Diagnosing Misconceptions about Special Relative Theory by Using a Four-Tire Test

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Abstract. The main purpose of this study was developing and applying a four-tier test for diagnose misconceptions about special relativity theory. The developed Four-Tier Special Relativity Theory Test (FTSRTT) was administered to 211 students studying physics department, physics educations and physics engineering from several universities in Ankara. The proportions of the false positives and false negatives were estimated to establish the content validity as 10% and 1 %, respectively. The Cronbach alpha reliability coefficients was found 0,71 for student's misconception score. Four misconceptions, which were held by more than 10 % of the students, were identified.

1 Introduction

In the past two decades, many studies have focused on the identification and modification of misconceptions that differ from established scientific knowledge [1]. In order to identify misconceptions, a valid and reliable diagnostic tool is required. There are different tools to diagnose misconceptions in science education and these tools have some advantages as well as disadvantages over the others [2]. In investigating student's misconceptions, multiple-tier tests (MTTs) tend to be a popular choice. The first tier of it is an ordinary multiple-choice test that includes in the items at least one misconception. The second tier of the test asks for the confidence of the answer tier. The third tier of the test asks for the reasoning for the answer in the first tier. The fourth tier of the test asks for the confidence of the reason tier [1,3].

2 Methodology

In this study, a cross-sectional survey method was used. This method was chosen in order to collect descriptive information about student's misconceptions about special relativity theory. Therefore, in the study, a four-tier special relativity theory test (FTSRTT) was developed to determine the student's misconceptions about special relativity theory, particularly the masses and energies of the motion which moved at a near light speed.

2.1 Development of the FTSRTT Instrument

First, the literature was reviewed, and misconceptions in the literature about the special relativity theory were investigated. Based on the literature, a list of possible misconceptions that students may have been established and 27 test items were prepared by researcher to investigate the possible misconceptions. The four-tier test was pilot-tested on 73 undergraduate students in the physics field (physics department. physics engineer and physics education who were not included in the main study. Following that, some of the questions were taken without making any changes and some of the questions were modified based on the pilot results. As a result, the 27-item final version of the four-tier test, called FTSRTT, was developed.

2.2 Sample

The accessible population for the study was all Turkish students who undergraduate education in the physics field (physics department, physics engineer and physics education of the state universities in Ankara.

2.3 Validity and Reliability of FTSRTT

Validity of the FTSRTT was established by some qualitative and quantitative techniques. First of all, the format and content of the test examined by the experts in the field item by item to ensure content-related evidence of validity. Secondly, the correlation between the students' response on the first and third tier and the confidence tiers were investigated to establish construct validity. Thirdly, proportions of false positives and false negatives were estimated for the content-related evidences. The false negative percentage for validity should be below %10 [4]. Lastly, explanatory factor analysis was carried out to be ensured construct validity of the test.

Coefficient alpha (α) was calculated to measure the reliability of the test. Cronbach-α values were calculated as 0.711 for the all tier (1*2*3*4) according to the misconceptions for the reliability of the FTSRTT. These validity and reliability results are sufficient for the FTSRTT to be used as a test to diagnose the misconceptions.

3 Conclusion

In present study to see how common the misconceptions are, the percentages of misconceptions according to only the first-tier, both first and third-tiers and all four-tiers were calculated separately. Consequently increase of tiers led to decrease of the percentage of students having misconceptions. This study shows that a four-tier test is useful in investigating misconceptions; in particular, in assessing the strength of misconceptions. Misconceptions which was owned by more than 10% of students was considered, as common[1]. Four misconception seem to be common. One of the remarkable results of this study was significant difference between the misconceptions of students who take a course that includes special relativity theory than not taking the course. This worthy of attention result can be considered as teacher or text books could be the source of mentioned misconceptions.

Regarding Special Relativity Theory among Physics Education Research, studies are still relatively rare, moreover any instrument to diagnose the misconception about this theory was not came across. Therefore FTSRTT will be useful in the literature for the further researches.

References

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