Analysis of Misconceptions on Reproductive System Material in Class XI IPS 2 Students of SMA Negeri 6 Madiun

Jevi Milda Rahmawati[1*], Ima Agung Nurcahyo [2], Cicilia Novi Primiani [3]

[1]Teacher Professional Education Department, Faculty of Teacher Training and Education, Universitas PGRI Madiun. Jl. Setiabudi No. 85, Madiun 63118, Jawa Timur, Indonesia

[2]SMA Negeri 6 Madiun. Jl. Suhud Nosingo No. 1 Madiun 63132, Jawa Timur, Indonesia

[3]Teacher Professional Education Department, Faculty of Teacher Training and Education, Universitas PGRI Madiun. Jl. Setiabudi No. 85, Madiun 63118, Jawa Timur, Indonesia

[*]Corresponding Author. E-mail address: primiani@unipma.ac.id

ABSTRACT

Conceptual understanding forms the basis of an important component in mastering higher-order thinking skills. This ideal condition is not in accordance with the fact that there are still many students who experience misconceptions. This study aims to determine the level of misconceptions that occur in students of class XI IPS 2 SMA Negeri 6 Madiun. The research method used in this study is descriptive-quantitative with survey techniques. The sample used was 34 students. The results of this study were that 64.7% of students did not understand the process of birth or gestation, 61.8% did not understand the stages of embryo development, 58.8% did not understand the stages of the ovarian cycle, 67.6% experienced misconceptions about the types of material contraception, 52.9% had misconceptions about reproductive system disorders sub-material, 48.5% had misconceptions about oogenesis stages sub-material, 41.2% understood reproductive system disorders sub-material, 38.2% understood spermatogenesis stages sub-material (38.2%), and 38.2% understood the benefits of breastfeeding for mothers and babies.

1. INTRODUCTION

Cross-interest subjects are included in the 2013 curriculum. Students from the Natural Sciences, Social Sciences, and Languages groups can take other subjects from other disciplines in which they are interested (Permendikbud 2018). The selection of free cross-interest subjects is determined by each student (Herpanda and Nirwana 2022; Kementerian Pendidikan dan Kebudayaan 2018), but in order to be more focused and useful for career development, the determination of cross-interest subjects is usually assisted by a counseling teacher (Herpanda and Nirwana 2022).

Biology is a cross-interest subject for groups of students specializing in social sciences at SMA Negeri 6 Madiun. The determination of cross-interest subjects is based on the results of counseling on students conducted by guidance counselors (results of interviews with biology teachers at SMA Negeri 6 Madiun). The application of cross-interest learning has a good purpose, namely to develop the interests and talents of students outside the main specialization (Permendikbud 2014).

Biology, which is the chosen subject across the interests of the IPS specialization program, is a branch of knowledge required in several professional work fields. Mastery of biology will direct students to understand environmental conditions, increase awareness of various health issues (Baram-Tsabari et al. 2010; Chavan and Patankar 2018), and train other scientific skills (Chavan and Patankar 2018). Some people think biology is a branch of science that is easy to learn, but the fact is that it is not so. Biology contains a lot of material that is abstract and invisible to the eye,

contains many foreign terms, and is related to material from other branches of science (Çimer 2012).

The reproductive system is a sub-material contained in biology material for class XI in the 2013 curriculum, which is contained in Basic Competency (KD) 3.12, 4.12, 3.13, and 3.13 (Kemdikbud 2018). Based on these regulations, it is known that the achievements that must be mastered by students are that they must be able to analyze the structure of the reproductive organ network with their functions, analyze the application of the reproductive system in humans, analyze exclusive breastfeeding programs, and analyze family planning (KB) programs. The results of being able to analyze are categorized as high-order thinking skills (Yani, A. & Mulyadi 2022). These skills can be mastered when students have a good understanding of concepts (Cindiati 2021). However, the fact is that many students have poor understanding of concepts, or what are called misconceptions.

A misconception is a condition of understanding an individual that is not in accordance with generally accepted scientific agreements (Galvin and Mooney Simmie 2015). Several studies have shown that misconceptions occur in many biological materials, such as cell biology material (Suwono et al. 2021), the reproductive system (Ardiyanti and Rahmawati Utami 2018; Hasyim et al. 2018), archaebacteria and eubacteria (Kurniasih and Haka 2017), genetics (Wulandari et al. 2021), as well as viruses and bacteria (Zulfia et al. 2019). Misconceptions have a negative impact on the learning process, mainly hindering understanding of related material (Nakhleh 1992).

