



Design of Instructional Materials with the Cooperative Learning Model Numbered Heads Together (NHT) for Junior High School

Novia Laudiyah Prafnesia*, Irdam Idrus, Dewi Jumiarni

Biology Education Study Program, Universitas Bengkulu, Indonesia

*Corresponding author: noviaprafnesia@gmail.com

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ABSTRACT

This study addresses the low student engagement and limited learning outcomes in biology lessons, particularly on the human excretory system in junior high schools. These issues are linked to the absence of instructional materials aligned with the 2013 Curriculum (K-13), which emphasizes active, collaborative, and student-centered learning. The aim of this research was to design instructional materials based on the cooperative learning model Numbered Heads Together (NHT) to strengthen students' conceptual understanding and active participation. The research employed a descriptive qualitative design focusing on the development of a Lesson Plan (RPP) for Grade VIII students. The procedures included curriculum and competency analysis, review of textbooks, formulation of learning indicators and objectives, selection of learning methods and media, and preparation of evaluation tools. Validation was conducted through literature review and expert judgment to ensure feasibility and relevance. The results showed that the RPP was successfully developed for two face-to-face meetings. The design incorporated KD 3.10, emphasizing analysis of the human excretory system, understanding disorders, and identifying health maintenance efforts. The learning process followed three stages introduction, core, and closing, implemented using the NHT syntax: numbering, questioning, thinking together, and answering. Supporting media included videos and PowerPoint, while evaluation used multiple-choice tests at cognitive levels C1–C4. The study concludes that the designed RPP is consistent with curriculum standards and has the potential to improve student engagement and outcomes.

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INTRODUCTION

Learning is a process of communication and interaction that involves students, teachers, and learning resources to achieve the intended competencies (Fahroni, 2024). This process is not limited to two-way interactions but also includes the exchange of

information and knowledge that supports students' potential development. In the context of 21st-century education, meaningful interaction is essential to foster critical thinking, collaboration, creativity, and communication skills (Wang et al., 2023).

Teachers play a central role in ensuring the success of the learning process as they act as designers, facilitators, and evaluators of classroom activities (Mu'aziyah & Isnawati, 2023). The quality of education and learning outcomes largely depend on how well teachers design instructional materials that are systematic, responsive to students' needs, and aligned with the curriculum (Saborío-Taylor & Rojas Ramírez, 2023). Thus, lesson planning and instructional design are not only technical requirements but also a key instrument to direct learning toward achieving predetermined objectives effectively (Tekir & Akar, 2019).

Observations conducted at SMPN 16 Bengkulu revealed that students' engagement in biology lessons remains low. Only about 50% of students actively participated during individual learning, and approximately 55% were active in group discussions. Their learning outcomes also fell short of expectations, as the classical mastery level reached only 60%, compared with the required standard of 75%. Furthermore, the minimum mastery criterion (KKM) for science subjects was set at 70, but many students did not achieve this benchmark. These findings indicate a clear gap between curriculum expectations and classroom realities.

Several factors may explain these conditions, including the use of underdeveloped instructional materials, a lack of updates in line with educational advancements, unsystematic learning processes, monotonous teacher-centered methods, and unequal participation among students (Sørensen et al., 2023). Such conditions have led to low motivation, limited collaboration, and reduced opportunities for students to express and exchange ideas (Owens & Hite, 2022). Therefore, innovation in designing instructional materials is needed to make biology learning more engaging and meaningful (Chisunum & Nwadiokwu, 2024).

In terms of educational policy, SMPN 16 Bengkulu still refers to the 2013 Curriculum (K-13), which is nationally implemented. The K-13 emphasizes the integration of attitudes, knowledge, and skills within classroom activities (Burhaein et al., 2020). It requires active student participation through scientific approaches, activity-based learning, and the application of cooperative learning models (Saadah et al., 2020). Therefore, designing instructional materials based on cooperative learning represents a practical implementation of the principles of the 2013 Curriculum in schools.

