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Guided Discovery-Blended Learning (GDBL): An Innovative Learning to Improve Conceptual Excretory System

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Abstract: This research aimed to determine the effect of the Guided Discovery Blended Learning (GDBL) strategy on concept mastery of the human excretory system. The research method was quasi-experimental with a pretest-posttest control group design. The samples consisted of the eleventh-grade students of Senior High school Jakarta in 2019/2020. Class MIPA-2 was the control class taught using Guided Discovery, and class MIPA-4 were the experimental class taught using GDBL. The learning process had been carried out both online and in the classroom. Research data were collected by integrating essay tests, students' responses to learning strategies, and observation sheets of syntax implementation. The data were descriptively analyzed and tested using ANCOVA. The normality test was performed using the Kolmogorov-Smirnov formula, and the homogeneity test was performed using Levene's test. The statistical tests indicated that the data were normally distributed and homogeneous; thus, ANCOVA analysis using SPSS 24 was performed. The data analysis with the ANCOVA test at 0,05 significance level obtained p value = 0.000, which means that H_0 was rejected. The research result implied that GDBL affected students' concept mastery of the human excretory system. It cultivated habits to independently rearrange the concept through teachers' guidance, both from sourcebooks and online media. GDBL can be used as an alternative for biology studies.

INTRODUCTION

Global-era teachers must master pedagogic competencies and increase information technology application in learning to help students improve concept mastery (Montoro et al., 2015). Biology subject in secondary school level is complex and abstract, and it becomes an obstacle for some students, resulting in poor concept understanding. When the demands of learning on the content concept are high, students require appropriate unique strategies and innovations in building their knowledge.

Concept mastery is vital for students in actualizing learning experiences. The learning process must be designed so that students could actively rearrange concepts (Aini et al., 2018; Khairaty et al., 2018; Widyastuti, 2017). The biology learning concept is less optimum, requiring intensive exercises (Anders et al., 2019). The human excretory system concept is a complex and abstract process that becomes an obstacle for several students. The students have difficulty interpreting the concept (Kaltakci Gurel et al., 2017; Raida, 2018).

Students' concept mastery must be enhanced in the learning process by actualizing it in real-life phenomena (Rindah et al., 2019; Rusdi et al., 2016). Concepts are organized knowledge. A deep understanding of concepts could be achieved by applying what they have learned in a real new situation.

Teachers have to apply innovation in learning to improve concept mastery. Several similar researchers compared real object learning, web, and blended learning (Permana & Chamisijatin, 2019). Conceptual knowledge includes categories, classification, and the relationship between two or more categories or classification (Anderson et al., 2001). Concept mastery is an intellectual basis for studying the scientific process (Phanphech et al., 2019).

It is necessary to develop a blended learning strategy on the biology, social, and environmental attitude of secondary level students (Nair & Bindu, 2016). Next is the mixed learning model for improving undergraduate students' learning achievement in Thailand (Banyen et al., 2016).

Low biology mastery will result in low-level thinking skills (analyzing, evaluation, and creating). Teachers need to condition their learning and assessment activities to foster complex cognitive processes (Harahap et al., 2020; Kristiani et al., 2020; Ristanto et al., 2018).

The discovery learning strategy application is expected to arouse students' curiosity and motivate them to work to obtain answers to increase conceptual mastery. The learning activity allows students to study in proper learning environments and applying the mental power to discover new concepts or principles (Smet, D.Cindy. et al., 2012). The students can find concepts independently through discovery learning (Sartono et al., 2017). It is similar to guided inquiry learning, where teachers provide guides for students to organize intellectual skills or thinking skills related to the reflective thinking process (Ristanto et al., 2018).

Teachers' concept mastery influences students' learning process in the class (Sadler & Sonnert, 2016; Zulfia et al., 2019). Further, Johnson (2017) states that teachers play a role as a mentor in the learning process and correct students' inaccurate concepts through questions, graphs or charts, examples, and illustrations. The use of media, images, concept maps, and videos can also actualize, stimulate, and facilitate students' understanding of discovery learning (Ningsih et al., 2019; Tudor, 2013). Students are not wrong; it needs to be guided. In the guided discovery, teachers provide instructions and design activities or provide an outline so that the learning is proven correct (Eggen & Kauchak, 2012).

