



# Development of Web-Integrated Investigation Worksheet about Protists

Lely Mardiyanti

Universitas Jambi, Jambi, Indonesia.

Received: July 14, 2023

Revised: November 28, 2023

Accepted: January 25, 2024

Published: January 31, 2024

Corresponding Author:

Lely Mardiyanti

[lelymardiyanti@unja.ac.id](mailto:lelymardiyanti@unja.ac.id)

DOI: [10.29303/jppipa.v10i1.4678](https://doi.org/10.29303/jppipa.v10i1.4678)

© 2024 The Authors. This open access article is distributed under a (CC-BY License)



**Abstract:** This study aims to produce a web-integrated investigation worksheet about protists that is valid, practical, and effective by following the McKenney & Reeves development model. The validity of the worksheet was obtained by filling out a validation questionnaire by teaching material experts and microbiology experts. The practicality of the worksheet was obtained through filling out response questionnaires by students and biology teachers. Meanwhile, the effectiveness of the worksheet was obtained from the difference in students' pretest and post-test scores. The results of filling out the validation questionnaire and response questionnaire were analyzed using percentages while the difference in student test scores was analyzed using paired t-test. The average of expert validation results obtained a value of 88.6% (valid). Implementation on 30 students of class X IPA SMA Islam Kepanjen Malang using the group investigation learning model showed that the worksheet proved to be very practical based on the average response which amounted to 89.3%. In addition, the paired t-test results showed that there was a big difference between the students' test scores before ( $M = 37.500$ ,  $SD = 13.310$ ) and after using the worksheet ( $M = 77.033$ ,  $SD = 13.013$ ),  $t(29) = 18.203$ ,  $p < 0.001$ ,  $d = 3.323$ . So, it can be concluded that the web-integrated investigation worksheet about protists is considered valid, very practical, and effective.

**Keywords:** worksheets; web-integrated teaching materials; protist teaching materials; group investigation.

## Introduction

Science learning, especially biology, can be directed toward achieving scientific skills through investigative activities (Muhdhar et al. 2021). In learning science, students are directed to compare the results of students predictions with theory through experiments using the scientific method (Amiroh et al. 2021). Science education is expected to be a vehicle for students to study themselves and the surrounding nature, as well as the prospect of further development in applying it in everyday life, which is based on the scientific method (Al-Muhdhar et al. 2021; Basaroh et al. 2021).

Based on the results of filling out a needs questionnaire by 21 students of class XI IPA at SMA Islam Kepanjen Malang, it is known that the difficulty felt in learning biology class X is when practicum

activities or experiments, even though 54% of biology learning activities that they like are practicum. The difficulties that arise are due to teaching materials that do not support learning activities. Teaching materials commonly used are handouts and lab manuals. The shortcomings of the handouts used are that they only contain material without any practicum activities which are usually used for materials with a lot of memorization such as plantae, animalia, and ecology. While the shortcomings of the practicum manual are that there are only instructions but no guidance, especially during practicum, which requires students to classify. So that students feel that the material that is difficult to learn in class X is protists and Animalia.

Based on the results of interviews with class X biology teachers, it is known that students have indeed been accustomed to learning cooperatively and

## How to Cite:

Mardiyanti, L. (2024). Development of Web-Integrated Investigation Worksheet about Protists. *Jurnal Penelitian Pendidikan IPA*, 10(1), 172–178. <https://doi.org/10.29303/jppipa.v10i1.4678>

conducting investigations or projects. The teaching materials used, in the form of handouts and practicum instructions, were made by the teacher himself. The teacher also admitted that teaching biology in class X IPA was difficult when it came to Animalia and protist material. Animalia material is considered difficult because it must simplify the material to be taught to students, while protist material is considered difficult when guiding practicum. Facilitating the protist practicum was recognized by the teacher as quite difficult because the practicum instructions he made only contained instructions without any guidance for classifying. The teacher revealed that the teaching materials needed in addition to handouts and lab manuals are worksheets and teaching materials that can guide the classification process, especially on protist material.

Based on previous research, the use of worksheets provides benefits for teachers and students. According to Amali, Kurniawati, and Zulhida, worksheets can be a tool to facilitate learning activities and form effective interactions between students and teachers (Amali, Kurniawati, and Zulhiddah 2019). In addition, the worksheet can better attract students' attention to learning and is relevant to the situation and conditions of the surrounding environment. Meanwhile, based on the results of research from Sugiyanto, Hasibuan, and Anggereni shows that worksheet can attract and increase students' enthusiasm for learning (Sugiyanto et al., 2018). In another study by Patresia, Silitonga, and Ginting, it was found that the use of worksheets in science learning can improve students' science process skills (Patresia et al., 2020).

