Science Misconceptions Analysis Between Factual and Conceptual Dimensions in Junior High School Students in Tamalate District of Makassar

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Abstract. The research was aimed to i) know the student's misconceptions on factual dimension, ii) know the student's misconceptions on conseptual dimension, and iii) analyze the differences student's misconceptions between factual and conseptual dimension. The research used quantitative descriptive. The population in this research were all of the students in junior high school grade 7th which have accredited A in Tamalate district of Makassar. The data was collected by using Random Sampling Class. The sample were 253 students. The data analysis in this research by statistic descriptive. The instrument in this research was a multiple-choice test with 25 items using the three-tier test method with a choice of reasons using the *certainly of response index* (CRI). The results showed that i) the student's misconceptions on factual dimension is 54.62%, ii) the student's misconceptions on conseptual dimension is 63,18%, and iii) the misconception of the conceptual dimension is higher than the factual dimension with a comparison of 2.3 ⋮ 2 and understanding the concept of the conceptual dimension is lower than the understanding of the concept of the factual dimension.

Keywords: Science Misconception, Factual Dimension, Conceptual Dimension

1. Introduction

First time basic ability required for students to have in science learning is ability to understand the concepts, principles and laws. Science Learning is a process to change students' conceptions of preconceptions or misconceptions become a concept that fits with apply various methods appropriate learning. Until then this is still a problem often experienced in science learning, namely: the quality of learning is still has not given the right result with what to expect. Various factors can influence non-optimal achievement of goals learning in junior high school, one of which the emergence of misconceptions. Misconceptions can be interpreted as meanings that are not in accordance with the concept, the application of an inappropriate concept, mixed concepts, and a hierarchical relationship between inappropriate concepts [1]. Misconceptions will cause wrong thoughts and views in understanding concepts so as to limit students in learning efforts and will hinder understanding and development between concepts that were previously studied and those that have been studied afterward.

The student often interprets the concept that is considered difficult in accordance with pre-conception that he already owns. Sometimes, the interpretation of students is not in accordance with the concept agreed by experts. A different concept is called as misconceptions or false concepts [2]. According to [2], most misconceptions that occur in students come from the students themselves which

can be categorized in several ways, including: preconceptions or students' initial concepts, associative thinking, humanistic thinking, incomplete/wrong reasoning, wrong intuition, the stage of student cognitive development, student abilities and also the student's own interest in learning.

After observing several A-accredited schools in Makassar, it can be seen that the Science material is too difficult for students to understand, causing low mastery of concepts and frequent misconceptions in understanding the material. According to[3], one of the causes of the low quality of science education to date is the existence of misconceptions and learning conditions that do not pay attention to students' preconceptions or initial conceptions. Misconceptions almost occur at all levels of education, ranging from elementary, junior high, high school students, college students, even teachers or lecturers [4]

The results of the preliminary study through observations and interviews with science teachers, it is known that students get unsatisfactory learning outcomes and do not understand its application in everyday life. The science material that has the most potential for misconceptions among students in grade VII is science material with physics. This is because physics contains many formulas, mathematical steps, and abstract materials that make students experience misconceptions. Misunderstanding of concepts or misconceptions by students will consistently affect the effectiveness of the learning process [5]. In addition, science teachers also do not know if students have misconceptions and do not know how to measure students' misconceptions. Therefore, to measure students' misconceptions, a diagnostic assessment tool in the form of a multiple-tier test is used.

Diagnostic tests are carried out to find out the conceptions and misconceptions possessed by students. Research on diagnostic tests has evolved. Diagnostic tests to find out the misconceptions that students have can be done through interviews, open tests, multiple-choice tests, multiple level tests, namely two-tier, three-tier, and four-tier, and others [5]. These tests have their respective merits from the results. Identifying misconceptions using the three-tier diagnostic test has an advantage over the two-tier test because it can distinguish students who lack knowledge based on students' beliefs when answering questions on one tier and two-tier [7][8]. Because this level of belief also affects the calculation of conceptions and misconceptions that are mastered by students.

The learning process is an activity carried out by the teacher in an effort to give direction to students in order to have the correct understanding. In fact, in a learning process, not all students have the ability to understand concepts well. So that students can misunderstand the concepts learned. They also may have pre-conceptions or naive theories in their mind about the new or experienced concept. Misconceptions also can be identified as students' prior knowledge, which are embedded in a system of logic and justification, albeit it may be incompatible with accepted scientific understanding [9].