One cooperative learning model particularly relevant to the K-13 is *Numbered Heads Together* (NHT). This model emphasizes shared responsibility within groups, where each student is assigned a number and may be randomly selected to represent their group (Wati et al., 2024). Consequently, all group members are encouraged to master the material, collaborate, and support each other (Mahmudah & Rasyid, 2022). This model is consistent with the principles of the K-13, which promote active participation, collaboration, and student-centered learning.

Based on the above considerations, this study aims to design biology instructional materials using the cooperative learning model NHT for the topic of the human excretory system in grade VIII of junior high school. The design is expected to enhance student engagement, improve learning outcomes, and support the more effective implementation of the 2013 Curriculum in schools.

METHOD

Research Design

This study employed a descriptive qualitative design aimed at describing the instructional materials designed with the cooperative learning model Numbered Heads Together (NHT) for the topic of the human excretory system in grade VIII junior high school. The product developed was a lesson plan (RPP) constructed through systematic stages of

instructional design. The focus of this study was to generate a design aligned with the 2013 Curriculum and to support improvements in student engagement and learning outcomes.

Population and Samples

The subject of this study was the instructional materials for biology in grade VIII of junior high school, designed based on the 2013 Curriculum, specifically basic competency (KD) 3.10. No student population was involved as respondents since the study focused on the design of instructional materials. However, the design process referred to the actual context of junior high schools that still apply the 2013 Curriculum.

Instrument

The research instruments consisted of curriculum analysis sheets, basic competency analysis, content review, and guidelines for formulating indicators, learning objectives, media, methods, and evaluation. These instruments were used to ensure that each stage of instructional design complied with curriculum standards and the principles of cooperative learning.

Procedure

The research procedures included: (1) curriculum analysis referring to Ministry of Education Regulation No. 35 of 2018; (2) analysis of basic competency 3.10 on the human excretory system referring to Regulation No. 24 of 2016; (3) content review of the 2017 revised science textbook for grade VIII; (4) formulation of learning indicators and objectives; (5) determination of learning models and methods suitable for students' characteristics and learning goals; (6) selection of instructional media; and (7) development of assessment tools.

Data Analysis Techniques

Data analysis followed the framework of Miles and Huberman as cited in Sugiyono (2009), consisting of data reduction, data display, and conclusion drawing. Data from curriculum analysis, indicators, objectives, and lesson plan design were compiled and described systematically. The designed instructional materials were then validated theoretically through literature review and expert judgment to assess their feasibility and alignment with the 2013 Curriculum.

RESULT AND DISCUSSION

The learning device designed in this study was a Lesson Plan (RPP) for two meetings on the topic of the *Human Excretory System* in Grade VIII of junior high school. The RPP was developed using the cooperative learning model Numbered Heads Together (NHT), which consists of four core stages: numbering, posing questions, thinking together, and answering.

Description of Basic Competency and Teaching Materials

The basic competency (KD) used as a reference was KD 3.10 from the Ministry of Education and Culture Regulation No. 24 of 2016, namely "*Analyzing the human excretory system and understanding its disorders as well as efforts to maintain excretory health.*" This KD contains two operational verbs: *analyzing*, which is categorized as the C4 cognitive level in Bloom's Taxonomy, and *understanding*, which is categorized as the C2 level. Accordingly, the learning process was designed to enable students to analyze the relationship between the structure and function of excretory organs, to understand the disorders that may occur, and to explain efforts to maintain the health of these organs.

The competency was arranged to support the achievement of the Core Competencies (KI), which consist of spiritual (KI-1), social (KI-2), knowledge (KI-3), and skills (KI-4) aspects. The operational verbs were carefully chosen so that learning outcomes can be

observed and measured through both classroom activities and assessments. The analysis of the KD began with identifying the operational verbs and linking them to the corresponding subject matter in order to generate clear indicators and learning objectives.

In this study, the main teaching material was the science textbook for Grade VIII SMP/MTs, second semester, revised 2017 edition, published by the Ministry of Education and Culture. The human excretory system is presented in Chapter 9 (pages 79–114) out of a total of 11 chapters. The content includes the structure and function of the kidneys, lungs, skin, and liver, physiological processes, disorders, and preventive efforts.

