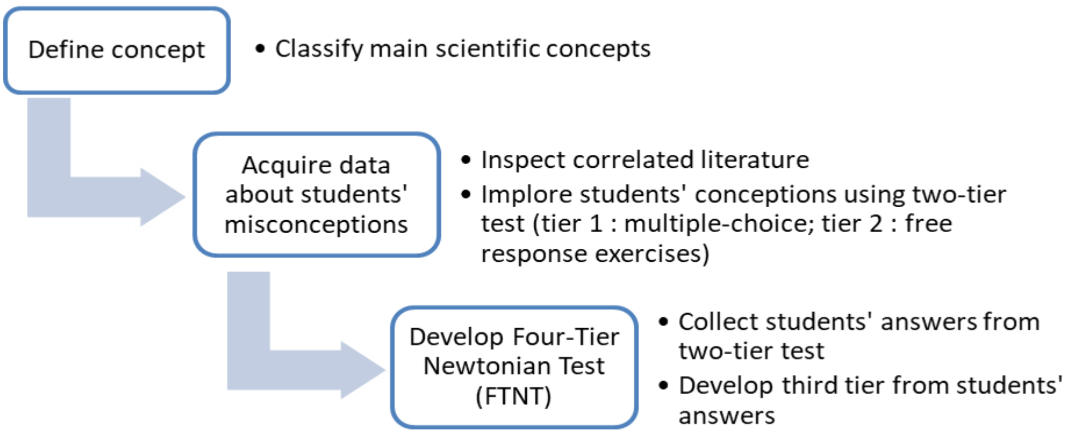

Figure 1. Phases in the development of Four-Tier Newtonian Test (FTNT)

The used instruments were two-tier and four-tier test. The four-tier test was the transformation from the two-tier test. First, the two-tier test was used to collect the data, and then the two-tier test was transformed into four-tier test. The second tier in two-tier was analyzed and organized as three tiers in the four-tier test. The use of two-tier test intended to compare the effectiveness with the four-tier test. The FTNT concerning of eight test items was performed by a mixed-methods (quantitatively and qualitatively analysis). The validity and reliability of the FTNT were analyzed to deliver an impression of the instrument was achievable or not to be charity.

The Content Validity Index (CVI) has conventionally been used to evaluate representativeness, understanding, indistinctness, and simplicity (Rico, Dios & Ruch, 2012). According to Rubio, Berg-Weger, Tebb, Lee and Rauch (2003), the CVI indicates the degree of item deliberation through separating the number of adjudicators delivering a decision of 3 or 4 on the conforming Likert scale through the overall quantity of adjudicators. The CVI also represents the significance of the standard through separating the quantity of adjudicators who measured the item resembled to the envisioned surface through the overall quantity of adjudicators. On behalf of the total measurement, the CVI was intended correspondingly afterward creation the applicable results on the items. This was complete through scheming the mean of the CVI aimed at all the preserved items. As an overall standard, the measured CVI values should be equal or more than 0.70 (Rico, Dios & Ruch, 2012). The result of CVI for FTNT was shown in Table 1.

Table 1. *The result of Content Validity Index (CVI)*

No.	Judges I	Judges II	Judges III	Judges IV	CVI	Decision
1	1	1	1	1	1,00	Used
2	1	1	1	1	1,00	Used
3	1	0	1	1	0,75	Used
4	1	0	1	1	0,75	Used
5	1	0	1	1	0,75	Used
6	1	0	1	1	0,75	Used
7	1	1	0	1	0,75	Used
8	1	0	1	1	0,75	Used

In Table 1, all the test items can be used since they found to be valid. At the number 1 and 2, the values of CVI were the highest. All the items reserved afterward the research of their representativeness then significance presented satisfactory standards aimed at the directories of understanding, indistinctness, and simplicity (CVI > 0.70). According to Rico, Dios & Ruch (2012), CVI is the grade to which the rudiments of an assessment tool are illustrative of the build of attention. On the other hand, the Kuder Richardson 20 (KR-20) coefficient calculated for the reliability. The KR-20 was 0.59 which means "moderate".

The Table 2 and Table 3 are an example of the test item on inertia concept in form of two-tier test and four-tier test.

Table 2. *Example of test item on inertia concept in form of two-tier test*

3.1 A bus which took several occupants oncoming at the roadway. In the middle of the trip, the driver suddenly braked because an occupant asks to stop the bus. All the occupants of the bus were pushed forward. The phenomena of encouraged the occupants indicated that....
a. The occupants were maintained their forward motion
b. The seat gave a force to the occupants
c. The bus was maintained the forward motion
d. the driver gave a force to the bus
e. The occupants gave the force
3.2 Reason:...
....

