Pythagoras method to complete einstein special relativity issues

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Abstract. A simple alternative to solve problems in the material of Einstein's special relativity. Einstein's special material of relativity is material that has so many similarities. Equations in the material of Einstein's special relativity among others are time dilation equations, long contractions, relativistic masses, and relativistic energy. This research will discuss how the relationship between the Pythagorean theorem equation and Einstein’s special relativity equation and show how to use the Pythagoras method to solve Einstein’s special relativity problem. Steps in this research are calculated the equation for the Pythagorean theorem, calculate the equation of Einstein's special relativity, then analyze how the relationships between the Pythagoras theorem equation with the Einstein's special relativity equation.

1. Introduction

Einstein's special relativity is a matter of physics which is classified into the material of modern physics. Physics is a difficult science. This was also explained by Sugiana in his article that the difficulty is caused by limited ability and lack interest of the student in physics, besides that physics is also considered a subject that has many complex equations [1]. The many equations found in Einstein's special material of relativity also creates its own difficulties for students who try to learn it. The equations of special relativity are the equation of time dilation, length contraction, relativistic mass, and relativistic energy. To reduce these difficulties a simple solution is needed so that problems in the material of special relativity can be solved easily. The Pythagoras theorem can be an option that can be used to solve the problem of Einstein’s special relativity. The Pythagoras theorem is an equation that has to do with the rightangles. The definition of the Pythagoras equation is the square area on the hypotenuse in the right triangle will have the same value as the sum of the square area from the other side of the elbow.

Previously research was conducted by Okun and Korkmaz, Previously, research was conducted by Okun and Korkmaz, namely about the Pythagorean theorem which can be one solution to solve the problem of Einstein's special relativity. The research what has been done by Okun is research on formula transmission from the theory of special and
general relativity into a simple form, namely the formula of energy, momentum, and mass [2]. The research conducted by Kormazk is a study of the application of the Pythagorean theorem to the world of education. The relativity equation used in korkmas research is time dilation equations, long contractions, and relativistic masses [3].

With these two basic researchers in this matter, This Research want to try to develop the relationship between the equation of the Pythagorean theorem with all the equations of Einstein's special relativity, namely time dilation equations, long contractions, relativistic masses, and relativistic energy. The renewal of this research lies in the form of the equation produced and the method used also uses a different approach, that is, using examples from the equation of the Pythagorean theorem, so that the existence of this renewal can make the alternative in solving Einstein's special problems of relativity simpler.

2. The equation of Einstein’s special relativity

Einstein's special relativity equation that will be analyzed in this research is time dilation equations, long contraction equations, relativistic mass equations, and relativistic energy equations.

2.1 Time dilation equation

Time measurement observed by an observer in motion with speeds approaching the speed of light will feel longer compared to time observed by a silent observer, this is called time dilation. Time dilation is affected by relative motion between observers and observed objects [5]. The same is true as explained by Joseph in his article that time dilation is a measurement where two observers will not get the same time measurement results [6].

The relationship between the two can be written into the equation as follows:

\[ \Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \]  

(1)

2.2 Long contraction equation

The length of an object measured by an observer which moves at speeds close to the speed of light will be shorter than the length of an object measured by silent observers [7]. The cause of this long contraction is the observer's relative motion of the object observed [8].

The relationship between the length of the object observed by a moving observer with an observer who is silent about things can be written in the long contraction equation as follows:

\[ L = L_0 \sqrt{1 - \frac{v^2}{c^2}} \]  

(2)

2.3 Relativistic mass equation

The object's mass is measured by the observer in a moving frame of reference with speeds approaching the speed of light will be bigger than that the mass of the object measured by the observer silence [9].
The equation for connecting the magnitude of the mass of an object which is measured by a moving observer with the mass of objects measured by a silent observer as follows:

\[ m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \]  

(3)

2.4 **Relationship between mass and energy**

The total energy of a moving object relative is the sum of the object's silent energy and motion energy, or it can be written:

\[ E = E_0 + K \]  

(4)

Or

\[ K = E - E_0 \]  

(5)

Noted that:

\[ E_0 = m_0c^2 \]  

(6)

\[ E = mc^2 \]  

(7)

Using relativistic mass equations as in equation (3), kinetic energy equations can be expressed in the following equation:

\[ K = \frac{m_0c^2 - m_0c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \]  

(8)

\[ K = \left( \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right) m_0c^2 \]  

(9)

\[ K = \left( \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right) E_0 \]  

(10)

So that relationships can be obtained between a large amount of energy measured by a moving observer with large measured energy by silent observers are as follows:

\[ E = \frac{E_0}{\sqrt{1 - \frac{v^2}{c^2}}} \]  

(11)

3. **Methodology**

This research will find out the relationships between the Pythagorean theorem equation with the Einstein's special relativity equation with the following steps, namely, calculate the equation for the Pythagoras theorem, calculate the equation of Einstein’s special relativity, then analyze how the relationships between the Pythagoras theorem equation with the Einstein's special relativity equation. The following are the calculating steps for the Pythagorean theorem equation and Einstein's special relativity equation.
3.1 Pythagorean Theorem

