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THE DIAGNOSIS OF SENIOR HIGH SCHOOL CLASS X MIA B STUDENTS MISCONCEPTIONS ABOUT HYDROSTATIC PRESSURE CONCEPT USING THREE-TIER

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ABSTRACT

One of the main problems in physics is the emergence of students' misconceptions which comes from the prejudices of false starts and a naive belief. Many studies have shown that students tend to have developed their own understanding before the formal teaching is done. The ideas which are developed by students which are different from the explanations by the experts are known as misconceptions. The initial idea that has been formed by the students is very difficult to change by the teachers although the materials are presented with scientific concepts. Misconceptions diagnosis research on the hydrostatic pressure concept was conducted on 23 students of class X MIA B SMAN 3 Malang using Three-tier test. The diagnosis results that the students get misconceptions on the indicators, it explain the hydrostatic pressure is influenced by the depth and at all points located in the horizontal area in the calm liquid has the same hydrostatic pressure, and the hydrostatic pressure is proportional to the density of the fluid, include 1) students believe that hydrostatic pressure is greater at a point closer to the closed cavity (43.5%), 2) the students believe that the hydrostatic pressure is proportional to the density of the submerged object (30.4%), 3) the students believe that the hydrostatic pressure is greater on the outside of the cave because it has a larger volume of fluid so that the pressure is higher (17.4%), 4) students had misconceptions in determining the depth in case of hydrostatic pressure (13%), 5) the students believe that the hydrostatic pressure is greater in the narrow place (13%).

Keywords: Hydrostatic Preassure , Misconceptions, Three-tier.

INTRODUCTION

One of the main problems in physics is the emergence of students' misconceptions which comes from the prejudices of false starts and a naive belief. Students develop ideas about how things work based on their experience (Driver, 1994). Many studies have shown that students tend to have developed their understanding before the formal teaching is done (Halim et al., 2014). The ideas are developed by the students are different from the explanations by the experts; this is a misconception (Chamber & Andre, 1997; Hammer 1996; Lawson, 1995; Yalcin, 2008). The initial idea that has been formed by the students is very difficult to change by teachers although presented with scientific concepts (Tsai, 1999; Sencar & Eryilmaz, 2004). The students' misconceptions in physics initially be derived from many sources, among others: their interaction with daily life, textbooks, reference books, teachers, languages, beliefs, and cultural practices (Ivowi & Uludotun, 1987; Soyinbo, 1993). Therefore, the teachers should identify the students' misconceptions before making a formal teaching so those misconceptions can be altered to scientific concepts after the formal teaching and learning process (Wong & Solomon, 2008).

The materials in physics are still full of misconceptions, one of them can be found on the hydrostatic pressure material. From a research

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conducted by Pratiwi & Wasis (2013) mentions that the students had misconceptions such as: 1) the magnitude of the pressure is influenced by the broadness of the container, 2) the density of water is less than the density of the oil because they have the same volume and height, 3) the magnitude of the pressure is determined by the broadness of the container, volume, and mass of the substance. Research conducted by Goszewski et al. (2012) also mentions the hydrostatic pressure of the material misconception: 1) the errors in the determination of h or depth, 2) the errors in determining the hydrostatic pressure which have three holes. Based on these results the researchers get a source of misconceptions in the hydrostatic pressure material generally in the determination of the depth (h), so in the future researchers will focus on the concept and other concepts are still likely to be considered as potential misconceptions.

A number of ways can be used to diagnose the misconceptions that occur in students. These ways may in the form of interviews (Atwood and Atwood, 1997), questionnaire (Stover & Saunders, 2004), open-ended question (Küçüközer, 2007), multiple choice test (Tsai & Chou, 2002; Trumper, 2003; Brunsell & Marcks, 2005), Two-tier test (Franklin, 1992; Tan et al., 2002; 2005) and Three-tier test (Eryilmaz, 2010; Eryilmaz & Surmeli, 2002; Pesman & Eryilmaz 2010; Arslan et al., 2012 ; Caleon, et al., 2010). One of the ways used in the misconceptions diagnosis is using three-tier diagnostic test. Three-tier diagnostic test is a diagnostic test that is composed of three tiers questions. The first level (one-tier) is a regular multiple choice, the second level (two-tier) in the form of a choice of reasons, and the third level (three-tier) in the form of questions affirmation from the answers that have been made on the level one and two (Kirbulut, 2014 ; Kutluay, 2005; Turker, 2005). The Three-tier diagnostic test has several advantages: 1) makes it possible to calculate the percentage of positively incorrect and negatively incorrect without conducting interviews with the students, which can be used to determine the validity of the tests (Perman & Eryilmaz, 2010), 2), evaluate the misconceptions, understand the reasons given by the students, and to distinguish the students' lack of knowledge and students' misconceptions (Guncay & Gulbas, 2015).