Guided discovery learning enables students to structure the excretory system concept by assimilating content by identifying organ structures, functions, mechanisms, and regulation of homeostasis, disorders, and excretory system technology. It can be done by discussing and presenting problem-solving under teachers' guidance (Abrahamson & Kapur, 2018; Shieh & Yu, 2016). They interact with each other to explore their abilities and convey ideas through the discovery process (Martaida et al., 2017).

Am integration of information and communication technology into the guided discovery learning will optimize learning objective achievement (Musyaddad & Suyanto, 2019; Plessis, 2015). Those who utilize online-based interactive media will get the chance to get new knowledge faster (Gurubatham, 2013). The e-learning system could become a program to facilitate the learning process via information technology application. E-learning suitable for blended learning is conducted outside face-to-face hours. The combination of e-learning and conventional class is blended learning (Best & Conceição, 2017).

Teachers provide online content based on indicators and discuss it in a conventional class known as blended learning (McGrath, 2013). Further, blended learning could become a stimulus of independent and authentic learning as students can still learn and complete the content as a pre-determined schedule outside the classroom (Ark et al., 2014; Heinze et al., 2007). Similarly, Diep et al. (2017) state that blended learning gives more time to study so that it has a significant effect on students' learning outcomes.

Technology utilization in biology learning activities is supported by senior high school students already familiar with online media. Moreover, each class has been equipped with wifi and projector facilities. Learning using a smartphone is also conducted by Ismanto et al. (2017). This study aimed to combine technology (e-learning) with guided discovery learning to enhance senior high school students' concept mastery.

Discovery learning emphasizes students actively rearrange concepts so that the human excretion system's conceptual arrangement is more optimal. The search should not only come from books and teachers but also from online media.

METHOD

Research Design

The research used was quasi-experimental with a pretest-posttest control group design (Sugiyono, 2015). The experimental group was taught using the Guided Discovery-Blended Learning (GDBL) strategy, and the control group was taught using guided discovery. The independent research variable was Guided Discovery-Blended Learning (GDBL), while the dependent variable was students' concept mastery in the human excretory system. The research result indicated that GDBL affected students' concept mastery of the human excretory system.

Table 1. The Research Design

Class	Pretest	Treatment	Posttest
E	a_1	X	a_2
C	b_1	-	b_2

Note: E = experimental class (GDBL); C= control class (guided discovery); a_1 = pretest of experimental class; a_2 = posttest of experimental class; b_1 = pretest of control class; b_2 = posttest of control class; X = treatment.

Population and Sample

This study's population was all eleventh-grade students of SMA Negeri Jakarta in the academic year of 2019/2020. The sample was selected using randomized sampling where two classes were selected, namely class IPA 2 and class IPA 4.

The sampling technique used was precision level of 1 % (Yamane, 1967). Based on the formula calculation, 71 students were selected as the research sample. As a result, thirty-six students were selected as the experimental class taught by GDBL, and thirty-five students were selected as the control class taught by discovery learning.

Instruments

The research instruments were an essay test in C1 - C6 cognitive realms by referring to Bloom's Taxonomy with revision (Anderson et al., 2002). The researchers limited the cognitive realms to C2, C3, C4, C5, and C6 (understanding, applying, analyzing, evaluating, and synthesizing) because C1 has been integrated to all indicators. The instrument's validity had been checked using construct and content validity, with an average score of 88.75. It means that the instruments were suitable to be utilized. Empirical validation test of item instruments used Pearson Product Moment formula. The result was higher than the r table in a minimum range of 0.386, indicating that, of the 20 questions tested, 15 were valid. Next, a reliability test was performed using Cronbach's Alpha resulted in a minimum value of 0.830, it means that the instruments were reliable to measure the concept mastery of the human excretory system. The instrument specification is presented in Table 2.

Table 2. The Specification of Human Excretory System Concept Mastery

Basic Competence	Learning Content	Question Number	Concept Mastery
Analyze the relationship between organ structures in the excretory system and link them with the excretory processes. Explain the mechanism as well as functional disorders likely to occurs in the excretory system.	Definition of excretion, secretion, and defecation.	1, 5	Understanding (C2)
	Structures and function of excretory organs (kidney, liver, skin, and lungs).	2, 4	Applying (C3)
	Homeostasis mechanism and osmoregulation in kidney and skin.	6, 9	Analyzing (C4)
	Disorders/abnormalities in the excretory system.	12,14	Evaluating (C5)
	Excretory system technology.	13,15	Creating (C6)

The instrument had gone through content validation and construct validation. Based on the validation, the instrument's contents are in line with Basic Competencies and competency indicators. The indicators of this study are (1) C2 students provide an understanding of teaching materials, including identification, explaining, and differentiating; (2) C3 students apply a procedure in certain circumstances; (3) C4 Students do the analysis; (4) C5 students determine attitudes based on references or standards that have been determined by testing and criticizing; (5) C6 students arrange the interconnected parts to form an original product.