Concepts are ideas forming objects or abstraction, helping an individual to comprehend the scientific world phenomena[10]. Misconceptions are delineated as ideas or insights from students who provide incorrect meaning constructed based on an event or person experience [11]. Misconceptions can be interpreted as meanings that are not in accordance with the concept, the application of an inappropriate concept, mixed concepts, and a hierarchical relationship between inappropriate concepts [1]

Science misconceptions are individual knowledge gained from educational experience or informal events that are irrelevant or not having the meaning according to scientific concepts [12]. In summary, the misconception in science can be described as student ideas from life experience or informal education, which is not structured well and resulting in the incorrect meaning according to a scientific concept.

Misconceptions in science is a barrier for students to learn science because in many cases, misconceptions can detain students to develop correct ideas used as the initial insight for advanced

learning. Teachers may experience misconception in teaching either physics, chemistry, or biology topics which leads, inevitably, in student misconceptions [13][14]. In other words, misconception will interfere with the quality and quantity of science learning process and outcomes for both student and teacher. This is in line with [15], the wrong concept can interfere with students' understanding in the next learning process. Therefore, educators need to be aware of misconceptions that can cause student learning outcomes to decline.

According to Suparno [1], misconceptions can be caused by six factors, namely the constructivism philosophy angle factor, the student factor, the humanistic thinking factor, the wrong reasoning factor, the wrong intuition factor, and also the textbook factor. To overcome misconceptions, students must become aware of the scientific concepts, the evidence that take on the validity of their misconceptions and the scientific concepts, and they must be able to generate the logical relationships between the evidence and alternative conceptions [16].

To overcome existing misconceptions, some kind of conceptual change has to occur in the student‟s mind. Each theory of conceptual change explains misconceptions in different ways; therefore, depending on definitions of "what misconceptions are," each theory offers particular ways for removing (or at least clarifying) misconceptions. A consequence of that is the fact that each theory usually presents its own approach to the curriculum. Thus, initial students‟ knowledge about to-be-learned material has to be evaluated very carefully [17].

Learning outcomes are specific skills, capacities, attitudes, and knowledge that a student ought to prossess as a result of a particular educational activity. Learning outcomes are important both for teacher and for students. For education, learning outcomes profide an organizing concept (or set of ideas) which anchor academic instruction. In addition, student learning is enchanced when learning outcomes are made explicit, and student can perceive the connection between learning activities and the proposed outcomes. Occurs between instructor and students, where checks built in to the curriculum ensure that learning outcomes are archived. These are valuable tools for a archeving any set of educational goals [18].

Competencies that must be possessed are humans who have high character and intellectuality, namely having cognitive abilities and thinking patterns so that they are able to solve problems. Therefore, in the learning process, the cognitive abilities of students must always be trained. According to [19], cognitive abilities based on the revised bloom taxonomy are divided into four dimensions of knowledge, namely the dimensions of factual, conceptual, procedural, and metacognitive knowledge. Each dimension of knowledge has a cognitive process dimension starting from C1 (remember), C2 (understanding), C3 (apply), C4 (analyze), C5 (evaluate) and C6 (create). Bloom's level of taxonomic thinking moves from things that are concrete to abstract and things that are simple to things that are more complex.

Therefore, to achieve the goals in the taxonomy, it is necessary to link concrete and simple things around the students' environment. To achieve that, it is necessary to have a dimension of knowledge and cognitive processes. The dimension of knowledge includes conceptual, factual, procedural, and metacognitive knowledge. Meanwhile, the cognitive process dimension includes remembering, understanding, applying, analyzing, evaluating, and creating. In the 2013 curriculum content standards, the focus of science subjects on core knowledge competencies consists of the dimensions of factual and conceptual knowledge.

According to [20], factual knowledge covers the attitudes of using, understanding, and communicating knowledge that constitutes the main concepts of any discipline. It is used to express

observable, provable or measurable events of nature in general. For the factual knowledge level, learners are expected to define and understand the basic concepts and to express the legends and units related to the concepts. Abstraction using basic information is not expected for this level. While conceptual knowledge is the level at which relations between concepts are established and classifications and generalizations are made. Theories,diagrams, charts, maps, models, and tables can be used to comment on the relationship between different conditions relating to a subject. Conceptual knowledge is divided into three subgroups: knowledge of classifications and categories, knowledge of principles and generalizations, and knowledge of theories, models, and structures.