From the picture, it will be obtained that:

\[
\sin \theta = \frac{p}{r} \quad (12)
\]
\[
\cos \theta = \frac{q}{r} \quad (13)
\]

The Pythagorean theorem is the square of the length of the hypotenuse equal to the sum of squares of the height of a right triangle with its base [4]. The pythagorean theorem can also be obtained from relationships trigonometry of \( \sin \theta \) with \( \cos \theta \) with the equation as follows:

\[
\sin^2 \theta + \cos^2 \theta = 1 \quad (14)
\]

So that it will be obtained:

\[
\frac{p^2}{r^2} + \frac{q^2}{r^2} = 1 \quad (15)
\]

3.2 Time dilation equation in the phytagorean theorem:
By the using phytagoras method the time dilation equation can be written as follows:

\[
\frac{\Delta t_0^2}{\Delta t^2} + \frac{v^2}{c^2} = 1 \quad (16)
\]

3.3 Long contraction equations in the Pythagorean theorem:
In the long contraction equation who uses the Pythagoras method an equation will be obtained as follows:

\[
\frac{L^2}{L_0^2} + \frac{v^2}{c^2} = 1 \quad (17)
\]

3.4 Relativistic mass equations in the Pythagorean theorem:
By using the same method as time dilation equations and long contractions, relativistic mass equations can be written as follows:

\[
\frac{m_0^2}{m^2} + \frac{v^2}{c^2} = 1 \quad (18)
\]
3.5 Relativistic energy equations in the Pythagorean theorem:
Using the same method as the equation - other similarities of special relativity, then the equation can be written as follows:

\[ \frac{E_0^2}{E^2} + \frac{v^2}{c^2} = 1 \] (19)

4. Result and discussion
From the results of the development that has been done, obtained the equation of special relativity which has similarities as in the Pythagorean theorem which has also been calculated namely, \( \frac{p^2}{r^2} + \frac{q^2}{r^2} = 1 \). These special relativity equations include (1) \( \Delta t_0^2 + \frac{v^2}{c^2} = 1 \) in the case of time dilation; (2) \( \frac{L^2}{L_0} + \frac{v^2}{c^2} = 1 \) in the case of long contraction; (3) \( \frac{m_0^2}{m^2} + \frac{v^2}{c^2} = 1 \) in the case of relativistic mass; and (4) \( \frac{E_0^2}{E^2} + \frac{v^2}{c^2} = 1 \) in the case of relativistic energy. In the four equations above, \( \Delta t_0, L_0, m_0, \) and \( E_0 \) is the time, length, mass and energy measured by the observer who is silent relative to the object observed or measured, while \( \Delta t, L, m, \) and \( E \) is time, length, mass and energy measured by observers moving relative to the object being observed or measured. For \( v \) is the speed of the observer and \( c \) is the speed of light.

The following is the result of an analysis of the Pythagorean theorem equation with Einstein’s special relativity equation. In the equation of time dilation when an analysis is carried out, it can be done by connecting the time dilation equation with the Pythagorean theorem equation. The relationship is obtained by specifying the time dilation equation variables with the Pythagorean theorem equation variable that is, \( \Delta t_0 \) as \( p \), \( v \) as \( q \) then \( \Delta t \) and \( c \) as \( r \). In the same length contraction equation the same thing is applied, which is to assume the long contraction equation variables with the pythagorean theorem equation variable so that it can be assumed \( L \) as \( p \), \( v \) as \( q \) then \( L_0 \) and \( c \) as \( r \). In relativistic mass equations ,can be assumed \( m_0 \) as \( p \) , \( v \) as \( q \) then \( m \) and \( c \) as \( r \). The relativistic energy equation can be assumed \( E_0 \) as \( p \) , \( v \) as \( q \) then \( E \) and \( c \) as \( r \). The results of the analysis can also be described in the following table form.

Table 1. The results of the analysis relationship Pythagoras equation with Einstein's special relativity equation.

| No. | Special relativity equation Einstein | Theorem Pythagoras | Image (Pythagoras Theorem) | Picture (Einstein’s Special Relativity Equation) |
|-----|----------------------------------|--------------------|---------------------------|---------------------------------------------|
| 1.  | \( \frac{\Delta t_0^2}{\Delta t^2} + \frac{v^2}{c^2} = 1 \) | \( \frac{p^2}{r^2} + \frac{q^2}{r^2} = 1 \) | \( \Delta t_0 \) | \( \Delta t_0 \) |
Paying attention to the four equations of special relativity when associated with the Pythagorean theorem equation, then the comparison $\Delta t$, $m$ and $E$ the amount of silence is a comparison of the number of sides of the right triangle to the pair of pythagorean numbers, except for cases of long contractions the reverse applies that is, comparison $L$ the amount of silence is a comparison of the number of short sides of right triangle to the pair of pythagorean numbers. The pair of Pythagorean numbers can be found using equations 1 $\cdot \frac{v^2}{c^2}$. For example, if the observer’s speed is against the object 0.8 c, then using the pythagorean theorem, the Pythagorean number pair is obtained 6. To determine the value of the relativistic magnitude, you can use the comparison of the Pythagorean number above according to the case.

