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The Development of The Cartoon-Assisted Practicum Guideline To Enhance Students' Science Process Skills in Physics Learning

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Abstract

A practicum guideline is a learning medium designed to support laboratory activities. This study aimed to develop a cartoon-assisted practicum guideline and to evaluate its feasibility, characteristics, and effectiveness in enhancing students' science process skills (SPS). The research used a Research and Development (R&D) approach with a modified 4D model (define-design-development, without dissemination). The developed practicum guideline focuses on a thin lens laboratory activity for high school students and is intended to support the teaching and learning of optics. The inclusion of cartoon characters was specifically designed to increase students' motivation, provide visual representations of key concepts, clarify content and procedural steps, guide and maintain students' focus, and facilitate overall comprehension. The feasibility test result showed that the developed product was very feasible, with overall feasibility indices of 83.15% and 84.84% as evaluated by practitioners and experts, respectively. The assessment covered four aspects: (i) content, (ii) presentation, (iii) language, and (iv) graphics. The product was classified as a good practicum guideline, as it applied the "visual principle", was coherently arranged to guide students through the practicum activity, and developed their SPS through appropriate supplementary features. Students' responses to the implementation of the cartoon-assisted practicum guideline were in good categories, as they reported feeling happy, enthusiastic, and interested in conducting laboratory activities. Therefore, it can be concluded that the cartoon-assisted practicum guideline was successfully developed and was partially effective in improving students' SPS.

Keywords: cartoon-assisted, practicum guideline, science process skill, physics learning.

INTRODUCTION

Physics is a branch of science that studies the natural phenomena of the universe within the framework of space and time (Giancoli, 2001). Physics learning covers the acquisition of concepts, values, processes, attitudes, and applications that are arranged to train the students to act and think critically, analytically, thoroughly, logically, rationally, and systematically (Jannah et al., 2020). It also aims to cultivate scientific habits of mind and behavior, fostering students' critical thinking, creativity, and independence (Rizkianawati et al., 2015). In this context, the science process skills (SPS) refer to the abilities and ways of thinking and acting based on the scientific methods, which enable students to construct, develop, test, or falsify scientific concepts, principles, laws, facts, and evidence (Rizkianawati et al., 2015; Yulianti et al., 2015).

In practice, science learning, including physics, is often conducted in a teacher-centered manner, with greater emphasis placed on mastering concepts, principles, and laws. This tendency is largely driven by the need to complete the prescribed curriculum within the allocated timeframe and to prepare students for school- and national-level examinations. As a consequence, the development of essential scientific processes, particularly SPS, tends to receive less attention (Winarto et al., 2020; Laksmi et al., 2014; Adisedjaja & Romlah, 2009). Furthermore, significant disparities in educational quality across regions in Indonesia further contribute to the limited implementation of SPS-oriented learning, especially in rural areas (Harususilo, 2019).

SPS is an essential component of scientific competence and can be effectively developed and observed through experimental activities, as its indicators are embedded in practicum-based learning (Sundari, 2020; Usman & Setiawati, 2001). The learning process provides students with opportunities to engage in practicum preparation, conduct hands-on experiments, analyze data, and communicate their findings (Rustaman, 2005; Dimyati & Moedjiono, 2002).

The practicum preparation stage includes: (i) formulating questions, (ii) planning experimental procedures, (iii) applying relevant concepts, (iv) identifying and classifying variables, and (v) formulating hypotheses (Oktafiani et al., 2017; Sumantri & Permana, 2001). During the hands-on experiment stage, students are expected to: (i) appropriately use materials and equipment, (ii) observe scientific phenomena in real time, (iii) apply and deepen their understanding of previously learned concepts, and (iv) systematically collect and record data (Rizkianawati et al., 2015).

In the analysis stage, students are guided to: (i) analyze their collected data, (ii) consult relevant references when necessary, (iii) compare experimental results with theoretical predictions, and (iv) draw conclusions (Adisedjaja & Romlah, 2009). Finally, students communicate their findings through: (i) a written report submitted to the teacher, (ii) oral presentations in class, or (iii) both formats (Usman, 2008; Hamalik, 2008). Hands-on experiments are typically conducted in laboratory settings; however, they may also be carried out in classrooms or outdoor environments, while other stages of the practicum can be completed in regular classroom settings.

The practicum guideline is one of the visual media that assist students in executing practicum activities (Cropley, 2015). In general, the practicum guideline contains some information related to the practicum objectives, instruments, and materials needed during the practicum, procedures, and assignments, helping the practicants (practicum performers) to draw a conclusion based on practicum results (Tim Dosen Fisika Dasar UNNES, 2018; Fons, 2008; Sulcoski & Rash, 1966). The practicum guideline, including visual media in the form of modules, which are composed of text (written verbal-language) and illustrated pictures, is designed to help the students in their studies, improve the quality of the learning process, and achieve the goals of practicum activities (Safitri, 2019; Mulyasa, 2006).

