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# Enhancing Students' Collaboration Skills Through Scientific Approach-Based Worksheets in Human Sensory System Learning

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**Abstract**

**Background:** *Collaborative skills are one of the essential 21st-century competencies that students must possess and develop to face the challenges of modern learning. To support the achievement of this skill, innovative and contextual teaching materials are needed to enable students to learn actively through teamwork. This study aims to develop a Student Worksheet based on the Scientific Approach for the sensory system topic that is valid, practical, and effective*. **Methodology:** *Data collection was conducted using various instruments aligned with the 4D development model (*Define, Design, Develop, Disseminate*). In the* Define *stage was conducted through interviews and questionnaires for teachers and students to identify learning challenges. In the* Design *stage, the initial draft of the Student Worksheet was created based on the needs analysis, learning objectives, the syntax of the scientific approach, and collaboration skill indicators. During the* Development *stage, the worksheet underwent validation by content and media experts, and its practicality was tested through teacher and student questionnaires. Effectiveness was assessed using pretest and posttest instruments aligned with the indicators of the sensory system topic. In the* dissemination *stage, the revised worksheet was shared with biology teachers and underwent limited field testing.* **Findings:** *The analysis results show that the Student Worksheet is highly valid, with validation scores of 93.33 % for teaching media and 92.72 % for content. Practicality was rated high, with teacher and student scores of 91.38 % and 91.77 %, respectively. Effectiveness was indicated by an N-Gain score of 0.84 (high category). The scientific contribution of this research lies in the integration of the scientific approach into a collaborative Student Worksheet*. **Contribution:** *the novelty is reflected in the design of scientific activities based on teamwork. The theoretical implication supports the constructivist approach, while the practical implication offers a model of contextual science teaching media relevant to 21st-century learning.*

**Keywords:** *4D Model; Collaborative Skill; Madrasah Aliyah; Scientific Approach; Student Worksheet*


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## INTRODUCTION

Global education in the 21st century has undergone a significant transformation, marked by a shift in learning paradigms in response to technological revolutions, globalization, and the growing complexity of modern challenges (Thahira & Jayanti, 2024). In this context, education systems are expected not only to transfer knowledge but also to equip students with relevant competencies to face contemporary demands, such as critical thinking, effective communication, creativity, and collaboration—collectively known as 4C skills (Thornhill et al., 2023). Global education trends, as reflected in frameworks like the Partnership for 21st Century Skills (P21), emphasize the importance of competency-based learning and the strengthening of soft skills applicable across disciplines and life contexts (Trilling & Fadel, 2009). This has led to a shift from conventional teacher-centered approaches toward active, student-centered learning, where learners act as active agents in constructing knowledge and skills through hands-on experiences, exploration, and teamwork (Selamat, 2023). Such changes reflect not only the needs of an increasingly collaborative and digital workforce but also the demands of a 21st-century society that values adaptability, problem-solving, and cross-cultural interaction. In this context, the urgency of implementing innovative and contextual learning models becomes critical, as education must not only teach "what" students need to know but also "how" they learn, think, and interact meaningfully (Prayogi, 2020). Therefore, current global education trends point toward the integration of pedagogical approaches that cultivate 21st-century skills in a balanced manner across cognitive, affective, and social dimensions (Bagus, 2022).

However, in practice, many challenges remain in the learning process, particularly in strengthening students' collaborative skills. Learning tends to be individual and passive, as the lecture method remains the primary approach. At the same time, group discussions function merely as a supplement and have yet to encourage active student interaction effectively. This issue is exacerbated by students' low interest in working collaboratively on assignments, resulting in underdeveloped collaboration skills. Based on the results of interviews and needs analysis questionnaires, the Biology teacher at MA Proyek UNIVA stated that student worksheets had never been used in teaching the sensory system topic and emphasized the need for such materials to help students better understand concepts in a structured manner while promoting active participation in learning. The teacher also noted that the continued use of lectures often leads to passive student engagement, and discussions are not always practical due to the low level of student involvement.