Understanding concepts or material has an important role in determining student learning outcomes. Based on previous research, it is known that understanding concepts has a significant influence on student learning outcomes (Nastiti & Syaifudin, 2020). This statement also applies within the scope of biology, which contains facts, concepts, principles, attributes, and theories that are interrelated with one another. If the wrong concept occurs within the scope of biology, it will affect student learning outcomes (Chavan & Patankar, 2018).

Misconceptions can be detected in various ways, namely using two-tier instruments (Ardiyanti and Rahmawati Utami 2018; Kurniasih and Haka 2017), three-tier instruments (Hasyim, 2018; Zulfia, 2019), and four-tier instruments (Wulandari et al. 2021). Misconception analysis using two tiers is the simplest and easiest to use (Kurniasih and Haka 2017). The addition of a second level (tier) will make students more careful in choosing their answers (Yusrizal and Halim 2017) and stimulate them to think at a higher level (Maulita et al. 2019). Misconception research needs to be done because it can be used to understand misunderstood concepts and explore problems. The results of this study can be used as a basis for determining appropriate improvement strategies going forward (Andariana et al. 2020; Chavan & Patankar 2018; Desstya et al. 2019).

Based on the background above, this study aims to analyze the level of misconceptions among students in class XI IPS 2 at SMA Negeri 6 Madiun. The instrument used in this study consisted of two tiers of reproductive system material. It is hoped that the results of this study can be used as a reference for teachers to determine the right steps to overcome these misconceptions.

2. MATERIALS AND METHODS

2.1. Research Design

The type of research used is descriptive quantitative with survey techniques. The purpose of this study is to provide information about the level of misconceptions that occur in a group. Group determination was carried out using a purposive sampling technique. The selected group then took a multiple-choice test regarding the reproductive system. The results of the test work were analyzed by grouping them according to the category of misconceptions that can be seen in Table 1. Then the grouping results were analyzed for percentages to find out the number of students who had misconceptions about the reproductive system material.

2.1.1. Population & Samples

The population used in this study was 100 students in class XI Social Studies, SMA Negeri 6 Madiun. The sample used in this study was 34 students in class XI IPS 2. The sample selection

technique used is simple random sampling. This technique was chosen because the third class has relatively the same cognitive value, so random sample selection can still represent the entire population.

2.1.2. Instruments

The instrument used in this study was 15 two-tier multiple-choice questions. The questions contained reproductive system material that had been internally validated (construction validation) by material experts. Construction validation results must be 100% so that they can be used. Furthermore, the questions were tested on 69 class XI MIPA students who had studied reproductive system material. The trial was used as external validation. The trial results were analyzed using ANATES. The results of the analysis show that the overall correlation value of XY items is 0.78 and the reliability value is 0.88. Of the 15 questions, there were four that were omitted because the results of the item analysis were not significant. The omitted questions are questions numbers 1, 3, 9, and 15.

2.1.3. Procedures

The stages carried out in this study were: 1) the preparatory stage, including determining the sample, developing questions, conducting construct validation, and external validation; 2) The implementation stage is giving questions that have been tested for construct validation and external validation to students in class XI IPS 2 on April 3, 2023; 3) The analysis stage is to analyze the data on the results of students' answers using Microsoft Excel to find out the level of misconceptions. The following is an example of questions tested on students to analyze the level of misconceptions that can be seen in Table 1.

Tabel 1. Examples of questions tested for students

No	Indicators of Competence Achievement	Question	Cognitive Level
1	Analyze the stages of oogenesis	*Tier 1*: Five Class XI students had a discussion about the process of oogenesis. They have different opinions: • Sandy: Oogenesis produces 1 ovum cell and 2 polar bodies • Rina: The process of oogenesis goes through the stages of mitosis and amitosis; • Rafi: The process of oogenesis goes through the stages of mitosis and meiosis; • Vinka: The process of oogenesis produces primary oocyte cells through meiotic division • Mifta: The process of oogenesis produces secondary oocyte cells through mitotic division The following is the most appropriate statement made by….. a. Sandy b. Rina c. Rafi d. Vinka e. Mifta **Key answer: c** *Tier 2*: The reason you chose the answer above is….. a. Oogenesis occurs through mitotic division, which produces primary oocytes, and meiotic division, which produces 1 ovum cell and 3 polar bodies	C4

