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Development of a Diagnostic Test for Student Misconception Detection of Coordination System Material Using Four-Tier Multiple Choice

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Abstract

This study is the development of diagnostic test instrument *four tier multiple choice* to detect student misconceptions on the system material of human coordination. The diagnostic test is carried out on students who have received the coordination system material. The purpose of this study is to analyze diagnostic test validity and to analyze the profile of students' misconceptions on the material of the coordination system using *four-tier multiple choices*. This research is a Research and Development (R&D) with the 4D method, namely *definite, design develop and disseminate*. The subjects of this research are the students of XII IPA 1, 2, and 3 at SMAN 1 Terusan Nunyai and the students of XII IPA 3, 4, and 5 at SMAN 1 Terbanggi Besar. The result of this research shows a valid question instrument with a CVR value is 0.80 and CVI value is 0.78 with 8 examiners and 35 items of questions. The profile of misconceptions at SMAN 1 Terusan Nunyai in the excellent class is 10.69%, medium class is 30.57% and low class is 40.86% who experienced misconceptions, while at SMAN 1 Terbanggi Besar, the category of excellent class is 26.94%, medium class is 32.12% and low class is 27.48%. The conclusion of this research is there are many students who experience misconceptions on the coordination system material in the nervous system and hormones.

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INTRODUCTION

The evaluation that exists in Indonesia is still less use for the Coordination System is one of several chapters that are studied about Biology in SMA class XI. The material of the coordination system needs a strong understanding and conditions with a complex concept so that it is considered difficult and misconceptions often occur. Misconceptions that occur in learning biology are still the main problem and the focal point of educational research in recent years (Hidayati et al., 2015).

Misconceptions are caused by students' prior knowledge of the prior concept that is wrong or the student's prior concept is correct, but students are wrong in connecting these concepts (Kusumaningrum, 2014). Several studies on misconceptions have been conducted. The results of research conducted by Ferawati (2012), obtained misconception data, namely 64% on the concept of understanding neurons, 72% of axon function, 62% of sympathetic nerve work, 35% of the human central nervous system, 44% of neuron function.

The material of coordination system has sub-chapters; one of them studies the hormone system. In a study conducted at SMA Negeri 1 Matanuli Pandan, student learning outcomes under the minimum completeness criteria (KKM) that had been determined by the school were 75, while the students' test results on hormone material averaged 65. At the cognitive level, C3 analysis was 50.65%, C4 synthesis 63.85% and C5 evaluation 70.34% of students are in the low category in understanding the hormone system material, so that teachers need to do a diagnostic test to measure students' ability to understand concepts (Irmayanti et al., 2017).

Based on data from previous studies research survey results 75% of the 64 students reported having trouble studying Biology in a variety of materials, 15% more students claimed not difficult or mediocre (Kusuma et al., 2017). Biology has material with varying levels of difficulty each student experiences. Material coordination system is one of the materials that are difficult 32% of students expressed difficulty in understanding abstract concepts that are not seen directly by the eye such as the nervous system and metabolic materials (Irmayanti et al., 2017). The material is difficult because of nerves and hormones in these materials require high-level thinking level because these concepts relate to processes in the body which cannot be observed directly.

The development of today's technology is very rapidly. The development of science learning is influenced by technology; technology education is close to the IPA (Rusilowati et al., 2015) thus the need for innovative ICT-based learning evaluation that allows teachers to detect misconceptions.

Based on interviews in high school biology teacher at SMA Yadika Bandar Lampung at the interview said that learning is complex biology that need understanding to avoid misconceptions, especially about the eleventh-grade material coordination system. The cause of the misconception among other teachers learning strategies are less meaningful for students, learning resources are less valid, and way of learning tend to memorize (Farihah et al., 2016).

The main cause of the misconception is from students who are less conscientious work on the problems, the lack of the ability of students to absorb information and lack of understanding of the material as a whole. The cause of the common misconception comes from the students which they often are false negative. False negatives are the reason selected on the second level is wrong but the student has to believe both answers are chosen. 48.68% with the number of 37 students had false Negative study was conducted by Syahrul & Setyarsih (2015). Other misconceptions include teachers, textbooks and context. Textbooks are one of the factors the occurrence of misconceptions (Suparno, 2013).