The topic of the sensory system is one of the essential yet relatively complex subjects in the Grade XI Biology curriculum. The sensory system, as part of the human coordination system, functions to receive and respond to stimuli from the environment (Nurlina et al., 2024). In biology learning, understanding the sensory system is crucial for enhancing students' collaborative skills. This topic holds high urgency as it directly relates to students' daily lives, particularly in understanding how the human body perceives and responds to environmental stimuli

(Campbell et al., 2017). A solid understanding of the sensory system helps students become more aware of the importance of maintaining the health of their sensory organs. However, based on observations and previous research, many students struggle to grasp complex concepts related to the sensory system, such as the mechanisms of sensory organs and their physiological processes (Riri et al., 2022). These difficulties are often due to the lack of interactive learning materials and resources that accommodate students' diverse learning styles. Therefore, an innovative learning approach is needed to help students understand these concepts more deeply and apply them in real-life contexts.

One suitable approach for students is the Scientific Approach, which consists of five main stages: observing, questioning, experimenting, reasoning, and communicating. This model aligns well with the characteristics of biology as a subject (Nurjanah et al., 2022). It emphasizes active student engagement in the learning process, encouraging learners to go beyond passive information reception and instead participate in exploration, experimentation, and scientific discussions. However, the implementation of this approach is often hindered by the lack of instructional materials that support Scientific Approach-based learning (Yanti, 2021). Many existing teaching resources are still textbook-oriented, resulting in passive learning and failing to encourage students to explore or collaborate in solving biological problems through scientific methods (Nurulloh & Puspasari, 2020). Consequently, students are not adequately trained in collaborative skills, which should be an integral part of the learning process. Therefore, there is a need for teaching methods and materials that can better facilitate students' deep understanding and engagement.

Student worksheets are one of the alternative teaching materials that can be integrated into learning based on the Scientific Approach (Lisanti et al., 2022). Worksheets designed using this approach are expected to help students construct concepts independently and enhance collaborative attitudes within study groups (Susilawati et al., 2023). Through Scientific Approach-based student worksheets, learners not only gain better conceptual understanding but also engage in more interactive and challenging learning experiences (Putriana & Widiarti, 2024). Moreover, well-structured worksheets can guide students to work together to complete tasks, thereby supporting the optimal development of their collaborative skills. Therefore, developing Scientific Approach-based student worksheets on the sensory system topic is expected to be a solution for improving both students' collaboration skills and their understanding of the subject matter.

Although various studies have addressed the development of student worksheets based on the Scientific Approach, there remains a research gap in their application to the topic of the human sensory system and in the development of students' collaboration skills (Suhendi et al., 2018). In terms of competencies, previous research has primarily focused on enhancing critical thinking rather than collaboration. For example, Purba et al., (2023) developed student worksheets using a Problem-Based Learning approach to improve critical thinking skills on the sensory system topic, while Kasih & Darussyamsu (2018) designed Scientific Approach-based worksheets on ecosystems and the impact of human activities on the environment. These studies emphasized conceptual understanding through scientific

methods but did not explicitly aim to foster collaboration skills during the learning process. Additionally, Nurwahidah et al., (2021) found that learning based on the Scientific Approach could support group discussions, but their study lacked evaluation instruments specifically designed to measure students' collaborative skills. Other studies, such as those by Sari & Lepiyanto, (2016) and Mubarokah, (2019) focused on the development of Scientific Approach-based student worksheets for topics like fungi and viruses. What distinguishes this study is its focus on enhancing collaboration skills, specifically within the topic of the sensory system.

Based on this review, a research gap remains in the development of Scientific Approach-based student worksheets that are specifically designed to improve collaboration skills in learning about the human sensory system. Previous studies have rarely addressed the direct assessment of collaborative competencies and have not examined the sensory system topic in depth, particularly in the context of biology instruction at senior Islamic high school (MA) or equivalent levels. This underscores the importance of conducting a study that not only adopts the Scientific Approach but also intentionally integrates and evaluates students' collaboration skills in the learning process.

This study aims to develop and evaluate the effectiveness of a Scientific Approach-based student worksheet on the sensory system topic to enhance the collaborative skills of Grade XI students at Madrasah Aliyah. The implications of this research are expected to contribute to the development of more innovative teaching materials aligned with 21st-century skills, thereby assisting teachers in creating more interactive and meaningful learning experiences. Furthermore, this study is anticipated to serve as a reference for developing more effective instructional models to improve students' collaborative skills in biology education.

## METHOD

The type of this research is development research or research and development. The research and development method is used to create new products and test their feasibility level Ikhsan & Handayani (2017) The research and development procedure in this study uses the 4D learning model developed by (Thiagarajan et al., 1974). The 4D development model consists of four stages, namely define, design, development, and disseminate (Lubis et al., 2022). The 4D development scheme can be seen in Figure 1.

