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Development of Student Worksheets Based on Science Process Skills on Excretory System Concepts

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Abstract: This research aims to produce a student worksheet based on Science Process Skills (SPS) on the concept of the excretory system and to see the responses of teachers and students to the worksheet. The method used is Research and Development (R&D) with a 4D development model (Define, Design, Develop, Disseminate), which is modified into 3D (without Disseminate). The instruments used in this study included a checklist of student worksheets, interview sheets, content validity and readability test instruments for student worksheets, and teacher and student response questionnaires. The development process was through a validity test by three experts, a readability test by 12 students, and a field trial by one biology teacher and 90 students. The results showed that the developed worksheet had an average validity percentage of 85.40% with excellent criteria. In the readability test, the average percentage of the worksheet reached 92.01%, with excellent criteria as well. While in the field trial, the responses of teachers and students showed excellent criteria with percentages of 87.42% and 86.65%. Based on the results, it can be concluded that the Student Worksheet is very suitable to be used in learning activities.

Keywords: Excretory System Concepts; Science Process Skills; Student Worksheet

Introduction

Education is essential in creating an environment and a learning process designed in such a way. However, the average learning process in schools is still more teacher-centred and makes students less active (Samputri, 2020; Radzali et al., 2018). Therefore, it is necessary to make a paradigm change that can make the learning process student-centred (Permendikbud, 2016).

A scientific approach also needs to be applied so that students can think scientifically, critically, and analytically. The principles of the scientific approach can not be separated from the findings in the field of science. In learning, science is realized as Natural Science (Kumala et al., 2020). Biology is one of the branches of science that describes a process for using problem-solving procedures with the scientific method (Zulfiani et al., 2009). That is related to Science Process Skills (SPS).

SPS trains students to develop scientific literacy skills, which are very important in modern society, especially because many issues are related to science and technology. Scientific process skills are split in two in the form of core and integrated scientific process skills (Elmas et al., 2018). Core scientific process skills include observation, classification, prediction, inference, and communication skills. These core skills will be necessary to construct new knowledge. Integrated scientific process skills are advanced skills such as determining and controlling variables, formulating and testing hypotheses, and experimenting (Turiman et al., 2012).

SPS is the basis of problem-solving in science and the scientific method (Kumala et al., 2020). SPS is not only helpful in problem-solving and knowledge development, but it also involves the process of scientific reasoning, critical thinking, and conceptual understanding (Gillies & Nichols, 2015).

SPS needs to be trained early to feel happier and challenged to find the concept of learning and develop themselves. SPS-based learning activities vary according to learning methods and require appropriate allocation of time and arrangements but will yield optimal outcomes in learning science. Guevara (2015) states that while learning varies conditions and strengthens memory, where learning becomes an integral part of long-term memory, the learning experience becomes more meaningful and valuable. One example of SPS is practicum activities, where students have to use their minds, tools and materials and interact with other friends (Arsih, 2010; Ergül et al., 2011).

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The level of students' understanding of SPS as the basis of learning is still very lacking because the implementation of learning tends to be monotonous and not yet conducive to the development of their SPS (Samputri, 2020; Gunawan et al., 2019). Monotonous learning is characterized by students' lack of involvement in finding a concept independently in the learning process. Therefore, active learning is needed to practice their SPS (Turiman et al., 2012).

The active learning process can be realized with the help of teaching material that becomes a guide for students to carry out learning. One of the teaching materials used is the Student Worksheet (Utami, Ruja, & Utaya, 2016; Ekantini & Wilujeng, 2018). The student worksheet contains instructions, guidelines, or steps for learning activities that students must carry out (Misbah et al., 2018). Mutlu (2020) evaluated how grade 7 students' scientific process skills changed in an inquiry-based learning environment through reflective worksheets. The results indicated that inquiry-based learning activities improved students' scientific process skills.