	b. Oogenesis occurs through mitotic division, which produces secondary oocytes, and meiotic division, which produces 1 ovum cell and 3 polar bodies c. Oogenesis occurs through mitotic division, which produces primary oocytes, and meiotic division, which produces four ootid cells d. Oogenesis occurs through mitotic division to produce secondary oocytes and meiotic division to produce 4 ootid cells e. Oogenesis occurs through mitotic division, which produces secondary oocytes, and meiosis 1 division, which produces 1 ovum cell and 3 polar bodies. **Key answer: c**	
2	*Tier 1*: Analyze the following statements and reasons: Oogenesis will stop after approximately 500 cycles **Because** The ovaries lose their response to the hormones FSH and LH, which have implications for low production of the hormone estrogen a. Statement is correct, reason is correct, and related; b. Statement is correct, reason is correct, and unrelated; c. Statement is correct, reason is wrong; d. Statement is wrong, reason is right; e. Wrong statement, wrong reason **Key answer: a** *Tier 2*: The following statements are true and related to the above problems, namely: a. The oogenesis stage begins after entering puberty; b. The oogenesis stage completes its mitotic stage shortly after birth; c. The oogenesis stage stops its mitotic stage before the birth process; d. The oogenesis stage completes its meiosis stage before the birth process; e. The oogenesis stage completes its meiosis stage shortly after birth **Key answer: c**	C4

2.1.4. Data Analysis

The results of the students' answers were analyzed and categorized based on the pattern of the answers to determine the level of misconceptions. Misconception categories are in Table 2.

Tabel 2. Misconception Determination Category

No	Student Answer Patterns	Category
1	B – B (The first-tier answers are correct, and the second-tier answers are correct)	Understand
2	B – S (The first-tier answers are correct, and the second-tier answers are false)	Misconception
3	S – B (The first-tier answers are false, and the second-tier answers are correct)	Misconception
4	S – S (The first-tier answers are false, and the second-tier answers are false)	Not Understand

Source: (Stephanie, 2019)

3. RESULTS AND DISCUSSION

3.1.Result

This research uses 11 two-tier questions that have been tested for validity and reliability. These questions include indicators analyzing the stages of spermatogenesis, analyzing the stages of oogenesis, analyzing the ovarian cycle, analyzing the process of pregnancy, analyzing the process of birth or gestation, analyzing the benefits of breastfeeding for mother and baby, analyzing types of reproductive system disorders, and analyzing types of contraceptives. The following is the result of the analysis of determining the category of misconceptions for each item of question, which can be seen in Table 3.

Tabel 3. Misconception Determination Analysis

Question Number	Misconception Determination Category Analysis	Amount	Percentage
1	Not Understand	19	55,8%
	Misconception	14	41,2%
	Understand	1	3%
2	Not Understand	12	35,3%
	Misconception	17	50%
	Understand	5	14,7%
3	Not Understand	20	58,8%
	Misconception	11	32,4%
	Understand	3	8,8%
4	Not Understand	21	61,8%
	Misconception	7	20,6%
	Understand	6	17,6%
5	Not Understand	22	64,7%
	Misconception	9	26,5%
	Understand	3	8,8%
6	Not Understand	9	26,5%
	Misconception	12	35,3%
	Understand	13	38,2%
7	Not Understand	9	26,5%
	Misconception	23	67,6%
	Understand	2	5,9%
8	Not Understand	6	17,6%
	Misconception	15	44,1%
	Understand	13	38,2%
9	Not Understand	12	35,3%
	Misconception	18	53%
	Understand	4	11,7%
10	Not Understand	12	35,3%
	Misconception	19	55,9%
	Understand	3	8,8%
11	Not Understand	7	20,6%
	Misconception	16	47,1%
	Understand	11	32,4%

The questions given to students in class XI IPS 2 consisted of 9 indicators, namely: 1) analyzing the stages of oogenesis (numbers 2 and 11), 2) analyzing the stages of spermatogenesis (number 8), 3) analyzing the ovarian cycle (number 3), 4) analyzing the process of pregnancy (numbers 1 and 9), 5) analyzing the stages of embryo development (number 4), 6) analyzing the process of birth or gestation (number 5), 7) analyzing the benefits of breastfeeding for mother and baby