The review of the human excretory system material and its relation to the basic competency is as follows. KD 3.10 states: *“Analyzing the human excretory system and understanding its disorders as well as efforts to maintain excretory health.”* Based on KD 3.10, the content covers the human excretory system, related disorders, and strategies for maintaining health. The material presented in the textbook aligns with the requirements of KD 3.10. A detailed analysis of the learning material is presented in Table 1, which shows the relationship between subtopics, learning sub-materials, and descriptions of the content to ensure that all essential aspects of KD 3.10 are adequately addressed.

Table 1
Analysis of Human Excretory System Material.

Subtopic	Sub-Learning Material	Description of Learning Material
Structure and function of the human excretory system	Definition of the human excretory system	The process of eliminating metabolic waste substances that are not needed by the body.
	Structure and function of the kidneys	The kidney structure consists of the cortex, medulla, and pelvis. Kidneys function to filter blood containing metabolic waste from cells throughout the body to produce urine. The stages of urine formation include filtration, reabsorption, and augmentation.
	Structure and function of the lungs	The structure of the human lungs consists of the trachea, bronchi, bronchioles, and alveoli. As an excretory organ, the lungs function to expel carbon dioxide.
	Structure and function of the skin	The skin structure consists of two main parts: the epidermis and dermis. The epidermis is composed of several layers (stratum corneum, stratum granulosum, stratum germinativum). The dermis consists of blood vessels, nerves, sebaceous glands, and sweat glands. The skin functions to excrete sweat.
	Structure and function of the liver	The structure of the human liver consists of blood vessels, bile ducts, and liver cells (hepatocytes). The human liver is divided into two lobes. The liver functions to excrete bile pigments.
Disorders of the human excretory system and efforts to prevent or overcome them	Kidneys	Nephritis: damage to nephrons due to infection by <i>Streptococcus</i> bacteria. Treatment efforts include dialysis or kidney transplantation.
	Lungs	Tuberculosis is a disease caused by bacteria that can affect all body tissues but most commonly occurs in the lungs.
	Skin	Acne (<i>acne vulgaris</i>) is a skin condition characterized by blockage and inflammation of the sebaceous (oil) glands.
	Liver	Hepatitis A: A disease that attacks the liver caused by the hepatitis A virus, commonly known as jaundice.

The verb *analyze* in Basic Competency 3.10, in relation to the human excretory system material, refers to analyzing the relationship between the structure of the human excretory organs and the functions of each organ. The cognitive process at level C4 (*analyzing*) in Bloom's Taxonomy means breaking down material into its constituent parts and determining how those parts relate to one another and to the overall structure or purpose (Ariyana, 2019). Thus, students are expected to analyze organ structures, organ functions, their relationship to physiological processes, and disorders in the human excretory system.

Description of the Formulation of Learning Indicators and Objectives

Based on the analysis of Basic Competency 3.10 and the review of the relevant material, learning indicators were formulated for two meetings. In the first meeting, six indicators were developed, focusing on the kidneys and lungs. In the second meeting, four indicators were formulated, which focused on the skin and liver. The learning indicators for Basic Competency 3.10 on the human excretory system, as formulated in this study, are presented in Table 2.

Table 2
Formulation of Learning Indicators.

Basic Competency	Learning Indicators – Meeting 1	Learning Indicators – Meeting 2
3.10 Analyze the human excretory system and understand disorders in the excretory system as well as efforts to maintain excretory system health	3.10.1 Identifying the organs of the human excretory system	3.10.7 Analyzing the relationship between the structure and function of the skin
	3.10.2 Explaining the functions of excretory organs in humans	3.10.8 Analyzing the relationship between the structure and function of the liver
	3.10.3 Analyzing the relationship between the structure and function of the kidneys	3.10.9 Explaining disorders and diseases of the skin and liver
	3.10.4 Analyzing the relationship between the structure and function of the lungs	3.10.10 Explaining efforts to maintain the health of the skin and liver
	3.10.5 Explaining disorders and diseases of the kidneys and lungs	
	3.10.6 Explaining efforts to maintain the health of the kidneys and lungs	

The next step after formulating the learning indicators is to formulate the learning objectives. The learning objectives designed in this study for the topic of the human excretory system in Grade VIII junior high school are presented in Tables 3 and 4. These objectives were formulated with reference to Basic Competency 3.10 and the corresponding learning indicators.