Procedures

The activity began with the preparation of a research proposal in September 2019. The implementation stage was in February 2020. The third stage was data analysis and article preparation.

Students in the experimental and control classes had a pretest before the excretory system to measure their initial knowledge. The learning was carried out in four meetings from February to March 2020. The first meeting was a discussion to prepare content for a presentation based on teachers' problems for each group. It was conveyed online before learning activities in class. A presentation follows it to synchronize perceptions of the content. The second meeting was about the kidney's functions, structures, and disorders. The third meeting was on excretory organs in the liver, lungs, skin, homeostasis mechanism, and osmoregulation. The fourth meeting was related to excretory system abnormalities and technologies.

In the control class, students learned using guided discovery. The experimental class used books, teachers, and online media using smartphones or laptops and projectors connected to the wifi network. Also, the classes used Google Classroom. The results of syntax implementation are illustrated in Figure 2. The GDBL steps adapted the Discovery Learning syntax according to Syah (2010) is described in Table 3, and research procedures can be seen in Figure 1.

Table 3. GDBL Procedures

No.	Syntax	Excretory System Learning Activities	Implementation
1.	Stimulation	1. Learners pay attention to explanation and form a group according to online content prepared by the teachers 2. The teachers provide stimuli in the form of questions to be explored as discussion materials by showing images	Online meeting

No.	Syntax	Excretory System Learning Activities	Implementation
		of abnormalities in the excretory system	
2.	Problem statement	3. The group members collaborate to identify problems on human excretory system organs, structures, functions, processes, homeostasis mechanism, osmoregulation, abnormalities, and technologies for presentation	Online meeting
3.	Data collection	4. The group members work to collect data to answer questions. 5. Solve problems, search for literature from sourcebooks and online media.	Online meeting
4.	Data processing	6. Data processing activities are carried out by comparing to the existing theories.	Face-to-face meeting
5.	Verification	7. The group members collaborate to decide whether problem-solving is correct or not by comparing each other, and it continues with the class presentation. 8. Other groups respond or ask questions.	Face-to-face Online meeting
6.	Generalization	9. The teachers review incorrect students' understanding. 10. The teachers, along with the students, draw some conclusions. 11. The discussion results are uploaded to Google Classroom.	Face-to-face Online meeting

(Syah, 2010)