The test instrument formatted on two-tier was utilized in the preliminary study to collect students' responses as reasoning choices located in the third-tier on four-tier test format.

Table 3. *Example of test item on inertia concept in form of four-tier test*

3.1 A bus which took several occupants oncoming at the roadway. In the middle of the trip, the driver suddenly braked because an occupant asks to stop the bus. All the occupants of the bus were pushed forward. The phenomena of encouraged the occupants indicated that....
a. The occupants were maintained their forward motion
b. The seat gave a force to the occupants
c. The bus was maintained the forward motion
d. the driver gave a force to the bus

e. The occupants gave the force
3.2Are you sure with your answer at 3.1?
a. Sure b. Not sure
3.3 The reason for your answer at 3.1:
a. There was a reaction force on the occupants
b. There was an inertia of the occupants
c. There was an action force of driver
d. There was an inertia on the bus
e. ....
3.4 Are you sure with your answer at 3.3?
a. Sure b. Not sure

The two-tier test was separated into two tiers, as it can be realized from Table 2. The first tier was the setup of the multiple choices and the second tier is the free response exercises. Students choose the first tier and write their reasons in the second tier. The FTNT was separated into four tiers, as it can be realized from Table 3. The first tier was the setup of multiple choices. The second tier was self-confidence rating for the first tier about “sure” and “not sure”. The third tier was in the setup of semi-open-ended. The latest tier was self-confidence rating for the third tier about “sure” and “not sure”. The third tier of FTNT was constructed by gathered student answers in the second tier of the two-tier test.

c) Data Analysis

Mixed methods were used for the data analysis (quantitative and qualitative). The percentages used in quantitative method for comparison of student conceptions in means of the score and total judges for CVI and equation (1) for KR-20.

$$R_{KR-20} = \frac{k}{k-1}\left(1 - \frac{\sum pq}{s^2}\right) \qquad (1)$$

Notes:

k : number of questions

p : number of the sample who answered correctly

q : number of the sample who answered wrongly

s2 : variance

And then, the test items were analyzed with some standards specified in Table 4 (for two-tier test) and Table 5 (for four-tier test) in order to categorize the student concepts. The criteria in Table 4 and Table 5 were developed from previous standards by Kaltakci and Didis (2007).

Table 4. *Standards for examining the two-tier test items*

Standards	Explanation of Standards
Misconception (MC)	• Tier-1 was correct and Tier-2 was unscientific reason • Tier-1 was wrong and Tier-2 was unscientific reason
Sound Understanding (SU)	Tier-1 was correct and Tier-2 was scientific reason
No Understanding (NU)	Tier-1 was wrong and Tier-2 was scientific reason
No Coding (NC)	Participants did not answer completely or fragment of tiers in test items.

From Table 4, there are four standards of student conceptions from examining two-tier test items which are Misconceptions (MC), Sound Understanding (SU), No Understanding (NU), and No Coding (NC).

Table 5. *Standards for examining the four-tier test items in FTNT*

Criteria	Explanation of Criteria
Misconception (MC)	Tier-1 and Tier-3 are wrong and confidence rating at Tier-2 and Tier-4 are "sure"
Sound Understanding (SU)	Tier-1 and Tier-3 are correct and confidence rating at Tier-2 and Tier-4 are "sure"
Partial Understanding (PU)	• Tier-1 and Tier-3 are correct and confidence rating at Tier-2 and Tier-4 are "not sure" • Tier-1 and Tier-3 are correct and only one confidence rating (Tier-2 or Tier-4) is "not sure" • Only one (Tier-1 or Tier-3) is correct and confidence rating at Tier-2 and Tier-4 are "not sure" • Only one (Tier-1 or Tier-3) is correct and only one confidence rating (Tier-2 and Tier-4) are "not sure" • Only one (Tier-1 or Tier-3) is correct and confidence rating at Tier-2 and Tier-4 are "sure"
No Understanding (NU)	• Tier-1 and Tier-3 are wrong and confidence rating at Tier-2 and Tier-4 are "not sure" • Tier-1 and Tier-3 are wrong and only one confidence rating (Tier-2 or Tier-4) is "not sure"
No Coding (NC)	Participants do not answer completely or fragment of tiers in test items.

At Table 5, student answers were categorized to Misconceptions (MC), Sound Understanding (SU), Partial Understanding (PU), No Understanding (NU), and No Coding (NC). This standard was used for examining four-tier test. The four-tier test was more specific to categories of student conceptions than the two-tier test.

FINDINGS

From data analysis, the result and discussion were displayed simultaneously. After displaying the result, it was discussed based on the data shown. The result of this research was shown in Table 6 as percentages of student answers of the four-tier test (FTNT) and two-tier test including categories of Misconception (MC), Sound Understanding (SU), Partial Understanding (PU), No Understanding (NU), and No Coding (NC).