Durmaz & Mutlu (2017) were to investigate the effect of instructional interventions on seventh-grade students' science process skills (SPS), and the results showed that there was a significant difference between the pre-test and post-test scores of the experimental group concerning the SPS assessment. However, the difference in the pre-test and post-test values of the control group related to the SPS assessment test was insignificant. The study results also revealed that students had some problems using the SPS.

Student worksheets can increase student activity because the materials are obtained differently from the teacher's explanation. The use of student worksheets can also make students not feel bored, and it is easier to master the learning materials (Rakhmi et al., 2017; Martin et al., 2012; Rahayu et al., 2017). This is in line with the goal of SPS, which emphasizes the active involvement of students in the learning process.

However, most student worksheets that the teacher uses only contain questions and practical work steps (Sari & Sumarmin, 2018). This is also supported by the results of observations conducted at MAN 11 Jakarta, which showed that the worksheets used were not fully oriented to science process skills for students. It can make students feel bored and burden them because they have to answer these questions. Even students rely on their friends to work (Sari & Sumarmin, 2018).

Based on these problems, student worksheets should be developed by adding SPS aspects to increase students' awareness of the relationship between science and everyday life (Puspita, 2019; Ekantini & Wilujeng, 2018). It can also help learn biology, one of which is the concept of the excretory system. The excretory system is an abstract concept related to physiological processes in the body, so it requires additional activities, such as practicum (Nisa et al., 2019).

In connection with online learning, practicum activities cannot be carried out due to many limitations, so students cannot train their SPS. However, based on interviews with several students, they argue that practicum still needs to be carried out even in online learning, noting that it uses simple tools and materials. They considered that practicum was a way to understand the learning material better.

Therefore, it is necessary to develop something that can help them do simple practicum independently so that students' SPS can remain trained. Based on several problems that have been described, researchers feel the need to conduct research with the title "Development of Student Worksheets Based on Science Process Skills on the Concept of Excretion System".

This study aims to produce student worksheets based on science process skills on the concept of the excretory system and see the responses of teachers and students to the student worksheets. The results of this research are expected to produce teaching materials that can be an alternative for teachers to be applied to learning activities and provide new learning experiences for students.

Method

This research was conducted at MAN 11 Jakarta in January-June 2021 in the 2020/2021 academic year, focusing on online development and testing. The subjects of this study included three expert validators (media, material, practitioner), a biology teacher for class XI, and all students in class XI MIA (Math and Natural Sciences) at the research site. This study uses the Research and Development (R&D) method, which helps develop and produce a product. Meanwhile, the development model used is 4-D (Define, Design, Develop, and Disseminate) (Thiagarajan, Semmel, & Semmel, 1974). However, this research does not include the dissemination stage due to time and place limitations.

The define stage is carried out to define the requirements for developing to follow the needs and learning objectives and increase the efficiency and effectiveness of learning. This stage consists of 5 activities: front-end analysis, student analysis, concept analysis, task analysis, and learning objectives. At this stage, an analysis of student worksheets at school and interviews with teachers and students were also carried out.

The design stage aims to prepare a prototype of student worksheets based on science process skills to be developed. This stage consists of preparing tests according to standards, selecting the suitable media, selecting the format that will be used, and preliminary design for the device according to the format and analysis that has been done.

The develop stage contains activities to validate the contents of the student worksheets that have been made to the experts and conduct a readability test of the student worksheets that is limited to 12 students. After that, the student worksheets were revised based on suggestions and input from experts and students

assessments. Finally, a field trial was conducted on all students in class XI MIA. Teachers and students were also asked to respond to the student worksheets used during this trial.

The instruments used in this study included a checklist of student worksheets at school, teacher and student interview sheets, content validity test instruments for student worksheets, readability test instruments for student worksheets, and teacher and student response questionnaires.

Data processing in this study used two main techniques, namely the Guttman scale and the Likert scale. The data that was processed using the Guttman scale included the results of the checklist of the student worksheets and the results of the readability test of the student worksheets. Meanwhile, the data processed with the Likert scale included the results of the validity test of the student worksheets and the results of the teacher and student response questionnaires.