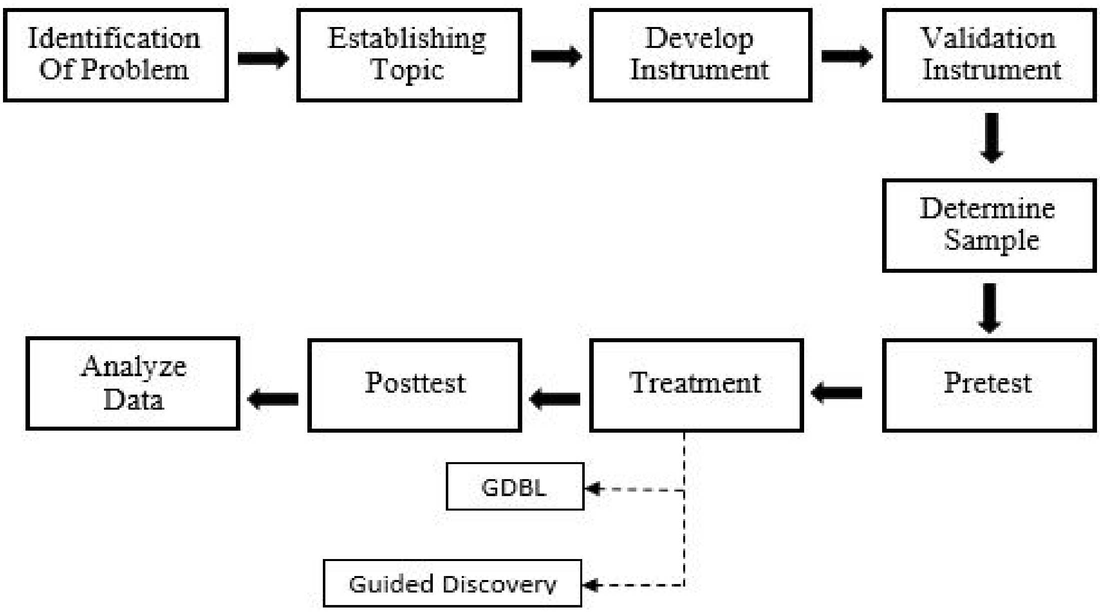


Figure 1. Research Procedure

RESULT AND DISCUSSION

Based on the research results, the descriptive statistics that consist of mean scores, maximum scores, and minimum scores of the GDBL and guided discovery classes are described in Table 4.

In general, students demonstrated the ability to master the concept, for example, in the C4 question domain (analyzing). The question asked an analysis of why people with diabetes Mellitus have glucose in their urine and often urinate at night. Students can already mention the organs with an abnormality, explain the organ's function, and explain that the organ is damaged. It can cause abnormalities to connect one organ to another in maintaining the excretory function to keep it normal. Example of answers from students who score 5: urine of diabetes Mellitus sufferers contain glucose because diabetics cannot store excess blood sugar caused by insulin deficiency due to damage to the pancreas. Blood sugar should be filtered back by the kidneys and returned to the bloodstream. Because blood sugar concentration is high, some glucose is excreted with urine not to harm the body. The urine becomes thick so that it will absorb more water from the body to dilute it. Through water secretion in the Henle arch to the distal tubule, tubular reabsorption of water is reduced. Thus, people with diabetes with high urine volume frequently urinate.

Table 4. Descriptive Statistics of the Conceptual Human Excretory System

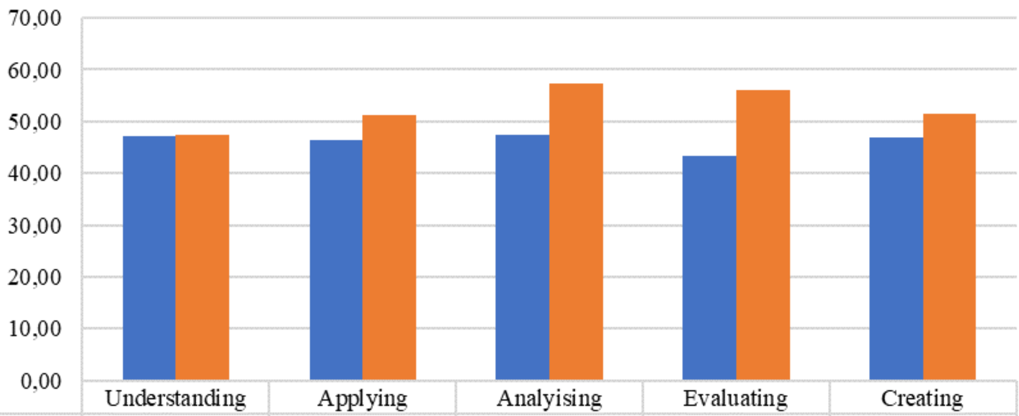
Data	Experiment Class		Control Class	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Mean	33.33	86.00	34.06	80.17
Min	24.00	80.00	24.00	74.00
Max	42.00	92.00	42.00	86.00
Standard Deviation	4.41	2.95	3.84	3.54
Variance	19.43	8.69	14.70	12.56

The research results indicated that the mean values of the human excretory system concept mastery in all indicators experienced increased in both classes (Table 4). The experiment class got the highest score (92), while the control class obtained 86. Students already understand how they have to learn, get additional material from the discussion between friends, teachers, and look for information on online media (Banyen et al., 2016). The students were prepared for a discussion about content in class, confident to argue, and pleased with the learning strategy so that the mastery of the concept increases (Diep et al., 2017; Plessis, 2015).