### Sample or Participant

This study was conducted at MA UNIVA Proyek, with research subjects consisting of 24 Grade XI students, including 10 male and 14 female students with an average age of 17 years. The subjects were selected using purposive sampling, based on the consideration that Grade XI students had already studied the sensory system topic as part of the curriculum and were deemed appropriate for developing and assessing collaborative skills through the use of Scientific Approach-based student worksheets. The characteristics of the selected subjects were considered representative of the target population and allowed for the optimal collection of relevant data.

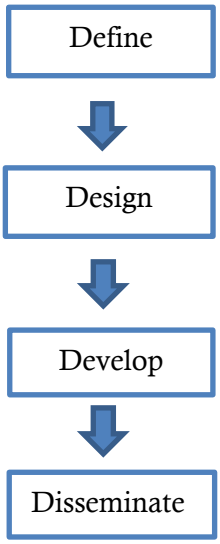



**Figure 1.** 4D Model Design (Thiagarajan et al., 1974)

**Instrument**

The instruments used in this study underwent a validation process by two experts: one content expert and one media expert, selected based on their academic qualifications and experience in developing biology instructional materials. In addition, a biology teacher was involved in assessing the readability and contextual relevance of the instruments within the school learning environment. The instruments included: (1) a worksheet validation sheet consisting of constructs for content feasibility, language, presentation, and graphic design; (2) teacher and student response questionnaires measuring aspects ofs attractiveness, content, and language; and (3) a worksheet effectiveness questionnaire used to assess the extent to which the worksheet supports the development of collaborative skills and conceptual understanding. All instruments used a Likert scale ranging from 1 to 4.

**Data collection**

The researcher used four techniques for field data collection, namely: direct observation to identify the actual conditions at the research site; distribution of questionnaires to students and teachers at Madrasah Aliyah UNIVA Proyek Medan to obtain written information; interviews to explore in more depth the problems that need to be addressed; and documentation as supporting evidence that the research was carried out systematically and in accordance with proper procedures.

**Procedure**

This research followed the stages of the 4D development model, which consists of Defining, Designing, Developing, and Disseminating.

***Define Stage**:*

The researcher conducted a needs analysis through interviews and questionnaires with teachers and students to identify problems in learning the sensory system. The analysis included front-end analysis, needs analysis, content, tasks, and learning objectives. The results served as the foundation for designing the content of student worksheets that support collaborative skills.

***Design Stage**:*

Based on the analysis's results, the researcher designed a scientific approach-based student worksheet incorporating five syntax steps: observing, questioning, experimenting, reasoning, and communicating. The design also considered readability principles, content integration, and visual appeal.

***Develop Stage**:*

Content and media experts validated the product using questionnaires that assessed aspects of content, language, presentation, and visual layout. Teacher and student responses regarding ease of use, clarity, and attractiveness evaluated practicality. The results of the validation and practicality tests were used to revise the worksheet.

***Disseminate Stage**:*

A limited trial was conducted in one class (24 students) to evaluate the product's effectiveness in improving collaborative skills. The instrument used was a collaboration questionnaire covering five aspects: communication, responsibility, mutual respect, flexibility, and contribution. This study was limited to a small-scale trial and did not proceed to large-scale dissemination.

## Data analysis

The types of data used in this study consisted of both qualitative and quantitative data. Qualitative data were obtained from interviews with one biology teacher, as well as feedback, comments, and suggestions from two validators (a content expert and a media expert) regarding the developed student worksheet product. Quantitative data were derived from the validators' assessment scores on the content and visual aspects of the worksheet using a Likert scale instrument. Additionally, quantitative data were gathered from the practicality response questionnaires completed by one teacher and 24 Grade XI students, as well as from the student collaboration skills questionnaire administered after the implementation of the worksheet. All collected data were analyzed using descriptive qualitative and quantitative approaches to determine the validity, practicality, and effectiveness of the developed product.