The fact that happened Indonesia mostly only used evaluation tools to measure students 'cognitive abilities, whereas the evaluation should be maximized to see the students' understanding of the concept according to the study Cahaya & Sanjaya (2015) research in Indonesia on the development of diagnostic tests is still limited. Instruments Four-tier diagnostic test multiple choice is an instrument of the most valid, reliable, and accurate way to identify misconceptions students. Four-tier instrument has the advantages of the Three-tier, Two-tier or regular multiple-choice because there are two items Four tier confidence index (CRI) (Pujayanto et al., 2018). In addition, the provision of Certainty of Response Index (CRI) is required to measure the students' level of

confidence in the answer so that researchers can look deeper student understanding (Idayanti et al., 2019).

Based on the description, the purpose of this study to analyze the validity of the development of diagnostic tests and student misconceptions profile in the material coordinate system using a four-tier multiple choice.

METHOD

This research is a development that follows the contours of Thiagarajan et al. (1974). Chronology of the development consists of four stages, namely stage define, design, develop and disseminate. The research was conducted at SMAN 1 Terusan Nunyai in Class XII IPA 1, 2, and 3 and SMAN 1 Terbanggi Besar in class XII IPA 3, 4, and 5. The experiment was conducted in the academic year 2020 / 2021.Data in this study include Data validity of diagnostic tests based website through questionnaires by subject matter experts and media were given to the expert lecturers in the field of materials and media. Student misconceptions profile data through the test results to the students of class XII.

The validity of the data retrieval is done online by providing validation questionnaire to experts due to the global pandemic Covid-19 and misconceptions of data online through the website of misconceptions detection diagnostic tests that have been developed by researchers. Each student who participated in the test was given the instructions for use of the website and are given a username and password on each student. Working time in question carried out simultaneously and the student cannot take the test before the stipulated time, but was able to access the websites that already have a username and password. As for the practicality of use of the website using the student questionnaire distributed via goggle form by researchers. Data supplied by each valuator then analyzed by quantitative descriptive through the CVR, CVI, and Percentage.

RESUTS AND DISCUSION

Validity of Diagnostic Test

The validity of student misconceptions diagnostic test consists of two components: the material expert validation and validation of media experts. Validity matter experts conducted by eight experts' materials while the validity of media experts conducted by two experts. The validity of the material using the formula of calculation of the CVR (Content Validity Ratio) and CVI (Content Validity Index) refers to any item of Problem. The result is based on the theory of the critical value of the CVR to 8 experts is ≥ 0.582 the results of CVR appropriate, based on the analysis of the calculation based on a matter that obtained an average value of CVR 0.7969 then be said about the accepted and appropriate. A summary of the calculation of the CVR (Content Validity Ratio) and CVI (Content Validity Index) diagnostic tests is presented in Table 2 below.

Tabel 1. Calculation Recapitulation CVR and CVI

explanation	Value
Total CVR	27.3008
Total Item Tes	35.0000
CVI	0.7800
Category CVI	Very Suitable

Based on Table 1, the CVI value which consists of 35 questions with 8 experts of 0.78 with a very suitable category. This shows that the content validity of the diagnostic test which consists of 35 questions has met the content validation standard with a very good category. This is based on the CVI criteria category, a test is said to have content validity if it measures certain specific objectives and is parallel to the material provided. The validity was seen using the content validity and the construct. The results of the construct validity obtained 35 questions that had a value greater than r table = 0.2586. Media validation was validated by 2 media experts, and the results recapitulation can be seen in Table 2.

Tabel 2 Media Recapitulation Diagnostic test website

Validation Results	Validator 1	Validator 2
Total Score	81	73
Maximum Score Amount	88	88
Percentage of diagnostic eligibility	92.05	82.95
conclusion	Very good	Very good

Based on Table 2, the percentage of media feasibility by expert 1 was 92.05% with the very good category and the presentation of the media

feasibility by expert 2 was 82.95% with the very good category. Questionnaire items on media validation include aspects of language, software engineering, audio-visual communication, design and appearance of the website being developed.