(number 6), 8) analyzing reproductive system disorders (number 10), 9) analyzing types of contraceptives (number 7). The following is a graph of the analysis of the categories of student answers for each indicator, which can be seen in graph 1.
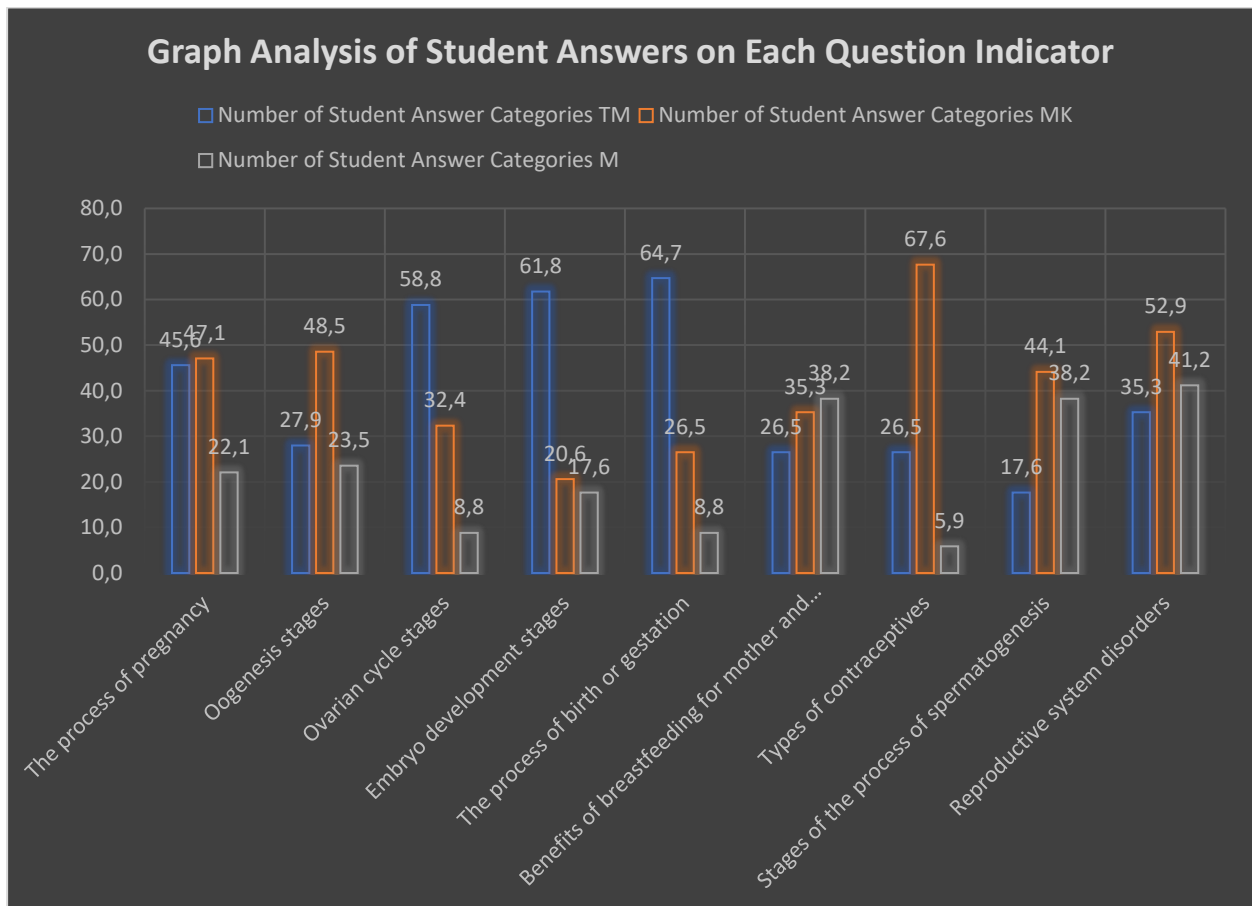

Fig. 1. Analysis of Student Answers on Each Question Indicator

From the graph above, it can be seen that there are three categories of student answers: not understanding (TM), misconceptions (MK), and understanding (M). The three concepts that students least understood were the process of birth or gestation (64.7%), the stages of embryonic development (61.8%), and the stages of the ovarian cycle (58.8%). The highest level of misconception occurred in the concept of types of contraception, namely 67.6%; reproductive system disorders, namely 52.9%; and the stages of oogenesis, namely 48.5%. The concepts that have the highest understanding are reproductive system disorders (41.2%), stages of spermatogenesis (38.2%), and the benefits of breastfeeding for mothers and babies (38.2%).