Table 5. The Average of Human Excretory System Concept Mastery

Indicator	N	Control		N	Experiment	
		Pretest (Mean ± SD)	**Posttest (Mean ± SD)**		**Pretest (Mean ± SD)**	**Posttest (Mean ± SD)**
Explaining	35	38.00 (±7.59)	85.14 (±7.81)	36	43.05 (±6,68)	90.56 (±6.29)
Applying	35	34.28 (±8.50)	80.57 (±8.02)	36	38.61 (±9,64)	89.72 (±9.09)
Analyzing	35	32.57 (±7.80)	80.00 (±7.66)	36	29.17 (±7,60)	86.38 (±7.21)
Evaluating	35	34.28 (±9.16)	77.71 (±8.43)	36	27.22 (±9,06)	83.33 (±9.56)
Creating	35	30.57 (±7.64)	77.42 (±7.00)	36	28.61 (±6,39)	80.00 (±4.14)
Average	35	33.94 (±2.73)	80.17 (±3.17)	36	33.33 (±7,06)	86.00 (±4.41)

Table 5 shows that the highest score was in the explaining indicator (90.56), while the lowest score was in the creating indicator (80.00). In terms of score increase, the analyzing indicator had the most significant increase with a difference of 57.21, from 29.17 to 86.38. The indicator with the lowest increase was explaining with a difference of 47.51, from 43.05 to 90.56 (Figure 2). The analyzing indicator experienced the highest increase because the students were trained by always looking for the correct answers from the exploration and collaboration stages, accustomed to matching from sourcebooks and online media, and teachers' explanations (Abrahamson & Kapur, 2018). Students independently learn concepts by actualizing real problems by utilizing ICT and teacher guidance so that their thinking is correct (Shieh & Yu, 2016).



	Understanding	Applying	Analyising	Evaluating	Creating
Control	47,14	46,29	47,43	43,43	46,86
Experiment	47,51	51,11	57,21	56,11	51,39

Figure 2. The Differences of Improvement

Posttest scores in the GDBL and guided discovery classes had an average difference of 5.83. The GDBL class's average posttest score was 86.00, and it was 80.17 in the Guided Discovery class. It was due to the GDBL that emphasizes concept reorganizing activity with teacher guidance from sourcebooks and online media. Additionally, it allows learning outside the classroom where students could exchange information online; thus, they could motivate each other by equating perceptions about the content delivered in the presentation (Diep et al., 2017; Nair & Bindu, 2016). Online learning is enjoyable for students, and it encourages them to explore their abilities. Consequently, learning becomes more optimal, and it makes students master the concept (Norberg et al., 2011; Permana & Chamisijatin, 2019). Moreover, it stimulates students' curiosity, motivates them to find an answer, and covers syntax that could enhance concept mastery.

The overall response toward the human excretory system content with the application of GDBL suggested an improvement of human excretory system concept mastery by 93 %. Learning using the GDBL strategy can enhance students' ability to rearrange the concept using their language by independently reading and searching for literature from the internet with teachers' guidance. The result of the students' response was 97.2 %. It implied that the students enjoyed implementing mixed learning; thus, the learning was more optimal.

The Implementation of GDBL

The results of GDBL learning syntax is summarized and displayed in Figure 3. The research was carried out within four meetings. The syntax implementation for student activities in the first meeting was 86.46. It was due to the students who were not familiar with being actively involved in a group discussion. Smart students dominated the discussion. It was increased in the second, third, and fourth meeting of 98.84.

The students started to get familiar with the learning strategies. Less active students were encouraged to state their ideas, and they were given a task to deliver the presentation. It indicated that the excretory system learning implementation was adequate and following the syntax.