The instrument validity is determined by the expert in accordance with the knowledge in their respective fields. Product validity is carried out by presenting experienced experts to assess the products being developed (Sugiyono, 2017). Following are the improvements made to the material expert validation, including improving the typography of writing in the questions, improving the language used properly, correcting the reasons for the diagnostic test questions, improving the work instructions, and adjusting the indicators with the cognitive level of the questions.

Profile of Student Misconceptions on Coordination System Material

The profile of misconceptions in this study was carried out on a large-scale test consisting of 2 schools with 6 classes, namely SMAN 1 Terbanggi Besar in class XII IPA 3 with excellent class categories, XII IPA 4 with medium class categories and XII IPA 5 with low class categories and SMAN 1 Terusan Nunyai in class XII MIA 1 with excellent class category, XII MIA 3 with medium class category, XII MIA 5 with low class category. The recapitulation of student misconception profiles can be seen in Table 3.

Table 3. Recapitulation of Student Misconceptions

School name	Class	Class Category	Percentage of Misconceptions
SMAN	XII IPA 3	excellent	27.07
Terbanggi	XII IPA 4	Medium	32.12
Besar	XII IPA 5	low	28.98
SMAN	XII IPA 1	Unggul	10.78
Terusan	XII IPA 3	Medium	30.57
Nunyai	XII IPA 5	Low	39.90

Based on Table 3, the results of diagnostic tests at SMAN 1 Terbanggi Besar class XII IPA 3 with the category of excellent class having a presentation of misconceptions 27.07%, class XII IPA 4 medium class categories have a misconception presentation 32.12%, class XII IPA 5 category low class has a presentation of misconceptions 28,98%, and the results at SMAN 1 Terusan Nunyai class XII MIA 1, high category has a presentation of misconception 10.69%, class XII MIA 3 medium category is having a presentation of misconception 30.57%, class XII MIA 5 low category has a presentation of misconception 38.57%. The test was carried out by dividing it into several class clusters, namely excellent, medium and low, the division of these clusters was based on the biology teacher interview. Misconception categories according to Suwarna (2013) are in Table 4 below.

Tabel 4. Misconception Level Category

Persentase	Category
0-30	low
31-60	Medium
61-100	High

Based on Table 4, the percentage with high misconception categories is vulnerable to the value of 61-100%. Misconceptions can occur because of students 'initial understanding or pre-conception, namely students' initial concepts before getting a lesson. Based on data, misconceptions that often occur in certain questions can be seen in Table 5.

Tabel 5. Butir Soal yang Tinggi Miskonsepsi

Scholl	Class	Ques-tion	student miscon-ceptions	student total	Percen-tage
SMAN 1	XII	4	16	35	45.71
Terusan	IPA 1	7	11		31.43
Nunyai	XII	7	23	30	76.67
	IPA 3	8	19		63.33
	XII	4	18	29	60.00
	IPA 5	7	23		79.11
SMAN 1	XII	4	13	21	61.90
Terbanggi	IPA 3	22	12		57.14
Besar	XII	4	20	29	68.97
	IPA 4	27	19		65.52
	XII	4	14	21	66.67
	IPA 5	17	12		57.14

Based on Table 5, there are frequent misconceptions at SMAN 1 Terusan Nunyai in question number four with the indicator mentioning the main nerve cell types in the human nervous system.

The following is a display of question number four diagnostic tests 4. The nervous system is composed of the main nerve cells, namely ...

a. Neuron dan Sel Schwann
b. Neuron dan neurit

c. Neuron dan neuroglia
d. Sel schwan dan neurit
e. Sel schwann dan neuroglia

How sure are your answers?
1. Sure
2. Not sure

Reason
a. The nervous system is composed of 2 types of cells the main nerves namely neurons and Schwan cells
b. The nervous system is composed of 2 types of cells the main nerves namely neuron and neurit
c. The nervous system is composed of 2 types of cells the main nerves namely neuron dan neuroglia
d. The nervous system is composed of 2 types of cells the main nerves namely schwann cell dan neurit
e. The nervous system is composed of 2 types of cells the main nerves namely neuroglia dan sel schwan

How sure are your answers?
1. Sure
2. Not sure

Concept:
Scientific concept states that the nervous system is composed of neurons and neuroglia support cells (Irmayanti *et al*. 2017)

Nerves are a component of the coordination system in the human body. The nervous system can be said to be a collection of neurons organized in such a way as to coordinate various body activities. Booklet A states that the neural network has a structure, namely neurons, Schwann cells and support cells (neuroglia), whereas scientifically the nervous system is composed of neurons and support cells (neuroglia) (Hidayati, 2015).