The presentations of visual information that are commonly conducted in the digital age (nowadays) are as important as the development of verbal-language skills and mathematical logic (Waluyanto, 2006). One visual medium that can be used as a learning tool is comics. Comics could be chosen because they are in high demand; a series of pictures and writings (which are coherently grooved) make the information clearer and easier to understand; can be used to develop visual-communication skills and creative problem-solver ways of thinking; could trigger the student's attention and participation, able to train the students to conduct research, strengthen, and develop their understanding of scientific concepts, materials, principles, or facts (Putra, 2021; Apriliani, 2017; Yulianti et al., 2015; Purwanto & Yuliani, 2013; Yulianti & Fianti, 2010; Sadiman, 2009; Waluyanto, 2006).

Implementing cartoon-based learning media can enhance students' interest in attending classes, help them understand lesson material, and reduce their anxiety (Nugroho & Ruliana, 2021). Furthermore, in boosting students' enthusiasm for learning, the use of animated cartoon films as educational media can also enhance students' academic performance in the cognitive domain (Jamal, Ibrahim, and Surif, 2018; Hambali, 2015), problem-solving abilities (Annisa, 2020), and critical thinking skills in physics (Azmy, 2020). Moreover, Badeo (2020) reported that a comic-based learning module in physics significantly improved students' SPS (i.e., student achievement and motivation).

The conceptual framework applied in this research was illustrated in Figure 1. The gap between the ideal outcomes expected by the academic community and the actual results obtained has given rise to several issues. One such issue is the relatively low average level of students' SPS in Indonesia. This problem can be addressed by integrating practicum activities into the teaching and learning process. During the practicum, the guided-inquiry-based cooperative learning method can be implemented. To carry out a practicum effectively, students require a practicum module that not only assists them in conducting a series of practical activities but also helps sustain their appreciation and enthusiasm throughout the learning process. Therefore, it is necessary to develop a practicum guideline enhanced with cartoon illustrations. The primary aim of this book is to foster students' science process skills. The embedded cartoons are intended to facilitate students' understanding of the content, support long-term memory retention, and maintain their interest in Physics learning activities.

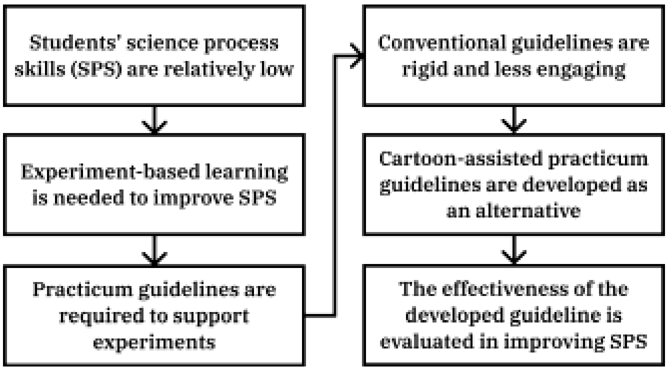

Figure 1. The Conceptual Framework

The purposes of this study were to prepare a cartoon-assisted practicum guideline to enhance the SPS of Senior High School students, to describe the characteristics and feasibility of this product, and to measure the effectiveness of the product in enhancing students' SPS.

METHOD

A. Research Design

This study used the R&D (Research and Development) method according to Sugiyono (2015), which involved preparing existing products and testing their effectiveness. The initial data were obtained from preliminary observations and interviews with the Physics teacher, serving as the foundational material for developing the practicum guideline. The subjects of this study were eleventh-grade science students at SMA Negeri 1 Ambarawa, consisting of five classes. The sample for the large-scale trial was selected purposively. Based on the recommendations of the physics teacher, the students' condition, and the researcher's considerations, 36 students from Class XI Science 4 were selected as the control group, and 36 students from Class XI Science 5 were selected as the experimental group.

The preparation was carried out using the modified 4D (define, design, development, and dissemination) method, without undertaking the final stage of product distribution (i.e., dissemination). The modified 4D method sequence is shown in Figure 2.

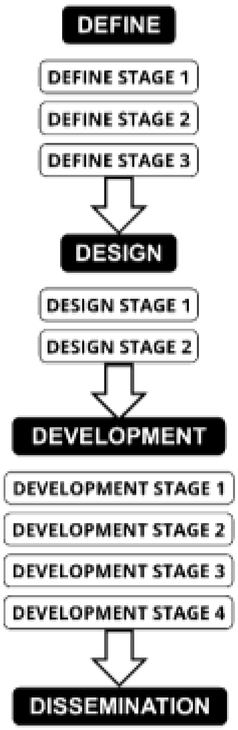

Figure 2. The 4D Sequence Used in This Study

Define Stage

This stage involved determining the product's type and specifications. It was divided into three steps:

- Define stage 1. A needs analysis was conducted through a literature review.
- Define stage 2. An analysis of the Physics curriculum, specifically the chapter on Optical Instruments.
- Define stage 3. The identification of core competencies and learning indicators.