Students participate in the learning process and generate knowledge by forming mental relationships between concepts. To bring up creative individuals who can think, research and acquire knowledge, the methods and techniques used in the educational process must be in accordance with these qualities. Misconception occurs due to several things, namely preconceptions, teachers, learning resources, learning methods to students themselves. The adverse impact caused by misconceptions is a decrease in learning outcomes because misconceptions experienced by students will hinder understanding the next concept. Based on this description, research will be conducted on the misconceptions of junior high school students in science material with the title " Science Misconceptions Analysis Between Factual and Conceptual Dimensions in Junior High School Students in Tamalate District of Makassar."

2. Methods

This type of research is descriptive research. The method used in this study is a survey method with a quantitative research approach. Quantitative descriptive research is to see, review and describe numerically about the object under study as it is and draw conclusions about it according to the phenomena that appeared at the time the research was conducted [21].

The data collection technique used Random Sampling Class which consisted of class VII students at an accredited SMPN A in the Tamalate district of Makassar. The schools studied amounted to 5 schools. The main data of this research is in the form of answers from respondents to the data of students' answers. Data analysis in this study used descriptive statistical analysis method. According to [22], descriptive statistics provide an overview or description of a data seen from the average (mean), standard deviation, variance, maximum, minimum, sum, range, kurtosis, and skewness (winning distribution). The instrument used in this study was a multiple-choice test of 25 items using the three-tier test method with a choice of reasons using the *certainly of response index* (CRI) method which aims to detect student misconceptions.

3. Results and Discussion

The research was conducted involving 7th grade students of A-accredited SMP in the Tamalate district of Makassar, which consisted of 5 schools, including: SMPN 15 Makassar, SMPN 18 Makassar, SMPN 24 Makassar, SMPN 26 Makassar and SMPN 27 Makassar. The results of the identification using the three-tier diagnostic test resulted in the level of understanding of conceptual and faktual misconceptions, and the level of learning outcomes.

Table 1. Dimensions of factual learners

	PK	**M**	**TPD**	**TPK**
SMPN 15 MAKASSAR	36.62%	59.20%	0.41%	3.78%

SMPN 18 MAKASSAR	47.30%	47.46%	0.79%	4.44%
SMPN 24 MAKASSAR	35.63%	55.34%	1.56%	7.47%
SMPN 26 MAKASSAR	34.16%	61.07%	1.21%	3.55%
SMPN 27 MAKASSAR	40.20%	50.06%	1.99%	7.75%
Average	38.78%	54.62%	1.19%	5.40%

Based on table 1, it can be known that the average concept results (PK) of learners are 38.78%, misconceptions (M) of learners are 54.62%, not confident (TPD) learners by 1.19%, and do not understand the concept (TPK) of learners by 5.40% in all State Junior High Schools accredited A in Tamalate District on factual dimensions. Understanding the concept (PK) is highest in SMPN 18 Makassar at 47.30%. Furthermore, followed by SMPN 27 Makassar by 40.20%, SMPN 15 Makassar by 36.62%, and SMPN 24 Makassar by 35.63%. So that SMPN 26 Makassar has the lowest concept understanding (PK) of 34.16%.