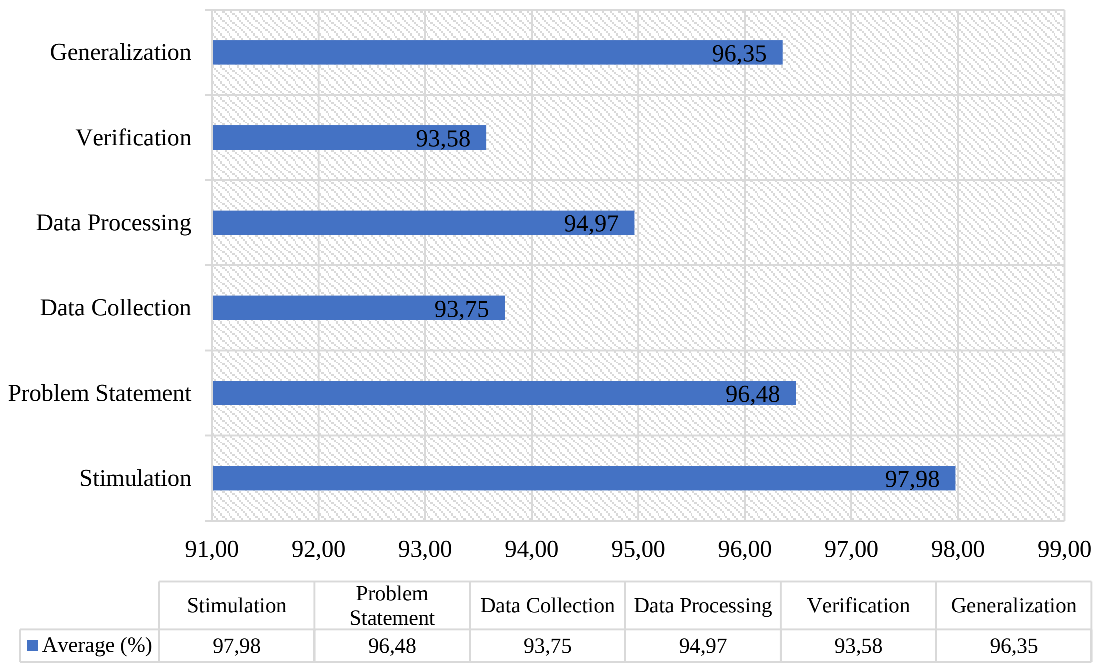


Figure 3. GDBL Syntax Implementation

Table 6. Normality of Pretest and Posttest of the Conceptual Human Excretory System

Class	N	Concept mastery		Significance	Description
		Sig. Pretest	Sig. Posttest		
Experiment	36	0.088	0.077	0.05	Normal
Control	35	0.200	0.058	0.05	Normal

Table 7. Homogeneity of the Conceptual Human Excretory System

Indicator	Levene Statistics	df1	df2	Sig
The conceptual human excretory system	1.696	1	69	0.197

Based on Table 6, the pretest and posttest significance was more significant than the significance of α = 0.05. It could be inferred that the pretest and posttest data of the concept mastery were normally distributed in both experimental and control classes.

Table 7 presents the homogeneity test using Levene's test with α = 0.05. The calculation resulted in db = 1.69 and α = 0. 573 > 0.05 or H_0 was accepted. It can be interpreted that the average pretest and posttest in groups taught with the GDBL model and those taught with guided discovery was homogeneous.

Correlation of the Conceptual Human Excretory System

According to the data analysis values obtained from the instrument test conducted, the correlation test results with α = 0.05 are presented in Table 8.

Table 8. Correlation of Pretest and Posttest Scores of the Conceptual Human Excretory System

Class	N	r	Sig.	Description
Experiment	36	0.387	0.020	Significant
Control	35	0.354	0.037	Significant

Significance at α = 0.05

Table 8 shows that the pretest scores in the experimental and control classes significantly correlated with the posttest scores. It was indicated by significance in both classes of 0.020 and 0.037, respectively, smaller than 0.05. The experimental class's relationship level and the control class was in a low category as the r value was at an interval of 0.2-0.39.

The calculation of the human excretory system concept mastery results acquired descriptive statistics that consisted of deviation standard and variances of the experimental class and control class, as indicated in Table 9.

Table 9. The Results of ANCOVA Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	700.666[a]	2	350.333	37.623	.000
Intercept	5515.879	1	5515.879	592.362	.000
Metode	641.707	1	641.707	68.914	.000
PreTest_PK	97.778	1	97.778	10.501	.002
Error	633.193	68	9.312		
Total	491948.000	71			
Corrected Total	1333.859	70			

a. SSquared = .525 (Adjusted R Squared = .511)

Based on Table 9, it can be seen that the pretest score had p value = 0.002 < α = 0.05 of the pretest score, with a confidence level of 95 %; thus, there was an effect of learning model implementation in the group taught with GDBL and conventional learning model on the posttest scores of the human excretory system concept mastery obtained by the students.

After being taught with the GDBL strategy, the students were capable of explaining, implementing, analyzing, evaluating, and creating in the human excretory system content that included aspects of the definition, structures and functions, homeostasis mechanism and osmoregulation, and the human excretory system diseases and technologies, so that the average score achieved was above the minimum completeness criteria.

In the GDBL class, the learning was more meaningful as students' search was more optimal. They searched for information on the excretory system content from online media and confirmed it to the sourcebooks and biology teachers. Therefore, the students were familiar with rearranging the concept according to their abilities. It corresponds to the e-learning system principle and could be utilized as a program to facilitate the conventional learning process by applying information technology (Rusman, 2012).