Quantitatively, the data obtained were then analyzed to produce data to be calculated using Formula 1 refers to Lisanti et al., (2022). Furthermore, the results of the data analysis on the validity and practicality of the LKPD were interpreted using the criteria presented in Tables 1 and 2.

$$Percentage = \frac{\text{score abtained}}{\text{maximum skor}} \text{ x } 100\ \% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (1)}$$

**Table 1.** Criteria for Validity Assessment Results (Ma'aniyah & Mintohari, 2019)

| Percentage (%) | Assessment Criteria |
|---|---|
| 81%-100% | Very valid |
| 61%-80% | Valid |
| 41%-60% | Fairly valid |
| 21%-40% | Less valid |
| 0%-20% | Not valid |

**Table 2.** Criteria for Practicality Assessment Results (Riduwan & Akdon, 2010)

| Percentage (%) | Assessment Criteria |
|---|---|
| 81-100 | Very practical |
| 61-80 | Practical |
| 41-60 | Fairly practical |
| 21-40 | Not practical |

Meanwhile, the effectiveness data of the student worksheet were obtained through observation scores using an assessment instrument for students' collaborative skills. The assessed aspects of collaboration included five leading indicators: (1) effective communication, (2) responsibility for group tasks, (3) mutual respect among group members, (4) flexibility in resolving conflicts or differences of opinion, and (5) active contribution to completing group assignments. The criterion for determining the effectiveness of the worksheet in developing collaborative skills was based on the average N-Gain value, which was used to assess the improvement in these skills. The improvement before and after the use of the student worksheet was calculated using the N-Gain formula refers to Harahap et al., (2021), as shown in Table 3, and based on Formula 2.

$$N\ Gain = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \text{ x } 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ (2)}$$

**Table 3.** N-Gain Criteria, refers to Riduwan & Akdon ( 2010)

| Percentage | Classification |
|---|---|
| g > 0.7 | High |
| 0.3 < g < 0.7 | Medium |
| G < 0.3 | Low |

## RESULT AND DISCUSSION

### Result Clear Paramaters

This study produced a printed Student Worksheet (a.k.a LKPD) based on the Scientific Approach for the sensory system material for grade XI MA students, aimed at enhancing students' collaboration skills. The development was carried out using the 4D model (Define, Design, Develop, Disseminate), incorporating scientific learning steps such as observing, questioning, experimenting, reasoning, and communicating. This LKPD was designed to encourage students to work together actively and engage directly in the learning process. The following are the findings from each development stage of the LKPD in this study.

### Define

The define stage includes five main steps: analysis of teacher needs, student needs, learning concepts, tasks, and learning objectives. This stage aims to identify and formulate the necessary requirements for the learning process.

***Teacher Needs Analysis***

This analysis aims to identify the background for developing a Scientific Approach-based LKPD on the sensory system material. Observations were conducted on the biology learning process at MA UNIVA Proyek Medan using interview and questionnaire instruments. The results showed that learning still relied on the 2013 Curriculum and was dominated by lecture methods. Teachers mainly used textbooks as the primary source of learning, while student collaboration and active

engagement were still low. Teachers also reported that the sensory system is an abstract concept in biology, involving physiological processes and anatomical structures not directly observable. Thus, a Scientific Approach-based LKPD was considered essential to support interactive learning and improve students' collaborative skills.

***Student Needs Analysis***

This was carried out to understand students' characteristics and learning needs. Interviews revealed that students wanted biology lessons to be more engaging and interactive. Pretest results indicated that their average collaboration skill score was 63, indicating the need for a printed LKPD that promotes active involvement and collaboration.

***Concept Analysis***

This analysis aimed to systematically identify and organize the learning material based on the relevant Basic Competence (KD). The selected material was the human sensory system (KD 3.7). Indicators included organizing parts of the sensory system, explaining organ functions, and analyzing structure-function relationships. The LKPD content was aligned with the Scientific Approach stages to support the development of collaborative skills.

***Task Analysis***

This aimed to identify suitable activities for achieving KD 4.7 (presenting the results of structure-function analysis). Tasks were designed as group activities, such as simple experiments on sensory function, followed by reporting and discussion presentations to enhance collaborative and scientific communication skills.

***Learning Objectives Analysis***

Based on Core Competencies (KI) and Basic Competencies (KD) in the 2013 Curriculum, the objectives were for students to: (i) Organize parts of the human sensory system, (ii) Explain the functions of each organ, (iii) Analyze structure-function relationships, (iv) Conduct observations or simple experiments and record them systematically and, (v) Present findings through reports, presentations, or oral communication. These objectives guided the development of the LKPD to foster students' collaborative skills using the Scientific Approach in line with 21st-century learning demands.

**Design Stage**

At this stage, the Scientific Approach-based LKPD was designed in A4 format, including components such as a cover, foreword, table of contents, KI and KD, instructions, learning materials, learning activities aligned with the Scientific Approach, references, and author biography. The visual design was carefully considered using Canva to make the printed LKPD visually appealing and easy to

understand. The layout, font, and relevant illustrations were selected to support learning, with added elements like "fun facts" to increase engagement.