The definition of the misconception category is when students answer correctly (B) in the first tier and answer wrongly in the second tier, and vice versa. The first-tier questions relate to the second tier. If students can answer correctly on one of the tiers, then the answer is a guess, so it is categorized as a misconception. The following is an example of student answers, as seen in Table 4.

Tabel 4. Examples of Student Answers

Number of Participant	Question and Answer in Bahasa Indonesia	Question and Answer in English
2	i. Perhatikan pernyataan berikut ini: 1) Candidiasis 2) HIV 3) Gonorhea 4) Sifilis 5) Herpes Genitalia Gangguan system reproduksi yang disebabkan oleh bakteri yaitu….. a. 1 dan 2 ✗ 1 dan 3 c. 2 dan 3 d. 2 dan 4 e. 3 dan 5 . Alasan Anda memilih jawaban diatas yaitu….. a. Candidiasis dan dan HIV merupakan gangguan system reproduksi yang disebabkan oleh bakteri *Candida albicans* dan HIV ✗ Candidiasis dan dan Gonorhea merupakan gangguan system reproduksi yang disebabkan oleh bakteri *Candida albicans* dan *Neisseria gonorrhoeae* c. HIV dan Gonorhea merupakan gangguan system reproduksi yang disebabkan oleh bakteri HIV dan *Neisseria gonorrhoeae* d. HIV dan Sifilis merupakan gangguan system reproduksi yang disebabkan oleh bakteri HIV dan *Troponema pallidum* e. Gonorhea dan Herpes Genitalis merupakan gangguan system reproduksi yang disebabkan oleh bakteri *Neisseria gonorrhoeae* dan *Herpes simplex*	Note the following statements: 1) Candidiasis 2) HIV 3) Gonorrhea 4) Syphilis 5) genital herpes Disorders of the reproductive system caused by bacteria, namely a. 1 and 2 b. 1 and 3 c. 2 and 3 d. 2 and 4 e. 3 and 5 Answer key: b The reason you chose the answer above is….. a. Candidiasis and HIV are reproductive system disorders caused by Candida albicans and HIV bacteria b. Candidiasis and gonorrhea are reproductive system disorders caused by Candida albicans and Neisseria gonorrhoeae bacteria. c. HIV and Gonorrhea are reproductive system disorders caused by HIV and Neisseria gonorrhoeae bacteria d. HIV and Syphilis are reproductive system disorders caused by HIV bacteria and Troponema pallidum e. Gonorrhea and Genital Herpes are reproductive system disorders caused by Neisseria gonorrhoeae and Herpes simplex bacteria Answer key: b

3.2. Discussion

Based on the data above, it is known that the understanding of concepts related to reproductive system material in class XI IPS 2 SMA Negeri 6 Madiun is still low; that is, 64.7% of students do not understand the process of birth or gestation, and 67.6% of students experience misconceptions about the sub-material types of contraceptives. This is in line with previous research, which states that the highest misconceptions when learning human anatomy and physiology material occur in the reproductive system sub-material (Andariana et al. 2020). Material in the reproductive system is difficult to learn because the nature of the material is abstract (Çimer 2012; Wahyuni et al. 2019), it contains many foreign terms, and the scope of the content is so broad and deep that students have difficulty understanding it (Çimer 2012).

The highest misconceptions occurred in the sub-materials regarding types of contraception, reproductive system disorders, and the process of oogenesis. Understanding this sub-material requires students to be able to recognize images and functions of the reproductive organs. Students admit difficulties in memorizing foreign terms in the form of bacteria or viruses that cause reproductive system disorders. Students also have difficulty understanding the stages of the mitotic

and meiotic division processes that occur in the oogenesis stage. In addition, students also have difficulty distinguishing types of contraceptives that are hormonal, physical, or chemical in nature.