Design Stage

This stage consists of activities related to designing the product in accordance with the specifications established during the define stage. The design stage can be outlined as follows:

- Design stage 1. This stage involved designing the layout and drafting the practicum guideline.
- Design stage 2. Create research instruments for measuring feasibility and product response as explained below:

Framework for feasibility validation of the practicum guideline:

a. Content Feasibility: (alignment of material with practicum needs, accuracy of content, completeness of supporting instructional materials).
b. Presentation Feasibility: (presentation techniques, presentation aids, completeness of presentation).
c. Language Feasibility: (clarity, communicative style, dialogic and interactive tone, appropriateness to students' developmental level, coherence and integration, use of terms, symbols, or icons).
d. Graphic Feasibility: (module dimensions, cover design, content layout design).

Framework of the product response questionnaire instrument: Reading habits

a. Practicum engagement
b. Practicum guideline quality
c. Practicum guideline utilization
d. General practicum skills
e. Thin lens practicum skills
f. Content of the practicum guideline
g. Ease thin lens practicum
h. Understanding lens focus concept
i. Analysis and conclusion skills
j. Practicum guideline for learning support

The framework of science process skill (SPS) is presented in Table 1.

Table 1. Framework of Science Process Skill **(**SPS**)**

Framework	Indicator
Measurement	Data collection
Record data	Observational data
Interpret data	Data analysis
Draw conclusion	Conclusion
	Practicum implementation
	Report completeness
	Report content quality
	Report neatness
Communicate	Report authenticity
	Practitioner discipline
	Practitioner activity

Development Stage

The development stage comprised several key steps as follows:

- Development stage 1. Conducting feasibility validation of the product by media and content experts.
- Development stage 2. Revising the practicum guideline and related test instruments based on validation feedback.
- Development stage 3. Conducting a large-scale trial by implementing the product in the Physics practicum guideline, specifically in the chapter on Optical Instruments.
- Development stage 4. Analyzing data obtained from the use of the practicum guideline.

Dissemination Stage

Dissemination of the validated product to the academic community was planned for the final stage. However, this activity was not carried out.

B. Data Collection Technique and Data Sources

Data collection techniques for the development of the practicum guideline are as follows:

1. Feasibility score of the practicum guideline. It was obtained through a product feasibility questionnaire. The questionnaire was developed by considering the following aspects:
   a. Content Feasibility - including the relevance and accuracy of the material, as well as supporting content.
   b. Presentation Feasibility - covering presentation techniques, supporting elements, and completeness.
   c. Language Feasibility - evaluating clarity, readability, and appropriateness of language.
   d. Graphic Feasibility - assessing visual design, layout, and graphical support.
2. Student responses to the practicum guideline. Collected using a product response questionnaire.

Data collection techniques to measure the enhancement of science process skill (SPS) are as follows:

a. Physics subject scores before the study. It was retrieved from the compiled grade records of the previous semester. These scores serve as a baseline for assessing the respondents' initial proficiency in Physics.
b. Cognitive preparation scores for practicum activities. Derived from students' responses to integrated questions within the practicum guideline, supported by assessment sheets. Pre-test scores conducted before the practicum sessions were also included.
c. Measurement and data recording skills during practicum. Assessed through analysis of video recordings of students' practicum activities, supported by observation sheets. The conditions of both groups (experimental and control) were identified and subsequently compared. The experimental group received preliminary assignments, whereas the control group did not. The treatment was considered effective if the experimental group outperformed the control group.
d. Skills in drawing conclusions and communicating results. Evaluated based on students' submitted reports, with additional support from observation sheets.
e. Student responses to the practicum guideline. Collected using a product response questionnaire.

C. Data Analysis Technique and Assessment Criteria

Data analysis techniques for developing the practicum guideline are as follows:

The research instruments were the feasibility test sheets for the practicum guideline. The data analysis in this study was in the form of the feasibility test results analysis (for problems and products). The feasibility test sheets for the related products and instruments were used to evaluate the practicum guideline's quality.

The validity of the instrument (essay-type items) can be determined using the correlation coefficient formula (Arikunto, 2013). The raw score product-moment correlation is calculated using Equation 1. The validity values were determined with reference to Table 2.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)}} \quad (1)$$

Variable description:
r_{xy} : item validity correlation coefficient
N : total number of respondents
X : student score on each test item
Y : total score of each student

Table 2. Classification Correlation Coefficient Validity

Correlation Coefficient	Validity
$0.80 < r_{xy} \leq 1.00$	Very high
$0.60 < r_{xy} \leq 0.80$	High
$0.40 < r_{xy} \leq 0.60$	Moderate
$0.20 < r_{xy} \leq 0.40$	Low
$0.00 < r_{xy} \leq 0.20$	Very low

Sundayana (2015) posits that the reliability of essay-type test items can be assessed using the Cronbach's Alpha reliability method, as presented in Equation 2.

$$r_{11} = \frac{k}{(k-1)}\left(1 - \frac{\sum s_i^{\,2}}{s_i^{\,2}}\right) \quad (2)$$

Variable description:
r_{11} : correlation coefficient reliability test
k : number of items in the instrument
$\sum s_i^{\,2}$: item-level variance
$s_i^{\,2}$: total variance per item

The reliability values were determined based on Table 3.

