The Development of POE-based (Predict, Observe, and Explain) E-Student Worksheet for Eleventh-Grade Plant Histology Subject

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ABSTRACT

This research developed electronic student worksheet (e-student worksheet) based on POE (Predict, Observe, and Explain) using the Liveworksheets feature. The research method was R&D (Research and Development) with a 4-D model, namely define, design, develop, and disseminate. There were three data collection techniques in this research, namely interview, questionnaire, and N-gain from the pretest and posttest scores. The analyzed data using qualitative descriptive analysis. The results showed that (1) the average percentage of e-student worksheet feasibility obtained was 92.90% with material expert validators of 94.23%, media expert validators of 88.23%, and practitioner validators of 96.25%. Therefore, the POE-based e-student worksheet can be used with a very valid or very feasible category. (2) The percentage obtained from student responses was 85% with a very good category. (3) The N-Gain value obtained was 0.39 with a medium category. Thus, the development of e-student worksheet based on POE (Predict, Observe, and Explain) on plant tissue material for the eleventh-grade students can be used with a very feasible category.

Pengembangan Lembar Kerja E-Student Berbasis POE (Predict, Observe, and Explain) untuk Mata Pelajaran Histologi Tumbuhan Kelas XI

ABSTRAK: Penelitian ini bertujuan mengembangkan lembar kerja siswa elektronik (e-student worksheet) berbasis POE (Predict, Observe, and Explain) dengan menggunakan fitur Liveworksheets. Metode penelitian yang digunakan adalah R&D (Research and Development) dengan model 4-D, yaitu define, design, develop, dan distribute. Ada tiga teknik pengumpulan data dalam penelitian ini, yaitu wawancara, angket, dan N-gain dari nilai pretest dan posttest. Teknik analisis yang digunakan deskriptif kualitatif. Hasil penelitian menunjukkan bahwa (1) rata-rata persentase kelayakan LKS yang diperoleh adalah 92,90% dengan validator ahli materi 94,23%, validator ahli media 88,23%, dan validator praktisi 96,25%. Oleh karena itu, LKS e-student berbasis POE dapat digunakan dengan kategori sangat valid atau sangat layak. (2) Persentase yang diperoleh dari respon siswa sebesar 85% dengan kategori sangat baik. (3) Nilai N-Gain yang diperoleh sebesar 0,39 dengan kategori sedang. Dengan demikian, pengembangan LKS berbasis POE (Predict, Observe, and Explain) pada materi jaringan tumbuhan untuk siswa kelas XI dapat digunakan dengan kategori sangat layak.

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INTRODUCTION

Learning in Indonesia is mainly done online, known as distance learning, due to the Covid-19 Pandemic (Anas & Murti, 2021; Ichsan, et al., 2020). The distance learning model presents a big challenge for teachers because many teachers are not used to using a blended and fully online learning system. Thus, distance learning must utilize information technology (Verawardina, et. al., 2020;Riski, 2021).

The Ministry of Education confirmed in circular no. 4 of 2020 that distance learning during the Covid-19 pandemic requires internet access (Hanifah, et al., 2020). Distance learning is also determined by several supporting factors, including mobile phones, bandwidth, internet networks, and appropriate teaching materials (Putria et al., 2020;Refendi et al., 2020). Teachers and students need information and communication technology-based learning resources during distance learning because learning must keep up with the times by integrating learning with information and communication technology (Amirullah & Susilo, 2016).

One media that can be used in distance learning activities is student worksheets. An e-student worksheet is an electronic activity sheet that can be opened on laptops, cellphones, and others. It can combine various features, such as images, videos, audio, and hyperlinks, to enable interaction between students and teachers (Lathifah, et al., 2021). However, printed student worksheets are still not effective and less practical to use in distance learning (Lathifah, et al., 2021).

Prastowo (2014) said that student worksheets are teaching materials that can reduce the teacher-centred paradigm to student-centred so that students will be more active. Liveworksheet is a platform in the form of a website that provides an alternative material delivery in the form of activity sheets that can be accessed and responded to online by students (Devi & Yuliani 2021). The Liveworksheet has drop-down features, short entries, essays, multiple choice, check boxes, joint with arrows, adding other website links, drag-drop, adding mp3 audio, displaying videos from YouTube, and listening and speaking (Hazlita, 2021;Rhosyida et al., 2021).