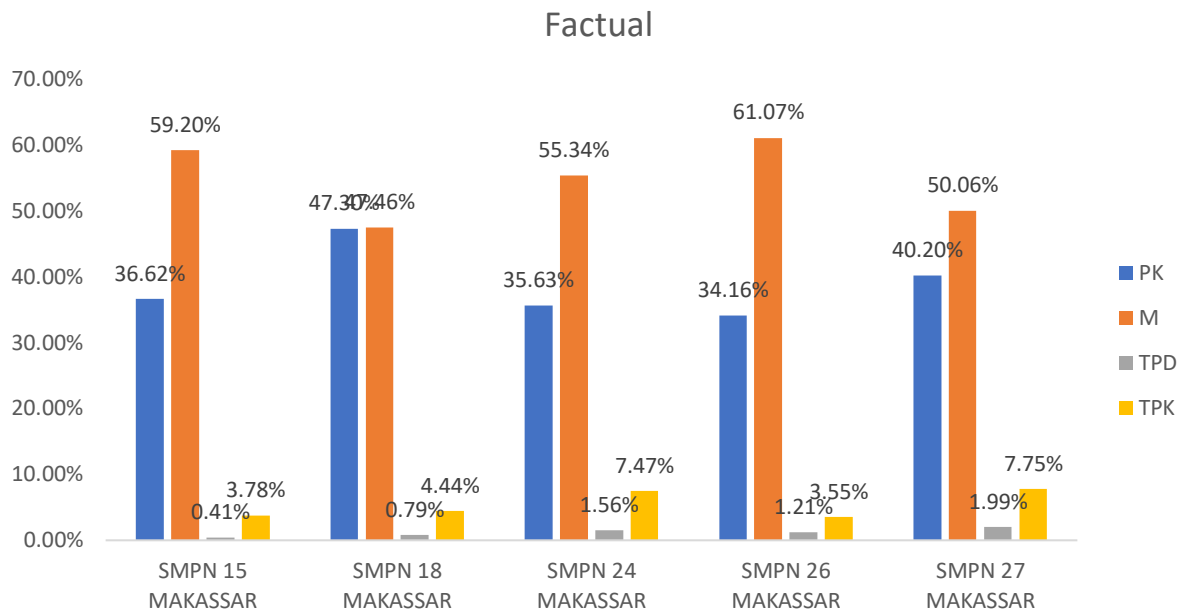
These results show that the average misconception (M) in the factual dimension of learners in tamalate secondary schools accredited A is higher than the average concept understanding (PK) of 38.78% owned by learners. The highest misconception (M) in the factual dimension is consecutively, namely SMPN 26 Makassar by 61.07%, SMPN 15 Makassar by 59.20%, SMPN 24 Makassar by 55.34%, SMPN 27 Makassar by 50.06%, and SMPN 18 Makassar by 47.46%.

Furthermore, data was found that learners who were not confident (TPD) were very low. This is evidenced by the average lack of confidence (TPD) of all state junior high schools accredited A in Tamalate Sub-District by 1.19%. Not the highest confidence (TPD) in the factual dimension is 1.99% in SMPN 27 Makassar. Then followed by SMPN 24 Makassar by 1.56%, SMPN 26 Makassar by 1.21%, SMPN 18 Makassar by 0.79%, and SMPN 15 Makassar by 0.41%.

The average concept of learning (TPK) of learners in the factual dimension in all state junior high schools accredited A in Tamalate sub-district is 5.40% with the lowest data found in SMPN 15 Makassar at 3.55%. While not understanding the concept (TPK) the highest amount of 7.75% is SMPN 27 Makassar. Do not understand the concept (TPK) SMPN 24 Makassar by 7.47%, SMPN 18 Makassar by 4.44%, and SMPN 15 Makassar by 3.78%.

For more details, here is a diagram of the factual dimensions of learners throughout SMP Negeri accredited A se-Sub-District Tamalate.

Figure 1. Diagram of factual dimension bars



Based on figure 1 it can be known that the results of misconceptions (M) of each school are closely related to not understanding the concept (TPK) and understanding the concept (PK) of a student. It is evidenced in the highest misconception (M) results in SMPN 26 and SMPN 15 Makassar, namely by misconceptions (M) of 61.07% and 59.20% with concept understanding (PK) only by 34.16% and 36.62%. While schools that have a misconception (M) are SMPN 18 Makassar and SMPN 27 Makassar by 47.46% and 50.06% with a high concept understanding (PK) which is 47.30%, and 40.20%. Schools that have a low misconception (M) are SMPN 24 Makassar by 55.34% with a low concept understanding (PK) of 35.63%.

This proves that schools that have high misconceptions then understand the concept (PK) of low learners, on the contrary, the misconception (M) of low schools then understand the concept (PK) of high learners. This is also supported by the high results of not understanding the concept (TPK) of learners who reached 7% meaning there are still some learners who do not understand the concept that Delivered by the teacher on a factual dimension.