**Develop Stage**

The development stages of the Scientific Approach-based student worksheet on the sensory system topic included a validation process by one content expert and one media expert. This validation aimed to assess the validity level of the developed worksheet. Both media and content validators carried out the validation, with the results presented in Tables 4 and 5. The media expert awarded a score of 57 out of 60, resulting in a validity percentage of 93.33%, while the content expert provided a score of 56 out of 60, with a validity percentage of 92.72%. These results indicate that the developed student worksheet falls into the "very valid" category. Nonetheless, both validators provided constructive suggestions for improvement, as illustrated in the supporting images shown in Table 8 and Figures 2, 3, 4, 5, and 6. Once deemed valid, the student worksheet was then tested in a limited trial involving a teacher and students through a response questionnaire. Table 6 shows that the teacher's response to the worksheet reached a score of 44 out of 48, with an average percentage of 91.38% across the aspects of attractiveness, content, and language—indicating that the worksheet is "very practical." Similarly, Table 6 presents response data from 24 students, with an average percentage score of 91.77%, also falling within the "very practical" category. This high level of practicality demonstrates that the worksheet is easy to use for both teachers and students during the learning process.

Practicality is a crucial factor in supporting the success of collaborative learning. Vazquez et al., (2017) stated that practical instructional tools allow teachers to focus more on active strategies such as collaboration. Similarly, Yoseptry et al., (2025) emphasized that learning media considered practical can enhance student engagement and interaction. The practicality indicators of the student worksheet include attractiveness, content, and language. An appealing design can motivate and actively engage students; the content is contextual and aligned with students' cognitive levels, making it easier to implement and discuss Becker & Jacobsen, (2020), and communicative language facilitates practical group work Steegmann et al., (2016). These findings align with Aprizal et al., (2023) who asserted that ease of use is a key determinant of practicality. Therefore, the Scientific Approach-based student worksheet has proven to be both practical and effective in enhancing collaborative skills in the sensory system topic.

**Table 4.** Validation Test Results by Media Expert

| No | Assessment Aspect | Score Obtained | Maximum Score | Percentage | Criteria |
|---|---|---|---|---|---|
| 1 | Graphics | 30 | 32 | 93,75% | Very valid |
| 2 | Presentation | 27 | 28 | 96,42% | Very valid |
| | Total | 57 | 60 | 93,33% | Very valid |

**Table 5.** Validation Test Results by Subject Matter Expert

| No | Assessment Aspect | Score | Maximum | Percentage | Criteria |
|---|---|---|---|---|---|

| | | Obtained | Score | | |
|---|---|---|---|---|---|
| 1 | Content | 45 | 48 | 93,75% | Very valid |
| 2 | Presentation | 11 | 12 | 91,66% | Very valid |
| | Total | 56 | 60 | 92,72% | Very valid |