E Liveworksheet-based e-student worksheets can provide learning variations to students so that the learning is not boring (Purwaningrum & Leksono, 2022). In addition, e-student worksheets encourage students to be active in learning and provide convenience in online learning (Prastika & Masniladevi, 2021;Agustina et al., 2022).

A preliminary study was conducted in September 2021 at SMA N 1 Tegal. The implementation of distance learning activities on plant tissue material is done virtually. The teacher only sends a learning video link to students, and students make virtual observations of the practicum video via the YouTube link. After that, students make reports of their virtual observations. However, students are not required to do their practicum at home, even though the plant tissue material is contextual. As a result, teachers do not know students' skills, so student learning outcomes on plant tissue material are less than optimal, as evidenced by the daily test scores of students who are still below the average (<80). A total of 12 students out of 34 students scored below the average.

One learning media teacher in distance learning can use an e-student worksheet based on POE (Predict, Observe, and Explain). POE allows the concept of plant tissue to be learned through predicting, observing, and explaining the results of observations. Students' initial ability can be known from the prediction results so that students are motivated to find answers to problems posed by the teacher. Based on the background of the problem above, it is necessary to develop an e-student worksheet based on POE (Predict, Observe, and Explain) that is feasible and can be used on plant tissue material to help teachers in online learning (Dewi, 2019).

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METHOD

This is development research with a 4-D model (Define, Design, Develop, and Disseminate). This research was carried out at SMA N 1 Tegal on August 15, 2021, to December 25, 2021, in the odd semester of the 2021/2022 school year. A limited trial has been conducted online involving 25 eleventh-grade students.

The '*Define*' stage includes four main stages: preliminary studies, curriculum analysis, task analysis, and the application used in the e-student worksheet. Researchers interviewed biology teachers at SMA N 1 Tegal in the preliminary study. The interview process found that during the Covid-19 Pandemic, teachers had never used student worksheets as teaching materials for distance learning, especially in plant tissue material.

The curriculum analysis phase (problem) aims to obtain material and basic competencies in biology learning. Next is the task analysis stage, a procedure for determining a learning activity and student activity on the e-student worksheet. The task analysis process compiles learning tools (lesson plans) with the POE (Predict, Observe, and Explain) model. The next step is to change the student worksheet into an e-student worksheet. The next step is to determine the application in developing the e-student worksheet. The application used in developing the e-student worksheet is the Liveworksheets website.

The initial design of the e-student worksheet was made with the Canva application to make it more attractive. The 'Design' stage includes two (2) main stages, namely choosing the format and designing the layout for the Canva application. The e-student worksheet format developed must be oriented to the syntax or POE stages, namely making predictions (Predict), proving conjectures or experiments to match predictions (Observe), and explaining the analysis of experimental or conjecture results (Explain).

The development stage (Develop) includes four main stages: preparing e-student worksheet media in the form of Liveworksheet, selecting the Liveworksheets feature, and preparing e-student worksheet links. The last stage is the product dissemination stage (Disseminate), carried out during the results seminar. This stage is carried out to promote product development so that users, both individuals and groups, can accept it. The product distribution stage is only limited to socialization with the audience (participants) of the results seminar to get input, corrections, and suggestions for improving the final product development.

Data collection techniques used in this study were interviews, validity test questionnaires (expert validation sheets), pretest and posttest, and limited test questionnaires (student responses). The data analysis used in this study results from expert validation of the POE-based e-student worksheet (Predict, Observe, and Explain), student responses, and the n-Gain value of the pretest and posttest.

The tools used to determine the feasibility are validation sheets of material experts, media experts, and biology teachers based on aspects of presentation, content, language, and suitability. The validation results were analyzed using the criteria of a *Likert* 1-4. The validation scores obtained from the three validators have been averaged. Then, the data is converted into percentage form with the following formula:

$$\text{P score validation (\%)} = \frac{\sum obtained\ score}{\sum maksimum\ score} \times 100\ \%$$

Table 1. Likert Scale for Validity of the E-Student Worksheet

Score	Category
4	Excellent
3	High
2	Moderate
1	Low

(Source: (Ridwan, 2017))

The percentage results of the data are then interpreted using feasibility criteria

adapted from Ridwan, (2017). The e-student worksheet is declared valid if it gets a validity score of more than 61% (**Table 2.**). The data are interpreted with descriptive techniques so that it can be seen how far the level of validity of the e-student worksheet that has been developed can be seen.

