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ANALYSIS OF MISCONCEPTIONS IN VIEW OF GENDER DIFFERENCES IN CHEMISTRY LEARNING

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Abstract: Misconceptions refer to students' incorrect understanding of a concept, which can lead to difficulties in problem-solving activities. This study aimed to examine the misconceptions of high school students regarding gender differences. The research was conducted in a selected high school, using a purposive sampling technique to select a class with above-average academic achievement. The research used a quantitative descriptive method and analyzed the data using GRM scoring. The findings showed that the average percentage of misconceptions held by students in all competency indicators was 28% for females and 22% for males. Misconceptions were found in all four competency indicators for buffer solution materials, including explaining the meaning of components, the working principle of buffer solutions, the role of buffer solutions in everyday life, and calculating the pH of buffer solutions. The highest percentage of misconceptions for both females and males was found in the first competency indicator, with 47% and 56%, respectively.

Keywords: Analysis, gender, buffer solutions, misconceptions

INTRODUCTION

Learning activities are learning processes that take place inside and outside the classroom that involve the role of the teacher and students, with the ultimate goal being to achieve student learning success (Mahmudah, 2018). This is to Piaget's learning theory, known as the Constructivism theory that this learning activity can automatically construct or build a child in assimilating and accommodating their thoughts (Waseso, 2018). This assimilation activity aims to develop cognitive learners in integrating their new experiences, while accommodation is the real action of students in dealing with stimulants given by the teacher (Ibda, 2015; Wijayanti & Basyar, 2016). Changes in behavior and thoughts experienced by students due to the teacher's provision of stimuli/stimulants are the same, as the nature, structure, and chemical compounds will change if a reaction or energy is released (Sulastri & Rahmadani, 2017).

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Chemistry is a subject that is hierarchical and has characteristics that have high complexity. The concepts studied are abstract and comprehensive because it consists of three representations that students must master, namely symbolic, macroscopic, and submicroscopic, in explaining chemical phenomena that occur in everyday life (Effendy, 2012; Isnaini & Ningrum, 2018). So that students are required to have comprehensive knowledge of studying chemistry. Thus, many of them experience difficulties accepting chemistry learning, resulting in students' diverse understanding of chemical concepts. This difference in concept causes a deviation or incompatibility of the concepts possessed by students (new concepts) with the proper concepts. This deviation is commonly known as a misconception (Antari et al., 2020).

The misconception is a deviation that occurs in students in providing interpretations of concepts and their application. This interpretation has a different understanding of the concept from the initial concept (Sofia et al., 2021). Misconceptions that occur and are experienced by students can be caused by several factors, such as: 1) the basic abilities possessed by students are still lacking because they do not repeat the material that has been studied; 2) the interest in learning chemistry is still very low because they think that chemistry is difficult; 3) students have the habit of memorizing and just remembering in studying chemistry, without any understanding of the concept; 4) there is a deviation from understanding the new concept with the proper concept (Barke et al., 2009; Djarwo, 2013).

Misconceptions occur at all grade levels and are experienced by most students. Learning methods that are still traditional cannot be used to eliminate misconceptions. An effective method for eliminating misconceptions is to use the constructivism method. In addition to constructivist learning methods, it is also necessary to pay attention to the dominance of student learning styles in learning activities so that students can overcome and minimize misconceptions (Majid et al., 2018; Üce & Ceyhan, 2019).

Based on the results of students at SMA Negeri 1 Colomadu, it was found that the problems found in the field were influenced by students' lack of understanding of the chemistry material given by the teacher, causing their level of understanding to be still low and there was even the possibility that they might

experience misconceptions. The chemical material in question is Buffer Solution. This is in line with previous research regarding misconceptions about buffer solutions using the Two Tiers Choice diagnostic test instrument (Antari et al., 2020).

Misconceptions cannot be eliminated but can be addressed and detected early. The way to detect misconceptions experienced by students includes using a diagnostic test instrument in the form of TTMC (Chandrasegaran et al., 2013). TTMC is a type of test that consists of 2 tiers (tier 1 and tier 2). Tier 1 contains the contents of the questions or main questions, while tier 2 contains the reasons for the tier 1 answers. Tier 2 is used as a basis for detecting misconceptions experienced by students (Adodo, 2013).

