Understanding of elementary school teachers on physical concepts

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Abstract. To avoid errors in understanding the concept of physics sustainably, misconception of physics needs to be diagnosed, both students and teachers in elementary or secondary education. However, this diagnosis is still rarely done in teachers at elementary school. This research is to describe and identify misconceptions in understanding on physical concept in elementary school teachers. This is a qualitative research. The respondent are 14 elementary school teachers in Surakarta, with stratified purposive sampling. Collecting data with test and interview, with open response essay test and an interview. The process of analysis through data collection, data reduction, and withdrawal of conclusions, done inductively. The results: 14.54% teachers have a scientific understanding of the concept, misconception category of 80.12%, and 4.17% not understand category. Misconceptions absolutely occur in the understanding of the time object to arrive at the ground. Misconceptions are categorized high on the concept of 1) the force of gravity (92.86%), 2) light velocity (92.86%), 3) frequency and amplitude (85.71%), 4) static electric force (78.57%), and 5) visible object by eye (57.15%). The conclusion that the understanding of elementary school teachers on the concept of physical science shows different levels and varies.

1. Introduction
Science is one of compulsory learning content that learned at Elementary school. At this level, the scope of science consists of biology, physics and also earth and a space science aspect, which consists of many concepts that should be understand by the teachers. But all this time, the majority of Elementary school’s teachers in Indonesia have mistaken in understanding the science concept [1]. According to Stein, concept in physics is more abstract and difficult to be understood [2]. More concepts in physics among others is the concepts about material and the characters, energy and the change (style, sound, heat, magnetism, electricity, light and simple aircraft). So, the mistake in understanding the physics concept (misconception) is easy to be done. Misconception is a condition which the understanding of the learner is different with the scientist understands [3]. If a misconception found by the Elementary school teachers, so, this is to be a big an obstacle in science learning [4], because the concepts of the science underlying the understanding of the concept to the next level [5]. Based on this, so it’s needed a study...
to know how the elementary teacher understanding the concepts, so that the mistake of the concepts understanding can be regenerated soon in the future.

Lawrence has researched about the understanding of physics concept among the elementary teachers [6]. The result show that misunderstanding in physics concept held in various concepts. The Research to know the understanding of physics concept at elementary teacher has been done in gravitational force material, magnetic gas and temperature used to specify the weather conditions [7]; force and motion material [8], concept of the type of mass substance and free fall motion [9]. Another research found a misconception gravity, magnetism, gases and temperature.

Based on the research before that still many concept which has not been studied. This research goal is going to describe and identify the understanding of elementary teacher to the physics concepts which different with the physics concept that has been detected before, that is the concept of gravitation to two objects that have mass (force gravitation), electricity, time that is needed to get the ground, low height and strong weak sound, light propagation in dark and bright places (light velocity concept), and to identify the concept in which the object can be seen by the eyes.

2. Methodology of research
This research is a qualitative research that describe the understanding of the concept of physics to teacher at elementary school, then identify is there any misconceptions. Data sources of this research is elementary school teacher at IV grade that apply curriculum 2013 in Surakarta using 14 teachers as sample from public and private elementary school with superior (A ) and good (B) quality which have been taken by purposive. The sample technique taken on a stratified purposive sampling. From the 14 TH elementary teachers, there are 6 teachers with certified educator and 8 teachers have been certified yet; 4 men and 10 woman. The research instruments used diagnostic open response essay form. 20 questions that have been through validation process first. Data analyzed inductive with reference to the concept understanding of a learner in some level, by Abraham quoted based on grouping by Marek [10], in misunderstanding, misconception and understanding categories. After knowing the answer going to misconception, continued with interview to confirm the answer.

3. Results and discussion
The elementary teacher understanding refer to the concept of science show the percentage in some categories presented in a Table 1.

| No | Science concept                                      | % respondent’s answer (teacher) |
|----|------------------------------------------------------|--------------------------------|
| 1  | Gravity that occurs from two mass objects            | Scientific concept: 0          |
|    |                                                      | misconception: 92,86           |
|    |                                                      | Misunderstanding: 7,14          |
| 2  | Electricity that owned because the object has electrically charged | Scientific concept: 21,43 |
|    |                                                      | misconception: 78,57           |
|    |                                                      | Misunderstanding: 0             |
| 3  | Time that is needed the mass object to get the ground | Scientific concept: 0          |
|    |                                                      | misconception: 100             |
|    |                                                      | Misunderstanding: 0             |
| 4  | Low height and strong weak the sound                 | Scientific concept: 0          |
|    |                                                      | misconception: 85,71           |
|    |                                                      | Misunderstanding: 14,29         |
| 5  | Light propagation in dark and bright places          | Scientific concept: 7,14        |
|    |                                                      | misconception: 92,86           |
|    |                                                      | Misunderstanding: 0             |
| 6  | The object can be seen by the eyes                   | Scientific concept: 35,71       |
|    |                                                      | misconception: 57,15           |
|    |                                                      | Misunderstanding: 7,14          |
|    | Percentage (%)                                      | 14,54                          |
|    |                                                      | 80,12                          |
|    |                                                      | 4,17                           |
Based on table 1, described as follows.