Table 3. Clasification Correlation Coefficient Reliability

Correlation Coefficient	Reliability
$0.80 < r_{11} \leq 1.00$	Very high
$0.60 < r_{11} \leq 0.80$	High
$0.40 < r_{11} \leq 0.60$	Moderate
$0.20 < r_{11} \leq 0.40$	Low
$0.00 < r_{11} \leq 0.20$	Very low

The assessment system employed a modified Likert scale adapted from Sugiyono (2015), as presented in Table 4.

Table 4. Likert Scale for Product Feasibility Evaluation

Score	Criteria
5	Excellent
4	Good
3	Fair
2	Poor
1	Very poor

The feasibility of the practicum guideline was tested using the formula (3) by Sudijono (2014). Meanwhile, the criteria for determining the product's feasibility level are outlined in Table 5.

$$P = \frac{f}{N} \times 100\% \quad (3)$$

Variable description:
P : product feasibility percentage
f : score obtained
N : maximum score

Table 5. Feasibility Level Criteria

Interval	Criteria
$85\% < P \leq 100\%$	Highly feasible
$70\% < P \leq 85\%$	Feasible
$50\% < P \leq 70\%$	Moderately feasible
$0\% < P \leq 50\%$	Not feasible

The feasibility tests for the related products and instruments were carried out by the lecturers as well as media and material experts (some permanent lecturers of Physics Education Study Program at UNNES, tenured more than ten years; some of the courses that had been taught are Learning Media, Basic Physics, Environmental Physics, and Educational Methodology), as well as the practitioners (two senior Physics teachers at SMA Negeri 1 Ambarawa).

The level of product effect on students' learning experience and SPS was analyzed using a Likert scale. The formula used to determine Likert-scale results was a modified percentage index proposed by Sudijono (2014).

$$I = \frac{n}{N} \times 100\% \quad (4)$$

Variable description:
I : index (%)

n : total score for each item

N : overall total score for each item

The effectiveness in improving the SPS was evaluated using the SPSS application or by applying the related t-test formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2} - 2r\left(\frac{s_1}{\sqrt{n_1}}\right)\left(\frac{s_2}{\sqrt{n_2}}\right)}} \quad (5)$$

The level of effectiveness was measured using the following effect size formula:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{S_{gab}} \quad (6)$$

$$S_{gab} = \sqrt{\frac{(n-1){s_1}^2 + (n-1){s_2}^2}{n_1 + n_2 - 2}} \quad (7)$$

Variable description:

$\bar{x}_1$: mean of the experimental group

$\bar{x}_2$: mean of the control group

n_1 : number of samples in the experimental group

n_1 : number of samples in the control group

${s_1}^2$: variance of the experimental group

${s_2}^2$: variance of the control group

The calculation results were classified according to Table 6. The effect size calculation process was facilitated using SPSS.

Table 6. Effect Size Criteria

d Value	Interpretation
0.8 < d ≤ 2.0	Large
0.5 < d ≤ 0.8	Medium
d ≤ 0.5	Small

Pre-research data for this study were obtained from physics subject scores before the study, compiled grade records from the previous semester, and small-scale testing of test items. The small-scale testing began with the design of test items with the following framework:

1. Define and explain optics.
2. Define and explain the laws of reflection and refraction.
3. Identify and explain the applications of optics in daily life.
4. Applying optical instrument theory in practicum activities

To simplify the process of distributing questions, codes were applied to the question as presented in Table 7.

Table 7. Question Code

Question code	Description
I	Multiple choice questions
II	Essay questions
1	Subtopic: Eye
2	Subtopic: Camera
3	Subtopic: Magnifying Glass
4	Subtopic: Microscope
5	Subtopic: Telescope
6	Subtopic: Thin Lens Experiment

The results of the validity and reliability testing are presented in Table 8.

Table 8. Validity and Reliability of the Question

Question Code	Validity	Reliability
II.6.1	0.681	0.89
II.6.5	0.763	
II.6.6 b)	0.458	
II.6.7	0.681	
II.6.8	0.841	
II.6.9 a)	0.924	
II.6.10 a)	0.663	
II.6.10 b)	0.681	
II.6.10 d)	0.653	
II.6.10 e)	0.708	
II.6.10 f)	0.699	
II.6.10 g)	0.853	

The results of the small-scale test were analyzed to determine item quality. Several items were discarded because they failed to meet feasibility criteria (Table 9). Twelve high-quality items were subsequently integrated into the cartoon-assisted practicum guideline developed in this study; a portion of these items was used as pre-test instruments before the practicum implementation in a large-scale test.

Table 9. Grouping Questions After Small-Scale Test

Small Scale Analyst Result	Question Code		
Not used in a large-scale trial	I.2.1	II.1.1	II.5.1
	II.6.2	II.6.3	II.6.4
	II.6.6 a)	II.6.10 c)	II.6.10 h)
Used questions in a large-scale trial	II.6.1	II.6.5	II.6.6 b)
	II.6.7	II.6.8	II.6.9 a)
	II.6.10 a)	II.6.10 b)	II.6.10 d)
	II.6.10 e)	II.6.10 f)	II.6.10 g)

RESULT AND DISCUSSION

Development Practicum Guideline Cartoon-Assisted

Define Stage

In this section, the cartoon-assisted practicum guideline with the modified 4D model was developed and implemented to enhance students' SPS. In the define stage, a needs analysis was conducted as the foundational basis for the development of the intended instructional product (Sihombing, Zamsiswaya, & Sawaluddin, 2024). The practicum guide is considered necessary for developing and enhancing students' SPS while also responding to the demands of the modern era (Dewi & Syafriani, 2024). It was determined that the product was a practicum module in the form of a book titled the Practicum Guideline, created to help develop students' SPS. It was developed according to a handbook published by Dinas Pendidikan Indonesia (Barus & Imam, 1995) and the thin-lenses experiment section, and applied as a prerequisite for the Optical Devices Chapter for Grade XI students in the 2nd semester.