Table 3
Learning Objectives for Meeting 1.

Learning Indicators	Learning Objectives
3.10.1 Identifying the organs of the human excretory system	1. Through discussion-based learning, students are able to identify four types of organs in the human excretory system accurately.
3.10.2 Explaining the functions of human excretory organs	2. Through discussion-based learning, students are able to explain the four functions of human excretory organs correctly.
3.10.3 Analyzing the relationship between the structure and function of the kidneys	3. Through discussion-based learning, students are able to analyze the relationship between the structure and function of the kidneys correctly.

Learning Indicators	Learning Objectives
3.10.4 Analyzing the relationship between the structure and function of the lungs	4. Through discussion-based learning, students are able to analyze the relationship between the structure and function of the lungs correctly.
3.10.5 Explaining disorders and diseases of the kidneys and lungs	5. Through discussion-based learning, students are able to explain at least two examples of disorders and diseases affecting the kidneys and lungs correctly.
3.10.6 Explaining efforts to maintain the health of the kidneys and lungs	6. Through discussion-based learning, students are able to explain at least two examples of efforts to maintain the health of the kidneys and lungs correctly.

Table 4
Learning Objectives for Meeting 2.

Learning Indicators	Learning Objectives
3.10.7 Analyzing the relationship between the structure and function of the skin	7. Through discussion-based learning, students are able to analyze the relationship between the structure and function of the skin correctly.
3.10.8 Analyzing the relationship between the structure and function of the liver	8. Through discussion-based learning, students are able to analyze the relationship between the structure and function of the liver correctly.
3.10.9 Explaining disorders and diseases of the skin and liver	9. Through discussion-based learning, students are able to explain at least two examples of disorders and diseases affecting the skin and liver correctly.
3.10.10 Explaining efforts to maintain the health of the skin and liver	10. Through discussion-based learning, students are able to explain at least two examples of efforts to maintain the health of the skin and liver correctly.

The formulation of the learning objectives above contains the components of Audience, Behaviour, Condition, and Degree (ABCD) (Munadi, 2019). Learning objectives must be clearly stated to indicate the competencies that students are expected to acquire. These objectives also imply that there are several character skills that teachers aim to develop in the learning process (Ariyana, 2019).

Description of the Learning Model

The instructional design in this study applied the cooperative learning model Numbered Heads Together (NHT). Cooperative learning involves students working in heterogeneous groups and encourages collaboration among members. NHT was selected because it fits the classroom context, where group learning is often dominated by academically stronger students, while others tend to be passive and rely on their peers for finding information, expressing opinions, or answering questions. Thus, NHT is expected to reduce such dominance and increase the participation of all group members. According to Lie (2002) in Herawati (2014), groups consisting of 4–5 students are required to work collaboratively while still maintaining individual responsibility.

This aligns with Winarni (2018), who stated that NHT emphasizes students' understanding by checking their mastery of the subject matter. A distinctive feature of NHT is that the teacher randomly appoints one student to represent the group, so every member is required to remain actively engaged. Rahmawati (2014) noted that NHT is generally used to strengthen comprehension or assess students' mastery of the material. Slavin (2010) in Yuliani (2018) further explained that group representatives are chosen through random selection, giving every student an equal chance to participate.

Description of the Learning Methods

The learning methods employed in this study were discussion and presentation. Discussions were conducted in two face-to-face meetings in the classroom. Students were divided into small groups of 4–5 members, and within the NHT framework discussion was primarily used during the *thinking together* and *answering* phases. This method trained students to be more creative in generating ideas, to exchange opinions, to express thoughts verbally, and to respect the perspectives of others (Sanjaya, 2008).