Based on these studies, an innovative worksheet integrated with a digital website is needed to facilitate students' investigation activities. Web-integrated investigation worksheets can be developed from worksheets in general. This is what is done in this research and development. This innovation certainly needs to be tested for validity, practicality, and effectiveness so that it can be feasible to use.

## Method

Research and development were conducted in class X IPA SMA Islam Kepanjen Malang by following the McKenney & Reeves development model (McKenney and Reeves 2018) which consists of 4 stages.

### Stage 1: Analysis and Exploration

A preliminary study was conducted including learner analysis, learning analysis, and analysis of teaching materials that have been used in schools

through filling out a need questionnaire by students and interviews with biology teachers.

### Stage 2: Design and Production

The design framework of the web-integrated investigation worksheet was made, followed by the making of the initial worksheet prototype, then revisions were made to improve the prototype.

### Stage 3: Evaluation and Reflection

The investigation worksheet was validated by teaching material experts and microbiology experts, then revisions were made according to the input provided by expert validators. The validation questionnaire grids are shown in Table 1.

**Table 1.** Grid of Validation Questionnaire

Validation	Aspects	Statement Item
Content by Microbiologist	Content:	
	1. Completeness of content	1, 2, 3
	2. Content accuracy	4, 5, 6
	3. Content support activities	7, 8, 9
	4. Recency of content	10, 11
	5. Material supporting student competencies	12, 13, 14, 15, 16, 17
	6. Use of instructions	18, 19, 20
	Language:	
	1. Use of Indonesian language	21
	2. Language clarity	22
Layout by Teaching Material Expert	3. Appropriateness of language	23
	4. Use of terms and symbols	24, 25
	Display:	
	1. General presentation organization	1, 2
	2. Presentation considerations of meaningfulness and usefulness	3
	3. Development of the knowledge formation process	4, 5, 6, 7
	4. General view	8, 9, 10, 11
5. Completeness of the investigation worksheet	12	
6. Presentation of learning	13, 14, 15, 16, 17, 18, 19	
7. Variation in delivery	20, 21, 22	

The results of filling out the validation questionnaire and response questionnaire were

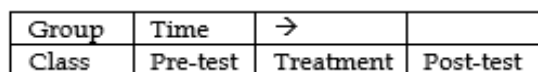
analyzed using percentages which were then matched with the validity criteria (Sa'dun 2013) in Table 2.

**Table 2.** Validity Criteria

Criteria (%)	Level	Description
95.01 – 100	Very valid	Can be used with minor revisions
85.01 – 95	Valid	Can be used with minor revisions
75.01 – 85	Moderately valid	Should not be used, there are many revisions
50.01 – 75	Poorly valid	Unusable due to many revisions
1 – 50	Invalid	Unusable due to many revisions

*Stage 4: Implementation and Dissemination*

The investigation worksheet was implemented for 30 students in class X IPA using the group investigation learning model (Ningsih et al., 2022). The implementation was carried out with a one-group pretest-posttest design (Leedy, Ormrod, and Johnson 2019), as in Figure 1.



**Figure 1.** One-Group Pretest-Posttest Design

A response questionnaire was filled in by biology teachers and students to determine the practicality of the investigation worksheet. The grids of biology teacher and student response questionnaires for practicality are shown in Table 3.

**Table 3.** Grid for Practicality Questionnaire

Aspects	Statement Item
Following the needs	1, 2
Facilitates student activities	3, 8
Ease and clarity of information	4, 5, 11
Ease and clarity of language	6, 7
Ease and clarity of display	9, 10, 12

The results of filling out the response questionnaire by biology teachers and students were analyzed using percentages which were then matched with the practicality criteria (Sa'dun 2013) in Table 4.

**Table 4.** Practicality Criteria

Criteria (%)	Level
85.01 – 100	Very practical
70.01 – 85	Practical
50.01 – 70	Poorly practical
1 – 50	Impractical

In addition, pre-test and post-test were conducted to determine the effectiveness of the investigation

worksheet. Students' pre-test and post-test results were analyzed using paired t-tests after meeting the assumption of normality in the distribution of data on the difference in test results. The assumption of normality of the distribution of data on the difference in student test results is met if the  $p$ -value > 0.05. The web-integrated investigation worksheet is said to be effective if there is a difference in student test scores before and after learning in the paired t-test results ( $p$ -value < 0.05). If the paired t-test results show a difference or effect, then an effect size calculation is carried out using *Cohen's d* to find out how much difference or influence there is. The effect size criteria of *Cohen's d* (Ellis 2010) can be seen in Table 5. After implementation, the investigation worksheet was distributed online.