**Table 6.** Practicality Test Results by Teacher and Students

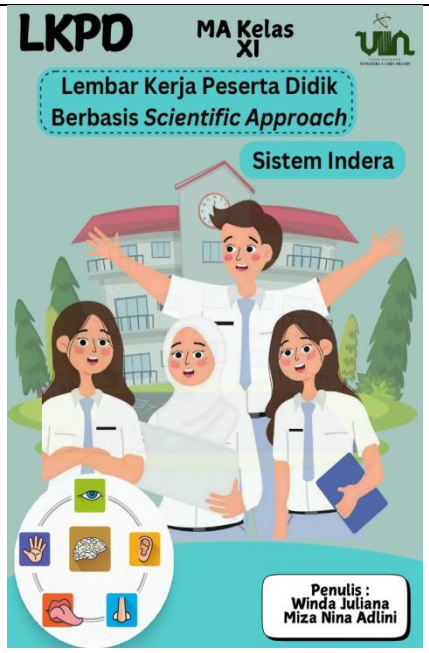
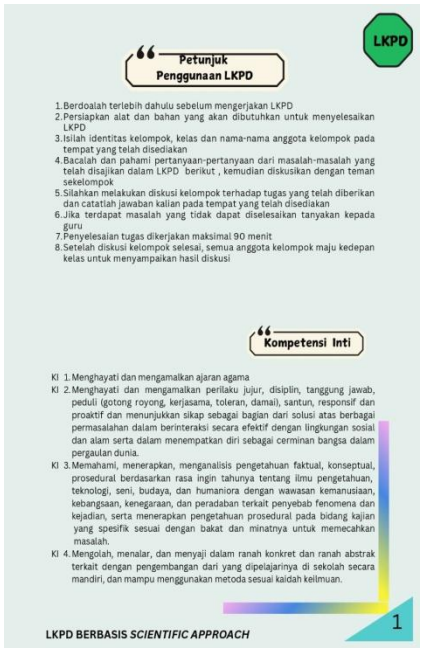
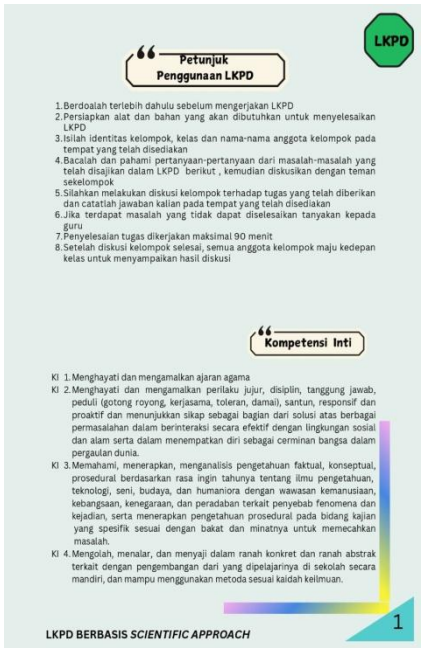
| No | Assessment Aspect | Score Obtained | Maximum Score | Percentage | Criteria |
|---|---|---|---|---|---|
| | | **Teacher** | | | |
| 1 | Iinterest | 19 | 20 | 95% | Very practical |
| 2 | Content | 14 | 16 | 87,5% | Practical |
| 3 | Language | 11 | 12 | 91,66% | Very practical |
| | Total | 44 | 48 | 91,38% | Very practical |
| | | **Student** | | | |
| | Average | 37 | 40 | 91,77% | Very practical |

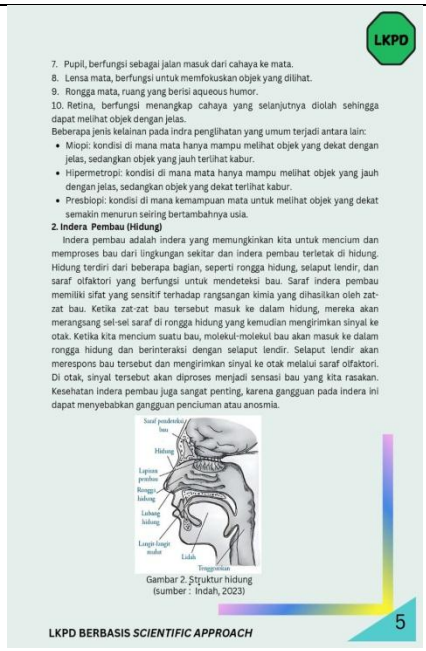
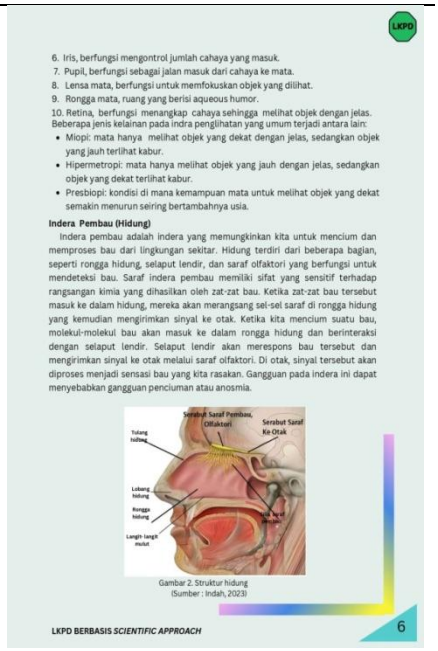
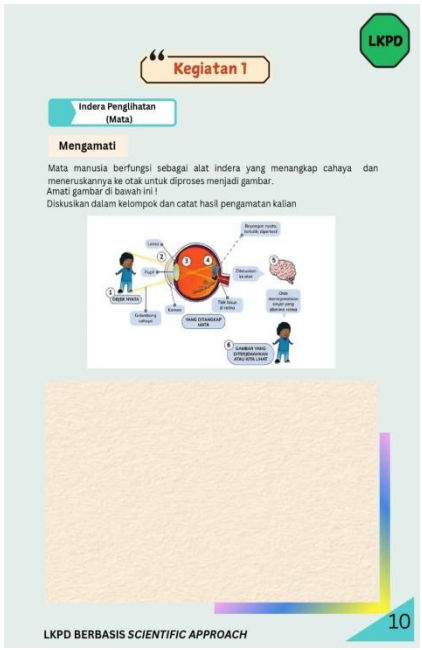
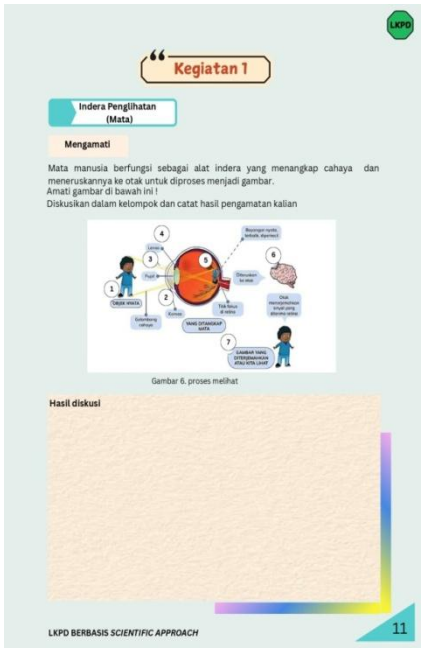
**Disseminate Stage**