From the description that has been revealed, it is found that the students sometimes have a different understanding with the experts, the result of this condition is the emergence of misconceptions. Misconceptions can be caused by an understanding that has formed before the formal teaching which is difficult to remove by the teacher. Teachers as a good educator should be able to reduce the potential emergence of misconceptions in their students. The first thing that can be done by the teachers is to know and understand the misconceptions appear in students. Therefore, researchers conducted a study to diagnose the students' misconceptions especially on hydrostatic pressure material, to help the teachers to have a better understanding of the potential misconceptions in the students.

METHODS

This research is a descriptive study using a quantitative approach as the representative of the research results. The sample in this study is SMAN 3 Malang class X MIA B who has studying the hydrostatic pressure material in the academic year 2015/2016. The respondents are 23 students consisting of 8 male students and 15 female students. The misconceptions in the diagnosis instruments are listed in Table 1.

The students of class X MIA B Malang are analyzed their misconceptions by providing four questions in the form of three-tier diagnostic test. The students are working on a three-tier diagnostic test for 20 minutes. The diagnosis data are presented in a form of a percentage of the total misconception and the total number of the students (23 students). In answering the questions on the multiple choice of the three-tier diagnostic test, students were asked to answer at level 1 anwer the questions, at level 2 the reasons of the choosen answers, as well as at the level 3 the students are required to provide the level of confiction in the accuracy of the answers given; by selecting the choice sure and unsure. Grouping students' conceptions based on three-tier diagnostic tests as in Table 2.

RESULTS AND DISCUSSIONS

The Students' Overall Concept about Hydrostatic Pressure Concept

The overall analysis results from the three-tier instrument is classified as students who master the concepts is 22.8%, 29.1% did not know the concept, while the rest indicated misconceptions Many studies have shown that students tend to have developed their own understanding before the formal teaching is done 35, 9% and 2.2% or less confident guessing. For more fully data of the students' distibution conception on hydrostatic pressure can be seen in Table 3.

Table 1. The misconception in diagnosis instruments

Indicators	Students' Misconception	No Items
Explaining the hydrostatic pressure on the same horizontal line is heavily influenced by the depth of the objects.		
1	- Students believe that the hydrostatic pressure is directly proportional to the distance of a point on the surface of the water.	1
	- Students believe that the hydrostatic pressure has a greater value in a narrow place.	1
	- Students believe that the hydrostatic pressure is directly proportional to the height.	1
	- Students believe that hydrostatic pressure is greater at the outsideof the cave because it has a larger fluid volume so that the pressure is higher.	2
	- Students believe that the fluid is more concentrated when it is placed in a container, which is denser / narrower then the hidrostatic pressure becomes greater.	2
	- Students believe that the depth in hydrostatic pressure is measured from the bottom of the fluid.	2
	- Students believe that the hydrostatic pressure is greater at the outside of the cave because the water outside the cave is more freely so that the pressure becomes smaller.	2
	- Students believe that the hydrostatic pressure is greater when the hole is wider.	3
	- Students believe that the hydrostatic pressure is greater when it is near an open hole.	3
	- Students believe that the hydrostatic pressure is greater when it is near a closed hole.	3
	- Siswa meyakini bahwa tekanan hidrostatis lebih besar pada rongga yang lebih sempit. Students believe that the hydrostatic pressure is greater in the narrower hole.	3
Explaining the hydrostatic preassure is proportional to the density of the fluid.		
2	- Students believe that the hydrostatic pressure is inversely proportional to the density of the fluid.	4
	- Students believe that the hydrostatic pressure is proportional to the mass of the object.	4
	- Students believe that the hydrostatic pressure is inversely proportional to the mass of the object.	4

Table 2. The Grouping Criteria of Students' Conception Based on Three-tier Diagnosis Test

Students' Response						Category	Code
Answer	**Code**	**Reason**	**Code**	**Conviction**	**Kode**		
True	B	True	B	Sure	Y	Mastering the concept	MK
True	B	False	S	Sure	Y	Misconception	M
False	S	True	B	Sure	Y	Misconception	M
False	S	False	S	Sure	Y	Misconception	M
True	B	True	B	Not sure	TY	Guessing, lack of confidence	TK
True	B	False	S	Not sure	TY	Not know the concept	TT
False	S	True	B	Not sure	TY	Not know the concept	TT
False	S	False	S	Not sure	TY	Not know the concept	TT

diadaptasi dari Arslan *et al*. (2012)

A Diagnosis in the indicator Explains that Hydrostatic Pressure is Influenced by Depth and All Points in the Horizontal Container in the Calm Fluid has the Same Hydrostatic Pressure

The question items to diagnose the students' misconceptions in the indicators are influenced by depth and all points located in the horizontal container in a calm liquid has the same hydrostatic pressure is presented in Figure 1, 2, and 3.