The objective learning achievement was related to the GDBL syntax that prepares students to learn from the first stage. It is carried out by providing stimuli as discussion materials and flash videos on the human excretory system. Flash videos are part of e-learning that is used to make it easier for students to understand the process of forming urine in the kidneys and actualize complex and abstract processes (Ningsih et al., 2019; Tudor, 2013). The students responded with questions. Therefore, they started with intellectual activity in their learning. The next stage was problem identification and data collection through a group discussion. Students are provided with an opportunity to explore problems from various sources, including online media, and it is in line with a study by Nair, T. & Bindu (2016). The teachers developed the problem-based guided discovery so that students could advance their thinking skills through their intellectual efforts in assimilating problems. Hence, as they rearranged the concept correctly, it is in line with the Group Investigation type's cooperative learning that could increase learning activities and biology concept mastery in Bacteria subject of Grade X students of SMAN 3 Bantul (Widyastuti, 2017). It also corresponds to research by Ristanto et al. (2018).

The fourth and fifth stages consisted of data processing and verification. In the fifth stage, students exchanged opinions through a group discussion. It intended to synchronize perceptions on a concept with guidance from the teachers. This is consistent with Piaget's constructivism theory (Ducret, 2001) that knowledge is a process instead of results; thus, students require practice in the learning. Moreover, students were trained to develop their thinking skills in solving problems they encountered. Students presented their group discussion results in the verification stage, while other groups had an opportunity to ask questions. In this stage, exchange opinions with other groups to answer through cognitive activity (Gurubatham, 2013).

The final stage of the GDBL is concluding. Teachers discuss inappropriate content by providing opportunities for students to answer questions and convey their ideas. On the stage, students must organize their knowledge and understanding to reconstruct concepts. This is the following (Martaida et al., 2017). Furthermore, the teacher and the students make conclusions. In line with Johnson (2017), that in Guided Discovery learning, teachers act as mentors in the learning process and correct inaccurate student concepts. In line with Plessis (2015) statement that conventional learning combined with the use of information and communication technology will increase learning objectives.

The difference between GDBL learning from other strategies, GDBL focuses on rearranging concepts through stimulating real-life problems with the guidance of teachers from sourcebooks and online media. Besides, it allows learning outside the classroom, flexible time so that it is fun and more optimal and makes students better master the concepts. This is in line with the research results Nair & Bindu (2016) and Permana & Chamisijatin (2019), stimulate student curiosity and motivate students to work to get answers and include syntax and a discussion learning environment which is expected to improve concept mastery. Implementing the GDBL strategy, students are trained to explore their potential so that they are accustomed to synthesizing content that impacts increasing conceptual mastery.

Several things could be presented from the GDBL according to the research results, namely: 1) it provides opportunities for students to utilize android smartphone to search for information and analyze them from the online learning material content and to discuss them with their peers as well as teachers to avoid the mistake in the concept rearranging; 2) it develops students' intellectual reasoning through habituation in completing the assignment that related to daily life problems; 3) it fosters students' positive attitudes to look for learning sources other than books; hence, they could organize various information into useful knowledge via independence of learning; and 4) teachers play a role as a mentor in the learning by facilitating students who are less capable of applying facts, ideas, concepts of the content into daily life real experiences (Abrahamson & Kapur, 2018; Gurubatham, 2013; Plessis, 2015; Shieh & Yu, 2016).

Things to be considered in the GDBL application included: sufficient time allocation to provide an opportunity for students in delivering their opinion during presentation discussion, teachers must provide a particular hour outside face-to-face hours for students to consult the learning content, and school must provide such facilities as wifi or internet network, permanent projectors in each class, and other facilities (Best & Conceição, 2017; Sugiharto et al., 2019).

CONCLUSION

According to the research conducted and data analysis results, it could be inferred that there was an effect of the GDBL strategy on students' concept mastery in the human excretory system. After learning using the GDBL, there was an improvement in the students' concept mastery. A combination of online learning and conventional learning based on discovery learning and collaborative activities could become a future effort to be implemented in biology learning in the class as it motivates students to explore their potentials. The GDBL could be an alternative in the online learning process by preparing a good internet network, projectors, computers and laptops, and other supporting facilities at school.

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