Based on a curriculum analysis, the teaching of optics in physics aligns with the 2013 Curriculum, which emphasizes conceptual understanding, practical experimentation, and the integration of everyday applications of optical phenomena.

The core competence of this study lies in students' ability to explain the working principles of optical instruments through the reflection and refraction of light by mirrors and lenses, as well as to present a structured report on the outcomes of optical experiments. The learning indicators addressed in this study include:

1. Defining and explaining optics as a fundamental branch of physics concerned with the behavior of light.
2. Defining and explaining the laws of reflection and refraction, and their relevance to optical phenomena.
3. Identifying and explaining applications of optics in everyday life.
4. Preparing for laboratory activities, including organizing materials, instruments, and procedures.
5. Conducting laboratory experiments on optical phenomena with accuracy and adherence to scientific methods.
6. Producing a structured laboratory report, presenting experimental data, analysis, and conclusions in accordance with academic standards.

Define Stage

The design stage commenced with the manual preparation of a basic sketch outlining the typology of the practicum guideline. The materials added to the product included practicum rules, general knowledge, practicum ethics, a calculation of data error, data accuracy and precision, a format for the practicum report, and a summary of the theoretical basis for the refraction practicum on thin lenses. The required instruments were prepared during the design stage in accordance with the predetermined framework. The product's draft was a color-coded text equipped with basic images or schemes. The color codes were: (1) black for basic material, (2) green for important information related to general knowledge or technical practicum activities, (3) red for questions, and (4) purple as an important information marker in the theoretical foundations. The cover design contained the product title "Practicum Guideline for High School Students", "Optics" as the sub-chapter, the UNNES's logo, and the author's identity.

The practicum guideline was designed with eleven features. The “Study Guide” feature was used to provide an overview of each feature's functions in this product and an overview of the assignment related to the practicum activities. The identification of cartoon characters was performed on the “Character Introduction” feature. The “Physics Practicum Code of Conduct” and “Introduction” features were used to provide an initial understanding before practicum activities were carried out. Student attendance can be recorded in the “Physics Practicum Participant Card” feature. The “Error Theory” and “Accurate and Precise” features were used to assist in analyzing the practicum results data. The basic information related to how to write practicum reports was provided through the “Physics Practicum Report” feature. The “Practical Instruments” feature contained an image or schematic set of optical practicum tools. The “OPTIKA: Thin Lens” feature contained the detailed explanations related to the thin lens practicum, which is divided into several sub-sections, namely: (1) Practicum Objective, (2) Practical Instruments and Materials, (3) Theory, (4) Work Steps, (5) Preliminary Assignment, (6) Postliminary Assignment, and (7) References. The “About Author” was the last feature in this product, which included an autobiography and the author's notes.

This product was set up on A5-sized paper; two layers of it were cover pages. Next, the file was printed on A4-sized paper in booklet mode. The five cartoon characters integrated into this product were created with CorelDRAW; the basic information and drawings or sketches were sourced from the internet. An example of cartoon characters is shown in Figure 3.

Figure 3. The Cartoon Characters

The five cartoon characters and their roles in the practicum guideline were determined during the define stage. Each cartoon character had a distinctive depiction dimension, considered the aesthetic value of high school teenagers, without violating the provisions of the learning media. The cheerful and curious character of the new female student (Figure 3(a) was used to trigger interactive nuances in the product, engaging readers and guiding them to explore the exciting world of scientific activities. The lazy but kind-hearted senior student Figure 3(b) character was used to convey some basic information related to science learning at school, to give tips & tricks, and to explain the role of three other cartoon characters (who were a senior physics teacher, a practicum assistant, and a laboratory administrator) in the practicum guideline.

The character of the senior physics teacher, Figure 3(c), was used to emphasize key information in the foundation of practical theory, to pose several questions, and to engage readers in following the process of practical learning activities (to show the indicators of SPS). He was a friendly older man who could explain things in a fun way, creating an enjoyable learning atmosphere. The enjoyable learning atmosphere made the students feel happy and stress-free; whether they were aware of it or not, they had learned many things and improved their social adaptation and cognitive skills (Yulianti & Fianti, 2010). The character of the practicum assistant, Figure 3(d), was described as a strict and serious young man. This character was responsible for providing important technical information for practicum activities and supporting the physics teacher character's role. The last character was the laboratory administrator, Figure 3(e), a friendly and patient female figure who was used to engage the readers to understand and apply work ethics (to influence the character building of the readers), as well as to assist the role of practicum assistants to provide some important information related to the technical activities of the practicum. Some examples of character traits that can be developed during physics learning include curiosity, honesty, discipline, and communication (Triwidianingsih, Yulianti, & Fianti, 2016). Character education should be provided to students at all levels of education because the character qualities of people are among the determining factors of a nation’s glory; besides, students’ academic achievement is affected by their character (Triwidianingsih et al., 2016).