On the hydrostatic quention item in holes in the ground are presented in Figure 1 and the distribution of students' answers are presented in Table 3. The right answer on these items is the choice of answers D and the exact reason the choice of answers C. Based on these data; it appears that 30.4% of students master the concepts included in the category of hydrostatic pressure in a straight line on a similar fluid has the same mass. Mostly in the categories do not know the concept of which are 43.5% and 26.1% indicated misconceptions.

The students who are indicated have misconceptions in the question items in figure 1 are: 1) the student believes the hydrostatic pressure has a greater value in a narrow place by 13.1%, 2) the students experienced an error in determining the depth of 13%. The diagnosis is in line with the findings of the study from Besson (2004) which states that the hydrostatic pressure in a narrow place / container then the hydrostatic pressure will be greater, while the results of Goszewski et al. (2012) reported that students tend to have misconceptions in determining the depth in case of hydrostatic pressure.

On the question items of hydrostatic pressure for a fish which is inside and outside the cave are presented in Figure 2 and the distribution of the responses are presented in Table 3. In the question on the second image the right anwer choice is A and the right reason of answer choice is B. Based on these data seem that only 21.7% of students included in the category of knowing the concept of hydrostatic pressure in a straight line on a similar fluid has the same mass. Most of the categories do not know the concept of 39.1%, 34.8% which are indicated to have misconceptions, and 4.3% to guess or lack of confiction.

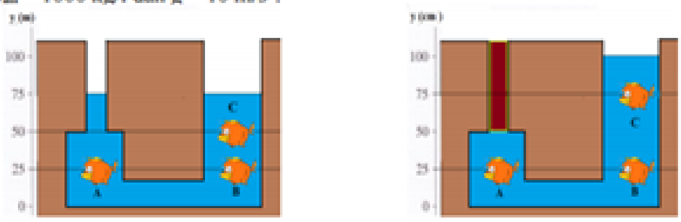
The students who indicated to have misconceptions on question items in the Figure 2, namely: 1) the students believe that hydrostatic pressure is greater at the outside of the cave because it has a larger volume so the pressure is higher (17.4%), 2) the students believe that the hydrostatic pressure at the outside of the cave is larger because the water is more freely so that the pressure becomes smaller (8.7%), 3) the students believe that the fluid is more concentrated when in a place, which is denser / narrower then the hydrostatic pressure becomes larger (4.3%), 4) the students believe that the depth of hydrostatic pressure is measured from the bottom of the fluid (4.3%). The diagnosis is consequence with the findings of recent research: 1) the hydrostatic pressure is proportional to the volume of fluid that is around the fish, 2) Beson (2004) at the outdoor, the air is free, so the hydrostatic pressure becomes smaller and at smaller place the water is more compressed.

On the question items of hydrostatic pressure, the points of the container which have open and close is presented in Figure 3 and the distribution of the responses are presented in Table 3. In Figure 3, the question items on the correct answer is D and the right reason of choice is A. Based on these data, it appears that only 21.7% of students are included in the category of knowing the concept of hydrostatic pressure in a straight line on a similar fluid has the same mass. At the categories who do not know the concept are 26.1%, 47.8% indicated as misconceptions, and 4.3% as guessing / do not convince with their answers. The students who are indicated having misconceptions on the question items in Figure 3, namely: 1) students believe that hydrostatic pressure is greater as it is closer to the point of closed hole (43.5%), 2) the students believe that the hydrostatic pressure in the narrower place

Table 3. The students' concept distribution on the hydrostatic pressure concept

Students' Response	Code	Question 1		Question 2		Question 3		Question 4		Number	
Answer Reason Conviction		N	%	N	%	N	%	N	%	N	%
Mastering the concept	PI	7	30,4	5	21,7	5	21,7	4	17,5	21	22,8
Do not know the concept	TP	10	43,5	9	39,1	6	26,1	11	47,8	36	29,1
Misconception	M	6	26,1	8	34,8	11	47,8	8	34,7	33	35,9
Lucky guesses/not so convice	KP	0	0	1	4,3	1	4,3	0	0	2	2,2
		23	100	23	100	23	100	23	100	92	100

Ikan A, ikan B, dan ikan C masing-masing bermassa 2 kg berada di kedalaman seperti pada gambar 1.1, kemudian sebuah balok besar ditempatkan pada celah di atas ikan A sehingga permukaan air di atas ikan A mengalami penurunan dan permukaan air di atas ikan B dan ikan C mengalami kenaikan permukaan air, lalu air menjadi tenang kembali, posisi ikan A dan ikan B tetap sejajar dan tidak berpindah dari posisi awal kecuali hanya ikan C yang berpindah seperti pada gambar 1.2, jika diketahui ρ_{air} = 1000 kg/l dan g = 10 m/s^2.