Gender is known as sex, a basic element derived from the human self-concept and our identity (Sears et al., 2015). Biologically, gender is divided into two, namely men and women. This difference occurs due to genetic factors found in human chromosomes. Genes on the X chromosome function as a form of human cognition and are closely related to intelligence. This difference is due to the X chromosome genes' performance involving the functions found in the organs of the human brain (Relawati, 2021), so the difference in intelligence between girls and boys lies in the performance of the X chromosome gene carried by each parent.

Girls tend to spend their time only doing activities in the room, resulting in mental formation within girls, including verbal through radio and television. Thus, girls are often not dependent on time but depending on room conditions. Unlike the case with boys, they prefer to spend their time exploring everything outdoors. Such as playing in the field with their peers, designing their games, and exploring more of their visual skills than verbal skills in completing each job so that boys are more dominant in improving visual, spatial, and temporary abilities compared to verbal.

This difference ultimately affects their existence in school. Female and male students always have significant differences in the school environment both in terms of (academic) and non- academic achievements. Female students are often involved in terms of gender roles and achievements, while male students prefer to explore their abilities by organizing (Ali, 2019).

Research on misconceptions in several chemistry lessons has been carried out, including identifying misconceptions about acid-base material, chemical equilibrium, atomic structure, chemical

bonds, and redox concepts (Afifah et al., 2021; Drastisianti et al., 2018; Isminiarti Izza et al., 2021; Qurrota & Nuswowati, 2018; Satriana et al., 2018). Research on buffer solution materials has not been widely carried out (Antari et al., 2020; Pongkendek & Kristyasari, 2021); even an analysis of misconceptions about buffer solution materials based on gender differences has never been carried out.

Research on gender differences existed before, but the analysis focused on scientific literacy, not misconceptions (Kristyasari et al., 2018). Based on field observation data and relevant research above, the majority of research is to identify students' misconceptions as a whole, the renewal of this research is to identify students' misconceptions regarding gender differences in chemistry learning.

METHOD

The design used in this research is quantitative descriptive, which aims to describe the condition of students based on gender objectively by using numbers starting from data collection, interpretation, appearance, and results (Arikunto, 2012). The place and time research was conducted at Public High School, in Sukoharjo. The sampling technique used purposive sampling, considering that the number of classes was limited; namely, there were only two classes, so classes with high average learning outcomes were used.

The research used eleventh grade students in a science program as the population, with a sample size of 35 students. To measure the data, a test was used with the Two-Tier Multiple Choice (TTMC) instrument, consisting of 15 questions. The data was analyzed using the Graded Response Model (GRM) method, which is a scoring guide that uses the Logistic Parameter model for Likert-scale multilevel responses. This method helps to determine the level of difficulty or misconception diagnosis on a continuum line. The scoring model used for determining the students' answer patterns and categories can be found in Table 1.

Table 1. GRM scoring model

Assessment Aspect	Score	Misconception Levels
*T*ier 1 and *T*ier 2 False	0	Don't understand the concept
*T*ier 1 False and *T*ier 2 True	1	Misconception
*T*ier 1 True and *T*ier 2 False	2	Misconception
*T*ier 1 dan *T*ier 2 True	3	Understand concept

The percentage calculation obtained is then categorized using the misconception category guidelines (Siwi, 2013), which are listed in Table 2.

Table 2. Misconception category

Criteria	(%)
High	61-100
Moderate	31-60
Low	0-30

RESULT AND DISCUSSION

Result

The results of this study were to analyze students' misconceptions regarding gender differences at Colomadu 1 Public High School, Sukoharjo. The questions used in identifying and analyzing these misconceptions are in the form of a TTMC assessment instrument. The researchers developed the TTMC instrument consisting of 15 items spread across four competency indicators. The distribution of questions based on competency indicators can be seen in Table 3.