The research instrument comprises three sections: the practicum guideline feasibility test, the product implementation response sheet, and the students’ SPS observation sheet. The practicum guideline feasibility test framework mentioned in the Research design: Design stage subsection in the Method originates from Safitri (2019), which Darsono validated with a score of 86.8%. The response sheet framework for product implementation listed in the Research design subsection was developed from a validated form by Utami (2019). The Likert scale from 1 to 4 was used to code responses, with strongly disagree, disagree, agree, and strongly agree coded as 1, 2, 3, and 4, respectively. Meanwhile, the students’ SPS observation sheet was completed using the framework detailed in Table 1, yielding a validation score of 33 out of 40, classified as “very valid” according to the form developed by Oktafiani (2018).

Development Stage

The development stage began with the feasibility validation of the practicum guideline and the validation instruments by media and content experts. The results of the cartoon-assisted practicum guideline feasibility were presented in Table 10. The validation index for the practicum guideline (84%) indicated that this product was as good as the other practicum modules, which also had mean feasibility indices above 80% and were classified as very feasible (Oktafiani, 2018; Nursuhud, 2016; Yulianti et al., 2015). According to Table 10, the practicum guideline’s materials and instruments were suited to the practicum's needs, were accurately written, and supported the learning activities. Worksheets enriched with concept cartoons improved prospective science teachers' metacognitive skills (Yurtyapan, 2021). However, no significant difference was found in the examination of the effects of concept cartoons and problem-based learning on students’ perceptions of their inquiry learning skills and their ability to relate knowledge to daily life (Balim et al., 2016).

Table 10. The Product's Feasibility Test Results

No.	The Feasibility Aspects	The Practitioners		The Experts	
		Index (%)	Criteria	Index (%)	Criteria
1	Contents	80.71	Very feasible	82.96	Very feasible
2	Presentations	85.45	Very feasible	84.54	Very feasible
3	Languages	80.00	Feasible	84.00	Very feasible
4	Graphics	86.43	Very feasible	87.86	Very feasible
The Product's Feasibility		83.15	Very feasible	84.84	Very feasible

This product had a clear purpose, was coherently presented, and, in line with the needs of the practicum activities, considered students' aesthetics and involvement. The introduction, contents, and concluding sections were completely presented; supported by the questions of the concept's understanding and practicum's preparation, the tables and supporting figures, and the references. The language in the module was straightforward, consistent, communicative, interactive, systematic, and aligned with students' developmental level. The size, cover, and contents of the module (including texts, pictures, symbols, tables, graphics, illustrations, and schemes) were appropriately arranged and designed.

The revisions were carried out in accordance with the validator's suggestions. For example, the theme presented in this cartoon-assisted practicum guideline was " Practicum Guide: Optics", which is printed on the front cover of the book. The development process was carried out on the cover, ensuring that this cartoon-assisted practicum guideline has a distinctive front cover design. The book cover is shown in Figure 4.

Figure 4. The Revised Cover

The cartoon-assisted practicum guideline applied the principles of visibility, interest, simplicity, and structure by carefully designing and organizing text, images, symbols, tables, graphs, illustrations, and diagrams within the module. These considerations included form, size, layout, color elements, and style. The principles of usefulness, accuracy, and legitimacy were also met, as the practicum source was several reliable references tailored to the students' learning needs and abilities. In addition, the cartoon characters integrated into the product provided visual support for student learning. Moreover, it was intended for several purposes: to prevent boredom during reading, to provide visual examples, to clarify and make it easier for students to understand the meaning of the sentences, and to direct the readers' focus. The practicum guide consisted of several sub-sections, beginning with the Preface, Table of Contents, Study Instructions, Character Introduction, Physics Practicum Rules, Physics Practicum Participant Card, Introduction, Error Theory, Accuracy and Precision, Physics Practicum Report, Practicum Tools: Optics, Optics: Thin Lens, and concluding with About the Author. Figure 5 presents the twelfth subtitle, Optics: Thin Lens.