Gambar 1.1 Gambar 1.2

Dari pernyataan di bawah ini mana yang tepat berdasarkan gambar 1.2…

a. Ikan A merasakan tekanan dari air lebih besar daripada ikan B dan C.
b. Ikan B merasakan tekanan dari air lebih besar daripada ikan A dan C.
c. Ikan C merasakan tekanan dari air lebih besar daripada ikan A dan B.
d. Ikan A dan B merasakan tekanan dari air yang sama besar.
e. Ikan A dan C merasakan tekanan dari air yang sama besar.
f. Ikan A, B, dan C merasakan tekanan dari air yang sama.

Alasan:

a. Ikan A berada di tempat yang lebih sempit sehingga tekanannya lebih besar.
b. Ikan B berada pada posisi 75 cm dari permukaan air.
c. Ikan A dan ikan B berada pada garis horisontal yang sejajar.
d. Ikan A memiliki jarak 25 cm dari penutup dan ikan C memiliki jarak 25 cm dari permukaan air.
e. Ikan A terletak paling jauh dari permukaan air.
f. Ikan A, B, C berada pada fluida yang sama.

Apakah kamu yakin?

a. Ya.
b. Tidak.

Figure 1. The hydrostatic pressure in the holes of the ground question items

makes it larger (4.3%). The diagnosis is in line with the findings of several recent research: 1) Besson (2004) hydrostatic pressure will be larger at a closed hole, 2) Kariotoglou & Psillos (1993) hydrostatic pressure at the narrow container has a narrow greater pressure.

The Diagnosis on the Indicators Explain that Hydrostatic Pressure has the Similar Density as Fluid

The Question items to diagnose the student has misconceptions on the indicators of hydrostatic pressure is proportional to the density of the fluid is presented in Figure 4. The distribution of the students' answers is presented in Table 3. The answer in Figure 4 which is the right answer is A and the right reason at the answer is C. Based on the data shows that only 17.4% of students are included in the category of knowing the concept of hydrostatic pressure is influenced by the density of the fluid. Most of the students are in the category of do not know the concept 47.8% and 34.7% indicated misconceptions.

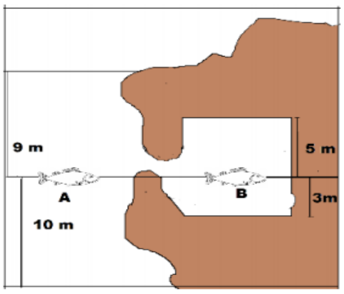
The misconception that indicated in students within the question items in Figure 4 are 1) the students believe that the hydrostatic pressure is proportional to the density of the submerged object which amounted to 30.4%, 2) students believe that hydrostatic pressure is inversely proportional to the density of the submerged object of 4.3.

CONCLUSION

Based on the results and explanation as described before, it can be concluded that based on the diagnosis by using Three-tier methods, there are students who indicated are having misconceptions associated to hrydrostatic pressure, covering the indicators which is explain the hydrostatic pressure that influenced by the depth and all points located in the horizontal place in a calm liquid has the same hydrostatic pressure and indicators explain the hydrostatic pressure is proportional to the density of the fluid was found that as many as 22.8% of students in mas-

Dilakukan pengamatan terhadap ikan A bermassa 2 kg yang berada di luar gua dan ikan B bermassa 2 kg yang berada di dalam gua, seperti pada gambar 6.1. Diketahui ρ_{air} = 1000 kg/l dan g = 10 m/s^2. Pengamat tersebut ialah Ahmad, Bertus, dan Gedhe. Hasil pengamatan masing-masing pengamat yaitu:

Pengamat	Hasil Laporan
Ahmad	Tekanan hidrosatis ikan A > ikan B
Bertus	Tekanan hidrostatis ikan A < ikan B
Gedhe	Tekanan hidrostatis ikan A = ikan B



Gambar 6.1

Dari ketiga laporan tersebut yang mempunyai hasil laporan yang benar adalah…

a. Gedhe, Ikan A dan B merasakan tekanan yang sama besar dari air danau.
b. Ahmad. Tekanan ikan A > ikan B.
c. Bertus,. Tekanan ikan A < ikan B.