The presentation method was applied by the teacher to explain the human excretory system using PowerPoint, while students presented the results of their group discussions during the *answering* phase. Presentation is defined as a public speaking activity to deliver material that requires physical readiness, mental preparation, and supporting facilities (Rustandi, 2015). Through this method, teachers can transfer knowledge effectively, foster cooperation, instill responsibility, and create an enjoyable learning atmosphere (*joyful learning*). In addition, presentation activities helped students build self-confidence, develop problem-analysis skills, express opinions, and defend their group arguments (Marpaung, 2018).

Description of the Learning Media

The selection of instructional media was based on the learning objectives, the NHT syntax, and the available facilities. The media employed were videos and PowerPoint. Videos were chosen to visualize physiological processes that cannot be directly observed, such as urine formation by the kidneys, carbon dioxide and water vapor excretion by the lungs, sweat production by the skin, and bile excretion by the liver. The use of videos has been proven to facilitate students' understanding and improve science learning outcomes (Yunita, 2017; Artam, 2015).

PowerPoint was used to present the main points of the material in a concise, clear, and engaging way. This medium helped teachers highlight essential content, kept students focused on the lesson, and supported both group discussions and presentations. In addition, PowerPoint was selected because it is simple, easy to operate, and capable of displaying text, images, and tables that capture students' attention. Previous studies have shown that the use of PowerPoint in learning can improve student achievement in excretory system topics (Rahmawati, 2016; Setyawan, 2010).

Description of the Learning Device

The Lesson Plan (RPP) in this study was designed for Grade VIII junior high school students in the second semester. The RPP consisted of two meetings, developed with reference to the teaching syllabus. Classroom activities were conducted face-to-face with a total allocation of 10 lesson hours, with each meeting lasting 3×40 minutes.

The RPP was developed based on Basic Competency 3.10 on the human excretory system. The first meeting focused on the excretory organs, the functions of the kidneys and lungs, and their disorders along with preventive efforts. The second meeting addressed the structure and function of the skin and liver, as well as common disorders and ways to maintain their health. The lesson plans were designed using the cooperative learning model Numbered Heads Together (NHT) and referred to Ministry Regulation No. 22 of 2016.

The learning process consisted of three main stages: introduction, core activities, and closing. The introduction, which lasted for 10 minutes, began with greetings, prayer, attendance, and classroom management. Apperception was provided through contextual illustrations, such as food waste in the first meeting and the phenomenon of frequent urination during cold weather in the second. The teacher also gave motivation, stated the learning objectives, and explained the group procedures under the NHT model.

The core activities, lasting 85 minutes, were carried out according to the NHT syntax as outlined by Winarni (2018): numbering, questioning, thinking together, and answering.

Students were divided into heterogeneous groups, each member was assigned a number, and they worked on Student Discussion Sheets. They read, discussed, and prepared answers collectively, while the teacher facilitated the process. Videos on excretory physiological processes were provided to strengthen understanding. During the answering stage, the teacher called on students based on selected numbers to present their group's discussion results, and students from other groups with the same number were invited to respond.

The closing stage lasted 25 minutes. In this stage, the teacher guided students to summarize the lesson, gave recognition to well-performing groups, and administered an individual test to evaluate understanding. After the test was completed, the session ended with a joint prayer and closing greetings.

Description of the Learning Evaluation Tools

The learning evaluation in this study employed a written test. In both the first and second meetings, the test consisted of 10 multiple-choice questions, each with four answer options. The allotted time was 15 minutes, giving students approximately one and a half minutes to complete each item. A total of 10 items were selected to ensure that the test could be completed within the given time. The test items were designed to measure cognitive abilities at levels C1 through C4.

CONCLUSION

The results of the research show that the use of digital devices has a clear impact on students' interest in reading. When students spend a significant amount of time using gadgets, especially for entertainment or non-educational purposes, their motivation and habit of reading tend to decline. This influence may be due to the fact that digital content often prioritizes speed and visual stimulation, which can reduce students' patience and interest in traditional reading activities. However, it is also important to recognize that students' interest in reading is shaped by many other factors, such as personal habits, family environment, and school culture. Devices are just one part of a larger picture that influences how students develop or lose their interest in reading.

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