Tabel 1. Criteria for Data Processing on the Guttman Scale

Alternative Answers	Score
Yes	1
No	0

Tabel 2. Criteria for Data Processing on the Likert Scale

Alternative Answers	Score
Very good (VG)	5
Good (G)	4
Pretty good (PG)	3
Not good (NG)	2
Not very good (NVG)	1

The data analysis technique used to process the research data into an average percentage uses the Formula 1.

$$P = \frac{\Sigma X}{\Sigma Xi} \; x \; 100\% \qquad (1)$$

Description:
P = Percentage
ΣX = Number of respondents' answers in 1 item
ΣXi = Maximum number of scores in items

Determination of the assessment criteria to describe and conclude the value that has been obtained from the calculation results can use the quality criteria for developing student worksheets based on science process skills the concept of the excretion system as listed in table 3.

Tabel 3. Criteria of Quality Interpretation Assessment

Score interval	Criteria
81-100%	Excellent
61-80%	Very Good
41-60%	Good
21-40%	Fair
0-20%	Poor

Adapted from Hairida & Setyaningrum (2020)

Result and Discussion

The research that has been done has produced student worksheets based on SPS on the excretory system concept. The student worksheets are included in the type of experiment because it primarily makes students conduct experiments or practicum. Devi et al. (2009) explained that the main characteristic of experimental student worksheets is practical work steps accompanied by tools and materials. The worksheet development stage includes define, design, develop and dissemination. The define stage begins with setting workseets development goals based on the problem. At the define stage, student worksheet was developed to improve the previous student worksheets used in schools because, based on the analysis of the checklist, it is still in the fair criteria. Look at Table 4.

Before analyzing the worksheets in school, interviews were first conducted with a biology teacher and students. These two activities are called front-end analysis, which is included in the define stage. Based on interviews, there is no application of SPS or practicum during online learning. Arsih (2010) explained that science process skills had become the basis for the student learning process because it involves three educational domains. Even students in the interview said that practicum needed to be carried out to understand the learning material better.

Tabel 4. Summary of Student Worksheet Checklist Results at School

Aspects	Percentage (%)	Criteria
Structure of student worksheets in general	50.00	Good
Science process skill indicators	10.00	Poor
Percentage of the average quality of student worksheets	30.00	Fair

Interviews with students were also conducted to fulfil one of the requirements in preparing student worksheets, namely didactic requirements. Umbaryati (2016) explains that student worksheets need to be prepared by considering each student's different levels of understanding so that all students are expected to have no difficulty working on student worksheets. After that, it is possible to analyze the tasks, concepts, and learning objectives that must be achieved.

The second stage of 4-D is carried out designs. The preparation of tests and the selection of media are helpful so that the contents in the student worksheets are accurate and relevant. Akbar (2017) explains that accurate student worksheets follow the scientific approach, and relevant student worksheets follow essential competencies and learning objectives. At the same time, the choice of format helps fulfil construction requirements in language use and technical requirements using letters and pictures in student worksheets (Umbaryati, 2016). After that, the initial design can be made.

The last stage in this research is developed because the dissemination stage is not carried out. Experts then validate prototypes of student worksheets that have gone through the design stage. This expert validation aims to determine the level of validity of the student worksheets to focus on the suitability of good development theory. After that, the validator provides input for improving student worksheets (Akbar, 2017). Validation in this study was carried out by three experts, which were divided into one material expert, one media expert, and one practitioner expert.