Table 2. Dimensions of conceptual learners

	PK	M	TPD	TPK
SMPN 15 MAKASSAR	20,98%	72,13%	0,86%	6,03%
SMPN 18 MAKASSAR	31,67%	57,78%	1,11%	9,44%
SMPN 24 MAKASSAR	34,46%	57,06%	1,41%	7,06%
SMPN 26 MAKASSAR	12,96%	71,96%	2,38%	12,70%
SMPN 27 MAKASSAR	31,78%	56,98%	1,94%	9,30%
Average	26,37%	63,18%	1,54%	8,91%

Based on table 1 it can be known that the average results of understanding the concept (PK) of learners are 26.37%, misconception (M) of learners is 63.18%, not confident (TPD) learners by 1.54%, and do not understand the concept (TPK) of learners by 8.91% in all state junior high schools accredited

A in Tamalate Sub-District. Understanding the concept (PK) is highest in SMPN 24 Makassar at 34,46%. Furthermore, followed by SMPN 27 Makassar by 31.78%,SMPN 18 Makassar by 31.67%, and SMPN 15 Makassar by 20.98%. Sehingga SMPN 26 Makassar has the lowest concept understanding (PK) of 12,96%.

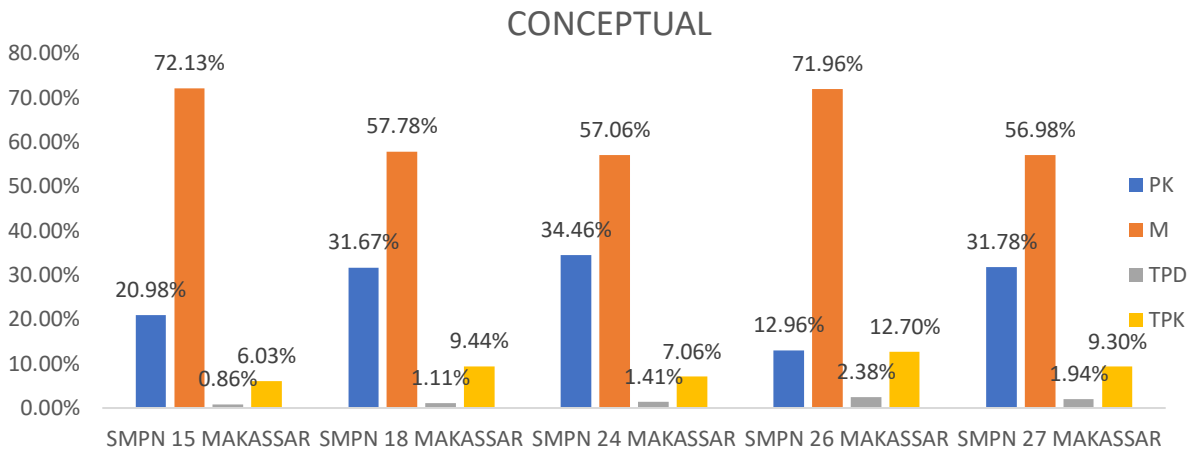
These results show that the average misconception (M) in the conceptual dimension of learners in tamalate secondary schools accredited A is higher than the average concept understanding (PK) of 26.37% owned by learners. The highest misconception (M) in the conceptual dimension is consecutively, namely SMPN 15 Makassar by 72.13%, SMPN 26 Makassar by 71,96%, SMPN 18 Makassar by 57,78%, SMPN 24 Makassar by 57,06%, and SMPN 27 Makassar by 56,98%.

Furthermore, data was found that learners who were not confident (TPD) were very low. Its is evidenced by the average lack of confidence (TPD) of all state junior high schools accredited A in Tamalate Sub-District by 1.54%. Not the highest confidence (TPD) in the conceptual dimension is 2.38% in SMPN 26 Makassar. Then followed by SMPN 27 Makassar by 1.94%, SMPN 24 Makassar by 1,41%, SMPN 18 Makassar by1,11%,and SMPN 15 Makassar by 0.86%.

The average do not understand the concept (TPK) of learners in the conceptual dimension in all state junior high schools accredited A in Tamalate Sub-District is 8.91% with the lowest data found in SMPN 15 Makassar of 6.03%. While not understanding the concept (TPK) the highest amounting to 12.70% is SMPN 26 Makassar. Do not understand the concept (TPK) SMPN 18 Makassar by 9.44%, SMPN 27 Makassar by 9.30%, and SMPN 24 Makassar by 7.06%.

For more details,berikut is a diagram of the conceptual dimensions of learners in all State Junior High Schools accredited A in Tamalate Subdistrict.