Table 6. *Percentages of student's answers of four-tier test and two-tier test*

Concepts	Four-Tier Test					Two-Tier Test			
	MC (%)	SU (%)	PU (%)	NU (%)	NC (%)	MC (%)	SU (%)	NU (%)	NC (%)
Balanced forces for stationary object	66	6	18	10	0	97	3	0	0
Balanced forces for moving object	53	0	10	34	3	100	0	0	0
Inertia	6	53	26	12	3	87	3	3	7
Force	59	3	26	6	6	87	3	7	3
Friction force	6	17	50	17	10	100	0	0	0
Normal force and gravity force	17	59	15	6	3	80	10	3	7
Gravity force and normal force at elevator	10	26	41	17	6	57	3	33	7
Friction force, normal force and gravity force for stacked beams	53	3	17	24	3	77	3	7	13

f = frequency; MC = Misconception; SU = Sound Understanding; PU = Partial Understanding; NU = No Understanding; NC = No Coding

It can be seen in Table 6, the percentage of student misconceptions were higher when the used diagnostic test in form of two-tier test, even some of reached to 100%. The eight test items in the FTNT were also explored in the rapports of concepts, correct concepts and student misconceptions which was shown in Table 7. The student misconceptions that shown in Table 7 were the most common misconceptions among the students.

Table 7. *Students' misconceptions after using FTNT*

Concepts	Correct Concepts	Students' Misconceptions
Balanced forces for stationary object	In stationary object on the table, the resultant of forces is equal to zero because there are two forces that are equal in the magnitude and have the opposite directions.	In stationary object on the table, there is no force interim on the object because the stationary object will keep on in the stationary condition.
Balanced forces for moving object	An object moving at the constant velocity on a slippery floor will continue to move even though no external force given because the force resultant is zero.	An object moving at the constant velocity on a slippery floor will rest by itself because a force who stop the motion of the object.
Inertia	In the event of encouraged the occupants to the opposite for vehicle brake abruptly, occupants maintain the forward motion because there is inertia on the occupants.	In the event of encouraged the occupants to the opposite for vehicle brake abruptly, occupants offer the reaction force because there is an action force of the vehicle when its brakes.
Force	If the object terrified vertically upward then the force at the highest point is only gravity force (if the buoyant force and friction force are negligible).	If the object terrified vertically upwards, then no force on the object when the highest point since the object was floating for a moment.
Friction force	In object initiated to move, the static friction force will be replaced by kinetic frictional force.	Static friction is worth a minimum when the object will start to move.
Normal force and gravity force	The normal force is always perpendicular to the surface of the touchpad with the starting point comes from the touchpad and gravity always towards the center of the earth with the starting point comes from the center of mass the object.	The normal force perpendicular to the surface of the touchpad and the friction force is always in contact with the wall.
Gravity force and normal force at elevator	The weighty objects in an elevator that move with constant upward acceleration will be larger than its original weight because the normal force on objects is getting bigger, but the weight of the objects that are in the elevator that moves with constant upward velocity will be equal to its weight because it is no influence of normal force.	The weighty objects in an elevator that move with constant upward acceleration will be greater than its original weight, but the weight of the objects that are in an elevator that moves with constant upward velocity will be smaller than its original weight.
Friction force, normal force and gravity force for stacked beams	When the two beams are stacked, and the lower beam pulled with a force F to the right, then the upper beam will be moved to the left although the force F only works on the lower beam. The forces acting on the beam upper is the normal force, gravity and friction force in the opposite direction to the motion of the upper beam the terms of the lower beam.	When the two beams are stacked, and lower beam pulled with a force F to the right, then the upper beam will move to the right. The forces acting on the beam upper is the force F, the normal force, gravity and friction force in the opposite direction to the motion of the beam above.

As seen from Table 7, the students had some misconceptions in balanced forces, inertia, friction force, normal force, and gravity force. These misconceptions could be detected more specifically by FTNT. More analysis about the changes of student misconceptions on the pre-test to post-test through FTNT, it was presented at Table 8 as student misconceptions, percentage of student misconceptions at the pre-test and post-test, the percentage of Conceptual Change (CC) and type of conceptual change.