Reproductive system material is one of the scopes of biology material at the senior high school (SMA) level. The details of the concept in this material are deep and broad because it is the basic material needed by students when they are going to continue their studies in higher education in science programs. The implementation of biology as a cross-interest subject has not been regulated regarding differences in the depth of the material for social studies majors. Students in this department experience difficulties mastering the material. This is evidenced by the percentage of misconceptions on each indicator item, namely 67.6% on the concept of types of contraceptives. These results are higher than those in previous studies, namely only 32.5% on the concept of menstruation (Ardiyanti and Rahmawati Utami 2018). This condition is in accordance with previous research, which explains that the material of the reproductive system is very broad in scope, for example, in the oogenesis and spermatogenesis sub-materials. Many students know the definitions of mitotic and meiotic divisions, but are unable to identify gametes that are haploid or diploid (Kalas et al. 2013). Understanding the basic concepts regarding the processes of oogenesis and spermatogenesis will influence the understanding of subsequent concepts and problem solving (Sesli and Kara 2012).

Misconceptions about a material can be caused by many factors. Some of these factors include: teachers who do not master the material so that they convey inappropriate concepts (Chavan and Patankar 2018; Desstya et al. 2019; Sezen Vekli and Birinci Konur 2021; Zulfia et al. 2019); too much material coverage; the teacher's teaching style; the negative feelings and attitudes of students toward a material; the initial concept brought by students (Pane, K.M & Aina 2022), as well as the lack of sources of teaching materials or supporting media (Çimer 2012). This statement is supported by research results that explain that misconceptions are mainly influenced by students' initial knowledge obtained in the previous stage. They tend to maintain these perceptions when studying them in class (Pane, K.M & Aina 2022). In addition to the initial knowledge factor, it is also influenced by the ability of students (IQ). Students with low IQs need to get explanations repeatedly in order to be able to understand a concept (Ilmiah et al. 2020; Pane, K.M & Aina 2022).

Teacher factors contribute to the various causes of misconceptions. These causes include: 1) providing incomplete information to students so that they find it difficult to connect several concepts; and 2) the learning method used being inappropriate. The tendency for teacher-centered learning can cause students to get bored (Puspitasari and Yuliani 2020); the focus is split between writing and listening (Khairaty et al. 2018); and students tend to review notes, which are of temporary nature (Pane, K.M & Aina 2022). Discussion learning methods without reinforcement by the teacher can also cause students to have diverse perceptions of a material (Yulianti 2017). The textbook factor is also a cause of misconceptions. Textbooks that have been used so far often contain incomplete material, ambiguous language and analogies, and inappropriate or poor image quality (Pane, K.M & Aina 2022). Some of these causes were confirmed by students, namely: 1) students majoring in social studies had difficulty understanding too much biology material and had a lot of foreign terms; 2) students were used to learning in a teacher-centered way; 3) students did not have the motivation to study biology; they studied only to abort the obligation to fulfill cross-interest subjects; 4) there were very limited sources of teaching materials; and 5) lazy students have low literacy skills.

Based on this description, the results of this misconception analysis are expected to be a consideration for the school to pay attention to the quality of learning at school. Schools can carry out supervision activities for teachers so that teachers' skills in pedagogic mastery and content are better maintained, choose appropriate textbooks, or develop appropriate learning media (Chavan and Patankar 2018; Çimer 2012; Sezen Vekli and Birinci Konur 2021). With these efforts, it is hoped that the level of misconceptions can be reduced.

4. CONCLUSIONS

The implementation of cross-interest lessons in the form of biology in the social studies department encounters many obstacles, including understanding concepts. From the results of this study, it was found that 64.7% of students did not understand the process of birth or gestation, 61.8% of students did not understand the stages of embryo development, 58.8% of students did not understand the stages of the ovarian cycle, 67.6% of participants students experienced misconceptions about the types of contraceptives in the sub-material, 52.9% had misconceptions about the reproductive system disorders sub-material, 48.5% of students experienced misconceptions about the oogenesis stages sub-material, 41.2% of students understood the reproductive system disorders sub-material , 38.2% of students understood the sub-material of the stages of spermatogenesis (38.2%), and 38.2% of students understood the sub-material of the benefits of breastfeeding for mothers and babies. The profiling data was only carried out in one social studies major class. The existence of this data is expected to be a consideration for profiling other social studies classes so that the problem of misconceptions can be overcome.

5. ACKNOWLEDGMENTS

6. REFERENCES

Andariana, A., Zubaidah, S., Mahanal, S., and Suarsini, E. 2020. Identification of biology students ' misconceptions in human anatomy and physiology course through three-tier diagnostic test. 8(3): 1071–1085.