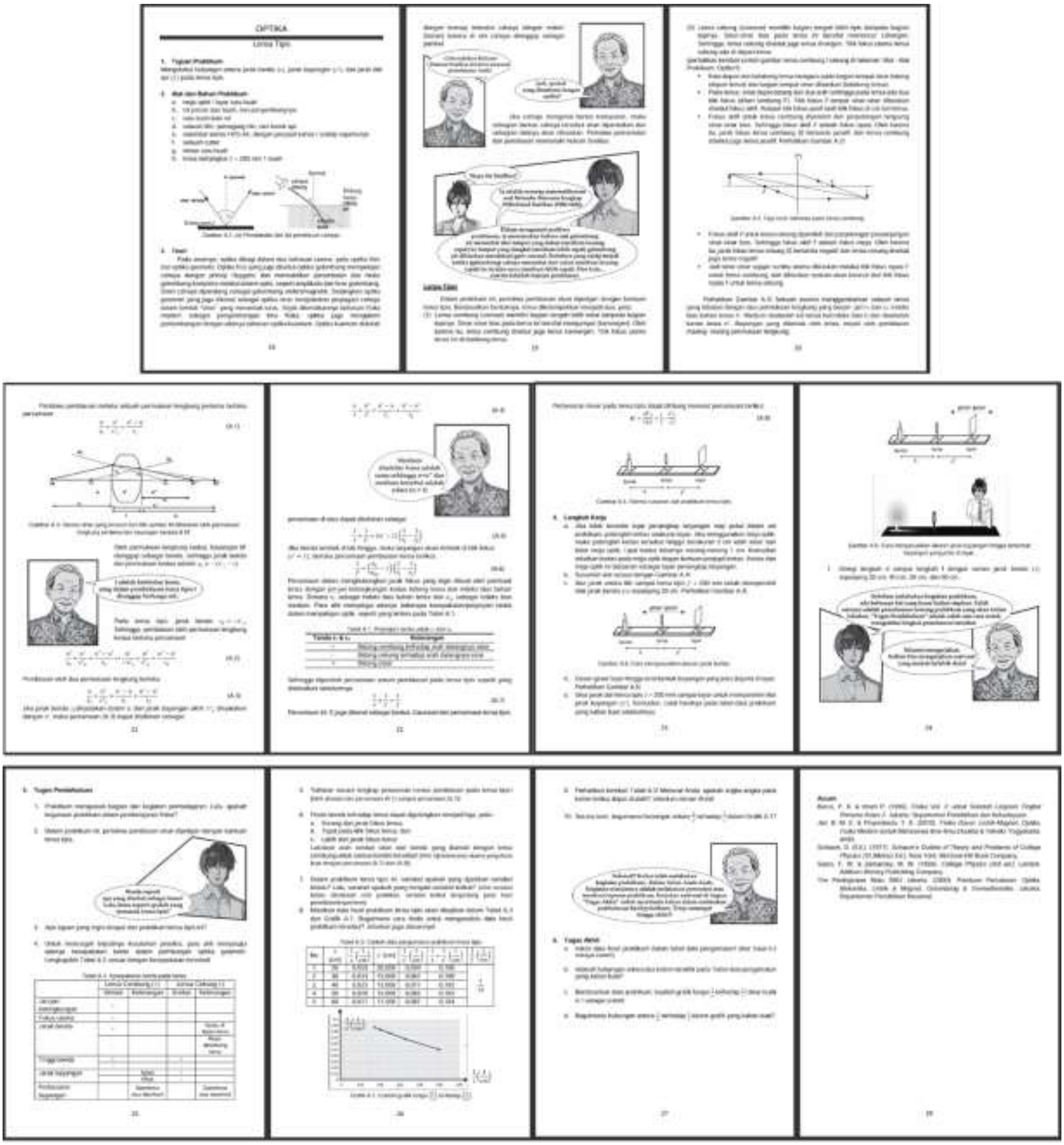

Figure 5. Content of Practicum Guideline

The large-scale test was carried out by implementing the practicum guideline. The implementation results and data analysis were presented in Tables 11, 12, 13, and 14. Based on

Table 12. The respondents were not yet able to thoroughly analyze the data. They were unable to determine the data's accuracy and precision, and they also failed to create proper observation data graphs. This occurred because they had never previously conducted data analysis from practicum results to the standards specified in this study. Whether students are accustomed to carrying out a process or using learning media is one of the factors that influence their skill level (Gunawan, Harjono, & Imran, 2016). The respondents still needed considerable guidance and direction from the teacher, even though the data analysis material had already been included in the "Error Theory" feature of the practicum guideline.

The results of the effect size calculation are presented in Table 13. Overall, the cartoon-assisted practicum guide had improved students' SPS skills with a small effect size. Although the guide was not effective in enhancing students' SPS skills in the drawing conclusions indicator, the respondents' skills in this area had already surpassed the predetermined achievement standards. Most respondents in the experimental group had not been assertive in stating their conclusions. Even though the conclusions they formulated had not deviated from optical concepts, they had not been well aligned with the objectives of the practicum. Most respondents in the experimental group were not assertive in stating their conclusions. Although the conclusions they formulated did not deviate from optical principles, they were not well aligned with the practicum's objectives. The skill of concluding can be improved by enhancing students' ability to formulate hypotheses (Oktafiani, 2018). Concluding is one of the cognitive skills. Understanding physics concepts and general cognitive skills can be improved when students experience meaningful learning that leaves a lasting impression (Gumilar & Setiawan, 2016).