Alasan:

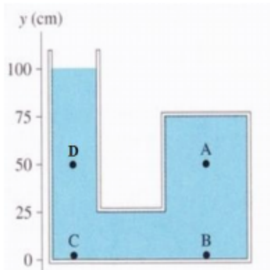
a. Ikan A berada di luar gua mempunyai meter kubik air yang lebih banyak sehingga tekanannya lebih tinggi.
b. Ikan A dan ikan B terletak pada satu garis horizontal yang sejajar.
c. Ikan B berada di dalam mempunyai air yang lebih terkonsentrasi ketika di tempat yang lebih rapat.
d. Ikan A merasakan tekanan dari air danau yang berada pada kedalaman 10 m dari dasar permukaan air.
e. Ikan A berada di luar gua karena air yang berada di luar gua lebih bebas sehingga tekanannya lebih kecil.

a. Yakin.
b. Tidak.

Figure 2. The question items of hydrostatic pressure of the fish inside and outside of the cave

Sebuah wadah yang terbuka pada salah satu sisinya ditunjukan pada gambar 4.1. Jika wadah tersebut berisi cairan yang bermassa jenis 100 kg/m^3, maka pernyataan di bawah ini yang benar adalah…

a. Tekanan hidrostatis di titik D dan A sama serta lebih besar dari titik C dan B.
b. Tekanan hidrostatis di titik A paling besar.
c. Tekanan hidrostatis di titil D paling besar.
d. Tekanan hidrostatis di titik C dan D sama serta lebih besar dari titik A dan D.



Gambar 4.1

Alasan:

a. Dalam posisi horisontal yang sejajar.
b. Paling dekat dengan rongga yang tertutup.
c. Paling dekat dengan rongga yang terbuka.
d. Terletak pada rongga yang lebih sempit.
e. Terletak pada rongga yang lebih luas.

Apakah kamu yakin?

a. Yakin.
b. Tidak.

Figure 3. The question items of hydrostatic pressure in a container which has open and close holes

tering the concept category, 39.1% did not know the concept, while 35.9% indicated experiencing misconceptions, and the balance of 2.2% in the category of guessing or less convince than a total of 23 students who took the tests.

The type misconceptions that often happend in this study are: 1) students believe that hydrostatic pressure is greater at a point closer to the closed hole (43.5%), 2) students believe that hydrostatic pressure is proportional to the density of the submerged object (30.4%), 3) the students believe that the hydrostatic pressure is greater outside of the cave because it has a larger volume of fluid so that the pressure is higher (17.4%), 4) the students have misconceptions in determining the depth in case of hydrostatic pressure (13 %), 5) the students believe that the hydrostatic pressure is greater in a narrow place (13%).

To prevent the misconceptions in students, researchers suggest to the reader as well as further research for the diagnosis of misconceptions before proceeds a learning process to the students, misconceptions that have grown need a further evaluation on the sources causes of misconcep-

Hasil praktikum kimia yang dilakukan Andi adalah sebagai berikut:

Jenis Zat	Massa jenis (g/cm^3)
Alumunium	2,70
Besi	7,86
Air laut	1,25
Air danau	1,00

Berdasarkan tabel di atas, maka pernyataan di bawah ini yang tepat ialah…

a. Besi memiliki tekanan hidrostatis lebih besar daripada almunium ketika dicelupkan ke dalam air laut.
b. Almunium yang dicelupkan dalam air danau memiliki tekanan hidrostatis lebih besar daripada almunium yang dicelupkan pada air laut.
c. Almunium memiliki tekanan hidrostatis lebeih besar daripada besi ketika dicelupkan dalam air laut.
d. Besi yang dicelupkan dalam air laut memiliki tekanan hidrostatis lebih besar daripada besi yang dicelupkan dalam air danau.

Alasan:

a. Tekanan hidrostatis berbanding lurus dengan massa jenis benda yang tercelup.
b. Tekanan hidrostatis berbanding terbalik dengan massa jenis benda yang tercelup.
c. Tekanan hidrostatis berbanding lurus dengan massa jenis fluida.
d. Tekanan hidrostatis berbanding terbalik dengan massa jenis fluida.

Apakah kamu yakin dengan jawaban yang kamu berikan?

a. Yakin.
b. Tidak.

Figure 4. The question items of hydrostatic pressure on the laboratorium data results

tions caused by students and other sources such as teachers, learning methods, textbooks, and reference books, doing a diagnosis research of misconceptions in other materials as well as efforts to overcome the misconception that indicated on the students, doing similar research by using more samples, so the results are more accurate.

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