3.1. The concept of gravity

Question: when mango trees fruit, some mangoes fall down. What kind of style is happening?

In this concept, there are 92,86% found misconception, 7,14% misunderstanding and no answer accordance with the scientific concept. All respondents said that when mangos fall down, there is gravity. And the misconception held because of the answer supported by inappropriate reasons, mango fall down because all objects on earth withdrawn by earth magnet/earth gravitation, so the objects still stay on earth. Gravitation is earth pull so all the objects sticking on earth.

Gravitation occurs to the object from up then fall down. Mango falls down extracted by earth gravitation. Gravitation affect the mango in which the stem is not strong. An object which is above will fall down. Free fall motion affected by gravitation. All objects that throw above/ at potential point above will fall down because of earth pull. Gravitation affected by heavy object. Earth gravitation caused all objects fall down. All objects will fall down to the earth because of earth pull/ magnetic as long as it’s atmosphere/ air. Category the teacher who does not understand approved with an answer said that mango falls down because of kinetic, object motion. When mango hang on tree, mango has potential energy to fall, so when mango is mature, the stem is not strong enough to hold the mango weight, so it will fall down because of gravitation.

According to scientific concept, gravitation is an interaction phenomena of attractive force between mass object in nature. Way of gravity towards the earth center and the size is the object weight that is depend on the mass and earth gravity [11]. This research involved 14 elementary teachers, 14,28% have science background, 28,57% have nonelementary teacher education background (Geography, Civic Education, state administration, Indonesian, English) and 57,14% have elementary teacher education background. The education of Elementary teacher has equipped the science material in 4 major. But, this is still possible will be a condition that understanding to science concepts lower than teacher who has science background (biology, physic, chemist) [12]. Although, Indonesian state does not standardize that elementary teacher should has science background, but has elementary education background that hoped can master 5 subjects [13].

3.2. The concept of static electricity

Question; “paper flakes will move and stick when brought closer with plastic ruler that has been rubbed to wool. Why does this happen?”

Based on scientific conception, this is happen because of electricity in a plastic ruler. Plastic ruler has electricity so it can pull the paper flakes. Electricity appear because of the electron of the wool move to the ruler, when the ruler neutral will have negative capacity (because receive the electron). 21,43% understand fit the science concept and 78,57% get misconception, alternatively answer; plastic that is rubbed over and over to the wool will create electricity. Because there is a static electricity. The ruler that is rubbed to the wool will create electricity because there is a static electricity in a ruler/not flowing. Electricity that caused by friction between wool and plastic ruler make the paper flakes move and stick.

Static electricity is one of subject that fill of mistake in understanding the concept. Static electricity tell about “capacity” and the power to pull/push electricity that created. So, this concept to be said more microscopic. Static electrical field is contrary to the magnetic field [14]. Respondents said that. Some statements show that they are misconception; a) plastic ruler is magnetic, so paper flakes will stick to the ruler, b) electromagnetic is owned by ruler plastic, c) when the ruler is rubbed will cause magnetic force, so the paper will stick. d) ruler that has rubbed there is magnetic field or electricity. That is show miss conception.
3.3. Time that is needed to an mass object to get the ground

The question to explore the concept is;

![Figure 1](image)

Figure 1. Feather and marble Scheme drooped to vacuum.

Figure 1 showing a feather and a marble released together from the same height in a vacuum tube. Which object that will get on tube base? Explain!

In accordance with the scientific conception, absence of air in a tube does not mean that there is no gravitation. In a tube still a gravitation.

On the figure, gravitation is an attractive force between objects (feather with the earth and marble with the earth). Both objects will fall with same speed and there is no friction with air so both of them will get the tube base together.

This concept shows an absolute misconception, marked with an answer that both objects will fall together to the tube base (no reason). Both objects will fall together because of the gravitational constant, so if an object dropped from same top it will drop together. This answer is not allowed proper reason that condition vacuum show that there is no friction air. In vacuum there is no gravitation, so no object can get the base and still fly. Both objects will get the base together, this is because of the constant of gravitation.

Another answer state that feather will get the tube base with varieties reasons: a) feather has a layer like candle, b) because in vacuum all object will fly and feather lighter, so it will get to the tube base, and c) because the feather is light and easily affected by earth gravitation, another state that marble will fall first because; a) has bigger mass, b) more weight an object so it will fall faster to base. This statement in line with the result of research done by Anggoro [15]. Vacuum means no gravitation, may both of them are flying. Some respondents state in line with the initial conception.