Ardiyanti, Y., and Rahmawati Utami, M. 2018. Identifikasi Miskonsepsi Siswa Pada Materi Sistem Reproduksi. *BIOSFER : Jurnal Biologi dan Pendidikan Biologi* 2(2). DOI: 10.23969/biosfer.v2i2.574

Baram-Tsabari, A., Sethi, R. J., Bry, L., and Yarden, A. 2010. Identifying students' interests in biology using a decade of self-generated questions. *Eurasia Journal of Mathematics, Science and Technology Education* 6(1): 63–75. DOI: 10.12973/ejmste/75228

Chavan, R., and Patankar, P. 2018. Perception of Biological Concepts Among HigherSecondary Teachers: a Study. *Aarhat Multidisciplinary International Education Research Journal* (48178): 144–153.

Çimer, A. 2012. What makes biology learning difficult and effective : S tudents ' views. 7(3): 61–71. DOI: 10.5897/ERR11.205

Cindiati, M. er al. 2021. The Correlation Between Critical Thinking Skills and The Learning Outcomes on Musculoskeletal System. *Bioedukasi: Jurnal Pendidikan Biologi* 14(2): 91. DOI: 10.20961/bioedukasi-uns.v14i2.52079

Desstya, A., Prasetyo, Z. K., Suyanta, Susila, I., and Irwanto. 2019. Developing an instrument to detect science misconception of an elementary school teacher. *International Journal of Instruction* 12(3): 201–218. DOI: 10.29333/iji.2019.12313a

Galvin, E., and Mooney Simmie, G. 2015. Identification of Misconceptions in the Teaching of Biology: A Pedagogical Cycle of Recognition, Reduction and Removal. *Higher Education of Social Science* 8(2): 1–8. DOI: 10.3968/6519

Hasyim, W., Suwono, H., and Susilo, H. 2018. Three-tier Test to Identify Students' Misconception of Human Reproduction System. *Jurnal Pendidikan Sains* 6(2): 48–54.

Herpanda, Y., and Nirwana, H. 2022. Studi Deskriptif Problematika Pelaksanaan Layanan Peminatan dan Layanan Karir pada Tingkat Sekolah Menengah Atas (Studi Kasus di SMA Negeri 1 Koto XI Tarusan Kabupaten Pesisir Selatan). *Jurnal Edukasi* 2(1): 1–9.

Ilmiah, B., Biologi, P., Matematika, F., Ilmu, D., Alam, P., and Biologi, Y. P. 2020. Laily Eka Pradina & Yuliani : Miskonsepsi Siswa pada Submateri Pertumbuhan 310 Laily Eka Pradina. 9(1): 310–318.

Kalas, P., O'Neill, A., Pollock, C., and Birol, G. 2013. Development of a meiosis concept inventory. *CBE Life Sciences Education* 12(4): 655–664. DOI: 10.1187/cbe.12-10-0174

Kemdikbud. 2018. Permendikbud nomor NOMOR 37 TAHUN 2018 TENTANG PERUBAHAN ATAS PERATURAN MENTERI PENDIDIKAN DAN KEBUDAYAAN NOMOR 24 TAHUN 2016 TENTANG KOMPETENSI INTI DAN KOMPETENSI DASAR PELAJARAN PADA KURIKULUM 2013 PADA PENDIDIKAN DASAR DAN PENDIDIKAN MENENGAH. *JDIH Kemendikbud* 2025: 1–527.

Kementerian Pendidikan dan Kebudayaan. 2018. Peraturan Menteri Pendidikan dan Kebudayaan Nomor 36 Tahun 2018 tentang Perubahan atas Peraturan Menteri Pendidikan dan Kebudayaan Nomor 59 Tahun 2014 tentang Kurikulum 2013 Sekolah Menengah Atas/Madrasah Aliyah. *Permendikbud* 1–12.

Khairaty, N. I., Taiyeb, A. M., and Hartati, H. 2018. Identifikasi Miskonsepsi Siswa Pada Materi Sistem Peredaran Darah Dengan Menggunakan Three-Tier Test Di Kelas Xi Ipa 1 Sma Negeri 1 Bontonompo. *Jurnal Nalar Pendidikan* 6(1): 7. DOI: 10.26858/jnp.v6i1.6037

Kurniasih, N., and Haka, N. B. 2017. Penggunaan Tes Diagnostik Two-Tier Multiple Choice Untuk Menganalisis Miskonsepsi Siswa Kelas X Pada Materi Archaebacteria Dan Eubacteria. *Biosfer: Jurnal Tadris Biologi* 8(1): 114–127. DOI: 10.24042/biosf.v8i1.1270