Tabel 5. Results of Student Worksheet Validity Test

Components	Percentage (%)	Criteria
Content eligibility	89.44	Excellent
Linguistics	81.67	Excellent
Presentation	88.57	Excellent
Graphic display	84.00	Excellent
Science process skill indicators	83.33	Excellent
Percentage and Total Criteria	85.40	Excellent

Table 5 above is the total validation result of the three validators, and the average percentage is 85.40% with excellent criteria. The component with the highest average percentage is content eligibility 89.44%. The contents of the student worksheets are much better than the student worksheets that were previously used in school. This eligibility includes conformity with Core Competencies and Basic Competencies, material needs, and usefulness. Akbar (2017) explains that a complete and systematic student worksheet can make it easier for users to use and master the contents of student worksheets.

Meanwhile, the aspect with the lowest average percentage is linguistics 81.67%. It is indicated by the existence of instructional sentences that are less effective and sometimes cause ambiguity so that it creates mis-understandings. Akbar (2017) states that student worksheets must be communicative so that they are clear and easily digested by users, such as using semi-formal language.

The validity process shows that the student worksheets need to be revised according to the validator's suggestions. The aim is that the student worksheets are more valid and can be tested and used in the learning process. Rajabi in Trimunarti et al. (2019) also states that validity can indicate the level of consistency in each part of the developed student worksheet, from objectives, materials, to assessments.

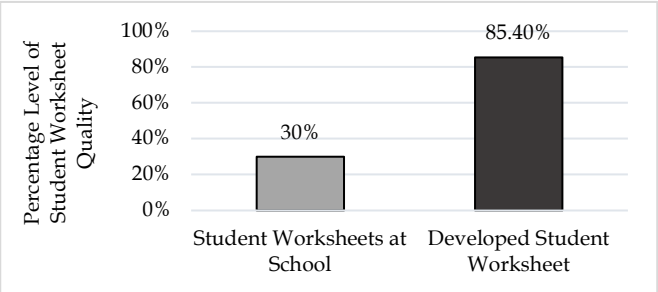

Figure 1. Comparison Graph of the Quality of Student Worksheets

After being revised, it continued with a limited readability test conducted by 12 students of class XI MIA. This test aims to see the text clarity, the display suitability, and the ease of use and usability of the worksheets. The results of the readability test can be seen in Table 6.

Tabel 6. Student Worksheet Readability Test Results

Indicators	Average Percentage of Indicator (%)	Percentage Average Total (%)	Criteria
Text clarity	97.22	92.01	Excellent
Display suitability	91.67		
Ease of use	87.50		
Use of student worksheets	91.67		

Table 6 shows the overall average percentage is 92.01%, with excellent criteria. It shows that student worksheets are very suitable to use by more students for learning activities. However, it still requires several revisions because respondents also suggested improvements to the student worksheet.

The most revision was on the ease of use indicator, with an average percentage of 87.50%. There are still some work steps that cannot be understood. At the same time, the indicator close to the maximum percentage is the clarity of the text with 97.22%. It is due to perfect sentences because they have been revised after the validation process.

The last activity of this research is a field trial to determine the responses of teachers and students to student worksheets used in learning. The results of the teacher response analysis can be seen in Table 7.

Tabel 7. Teacher's Response Analysis Results

Components	Percentage (%)	Criteria
Practicality	85.00	Excellent
Eligibility of Contents	91.67	Excellent
Graphic display	88.00	Excellent
Linguistics	85.00	Excellent
Percentage and Total Criteria	87.42	Excellent

Based on the teacher's response analysis, the average percentage was 87.42%, with excellent criteria. The aspect that gets the highest score is the feasibility of the material content, with a percentage of 91.67%. It shows that the teacher assesses that the contents are are very feasible and can also be a source of learning for students.

Tabel 8. Student's Response Analysis Results

Components	Percentage (%)	Criteria
Practicality	82.17	Excellent
Eligibility of Contents	85.72	Excellent
Graphic display	89.29	Excellent
Linguistics	89.41	Excellent
Percentage and Total Criteria	86.65	Excellent

While the responses given by 90 students had an average percentage of 86.65%, only 0.77% different from the teacher's response. The high rating given by students

lies in the linguistic aspect of 89.41%. This aspect has continuously been improved since it was validated to a limited readability test. It fulfils the requirements of a suitable student worksheet, which uses language following the guidelines and has the appropriate level of readability.