**Table 5.** Effect Size Criteria of *Cohen's d*

<i>d</i> Value	Effect Size
≥ 0.8	Large
0.5 – < 0.8	Medium
0.2 – < 0.5	Small

**Result and Discussion**

*Validity Results*

The web-integrated investigation worksheet about protists consists of a cover, learning outcomes, instructions for use, practicum activity guides, and discussions for investigation. The format of the investigation worksheet is following the worksheet format proposed by Fitri and Suparman; Nuari and Suparman; Patresia, Silitonga, and Ginting (Fitri and Suparman 2019; Nuari & Suparman 2019; Patresia et al. 2020). The final appearance of the developed investigation worksheet and web about protists can be seen in Figure 2.

The results of the validity of the investigation worksheet obtained from filling out the validation questionnaire by teaching material experts and microbiology experts are listed in Table 6.



(a)



(b)

Figure 2. Final Display of (a) Investigation Worksheet and (b) Web

Language	87	Valid
Display	92.7	Very valid
Average	88.6	Valid



Before being used for implementation, the investigation worksheet was revised according to the suggestions of the experts so that its validity reached 100%. The suggestions for improvements given by experts to the investigation worksheet along with excerpts of the revised results can be seen in Table 7. Worksheet validity is essential to assess the quality of its content and appearance before it is used for implementation (Arnawa et al. 2019; Ekantini & Wilujeng 2018; Ramadhan et al. 2020).

Table 6. Summary of Validation Results by Experts

Aspects	Percentage (%)	Category
Content	86	Valid

Table 7. Revised Result of Investigation Worksheet

Suggestions	Before Revision	After Revision
It is better if the colors chosen are brighter to make it more attractive		
It's better if you give it a page		

Suggestions	Before Revision	After Revision
It is better to add a discussion to analyze the diseases or disadvantages that can be caused by Protista		

**Practicality Results**

The practicality of the investigation worksheet is based on the results of filling out response questionnaires by biology teachers and students which can be seen in Table 8. Practicality obtained from user responses is very important to know how comfortable and easy the worksheet is when used in learning (Arnawa et al. 2019; Nasution & Yerizon 2019).

**Table 8.** Results of Response Questionnaires by Biology Teachers and Students

Aspects	Response (%)		Average (%)	Category
	Teacher	Students		
Following the needs.	96.7	81.5	81.5	Practical
Facilitates student activities.	98	85.4	91.7	Very practical
Ease and clarity of information.	93.3	91	92.2	Very practical
Ease and clarity of language	93.3	88.2	90.8	Very practical
Ease and clarity of display	84	81.8	82.9	Practical
Average	93.1	85.6	89.3	Very practical

**Effectiveness Results**

Before conducting a paired t-test analysis on students' pretest and post-test scores, the assumption of normality of the distribution of data on the difference in student test scores was tested. The results of the normality test of the distribution of the difference in student test scores can be seen in Table 9.

**Table 11.** Paired t-Test Results

	Mean	Std. Deviation	Std. Error Mean	Paired Differences		t	df	Sig. (2-tailed)	
				95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest - Posttest	-39.533	11.895	2.171	-43.975	-35.091	-18.203	29	<0.001

**Table 9.** Results of the Normality Assumption Test for the Distribution of Data on the Difference in Student Test Scores

	Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	df	Sig.
Difference in Test Scores	0.151	30	0.079

a. Lilliefors Significance Correction

The *Kolmogorov-Smirnov* test results inform that the data on the difference in student test scores are normally distributed [ $D(30) = 0.151, p = 0.079$ ] and can be continued for paired t-tests. The results of the paired t-test can be seen in Table 10 and Table 11, followed by the results of the effect size calculation with *Cohen's d* in Table 12.

The results of the paired t-test and the calculation of effect size with *Cohens'd* inform that there is a big difference between student test scores before ( $M = 37.500, SD = 13.310$ ) and after using the web-integrated investigation worksheet ( $M = 77.033, SD = 13.013$ ),  $t(29) = 18.203, p < 0.001, d = 3.323$ . So, it can be concluded that the web-integrated investigation worksheet about protists effectively improves student test results.