Figure 2. Conceptual dimension bar diagram



Based on figure 2 it can be known that the results of misconceptions (M) of each school are closely related to not understanding the concept (TPK) and understanding the concept (PK) of a student. It is evidenced in the results of misconceptions (M) highest in Makassar and SMPN 26 Makassar, namely by misconceptions (M) of 72.13% and 71.96% with concept understanding (PK) only 20.96% and 12.96%. Meanwhile schools that have the smallest misconception (M) are SMPN 27 Makassar, SMPN 24 Makassar, and SMPN 18 Makassar which is 56.98%, 57.06%, 57.78% with a high concept understanding (PK) of 31.78%, 34.46%, and 31.67%. This proves that schools that have a high misconception (M) in the conceptual dimension then understand the concept (PK) of learners will be low, Misconception (M) The conceptual dimensions of students are low then understand the concept

(PK) of learners will be high. This is also supported by low results of no confidence (TPD) learners no more than 2% for schools that have a low misconception (M). Means average confidence of learners is very good in answering questions in the conceptual dimension, namely SMPN 27 Makassar, SMPN 24 Makassar, and SMPN 18.

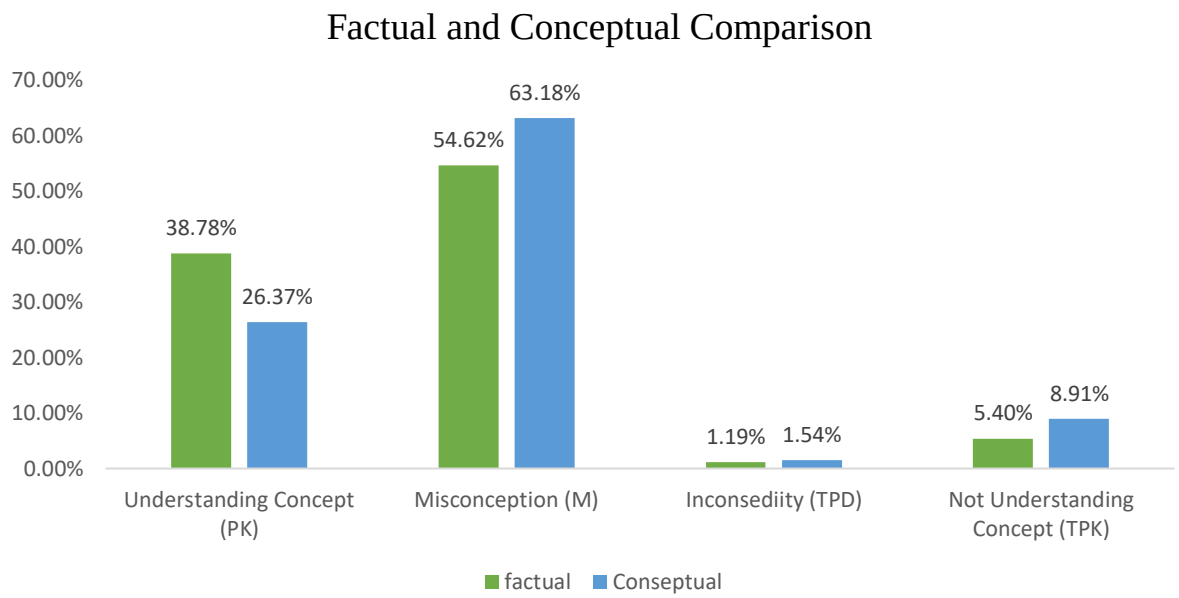
Conceptual knowledge is the ability of students in building concepts that have been studied [23] For students who have low conceptual understanding, have difficulty in learning in school that students can not listen back to what the teacher has explained while in class, which is for students who have high ability to understand can understand what the teacher explained in one explanation or one class meeting.

Table 3. Factual and Conceptual Comparison

	Factual	Conceptual	Comparison
Understanding Concept (PK)	38.78%	26.67%	2,9 : 2
Misconception (M)	54.62%	63.18%	2,3 : 2
Inconsediity (TPD)	1.19%	1.54%	2 : 2,58
Not Understanding Concept (TPK)	5.40%	8.91%	2 : 3.3

Based on Table 3. It is known that the average understanding of concepts on the factual and conceptual dimensions is 38.78% and 26.67 students, with a comparison of 2.9 : 2. Furthermore, the misconceptions of factual dimensions and conceptual dimensions are 54.62% and 63 .18% with a comparison of 2.3 : 2. Based on the results above, it proves that the misconceptions on the conceptual dimension are 63.18% higher than the misconceptions on the factual dimensions of 54.62%. For more details, see the following diagram.