Table 8. *The changes of students' misconceptions from pre-test to post-test*

Students' Misconceptions	Pre-test (%)	Post-test (%)	Conceptual Change (CC) (%)	Type of CC
MC1	S1, S2, S3, S4, S5, S6, S7, S8, S11, S15, S16, S17, S18, S20, S21, S22, S23, S24, S25, S26, S27, S28 (66)	S3, S4, S6, S7, S9, S11, S15, S18, S19, S20, S23, S25, S26, S27, S28, S29, S30 (51)	15	+ (positive)
MC2	S2, S3, S4, S5, S6, S12, S13, S15, S17, S19, S20, S21, S22, S25, S28, S29, S30 (53)	S3, S5, S6, S12, S13, S16, S21, S30 (24)	29	+ (positive)
MC3	S6, S16 (6)	S6 (3)	3	+ (positive)
MC4	S3, S4, S5, S6, S7, S8, S9, S10, S11, S16, S17, S18, S20, S23, S24, S26, S27, S28, S29, S30 (59)	S1, S4, S6, S9, S10, S15, S16, S17, S18, S20, S21, S22, S23, S24, S30 (45)	14	+ (positive)
MC5	S5, S21 (6)	S20 (3)	3	+ (positive)
MC6	S5, S12, S13, S16, S17, S30 (17)	S5, S9, S16, S17, S20, S21 (17)	0	0 (no change)
MC7	S6, S16, S21 (10)	S18 (3)	7	+ (positive)
MC8	S3, S4, S6, S9, S10, S12, S13, S15, S16, S17, S21, S23, S24, S25, S26, S28, S29, S30 (53)	S3, S4, S6, S9, S10, S11, S13, S14, S17, S18, S20, S21, S23, S24, S25, S26, S28, S29 (53)	0	0 (no change)

The Conceptual Change (CC) was the difference between the pre-test and post-test (the pre-test minus the post-test). When the result of CC is positive, then the type of conceptual change was "positive". In other words, the student misconceptions were decline. When the result of CC was negative, then the type of conceptual change was "negative". So, the student misconceptions were in increase. When the result of CC was zero (0), then the type of conceptual change was "no change". At Table 8, the type of conceptual change was positive and no change.

DISCUSSION and CONCLUSION

From the Table 6, the highest percentage of student misconceptions was in number 1 (66%), but the highest percentages of student misconceptions were number 2 and 5 which attain 100%. From this table, student misconceptions were higher if there is two-tier test. In other words, the two-tier test was less able to distinguish student conceptions, especially misconceptions. According to Gurel, Eryilmaz & McDermott (2015) and Yang (2017), two-tier test has some limits in discerning lack of understanding as of misconceptions, mistakes, or scientific knowledge. Four-tier tests have a benefit in excess of two-tier tests that focus on lack of understanding that can distinguish student misconceptions through incomes of the dispersed self-confidence tiers which aimed at cooperation foremost then reasoning tiers. Therefore, the identification of misconceptions through four-tier test might be more effective than two-tier test. The FTNT can assist teachers to comprehend the alternate interpretations that students grasp roughly the Newton's Laws concept and assist them in increasing the concept through suitably intended teaching techniques and resources (Liampa Malandrakis, Papadopoulou & Pnevmatikos, 2017).

As shown at Table 8, the peak of modifications in student misconceptions were positive. The number of students who imprisoned misconceptions were reduced in M1, M2, M3, M4, M5, and M7. This was the present foundation that students rehabilitated their misconceptions regarding scientific conceptions. At the illustration of M2, percentages of student misconception were 53% on the pre-test and 24% on the post-test. There was 29% (53% - 24%) of conceptual changes on the student misconception. In Table 8, there was no change in the student misconceptions in M6 and M8. This was emerged as students were not moved by the unique scientific conceptions through term concept that usually used with absolute rules and difficult constraint related to the comprehensive container of psychosomatic difficulties (Samsudin et al., 2017b). The student conceptions could not be instantaneously modified since student misconceptions were entrenched in student cognizance. In streak through other alternative researchers (e.g. Samsudin et al., 2017b; Shen et al., 2017; Liu & Fang, 2016; Cantinho et al., 2016; Gok, 2015) said that the national conceptual change was problematic to right and a time-consuming method for misconceptions which were healthily ingrained in previous theorist sketch of students. In addition, further influences were less truthful such as learning methods or students were not concentrating in the learning process can lead to misconceptions in themselves (e.g. Taber & Tan, 2007; Chamizo, 2013; Hockicko et al., 2014).

The main aim of this research was to analyze student misconceptions on Newton's Laws concepts through Four-Tier Newtonian Test (FTNT). The FTNT was developed from the two-tier test. The FTNT can be used to detect student misconceptions to prepare the learning strategy in the classroom. The identification of misconceptions through the four-tier test (FTNT) might be more effective than two-tier test.

Suggestions

The outcomes of this research were several allegations which aimed at classroom repetition such as the expansion of a diagnostic test to evaluate the corporate student misconceptions in Newton's Laws had advantages to teachers in planning and expanding their instruction on the subject. Teachers or researchers can expand the concepts of Newton's Laws that used in diagnostic test and developed for other physics concepts.

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