**Table 10.** Results of Paired t-Statistics

		Mean	N	Std.	Std.
				Deviation	Error Mean
Pair 1	Pretest	37.500	30	13.310	2.430
	Posttest	77.033	30	13.013	2.376

**Table 12.** Effect Size Calculation Results with *Cohen's d*

Pair 1	Pretest - Posttest	<i>Cohen's d</i>	Standardize <sup>a</sup>	Point Estimate	95% Confidence Interval	
					Lower	Upper
			11.895	-3.323	-4.241	-2.396

a. The denominator used in estimating the effect sizes.

*Cohen's d* uses the sample standard deviation of the mean difference.

These results are similar to the results of Sudarmin et al's research which shows that the test results of students taught with worksheets have increased (Sudarmin et al., 2019). In addition, based on the results of Nasrullah and Marlina's research, the use of web-integrated worksheets can increase students' learning activities, knowledge, and motivation (Nasrullah et al., 2018).

Based on this, it can be stated that the advantages of the web-integrated investigation worksheet about protists, besides being valid and very practical, can also effectively improve students' learning outcomes. Another advantage of this investigation worksheet is that it has experimental activities, observations, and discussion forums to direct students to investigative activities and is equipped with a web to assist in classifying Protista. The shortcomings of the web-integrated investigation worksheet found are that it requires internet access to access the website and requires website rejuvenation every year.

**Conclusion**

The web-integrated investigation worksheet about protists was declared valid by experts with an average score of 88.6% and became 100% after revisions were made according to the suggestions given by experts. The investigation worksheet also proved to be very practical when used based on the average response from biology teachers and 30 students which amounted to 89.3%. The investigation worksheet was even proven to be effective in influencing student test results based on the results of the paired t-test and the calculation of effect size with *Cohen's d*. There was a large difference between student test scores before ( $M = 37.500, SD = 13.310$ ) and after using the investigation worksheet ( $M = 77.033, SD = 13.013$ ),  $t(29) = 18.203, p < 0.001, d = 3.323$ . So, it can be concluded that the web-integrated investigation worksheet is valid, very practical, and effective. Suggestions that researchers can provide for the sustainability and utilization of this investigation worksheet are that users are recommended to use the group investigation learning model when using this investigation worksheet, each user is recommended to ensure the availability of internet access to open the website that has been integrated with the investigation worksheet. In addition, it is necessary to test the effectiveness of this investigation worksheet for other

student learning abilities or outcomes, such as various 21<sup>st</sup>-century skills.

**Acknowledgments**

Thank you to the teachers and students of SMA Islam Kepanjen Malang and lecturers at Universitas Negeri Malang, who have helped in this research.

**Author Contributions**

Lely Mardiyanti: Conceptualized the research idea, designed methodology, validated, analyzed data, wrote, reviewed, and edited.

**Funding**

The research is not receiving any funding support from any source.

**Conflicts of Interest**

The author declares no conflict of interest.

**References**

Al-Muhdhar, M. H. I., Basaroh, A. S., Prasetyo, T. I., Sumberartha, I. W., Mardiyanti, L., & Fanani, Z. (2021). Improvement of Creative Thinking Skills and Environmental Literacy through the E-Module of Surrounding Nature Exploration. *AIP Conference Proceedings*, 2330(1). <https://doi.org/10.1063/5.0043102>.

Amali, K., Kurniawati, Y., & Zulhiddah, Z. (2019). Pengembangan Lembar Kerja Peserta Didik Berbasis Sains Teknologi Masyarakat pada Mata Pelajaran IPA di Sekolah Dasar. *Journal of Natural Science and Integration*, 2(2), 191-202. <https://doi.org/10.24014/jnsi.v2i2.8151>.

Amiroh, F., Irawati, M. H., Suhadi, S., & Mardiyanti, L. (2021, March). The effectiveness of guided inquiry-based module to improve high school students' environmental literacy. In *AIP Conference Proceedings*, 2330(1). <https://doi.org/10.1063/5.0043194>.