Table 3. Competency indicators

Competency Indicator	Question number
Explain the meaning and components of a buffer solution	1,2,4,5,6,7,12,13
Explain the working principle of buffer solutions	3,8,9
Explain the role of buffer solutions in everyday life	10,11
Calculate the pH of a buffer solution	14,15

The distribution of the questions was unbalanced in terms of number, and this was because the researcher saw an indication that students at SMA Negeri 1 Colomadu, Sukaharjo, had misconceptions about indicator 1. Judging from the results of their low learning achievement on this indicator, the researcher wanted to identify and analyze the percentage level of students' misconceptions in each competency indicator. The results of these misconceptions are shown in Table 4.

Table 4. Percentage of misconceptions on competency indicators

Competency Indicator	(%)	
	Male	Female
Explain the meaning and components of a buffer solution	56	47
Explain the working principle of buffer solutions	11	23
Explain the role of buffer solutions in everyday life	13	19
Calculate the pH of a buffer solution	9	21

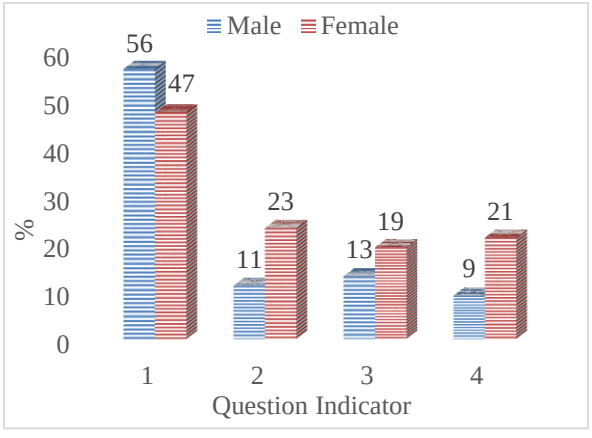

Figure 1. Total percentage of misconceptions on competency indicators.

DISCUSSION

The results of the misconception analysis conducted on 35 students, consisting of 13 male and 22 female students, showed clear differences in each material competency indicator. The total competency indicators selected in the buffer solution material are four indicators. Based on the data presented in Table 4, male students clearly excel in understanding concepts in the second, third, and fourth indicators of competency in buffer solution material. Female students only excel in understanding concepts in the first indicator due to the genetic nature of women who have superiority in the field of verbal, so on indicators regarding understanding and components regarding buffer solutions, female students experience fewer misconceptions than male students. Male students have more mastered indicators related to activities in the field, such as working principles and the role of buffer solutions and calculations.

This can also be seen from the average percentage of misconceptions obtained from the two genders of students. Male students have fewer misconceptions than female students, namely 22%. In comparison, students have an average percentage of misconceptions of 28%, so it can be concluded that male students have a good conceptual understanding of chemical material, especially buffer solutions, than female students; this is consistent with gender research that has been conducted by previous researchers which stated that the ability of male students in calculation indicators is superior to the abilities of female students (Kristyasari et al., 2018) even though the percentage difference between the two is very small the misconceptions experienced by all students are in the medium category with a range of 22% -28%. The superior ability of male students to understand chemistry learning is to previous research related to misconceptions in mathematics. Research (Ramadany, 2020) states that in mathematics, male students do not experience misconceptions, while female students experience misconceptions.

This happens because boys have higher non-verbal abilities, such as math and visual skills, than female students. Previous research has shown that male students dominate mathematical abilities (calculations), visual abilities, and field exploration (Ikram et al., 2018; Kristyasari et al., 2018; Ramadany, 2020). However, in physics material related to understanding without calculation, male students experience the highest misconceptions compared to female students. This is

because female students prefer anti-social things, such as activities in the room. So that causes girls to only excel in material that contains only memorization, communication, and verbal (Ali, 2019). From the results of this study, both the average percentage of male and female students' misconceptions in each competency indicator and as a whole, it can be concluded that the use of appropriate and innovative strategies in learning activities, both from the selection of models, methods, modules, and even assessment instruments can minimize differences. Gender in the misconceptions experienced by students can even correct student misconceptions from an early age.

CONCLUSION

Based on the results of research on the analysis of students' misconceptions in terms of gender differences in chemistry learning sequentially, the percentage of students misconceptions was obtained, 22% male and 28% female, while in terms of material competency indicators, male and female students experienced misconceptions the largest in the first indicator that is as much as 56% and 47%.

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