Table 2. Validity Criteria

Percentage (%)	Interpretation Criteria
0 – 20	Invalid
21 – 40	Less Valid
41 – 60	Moderately Valid
61 – 80	Valid
81 - 100	Highly Valid

(Source: (Ridwan, 2017))

Data analysis techniques were carried out qualitatively and quantitative descriptive. Descriptive-qualitative analysis was carried out by collecting data in the form of suggestions and input from the validators for later use in evaluation and improvement. Descriptive quantitative analysis was carried out to analyze data in the form of scores obtained from the validation results (Indriani, 2020).

The assessment of the instrument is arranged according to a Likert scale. After being validated by material end media experts, the product is revised according to input from the validator. After being valid, the e-student worksheet was tested on 25 eleventh-grade science students of SMA N 1 Tegal.

Table 3. Likert Scale for Student Response Questionnaire

Score	Category
4	Excellent
3	High
2	Moderate
1	Low

Source: (Guniarti, et al., 2019)

Table 4. Student Response Assessment

Average Percentage	Criteria	Score
0% - 25%	Poor	1
26 % - 50%	Low	2
51% - 75%	High	3
76% - 100%	Excellent	4

Source: (Hake, 1991)

Analysis of learning outcomes in this study was seen from the increase in scores. The increase in value is seen by comparing scores between the posttest and the pretest analyzed using the N-gain score. The gain value obtained has been interpreted according to the criteria to determine the increase in the pretest and posttest scores. The gain level criteria can be seen in Table 5.

$$\text{N-gain} = \frac{Posttest\ score - Pretest\ score}{100 - Pretest\ score}$$

Table 5. *N-gain* Criteria

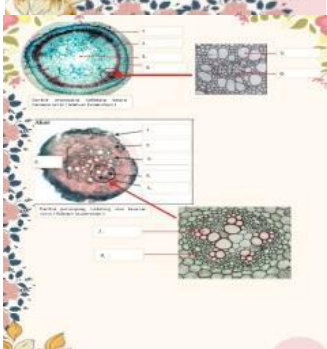| - gain	Category
0.70 < g < 1.00	High
0.30 < g < 0.70	Moderate
0.00 < g < 0.30	Low

RESULTS AND DISCUSSION

This development research resulted in a product in the form of an e-student worksheet using Liveworksheet*s* for plant tissue material based on Predict, Observe, and Explain (POE). An e-student worksheet based on Predict, Observe, and Explain on plant tissue has been researched and developed using a 4-D model consisting of four stages, Define, Design, Develop, and Disseminate. The e-student worksheet validated by the validator and tested will be discussed in this chapter.

There are three e-student worksheets developed by the researchers, namely e-student worksheet one on meristematic tissue sub-material, e-student worksheet two on transport sub-material in plants, and e-student worksheet three on organ anatomy structure sub-material of plant stems. The images of the resulting products can be seen in Table 6.

Table 6. Display of the E-student Worksheet
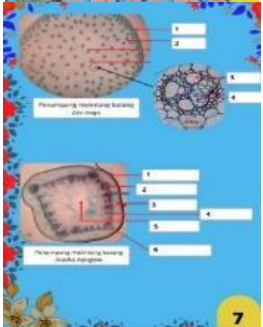
No	Display	Description
	E-STUDENT WORKSHEET 1 (Meristem Network)	
1.		The cover of e-student worksheet 1 is orange. It consists of a title, developer identity, owner identity, thesis supervisor identity, target user, plant tissue sub-material, university logo, time of use, and pictures related to tissue material in plants.
2.		The second sheet contains instructions for use.
3.		The third sheet contains the title of the sub-material, basic competencies, and learning indicators that will be achieved in the material.
4.		The fourth sheet contains the learning objectives to be achieved in the material.