Maulita, S. R., Sukarmin, S., and Marzuki, A. 2019. The Content Validity: Two-Tier Multiple Choices Instrument to Measure Higher-Order Thinking Skills. *Journal of Physics: Conference Series* 1155(1). DOI: 10.1088/1742-6596/1155/1/012042

Nakhleh, M. B. 1992. Why some students don't learn chemistry: Chemical misconceptions. *Journal of Chemical Education* 69(3): 191–196. DOI: 10.1021/ed069p191

Nastiti, F. F., and Syaifudin, A. H. 2020. Hubungan Pemahaman Konsep Matematis Terhadap Hasil Belajar Siswa Kelas Viii Smp N 1 Plosoklaten Pada Materi Lingkaran. *PHI: Jurnal Pendidikan Matematika* 4(1): 8. DOI: 10.33087/phi.v4i1.80

Pane, K.M & Aina, M. 2022. A LITERATURE STUDY : MISCONCEPTIONS OF BIOLOGY MATERIALS IN HIGH SCHOOL IN JAMBI CITY. 1: 338–349.

Permendikbud. 2014. Permen No 64 Tahun 2014 Tentang Peminatan Pada Pendidikan Menengah. *Menteri Pendidikan dan Kebudayaan Republik Indonesia*.

Permendikbud. 2018. Peraturan Menteri Pendidikan dan Kebudayaan Nomor 36 Tahun 2018 Tentang Perubahan Atas Peraturan Menteri Pendidikan Dan Kebudayaan Nomor 59 Tahun 2014. *Permendikbud* 1–12.

Puspitasari, A. H., and Yuliani. 2020. Analisis Miskonsepsi Materi Enzim dengan Menggunakan TT-MCTE Terhadap Siswa SMA. *BioEdu Berkala Ilmiah Pendidikan Biologi* 9(1): 93–101.

Sesli, E., and Kara, Y. 2012. Development and application of a two-tier multiple-choice diagnostic test for high school students' understanding of cell division and reproduction. *Journal of Biological Education* 46(4): 214–225. DOI: 10.1080/00219266.2012.688849

Sezen Vekli, G., and Birinci Konur, K. 2021. Are Pre-Service Science Teachers Qualified Enough to Teach Human Reproductive System? *International Journal of Progressive Education* 17(5): 48–59. DOI: 10.29329/ijpe.2021.375.4

Suwono, H., Prasetyo, T. I., Lestari, U., Lukiati, B., Fachrunnisa, R., Kusairi, S., Saefi, M., Fauzi, A., and Atho'Illah, M. F. 2021. Cell Biology Diagnostic Test (CBD-Test) portrays pre-service teacher misconceptions about biology cell. *Journal of Biological Education* Routledge 55(1): 82–105. DOI: 10.1080/00219266.2019.1643765

Wahyuni, N., Suwono, H., and Lestari, U. 2019. Learning Difficulties of High School Students in Understanding the Material of Human Reproductive Systems Triggering Misconceptions. *Jurnal Pendidikan Sains* 7(4): 116–121.

Wulandari, S., Gusmalini*, A., and Zulfarina, Z. 2021. Analisis Miskonsepsi Mahasiswa Pada Konsep Genetika Menggunakan Instrumen Four Tier Diagnostic Test. *Jurnal Pendidikan Sains Indonesia* 9(4): 642–654. DOI: 10.24815/jpsi.v9i4.21153

Yani, A. & Mulyadi, A. 2022. Higher Order Thinking Skills (HOTS) - Oriented Learning in Geography Learning. 31: 101–113.

Yulianti, N. K. 2017. MISKONSEPSI SISWA PADA PEMBELAJARAN IPA SERTA REMEDIASINYA. *Jurnal Bio Educatio* 2(2): 50–58.

Yusrizal, and Halim, A. 2017. the Effect of the One-Tier , Two-Tier , and Three-Tier Diagnostic Test Toward the Students ' Confidence and. *Unnes Science Educational Journal* 6(2): 1583–1590.

Zulfia, F. A., Susilo, H., and Listyorini, D. 2019. Virus-bacteria diagnostic test (vbd-test) in identifying biology teacher's misconception. *Biosfer* 12(2): 144–156. DOI: 10.21009/biosferjpb.v12n2.144-156