The profile of misconceptions that occurred in class XII IPA 3 at SMAN 1 Terbanggi Besar, namely question number 4 students understand that the neural network has a structure, namely neurons, Schwann cells and support cells (neuroglia), whereas scientific concept based on the histology team states that the nervous system is composed on neurons and support cells (neuroglia) in Hidayati et al. 2015 research which identified the misconceptions of the nervous system in biology textbook class XI textbook IV states "The nervous system consists of 3 types of cells that have different structures and functions, namely neurons, Schwan cells and support cells (neuroglia)". The scientific concept states that the nervous system is composed of 2 main types of cells, namely neurons and glia cells.

A misconception occurs in question number 22 related to differences in the work mechanism of the nervous system and the work of the hormone system. The right answer is that nerve signals are carried by sensory neurons, while hormone signals are carried through the circulatory system. The signals are transmitted in the form of electricity through neurons, so that they respond to stimuli very quickly. The nervous system functions for sensory perception (reception of stimuli), motor activity, homeostasis of the body's physiological processes and the development of thoughts and memories. The hormone system is a chemical signal in the form of organic compounds secreted into the circulatory system.

Effect of hormone on body tissue can occur in a short time (a few seconds) to a few years. Hormonal systems interact with the nervous system functions to regulate the activities of the body, homeostasis, growth, sexual development and reproductive cycle, the cycle of sleep and nutrient cycling.

In class XII IPA 4 at SMAN 1 Terbanggi Besar students experience a misconception in question 27 with the indicator determining which hormone gland is functioning and the location of the hormone produced. The pair of glands and hormones that function to stimulate the release of pancreatic juice is the small intestine that secretes the hormone cholecystokinin, which stimulates the concentration of bile and the secretion of pancreatic enzymes. Cholecistokinin hormone is located in the duodenum (small intestine). Cholecystokinin, otherwise known as CCK or CCK-PZ, is a hormone that was once called pancreozymin because of its action on the pancreas.

Misconceptions in class XII IPA 5 on questions number 4 and number 17. Question No. 17 with indicators analyzing images of nervous system disorders, the correct answer is patient B is Alzheimer's sufferer. Someone who has entered old age often has memory problems. Memory disorders in the elderly are caused by the central nerve degeneration in the central nerve. The memory disorder that occurs is called dementia or Alzheimer's. Most of Alzheimer's sufferers

experience memory problems, changes in personality, mood and behavior, problems in interactions (Al-Naamietal, 2013).

Misconceptions are generally experienced by students at the low, medium and high grade levels in question number 4, which is about the nervous system nervous system. The nervous system can be divided into two types, namely the central nervous system and the peripheral nervous system. The nervous system consists of the spinal cord and the brain, the central nervous system is used as a coordination center for actions to be carried out, while the peripheral nervous system contains sensory axons and motor axons, so it can be called mixed nerves. The peripheral nervous system functions to provide information to the central nervous system about the presence of a stimulus (stimulation) and causes muscles and glands to respond.

Learning sources that provide inaccurate information make students misconceptions about the textbooks used at SMAN 1 Terusan Nunyai using publisher Y by saying that the nervous system states that the kinds of neural networks that have different structures and functions are neurons, Schwann cells and support cells (neuroglia). Fajriana et al. (2016) state that the biology textbook is expected to be able to provide all the information needed by teachers and students and present the material properly and correctly. However, there are still misconceptions in the concepts in the Biology textbook. As happened in high school biology textbooks on the nervous system material contains misconceptions (Ramadhan, 2016).