Misconception can be experienced by the students (college student) and teacher [16]. Like a student, elementary teacher can meet misconception too [17]. Early concept which are owned by teacher concern with this problem has great relation to nature phenomena he observed. Many studies about student conception from all education level start from elementary to university [18]. According to constructivism, new knowledge will be constructed on an understanding [19]. Can be analyzed, as a learner a teacher has a concept that sourced to phenomena. Teacher said that in vacuum, there is no gravitation. Teacher has early conception when see the astronaut fly in vacuum, so teacher will associate gravitation in vacuum.
3.4. Low high and strong weak sound

Question: Awang knock the table with two ways. Way 1: Awang knock loudly. Way 2: Awang knock the table slowdown. Analize the different sound from the high low and strong weak completed with scheme!

According to scientific concept, both ways have same frequency, so high low sound resulting will same. Table knock loudly create big amplitude and when the table knock slow will create little amplitude. Bigger amplitude, sound will stronger and more little amplitude, the sound will weak too. If the wave formation is described it will show on Figure 2;

![Figure 2](image)

2a. Strong sound 2b. weak sound

**Figure 2.** The scheme for the formation of waves formation from the table that is knocked strong and slow.

85,71% show misconception condition with alternatively concept; strong weak sound decided by sound frequency, amount of vibration, size of the sound device and amplitude. Knock the table loudly create high sound because frequency that be created more (more vibration any time), so create high sound. High sound and frequency continually will create strong sound. While knock the table slowly, the frequent intensity lower so the sound will slow too. I = loud, fast, unclear sound. II= slow and clear sound. I = high and strong sound. II= low and weak sound. Way 1 sound louder compared with way 2, because big clash. Way I= sound that is created of course will be higher because will strong vibrate too. II= sound will be weak because knock slowly. I= high sound. II= low sound. I= high pitch, strong. II= low pitch, weak. Strong weak a sound determined by amplitude. I= cause fast vibration frequency so the sound high and strong. II= cause slow vibration frequency so the sound is low. 14,29% include in misunderstanding category because they don’t answer.

New concept can’t be learned by learner if they still in misconception condition on basic concept [20]. On this case, teacher should understand about frequency and amplitude first. Teacher still make mistake when associate between strong weak and high low sound with amplitude and frequency concept.

3.5. Light creep concept

Question: two candles are turned on. First candle put out with bright light. Second candle put in a dark room. Which light that will reach to our eyes as observer?

7,14% understand the concept and 92,86% get misconception. Indication of misconception are shown at the response state that the candle light in a dark room faster reach the eyes because a) candle in dark room is the only one source of light; b) our eyes right on target/see the light because our eyes sensitive to light’s) in dark room, fast object reflect light because our eyes reflect light and I dark room it’s only one light source that is candle, so our eyes will capture the candle light fastly, different when it in outdoor, because the light just focused in candle. And candle that put in bright light, the candle will not reach our eyes because light lamp/ sun stronger. First known concept by respondent is a concept of light creep in environment with different light intensities (dark and bright room). If respondent answer any
different light creep at those two places, so the concept is the speed of light decided by medium density through which light passes not understood yet [21]. They still think that light creep of candle influenced by light intensities in environment. This is concern with finding the distance light travels depends on day or night [22]. Less light intensity in dark condition, the light creep is faster. And this is wrong concept. According to scientific concept no light that precedes to reach to the observer’s eyes. So, both candle light will be seen together by the observer. Because the light creep is same. Light creep the fastest in vacuum (tenuous medium). Getting closer to medium, the smaller the light speed.

3.6. Concept about an object that can be seen by our eyes

The understanding of concept about a reason of an object can be seen by eyes show 35.71% respondents concern with the scientific concept, 7.14% do not understand because no answer and 57.15% getting misconception. This misconception is marked by respondents that state we have the five senses that is eyes with pupil and retina in order to get/see the object. Essay questions with large answer made in order to respondent can analyse the concepts, conduct the concept, analyse the problem or evaluate the result that can be used to diagnose misconception condition [23]. Therefore, the essay characteristic with expanded answer is more scoring to critical thinking or higher order thinking [24]. But, the analysis result show that not all the concept in a phenomenon can be explained yet. To light creep phenomenon, respondent associate it with light intensity that actually same. They do not realized that they have bring up a concept about intensity but they do not explain the meaning.

This is can be seen to the respondent’s answer state that an object can be seen because there is light enter to our eyes. We can see because there is light and we have sense of sight. Our eyes get reflection of light that enter our eyes. Because eyes capture the light so we can see object around us. Because our eyes catch light so we can see an object. Unexplained about the concept of reflection of light, so it’s not fit with the scientific concept that an object can be seen due to a light that reach the object then the light will be reflected and enter to our eyes [25]. Light will be reflected by an object then create an object in our eyes.

4. Conclusion

In understanding physic concept, majority teacher at elementary school in Surakarta is at misconception position. Misconception absolutely happen in concept timing that is needed by an object to get the surface, and then followed by gravitation concept, light creep and sound. This condition can be used as a basic to increase professionalism teacher at elementary school to science subject through workshop or another professionalism program, so misconception can be resolved soon.

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