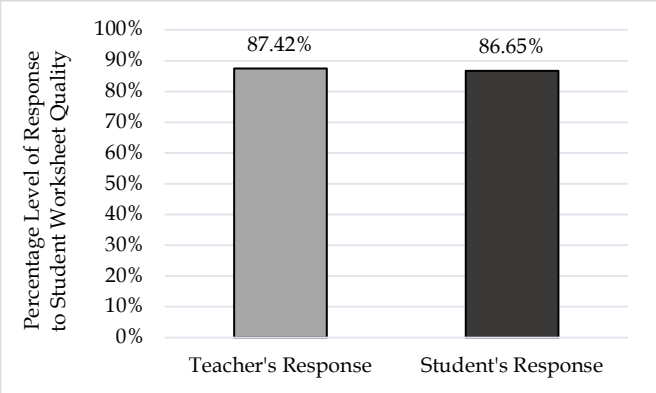

Figure 2. Comparison Graph of Responses to Developed Student Worksheets

The validation and readability test results can show the feasibility level of the student worksheet, which is excellent. The responses of teachers and students also showed positive results. Following Rahmatillah et al. (2017) research, a positive response indicates that the SPS-based student worksheets are feasible for students to use because they are practical, easy to learn, and complete. While the results of research by Utami et al. (2016), positive responses from students showed that student worksheets made them more interested and active in learning because they were not bored.

The resulting student worksheets are also following the research of Putriani et al. (2017), where student worksheets were developed to enable students to practice their science process skills so that the concepts learned can be discovered and understood independently. Rosidi (2016) also explains that student worksheets based on SPS can make students understand more about scientific principles. Rahayu et al. (2018) mention that SPS-based student worksheets can hone students' logical thinking skills.

The designs on the developed student worksheets are also excellent, including colours and illustrative images. It is another advantage of the student worksheets. Widodo et al. (2012) also make design advantage in their student worksheets because it can attract students, so they do not get bored in learning.

This student worksheet is used for distance learning due to the Covid-19 pandemic, making students learn from their own homes. However, the use of student worksheets has succeeded in helping students carry out practicum activities. Damayanti in Efendi & Sartika (2021) explains that the implementation of practicum requires preparation to run well, such as learning tools, the readiness of teachers and students, tools and practicum materials, and learning time.

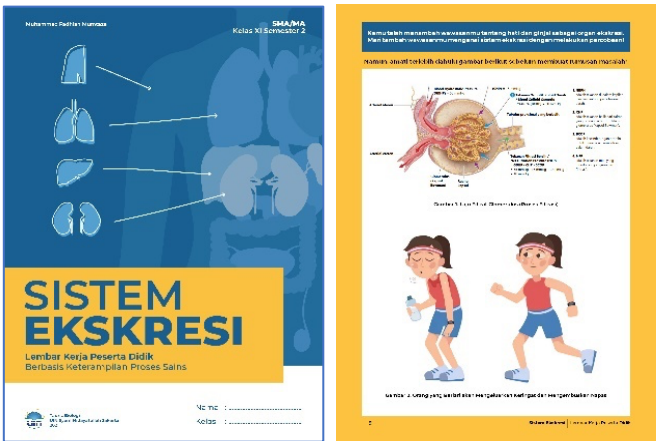

Figure 3. Student Worksheet Design (a) Front Cover; and (b) Use of Illustrated Images