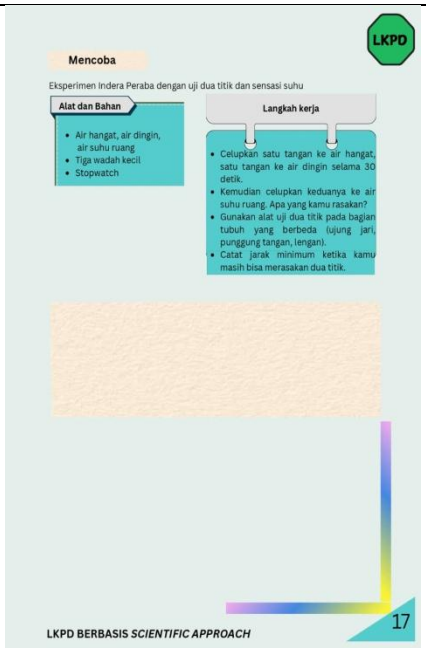
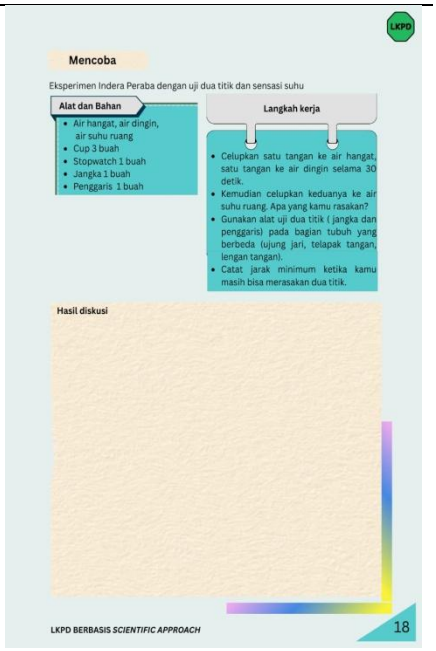
The development of the Scientific Approach-based Student Worksheet on the sensory system topic was carried out through stages of validation, revision, and limited trials to assess its effectiveness. After the validation and revision processes, the worksheet was implemented on a limited scale in Class XI MIA 2 at MA UNIVA Proyek as an initial step before wider dissemination. This trial aimed to evaluate the impact of the student worksheet on students' collaborative skills during the learning process. As shown in Figure 6, the results of the pretest and posttest data analysis indicated a significant improvement in collaboration skills, with an average N-Gain score of 0.84, categorized as high. This improvement demonstrates that the developed worksheet successfully encouraged students to understand, interpret, and analyze information related to the sensory system more deeply. Additionally, observations of students' collaborative activities during the learning process also revealed positive growth, as students were able to work effectively in groups to complete the tasks provided in the worksheet.