Amawa, I., Yerizon, Y., Sri, N., & Putra, R. T. (2019). Development of Students' Worksheet Based on Apos Theory Approach to Improve Student Achievement in Learning System of Linear Equations. *International Journal of Scientific and Technology Research*, 8(4), 287-292. Retrieved from <http://repository.unp.ac.id/26413/>

Basaroh, A. S., Al Muhdhar, M. H. I., Prasetyo, T. I.,

- Sumberartha, I. W., Mardiyanti, L., & Fanani, Z. (2021). Pengembangan E-Modul Model Eksperiential Jelajah Alam Sekitar (Ejas) Pada Materi Plantae. *Jurnal Pendidikan Biologi*, 12(1), 30. <https://doi.org/10.17977/um052v12i1p30-39>.
- Ekantini, A., & Insih, W. (2018). The Development of Science Student Worksheet Based on Education for Environmental Sustainable Development to Enhance Scientific Literacy. *Universal Journal of Educational Research* 6(6), 1339-1347. <https://doi.org/10.13189/ujer.2018.060625>.
- Ellis, P. D. (2010). *The Essential Guide to Effect Sizes: Statistical Power, Meta-Analysis, and the Interpretation of Research Results*. Cambridge University Press.
- Fitri, N. L., & Suparman. (2019). Designing Worksheet Using the Context of Sugarcane. *International Journal of Scientific and Technology Research*, 8(10), 3369-3372.
- Leedy, Paul, Ormrod, J. E., & Johnson, L. R. (2019). *Practical Research Planning And Design*, 12th ed. United Kingdom: Pearson Education, Inc.
- McKenney, S., & T. C. Reeves. (2018). *Conducting Educational Design Research*. Taylor & Francis.
- Muhdhar, M. H. I. A., Aini, N., Rohman, F., Sumberartha, I. W., Mardiyanti, L., & Wardhani, W. (2021). Improvement of Collaboration Skills and Environmental Literacy through the Surrounding Nature Exploration Integrated Group Investigation. *AIP Conference Proceedings*, 2330(1). <https://doi.org/10.1063/5.0043101>.
- Nasrullah, A., Marlina, M., & Dwiyantri, W. (2018). Development of Student Worksheet-Based College E-Learning Through Edmodo to Maximize the Results of Learning and Motivation in Economic Mathematics Learning. *International Journal of Emerging Technologies in Learning*, 13(12), 211-229. <https://doi.org/10.3991/ijet.v13i12.8636>.
- Nasution, D. H., & Yerizon, Y. (2019). Development of student worksheets based on discovery learning to improve student mathematical problem solving ability in class X senior high school. *International Journal of Scientific dan technology Research*, 8(6), 228-231. Retrieved from <http://repository.unp.ac.id/26415/>
- Ningsih, S. R., Suryani, A. I., & Maulana, I. T. (2022). The Implementation of Group Investigation E-Task in Activities Learning (GIETAL) in Higher Education. *Electronic Journal of E-Learning*, 20(2), 120-33. <https://doi.org/10.34190/ejel.20.2.2066>.
- Nuari, L. F., & Suparman. (2019). Designing Worksheets for the Mentally Retarded Student in Multiplication Operations. *International Journal of Scientific and Technology Research*, 8(10), 3579-84. Retrieved from <https://www.ijstr.org/paper-references.php?ref=IJSTR-1019-23409>
- Patresia, I., Silitonga, M., & Ginting, A. (2020). Developing Biology Students' Worksheet Based on STEAM to Empower Science Process Skills. *Journal of Biological Education Indonesia (Jurnal Pendidikan Biologi Indonesia)*, 6(1), 147-156. <https://doi.org/10.22219/jpbi.v6i1.10225>.
- Ramadhan, K. A., Suparman., Hairun, Y., & Bani, A. (2020). The Development of Hots-Based Student Worksheets with Discovery Learning Model. *Universal Journal of Educational Research*, 8(3), 888-94. <https://doi.org/10.13189/ujer.2020.080320>.
- Sa'dun, A. (2013). *Instrumen Perangkat Pembelajaran*. Bandung: PT Remaja Rosdakarya.
- Sudarmin, S., L. Zahro, S. E. Pujiastuti, R. Asyhar, Z. Zaenuri, and A. Rosita. (2019). The Development of PBL-Based Worksheets Integrated with Green Chemistry and Ethnoscience to Improve Students' Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, 8(4), 492-99. <https://doi.org/10.15294/jpii.v8i4.17546>.
- Sugiyanto, Y., Hasibuan, M. H. E., & Anggereni, E. (2018). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Kontekstual Pada Materi Ekosistem Kelas VII SMPN Tanjung Jabung Timur: The Development of Contextual Based Student Worksheet (LKPD) in the Material of Class VII Ecosystem, SMP Tanjung Jabung Timur. *Edu-Sains: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, 7(1), 23-33. <https://doi.org/10.22437/jmpmipa.v7i1.7279>.