No	Display	Description
5.		The fifth sheet contains activity sheet 1. There are pictures and materials for tomato plants so that students think critically about thickening the diameter of tomato plant stems. Next are questions as initial predictions, where students write their prediction results in the provided column.
6.		The sheet contains an invitation to prove the prediction results through an observation consisting of the purpose of the observation, the tools and materials that must be provided in conducting the observations, the workings of the observations to be made, and a table of observations.
7.		The seventh sheet contains several cross-sectional pictures of dicot and monocot plants. Students observe the picture and write down what tissues are in the picture of the anatomical structure of the plant.
8.		The eighth sheet contains a table of observations.

No	Display	Description
9.		This sheet contains an analysis of the observations made and explains the relationship between the predicted results and the observations made by students.

E-STUDENT WORKSHEET 2 (Transportation in Plants)

No	Display	Description
10.		Cover e-student worksheet 2 with a light green background and consists of a title, developer identity, owner identity, thesis supervisor identity, target user, plant tissue sub-material, university logo, time of use, and pictures of tissue material in plants.
11.		The second sheet contains instructions for use.
12.		The third sheet contains the title of the sub-material, basic competencies, and learning indicators that will be achieved in the material.

No	Display	Description
13.		The fourth sheet contains the learning objectives to be achieved in the material.
14.		The fifth sheet contains activity sheet 2. There are pictures of plants with water media and introductory material so that students think critically about transportation events in plants. Next is a question as an initial prediction where students write their prediction results in the provided column.
15.		The sixth sheet contains an invitation to prove the prediction results through an observation consisting of the objectives of the observations, tools, and materials that must be provided.
16.		The seventh sheet contains the workings for experimenting.
17.		The eighth sheet contains a table of observations.

No	Display	Description
18.		The ninth sheet contains an analysis of the experiments' results, where students explain the relationship between the predicted and experimental results.

E-Student Worksheet 3 (Anatomical Structure of Stem Organs in Plants)

No	Display	Description
19.		The cover of e-student worksheet 3 is blue. It consists of a title, developer identity, owner identity, thesis supervisor identity, target user, plant tissue sub-material, university logo, time of use, and pictures related to tissue material in plants.
20.		The second sheet contains instructions for use.
21.		The third sheet contains the title of the sub-material, basic competencies, and learning indicators to be achieved in the material.
22.		The fourth sheet contains the learning objectives to be achieved in the material.

No	Display	Description
23.		The fifth sheet contains activity sheet 3, with pictures of coconut trees and teak trees that have been cut down and introductory material so that students think critically about the events of the annual circle on the tree. There is a question as an initial prediction where students write their prediction results in the provided column.
24.		The sixth sheet contains an invitation to prove the prediction results through an observation consisting of the objective of the observation, tools, materials that must be provided, how to work, and a table of observations.
25.		The seventh sheet contains several cross-sectional pictures of dicot and monocot plants. Students observe the picture and write down what tissues are in the picture of the anatomical structure of the plant.
26.		The tenth sheet contains an analysis of the results of the observations and explains the relationship between the predicted results and the results of the observations.

One of the characteristics of the e-student worksheet developed is Liveworksheets which are interactive and can be accessed through the website (Indriani & Marhaeni, 2022).). E-student worksheets can be operated using a laptop or mobile phone and accessed online (Ratnawati, 2021). The e-student worksheet also presents several quizzes or questions related to plant tissue material, making it easier for students to fill out answers to practice questions in the Liveworksheet.

The use of technology plays an important role in distance learning which students now carry out. This e-student worksheet can be used for distance learning which is useful during the Covid-19 Pandemic (Prastika & Masniladevi, 2021). This is supported by (Zulkardi et al., 2020) who said that in this Covid-19 Pandemic condition, teachers should make interesting learning through more varied electronic learning media.

After the e-student worksheet was developed, the expert validator conducted an assessment. The expert validator consists of several experts who are lecturers from the Faculty of Teacher Training and

Education, University of Muhammadiyah Purwokerto. The names of expert validators are:

Table 7. Name of the Experts

Validator	
Validator Material Validator	Yusi Risnani, M.Pd
Media Validator	Aji Heru Muslim, M.Pd.
Validator Practitioner	Early Falikhati, S.Si

1. Validity of Activity Sheets

The student activity sheet developed were prototype 1, 2, and 3. The activity sheets were first validated and assessed by material expert validators and media expert validators, and one biology teacher at SMA N 1 Tegal. The worksheets must first go through the validation process. This validation is carried out to determine the feasibility level (Noprinda & Soleh, 2019).