Another thing that is a source of misconceptions that come from students is interest in learning. Some of the subjects who experienced misconceptions were students with low learning interest. This is indicated by the subject's response during learning. Old students respond to teacher orders in the online learning stage. Misconceptions in students can also come from wrong concepts taught by teachers at previous levels of education. The existence of this misconception will certainly hinder the learning process of students. Misconceptions in students that appear continuously can interfere with the formation of scientific conceptions.

Learning that do not address the misconceptions cause learning difficulties and will ultimately lead to poor performance of their learning for student achievement comes from a good understanding (Inayah, 2013).

Misconceptions can be identified by using a diagnostic test instrument given to students after the learning process is carried out (Mubarak *et al.*, 2016). There are many ways to detect student misconceptions, namely interviews, open tests, multiple choice tests and tiered tests (Wahidah *et al.*, 2019). Most of the respondents indicated an inadequate understanding of the concept of waves. Eleven alternative conceptions (ACs), expressed with confidence by more than 10% of students, were identified; four of these ACs were expressed with great confidence. (Caleon & Subramaniam, 2010).

The advantage of the four tier multiple choice diagnostic test is that it can diagnose misconceptions experienced by students more deeply because students must believe the answers and reasons they fill in, can determine parts of the material that require more emphasis during learning, can plan better learning for help reduce misconceptions of students (Mubarak et al., 2016). Misconception also occurs because long-term memory has been lost. Long Term Memory (LTM), which is the part that contains all one's knowledge, this section has an unlimited capacity to store memory. If someone is unable to retrieve the stored information, that person is said to have forgotten (Mubarak et al., 2016).

The development of scientific literacy provides a comprehensive understanding of scientific concepts and methods, improves scientific cognition, and knows the relationship between technology and science development on the environment (Noviyanti et al., 2014). This phenomenon of misconceptions can cause learning difficulties for students and indirectly have an impact on the low achievement of students' scores because if the misconceptions are allowed to continue and are not resolved, the misconceptions will be integrated into the cognitive structure of students and will be firmly attached to their minds so that they can inhibits the assimilation process of new conceptions (Mukrimatussa'adiyah, 2017).

CONCLUTION

The development of coordination system material diagnostic test showed that it is valid with a CVR value of 0.80 and a CVI value consisting of 35 questions with 8 experts of 0.78 in the appropriate category. The misconception profile in SMAN 1 Terusan Nunyai in the excellent class 10.69%, medium class 30.57% and low class 40.86% who experienced misconceptions, while at SMAN 1 Terbanggi Besar in the excellent class category 26.94% medium class 32.12% and low class 27.48%. The conclusion is that there are still many students who have misconceptions on the material of the coordination system on the nervous system and hormones.

REFERENCES

Arikunto, Suharsimi(Ed.). 2007.Prosedur Penelitian Suatu Pendekatan Praktek Edisi Revisi V.Jakarta:Bumi Aksara.

Al-Naami., Gharaibeh, N., & Kheshman, A. A. (2013). Automated Detection of Alzheimer Disease Using Region Growing technique and Artificial Neural Network. *International Journal of Biomedical and Biological Engineering*, *7*(5), 204–208

Cahaya, A. & Sanjaya, G. M. (2015). The Development of Three Tier DiagnostikTest To Identify Student Miskonseption In Chemical Bonding On thGrader.*Journal Of Chemical Educations*, *4*(3). 456-465

Caleon, I., &Subramaniam, R. (2010). Development and Aplication of a Three Tier Diagnostic Test to Assess Secondary Student' Understanding of Wave. *International Journal of Science Education*. 32(7),939-961.

Farihah A., N, Pukan K., K, Marianti A. (2016). Analisis Miskonsepsi materi Sistem Regulasi pada Siswa Kelas XI SMA Kota Semarang.*Journal of Biology Education*. (UNNES). 5 (3). 319-329.

Ferawati, Shelvy. (2012). Identifikasi Miskonsepsi pada Sistem Regulasi Manusia dan Faktor-Faktor Penyebabnya di SMA Negeri 2 Poso Kota Selatan.*JurnalKependidikan*.*1*(1): 47-55.

Hidayati I, Abdullah. &Sabri M. (2015). Identifikasi Miskonsepsi Sistem Saraf Pada Bukuteksbiologi Kelas Xi. *Jurnal Biotik*, *3*(1). 39–44.