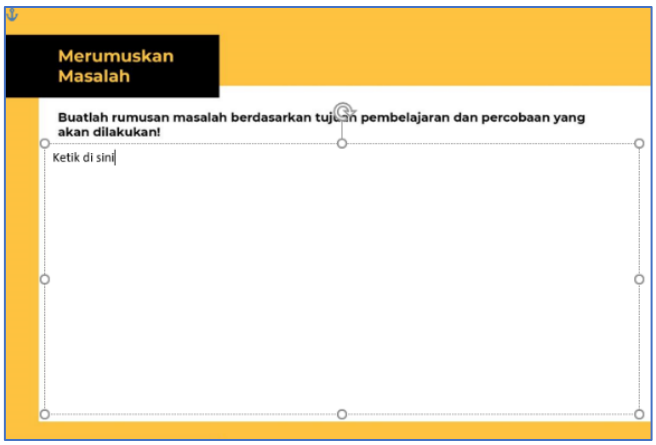

Figure 4. Use of Text Boxes for Filling Out Student Worksheets

The student worksheets in this study used other media to access them, namely *Microsoft Office Word*. It is because the student worksheets are in JPG format. Therefore, a JPG format file is placed on every page in *Word*. Then in the empty column in the student worksheet, a text box is added according to the column size.

Febriansyah et al. (2021) used student worksheets using similar additional media, but he used FlipHTML5 web-based media. The student worksheets it produced to show an excellent category. Almost all students who use these student worksheets experience an increase in their science process skills. It can be seen from the answers given by them.

Another study was conducted by Apriyanto et al. (2019), which was to develop student worksheets using the 3D page flip software application. The student worksheets are in the excellent category and suitable for learning activities. Haryanto & Ernawati (2020) modified student worksheets based on science process skills using the Kvisoft Flipbook application. The results show that there is an increase in SPS in students. Some relevant studies prove that student worksheets can also be used for distance learning by turning them into electronic student worksheets.

Science Process Skills Analysis

Analysis of SPS aspects in student worksheets can be done after being done and assessed by the teacher. According to the assessment rubric, the analysis is carried out by counting the number of students who answer or carry out these activities and get the maximum value.

Table 9. Results of the Aspect Analysis of Science Process Skills

SPS aspects	Average Percentage (%)	Percentage Average Total (%)	Total Criteria
Observing	66.67		
Interpret	80.00		
Classify	71.11		
Predict	66.67		
Formulate the problem	100.00		
Making a hypothesis	77.78	80.67	Excellent
Doing an experiment	100.00		
Using tools and materials	73.33		
Communicating	77.78		
Applying the concept	93.33		

Based on this analysis, students' level of mastery is in excellent criteria with an average percentage of 80.67%. The most mastered aspects are formulating problems and conducting experiments, meaning that they understand the problems contained in the student worksheets. It seems that adding pictures before formulating the problem is also effective in helping them. Hamadi et al. (2018) explained that students need to be brought to see the problems of the material they are studying to raise questions.

However, students still lack in observing and predicting with an average percentage of 66.67%, although it is still in excellent criteria. Students only read discourse, not using other senses. Darmaji in Maison et al. (2019) explains that observing is the first step of each activity, so it needs to be strengthened from the early stages. While predicting, students still misunderstood and were less thorough with the cases given.

The SPS aspects are well arranged in the student worksheets, indirectly training the SPS of the students. They can carry out a sequence of learning activities by the specified rubric. In addition to determining student scores, this rubric can also show how far their level of understanding of the SPS is.

Conclusion

Based on the research that has been done, it can be concluded that the student worksheets produced have excellent criteria. From the validation results carried out by three validators, the average percentage of student worksheet eligibility levels reached 85.40%. The responses given by the teacher and students are also in line with the feasibility level of the student worksheets. It is an excellent criterion. The percentage of teacher responses to student worksheets in total is 87.42%, while the average percentage of responses given by students is 86.65%.

Based on these data, it can be said that the student worksheets based on science process skills developed have very feasible criteria to be applied to excretory system learning activities more broadly. Even on the analysis results of the SPS aspects in the student worksheets, it can be seen that students can apply each aspect with a percentage of 80.67%. In addition, they can also become more active and creative during online learning, which tends to return to teacher-centeredness. It is supported by experimental activities in student worksheets to understand better the concepts being studied.

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