Experts in the first stage of the validation process examined the product. Then the study's results were analyzed qualitatively so that suggestions were made to improve (Jusmiana et al., 2020). The suggestions and input obtained during the review by the validator are described in detail:

Table 8. Expert Validator's Suggestions for Practicality and Revision of E-Student Worksheet

No	Comments and Suggestions	Revision Results
1.	The material presented is good enough to be applied in the distance learning period. However, developers need to add HOTS learning that stimulates learners.	

The validation stages of the developed e-student worksheet are needed for more in-depth improvements before their feasibility is reviewed through a biology teacher response questionnaire. Three experts carried out the validation of the e-student worksheet to determine the feasibility level. Table 9 contains the values of the validators for all aspects.

Table 9. Expert Validator Recapitulation Results for All Aspects

No	Expert Validator	Average Rating
1.	Material Validator	94, 23 %
2.	Media Validator	88, 23 %
3.	Practitioner Validator	96.25%
Total		189.81 %
Final Average		92, 90%
Category		**Very Valid**

The average validation value from material experts, media experts, and practitioners on prototype 2 is 92.90%, which is 81% - 100% in the very valid category (Ridwan, 2017). After revising prototype two according to input from material and media expert validators, the student worksheet is already feasible to use and ready to be tested.

Prototype 1 does not yet have data to process. After prototype one was revised based on suggestions from the validators and became prototype 2, the validators then filled out the validation sheet that had been provided. The validators only point out the deficiencies in the activity sheet. The data that has been obtained is then analyzed using statistical-descriptive analysis by finding the average of all aspects assessed.

The results of the average of all aspects are then seen in the range of validity criteria values to determine the validation category of the validators. The results of the validation of various aspects of the assessment are presented in the diagram as follows:
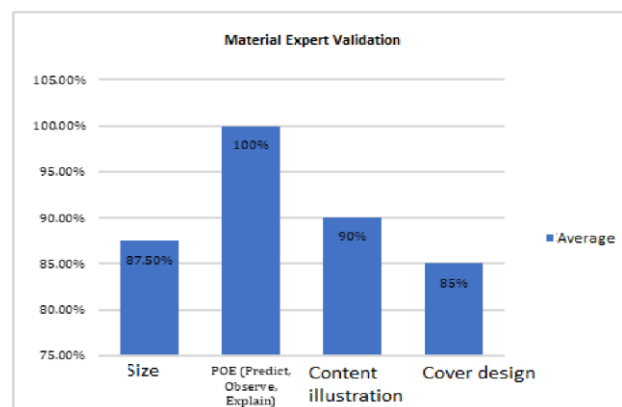

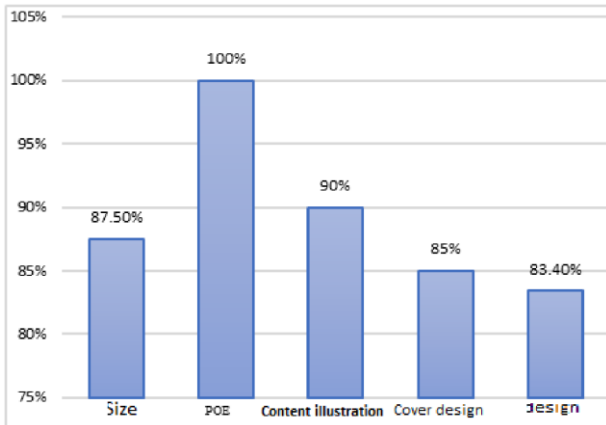**Figure 1.** Diagram of the Validation Results of Material Experts

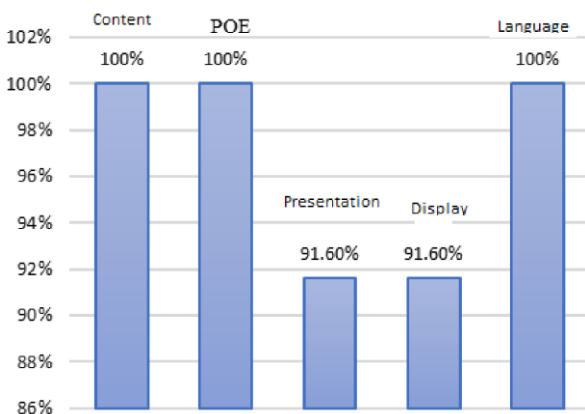**Figure 2.** Diagram of Media Expert Validation Results

Figure 3. Diagram of the Validation Results of Expert Practitioners

2. Students Responses

The responses were observed using student response questionnaires. The results of student responses are based on four aspects: aspects of content feasibility, display aspects, linguistic aspects, and aspects of POE steps. A summary of the analysis of student responses in the limited trial can be seen in Table 10.