Table 11. Data Obtained from Large-Scale Testing on The Science Process Skill (SPS) Indicator

Code	Data Collection	Observational Data	Data Analysis	Conclusion	Practicum Implementation	Report Completeness	Report Content Quality	Report Neatness	Report Authenticity	Practitioner Discipline	Practitioner Activity
C-1	9	10	3	9	10	6	65	6	10	0	3
C-2	6	5	3	9	5	6	65	9	10	0	3
C-3	9	10	3	9	10	6	63	9	5	0	3
C-…	…	…	…	…	…	…	…	…	…	…	…
C-18	9	10	3	9	10	6	63	9	10	0	3
E-1	9	10	3	6	10	6	79	9	15	0	6
E-2	9	15	3	6	15	9	77	6	10	0	9
E-3	9	15	3	9	15	6	75	6	10	0	6
E-…	…	…	…	…	…	…	…	…	…	…	…
E-19	9	15	3	9	15	9	74	6	10	0	6

Table 12. The Analysis of Students' Science Process Skill (SPS**)** Indicators Results

The (SPS) Indicators	Control Group		Experimental Group		Explanation
	Index (%)	Criteria	Index (%)	Criteria	
Measure	94.44	Very feasible	100	Very feasible	The experimental group is more feasible
Record data	93.50	Very feasible	94.42	Very feasible	Both groups are equally feasible
Interpret data	33.33	Not feasible	33.33	Not feasible	Both groups are equally not feasible
Draw conclusions	72.97	Feasible	83.88	Very feasible	The experimental group is more feasible
Communicate	73.38	Feasible	79.83	Feasible	Both groups are equally feasible

Table 13. Effect Size of Science Process Skill **(**SPS)

Indicators SPS	Effect size	Criteria
Measure	0.000	Small
Record data	0.071	Small
Interpret data	0.000	Small
Draw conclusions	-1.870	Small
Communicate	0.983	Small

The product response questionnaire was given to the students of Class XI Science 5, who served as the large-scale trial experimental group. In the response questionnaire, respondents completed a checklist based on the provided statements and instructions, and also provided additional written feedback in the “Comments and Suggestions for Improvement” section. The results of the data analysis were presented in Table 14.

Table 14. Indicators of response to product implementation

No.	Indicators in The Questionnaire	Index (%)	Criteria
1	Reading habits	75.143	Good
2	Practicum skills & report writing	68.333	Good
3	Students reading the practicum guideline	56.786	Fair
	The ability of the cartoon-assisted practicum guideline to:		
4	The importance of practicum & scientific attitude	65.476	Good
5	Helping with cognitive preparation for practicum	64.464	Good
6	Helping with procedural preparation for practicum	70.873	Good
7	Practicum helps in understanding the material	63.571	Good
8	Students' interest in using the module	50.714	Fair
9	Students' interest in module development	74.286	Good
	Response to the Practicum Module	65.516	Good

Table 14 showed that students felt capable of performing the practicum and producing a successful report. Students' statements regarding their practicum skills aligned with their performance during the practicum, with most students completing the tasks. This demonstrates that the cartoon-assisted practicum guideline can make students feel happy, excited, and motivated to carry out the practicum.

The practicum guideline was a good practicum module, as shown in Table 12. The product was considered highly feasible, with feasibility scores of 83 from the practitioners and 85 from the experts. It was able to act as a means of supporting roles in the learning process as shown in Table 14 *“Practicum helps understanding of the material”* reached index 63.571%, which indicates the good criteria; this product was able to facilitate the students to access the learning material, facilitate the teachers to provide the assignments to increase their student’s mastery of a subject, to train their independence (Apriliani, 2017). This product also followed the "Visuals Principle" (visible, interesting, simple, useful, accurate, legitimate, and structured) as explained by Nurseto (2012).

Learning through cartoons can foster effective learning by immersing students in an enjoyable atmosphere and creating a cheerful, engaging classroom environment. Implementing cartoon-based learning media can enhance students' interest in attending classes, help them understand the lesson material, and reduce their anxiety. In addition to boosting students' enthusiasm for learning, the use of animated cartoon films as educational media can also enhance students' academic performance in the cognitive domain (Nugroho & Ruliana, 2021; Hambali, 2015; Nurohimah et al., 2012).

CONCLUSION

The practicum guideline, assisted by a cartoon, was successfully developed and deemed very feasible (scoring 83 from practitioners and 85 from experts). This product was classified as a good practicum guideline. The cartoon characters were successful in increasing students' motivation and in providing visual explanations, clarity, focus, and ease in understanding sentence meaning. The student's responses to the application of the cartoon-assisted practicum guideline fall into the good category. The cartoon-assisted practicum guideline has been well developed and partially effective in enhancing students' SPS.

Cartoons were proven to enhance students' motivation, interest, and comprehension of practicum materials. Therefore, it was recommended that future practicum module development retain engaging, simple, and educational visual cartoon elements. The integration of instructional videos was also suggested to make the cartoon-assisted practicum guideline more interactive. Although the product demonstrated high feasibility, ongoing evaluation remained necessary to ensure its effectiveness across various educational contexts and levels. Periodic adjustments to content and visual design were advised, based on feedback from both students and teachers. In applying this cartoon-assisted practicum guideline, teachers are proposed to use guided-inquiry learning methods to enhance students' SPS. If the postliminary assignment is considered too demanding for students, teachers may introduce adjustments such as replacing it with a practicum result presentation.

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