For time dilation, apply $\frac{\Delta t}{\Delta t_0} = \frac{10}{6}$ or the time measured by a moving observer is $\frac{10}{6}$ times the time measured by a silent observer . Thus for long contractions, apply $\frac{L}{L_0} = \frac{6}{10}$ or the length of the object measured by the observer that is moving relative is $\frac{6}{10}$ times the length of the object measured by a silent observer. In relativistic mass equations, apply $\frac{m}{m_0} = \frac{10}{6}$ or the mass of the object measured by the observer that moves relative is
multiplied by the mass of the object measured by the silent observer. It also applies equally to relativistic energy equations that is, $E = \frac{10}{6} E_0$ or energy measured by observers who move relative is $\frac{10}{6}$ multiplied by the energy measured by an observer that is stationary relative to the object being measured.

The following is an example of a case on the question of Einstein’s special relativity, namely the equation of time dilation, length contraction, relativistic mass and relativistic energy. The first case, the problem of time dilation. If it is known that the time observed by an observer moving towards an event has a change in time ($\Delta t$) as much 20 seconds, then it is known that in the event the observer moves with speed ($v$) 0.8$c$. The $v$ value can also be written in the form $v = \frac{8}{10} c$. Enter this value into right triangle with $v$ on side q and c on side r. The p side can be obtained using the pythagorean method, so that the side p is obtained 6. Thus, the change in time is measured by a silent observer relative to the object ($\Delta t_0$) is $\Delta t_0 = \frac{6}{10} \Delta t$. The size of $\Delta t$ is 20 seconds, so the magnitude $\Delta t_0$ is $6 \times 10^6$ seconds. Obtained the amount of $\Delta t_0$ is 12 seconds.

The second case, the problem of long contractions. It is known that the length of the object observed by the observer is stationary relative to the object ($L_0$) is 100. From these events, the thing that will be sought is the length of the object observed by an observer moving relative to the object. Observers move at speed 0.4$c$. From the value $v$ which says 0.4$c$ will have the same value when changed to $v = \frac{4}{10} c$. Enter this value into right triangle with $v$ on side q and c on side r. The p side can be obtained using the pythagorean method, so that the p side is $2 \sqrt{2}T$. Then the length of the object observed by the observer moving relative to the object ($L$) is $L = \frac{2\sqrt{2}T}{10} \times L_0$. The size of $L_0$ is 100, so the magnitude $L$ is $L = \frac{2\sqrt{2}T}{10} \times 100$. Obtained amount $L$ is $20 \sqrt{2}T$, or 91.6 m.

The third case, relativistic mass problems. There is an incident where an object is being observed by a silent observer and is observed by an observer moving at a speed close to the speed of light, if it is known the value of the mass of objects observed by the observer is silent ($m_0$) is 50 gr, then in this event, the thing to look for is the mass of objects observed by observers moving at speed ($v$) 0.6$c$. The speed value can be changed to $\frac{v}{c} = \frac{6}{10}$. Enter this value into right triangle with $v$ on side q and c on side r. The p side can be obtained using the pythagorean method, so that the p side is 8. So to find the mass of objects observed by a moving observer ($m$) can be done by means of $m = \frac{10}{8} m_0$. It is known that $m_0$ is 50 gr, then the size of m is $10 \times 50$. So it is found that the size of m is 6.25 gr.

The fourth case, relativistic energy problems. If it is known that there is an object observed by an observer in a moving state at a speed close to the speed of light and the object has the energy ($E$) of 40 Mev, then from the event the thing to look for is the amount of silent energy from the object. The speed of a moving observer is 0.6$c$. The value of 0.6$c$ can be written in $\frac{v}{c} = \frac{6}{10}$. Enter this value into right triangle with $v$ on side q and c on side r. The p side can be obtained using the pythagorean method, so that the p side is 8. So to find the amount of energy observed by the silent observer ($E_0$) it can be done by $E_0 = \frac{8}{10} E$. It is known that the magnitude of $E$ is 40, then the magnitude of $E$ is $\frac{8}{10} \times 40$. So that it is found that the size of $E$ is 32 Mev.
From several cases of time dilation problems, long contractions, relativistic masses and relativistic energy have proven that Einstein's special form of special relativity that has similarities to the Pythagorean theorem equation, can make Pythagorean theorem one of the quick and simple methods to solve Einstein's special relativity problem. This research can be further developed for future researchers. So that in this case, the advice that can be given from the author to the next researcher is the results of this study can be applied to learning. The next researcher can also find an alternative problem-solving in other physics material.

5. Conclusion
Based on the calculations of Einstein's special relativity equations a new equation have been obtained. Furthermore, after analysis showed that the equation of Einstein's special relativity with the Pythagoras theorem equation has the same form of the equation. The similarity of the form of equations can make the Pythagorean theorem a simple solution to solve Einstein's special relativity problem.

6. Acknowledgement
We would like to thank all the groups Physics Education from FKIP University of Jember of the year 2019 which has worked well together so that this research can run smoothly.

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