Table 10. Results of the Analysis of Student Responses in the Limited Trial

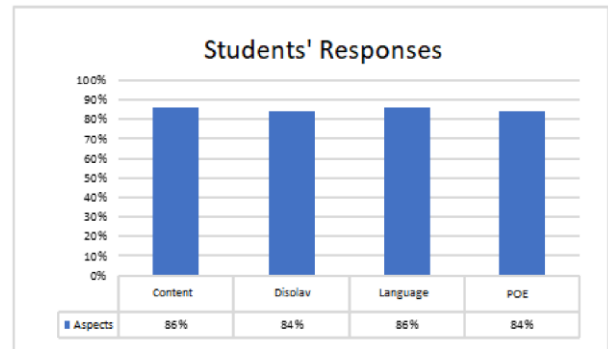| No	Aspect	Average value	Category
1.	Content Feasibility	86%	Very Valid
2.	Display	84%	Very Valid
3.	Language	86%	Very Valid
4.	POE	84%	Very Valid
	Total Average	85%	Very Valid

Figure 4. Diagram of Student Response Results in Limited Trials

The analysis of responses to product tests limited to 25 students obtained an overall average of 85% with a very valid category (Ridwan, 2017). Therefore, the POE-based e-student worksheet (*Predict, Observe, and Explain*) is feasible and can be used in research.

3. Learning Test Results

The students' pretest and posttest results were obtained from the limited trial carried out in class XI IPA 2. The results of student learning tests before using the e-student worksheet and after using the e-student worksheet can be seen in Table 11, where the standard gain obtained is 0.39 with a moderate increase category.

Table 11. Student Learning Test Results in Limited Trial

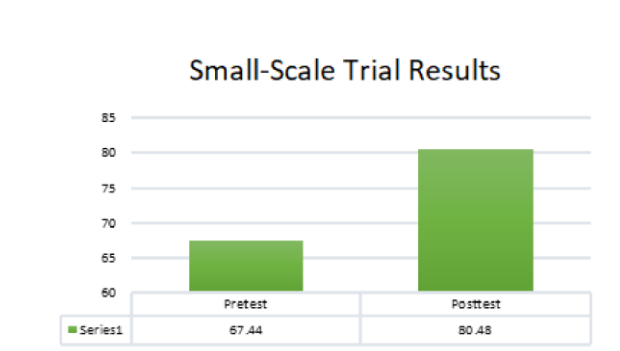| Test	Score Learning Test Results			N-gain	Category
	Min	Max	Mean		
Pretest	48	81	67.44	0.39	Moderate
Posttest	68	90	80.48		

Figure 5. Diagram of the Average Student Learning Outcomes on the Limited Trial

The standard value of student learning gain obtained in the limited trial is 0.39 in the Medium category (Hake, 1991). The higher the standard gain value obtained, the higher the increase in student learning outcomes. This follows the opinion of Hake (1991), which says that if the normalized gain value is in the range of 0.30 to 0.70, the value is included in the medium category. From the standard gain value, it can be concluded that there is an increase in learning outcomes after participating in online learning activities using POE-based e-student worksheets (*Predict, Observe, and Explain*). Based on the results of the research and discussion above, it can be said that POE-based e-student worksheets can affect student learning outcomes on plant tissue material during distance learning following the interpretation of gain standards (Hake, 1991).

CONCLUSIONS AND SUGGESTIONS

E-student worksheet based on Predict, Observe and Explain (POE) was developed with a 4-D development model and must go through a validation stage by a material expert, media expert, and practitioner. Based on expert due diligence data, the developed e-student worksheet is in the very valid category. These results indicate that the e-student worksheet that has been developed is valid and feasible to use based on experts' assessments. Further researchers are advised to research this e-students worksheet and try it out in other schools.

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