Figure 3. Factual and Conceptual Comparison



The misconception of the conceptual dimension is higher than the factual dimension and understanding the concept of the conceptual dimension is lower than the understanding of the concept of the factual dimension. Not confident in the conceptual dimension and factual dimensions have almost the same value of averages of 1.54% and 1.19%, this study is also supported by the results of

learners. Not understanding the concept in the conceptual dimension is higher at 8.91% compared to the factual dimension of 5.4%.

Research conducted by [24], states that immense conceptual cognitive knowledge learners are better than factual knowledge. This is because in factual knowledge the type of problem is the definition of a particular term that is easily understood by learners. Conceptual knowledge is more complex and organized knowledge. The cause of this misconception usually occurs when the learning process carried out in the classroom is not in accordance with the scientific learning process or student learning interaction only one way, namely from teacher to student only [25]. This is in line with the research conducted by [26], if the students have some misconception, it will assume that the concept is genuine, but the reality is false, affecting an expected learning process. According to [27] who found that the misconceptions that occur are not due to understanding or understanding of wrong concepts during the learning process, but the initial conception that learners bring into the classroom.

4. Conclusions

The research was conducted involving 7th grade students of A-accredited SMP in the Tamalate district of Makassar, which consisted of 5 schools, including: SMPN 15 Makassar, SMPN 18 Makassar, SMPN 24 Makassar, SMPN 26 Makassar and SMPN 27 Makassar. The results showed that i) the student's misconceptions on factual dimension is 54.62%, ii) the student's misconceptions on conceptual dimension is 63,18%, and iii) the misconception of the conceptual dimension is higher than the factual dimension with a comparison of 2.3 : 2 and understanding the concept of the conceptual dimension is lower than the understanding of the concept of the factual dimension.

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References

[1] Suparno P. 2013. Miskonsepsi dan Perubahan Konsep dalam Pendidikan Fisika. Jakarta: Grasindo.

[2] Suparno P. 2005. Miskonsepsi dan Perubahan Konsep Dalam Pendidikan Fisika. Jakarta: Grasindo.

[3] Mosik & Maulana P. 2010. Usaha Mengurangi Terjadinya Miskonsepsi Fisika Melalui Pembelajaran Dengan Pendekatan Konflik Kognitif. *Jurnal Pendidikan Fisika Indonesia*, 6, 98 – 103. https://journal.unnes.ac.id/nju/index.php/JPFI/article/download/1120/1035

[4] Saregar A. 2016. Pembelajaran Pengantar Fisika Kuantum dengan Memanfaatkan Media PhET Simulation Dan LKM Melalui Pendekatan Saintifik : Dampak Pada Minat Dan Penguasaan Konsep Mahasiswa. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 5(1), 53–60. http://103.88.229.8/index.php/al-biruni/article/download/105/95

[5] Wahyuningsih T, Raharjo T, & Masithoh D F. 2013. Pembuatan Intrumen Tes Diagnostik Fisika SMA Kelas XI. *Jurnal Pendidikan Fisika*, 1(1). https://digilib.uns.ac.id/dokumen/download/30025/NjMyMzA=/Pembuatan-Instrumen-Tes-Diagnostik-Fisika-SMA-Kelas-XI-Binder6.pdf

[6] Gurel D K, Eryilmaz A, & McDermott L C. 2015. A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science. Erusia

Journal of Mathematics, Science & Technology Education, 11 (5). https://open.metu.edu.tr/bitstream/handle/11511/38957/index.pdf

[7] Peşman H & Eryilmaz A. 2005. Development of a three-tier test to assess ninth grade students' misconceptions about simple electric circuits. The Journal of Educational Research, 103:208–222. https://open.metu.edu.tr/bitstream/handle/11511/15572/index.pdf?sequence=1

[8] Kurniawan Y & Suhandi A. 2015. The Three Tier-Test for Identification the Quantity of Students' Misconception on Newton's's First Laws. *International Conference on Global Trends Academics Research (GTAR)*. Vol. 2, 313-318.

[9] Tomita M K. 2008. Examining the influence of formative assessment on conceptual accumulation and conceptual change. *Doctoral dissertation*, Stanford University.