Idayanti., Darsono. T., & Midyarto B. N. (2019). Pengembangan Tes Diagnostik Menggunakan Certainty Of Response Index (CRI). *Jurnal Ilmiah Pendidikan Biologi*, *8*(1), 22–27.

Inayah, R., Martono, T& Sawiji, H. (2013). Pengaruh Kompetensi Guru, Motivasi Belajar Siswa, dan fasilitas Belajar Terhadap Prestasi Belajar Mata Pelajaran Ekonomi pada Siswa Kelas XI IPS SMA Negeri 1. *Jurnal Pendidikan Insan Mandiri*, *1*(1). 1–13.

Irmayanti, I., Hasruddin, H., & Kartika, K. (2017). Analisis Kesulitan Belajar Siswa Pada Materi Pokok Hormon Di Kelas XI IPA SMA Negeri 1 Matauli Pandan Tahun Pembelajaran 2016/2017. *Jurnal Pendidikan Matematika Dan Sains*, *12*(1), 1–6.

Kusumaningrum, Ratri. (2014)."Pengaruh ModelGuided Discovery Learningterhadap Miskonsepsisiswa kelas XI IPA SMA Muhammadiyah 1Karanganyar pada Konsep Sistem Imun".*Skripsi*.Surakarta:Universitas Sebelas Maret.

Kusuma, R. D., Rohman, F., & Syamsuri, I. (2017). Permasalahan Dalam Pembelajaran Biologi Pada Jurusan Pertanian Smk Negeri 1 Kademangan Blitar. *Prosiding Seminar Nasional Iii Tahun*, *April*, 133–136.

Mubarak, S., Susilaningsih, E., & Cahyono E.(2016). Pengembangan TesDiagnostik Three Tier Multiple Choice Untuk MengidentifikasiMiskonsepsi Peserta Didik Kelas XI. *Jounal Innovative ScienceEducation*. 5 (2). 101-110.

Mukrimatussa'adiyah. (2017). Penggunaan Computer Suported Conceptual Change Text (Cscctekx) Terkait Materi Kemagnetan Untuk Pengajaran Remedial yang Berorientasi Remediasi Miskonsepsi Siswa SMA. Tesis. Universitas Pendidikan Indonesia

Noviyanti, L., Rini, D., & Ngabekti, S. (2014). Pengembangan Instrumen Self Dan Peer Assessment Berbasis Literasi Sains Di Tingkat Sma. *Lembaran Ilmu Kependidikan*, *43*(1), 32–39.

Pujayanto, P., Budiharti, R., Adhitama, E., Nuraini, A., & Putri, H. V. (2018). The development of a web-based assessment system to identify students' misconceptionautomatically on linear kinematics with a four-tier instrument test. *JournalPhysics Education*, *53*(4).1-8.

Ramadhan, N. A., (2016), Identifikasi Miskonsepsi Sistem Saraf Manusia DalamBukuTeksBiologi SMA di KotaYogyakarta, *Jurnal Pendidikan Biologi*,*5*(1). 37-45.

Rusilowati, A., Sunyoto, E. N., & Sri Mulyani, E.S. (2015). Developing Of Science Textbook Based On Scientific Literacy For Seventh Grade Of Secodary School. *Journal of international conference on mathematics.Science adn education.1*(1). 42-45.

Suparno, Paul. 2013. Miskonsepsi dan Perubahan Konsep dalam Pendidikan Fisika. CetakanKedua. Jakarta: PT Grasindo.

Suwarno. (2009). *Panduan Pembelajaran Biologi SMA dan MA Kelas XI*. Indeks.

Syahrul, D.A. & Setyarsih, W. (2015). Identifikasi Miskonsepsi Dan PenyebabMiskonsepsi Siswa Dengan Three Tier Diagnostic Tes Pada MateriDinamika Rotasi. *Jurnal Inovasi Pendidikan Fisika*,*4*(3). 57-70.

Wahidah, N., & Saptono, S. (2019). The Development of Three Tier Multiple Choice Test to Explore Junior High School Students ' Scientific Literacy Misconceptions. *Journal of Innovative Science Education*, *8*(2), 190–198.