[10] Eggen P D, Kauchak D P, & Garry S. 2004. *Educational Psychology: Windows on Classrooms*. Upper Saddle River, NJ: Pearson/Merrill Prentice Itsl.

[11] Martin R E, Sexton C M, & Gerlovich J A. 2001. *Teaching Science for All Children*. Allyn and Bacon.

[12] Allen M. 2014. *Misconceptions in Primary Science*. McGraw-Hill Education (UK).

[13] Bektas, O. 2017. Pre-Service Science Teachers' Pedagogical Content Knowledge in the Physics, Chemistry, and Biology Topics. *European Journal of Physics Education*, 6 (2), 41-53.

[14] Moodley, K., & Gaigher, E. (2019). Teaching Electric Circuits: Teachers' Perceptions and Learners' Misconceptions. *Research in Science Education*, 49(1), 73-89.

[15] Zulvita R., Itsim A., & Elsia. 2017. Identifikasi dan Remediasi Miskonsepsi Konsep Hukum Newton dengan Menggunakan Metode Eksperimen di MAN Darussalam. *Jurnal Ilmiah Mahasiswa (JIM)*, 2, 128-134.

[16] Lawson, A E & Thompson, L D. 1988. Formal reasoning ability and misconceptions concerning genetics and natural selection. *Journal of Research in Science Teaching*, 25(9), 733–746.

[17] Goris, Tatiana, and Michael Dyrenfurth. 2010. "Students' misconceptions in science, technology, and engineering." *ASEE Illinois/Indiana section conference*.

[18] Rowe D, & Johnston L. 2013. Learning outcomes. *Higher education for sustainability. Routledge, Abingdon*, 45-60.

[19] Gunawan I. and Palupi A. R. 2016. "Taksonomi Bloom–revisi ranah kognitif: kerangka landasan untuk pembelajaran, pengajaran, dan penilaian," *Prem. Educ. J. Pendidik. dasar dan pembelajaran*, 2(2).

[20] Ayvaci, H. S. & Turkdogan, A. (2010). Yeniden yapılandırılan Bloom Taksonomisi'ne göre fen ve teknoloji dersi yazılı sorularının incelenmesi. *Türk Fen Eğitimi Dergisi*, 7(1), 13-25.

[21] Putra, Erik Ade. (2015). Anak Berkesulitan Belajar di Sekolah Dasar Se-Kelurahan Kalumbuk Padang (Penelitian Deskriptif Kuantitatif. *Jurnal Ilmiah Pendidikan Khusus*, 4 (3) 71-76. http://ejournal.unp.ac.id/index.php/jupekhu/article/viewFile/6065/4707

[22] Ghozali, Imam. 2013. *Aplikasi Analisis Multivariate dengan Program IBM SPSS 21 Update PLS Regresi*. Semarang: Badan Penerbit Universitas Diponegoro.

[23] Puri, D T. 2016. Penggunaan Model Problem Based Learning (Pbl) dalam Pembelajaran Perubahan Lingkungan dan Daur Ulang Sampah Untuk Meningkatkan Pengetahuan Konseptual dan Keterampilan Berpikir Kritis Pada Siswa Kelas X SMA Negeri 1 Gombong. Jurnal Pendidikan Biologi, 5(6).

[24] Agustin, W. N., Purwati, K. S., & Vita, M. 2021. Profil pengetahuan dan proses kognitif peserta didik pada sub materi vertebrata. Quagga: Jurnal Pendidikan dan Biologi, 13(1): 14-25.

[25] Setiawan, W E & Rusmana, N E. 2020. Penerapan model pembelajaran berbasis masalah dalam meningkatkan pemahaman konsep dan meningkatkan miskonsepsi siswa tentang materi IPA kelas V SD. Jurnal Tunas Bangsa,7(1): 116-126.

[26] Tazkiah, F I., Sri Mulyani, Sentot Budi Rahardjo. 2021. Identifikasi Gaya Belajar Kolb pada Siswa Kelas VII dan Pengaruhnya terhadap Miskonsepsi dalam Pembelajaran IPA. Jurnal Pendidikan, Pengajaran, dan Pembelajaran, 6(1): 7-12.

[27] Andriana, E. 2014. Remediasi Kesalahpahaman Pembiasan Cahaya pada Lensa Tipis Menggunakan Instruksi Langsung Berbantuan Animasi Flash SMA. Jurnal Pendidikan dan Pembelajaran. 5 (2): 82-94.