**Table 8.** Results of Media and Content Revisions

| Validator Suggestions | Before | After |
|---|---|---|

| Validator Suggestions | Before | After |
|---|---|---|
| **Figure 1.**<br><br>Image showing improvements based on the validator's suggestion to adjust design elements according to the characteristics of Madrasah Aliyah. |  |  |
| **Figure 2.**<br><br>Image showing improvements based on the validator's suggestion to provide usage instructions for teachers, not just for students. |  |  |

| Validator Suggestions | Before | After |
|---|---|---|
| **Figure 3.** Image of the olfactory sensory system organ, revised to be in color to make it more visually appealing. |  |  |
| **Figure 4.** Image showing improvements based on the validator's suggestion to clarify the sequence in the "observing" activity in Activity 1. |  |  |

| Validator Suggestions | Before | After |
|---|---|---|
| **Figure 5.** Image showing improvements based on the validator's suggestion to add specific measurements and quantities for tools and materials. |   |   |

The Scientific Approach syntax embedded in the student worksheet—such as observing, questioning, experimenting, reasoning, and communicating—encourages students to engage in the learning process actively. In this context, students do not merely acquire knowledge passively but construct understanding through discussion and collaboration. This aligns with the findings of Utariadi et al., (2021), who stated that Scientific Approach-based worksheets facilitate the learning process by providing clear, sequential, and activity-based guidance. Students' active involvement in interpreting information, identifying problems, and drawing conclusions collaboratively reflects the practical implementation of the Scientific Approach in strengthening 21st-century skills, particularly collaboration. Through experiment-based and discussion-based tasks, students learn to appreciate the roles and perspectives of each group member.

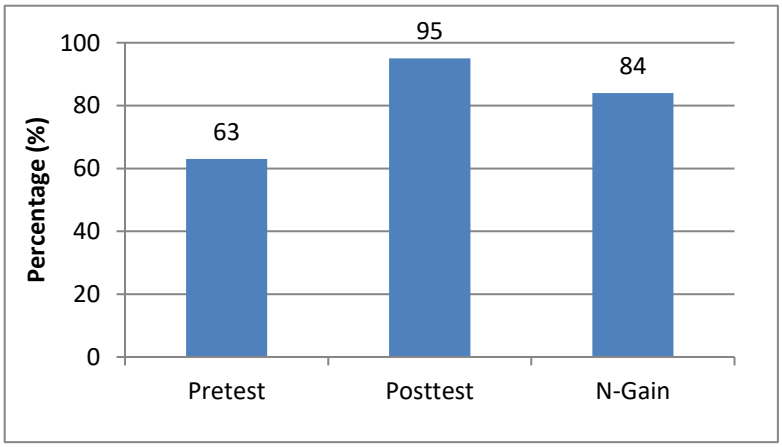



**Figure 6.** Diagram of Students' Collaboration Skills

The use of printed media in the development of student worksheets (LKPD) has proven effective in increasing student interest and participation. Raditya et al., (2023) stated that engaging and systematic instructional media can foster collaboration by creating an active and meaningful learning experience. This aligns with the Scientific Approach-based student worksheet, which is designed following scientific stages such as observing, questioning, experimenting, reasoning, and communicating. Each stage is structured to promote interaction, including group discussions, collaborative experiments, and presentations. This strategy provides opportunities for students to form solid learning teams to explore the sensory system material, thus demonstrating that printed media remains relevant and effective in fostering collaboration skills.

Furthermore, although it does not utilize digital platforms such as Moodle, as described by Ummah, (2019), the printed student worksheet developed in this study successfully provides an engaging and meaningful learning experience. This is achieved through the use of communicative illustrations, reflective questions, and project-based tasks that promote active student participation. The systematic page layout, clear instructions, and tiered assignments help students focus on understanding concepts while enhancing their involvement in the learning process. In addition, collaborative activities such as group case studies, scientific debates, and simulations of the sensory system in everyday life are strategically integrated to strengthen group interactions. Evaluation of collaborative skills revealed a significant improvement based on N-Gain analysis, indicating the effectiveness of the worksheet in developing students' social competencies Nurlina et al., (2024). By systematically applying the Scientific Approach through the stages of observing, questioning, experimenting, reasoning, and communicating, this worksheet not only sharpens cognitive abilities but also contributes to the development of scientific attitudes and essential collaborative skills for 21st-century learning.

The strength of the printed student worksheet based on the Scientific Approach lies in its ability to bridge theoretical learning with real-world activities that foster collaboration. Students are encouraged not only to work together but also to formulate hypotheses, conduct observations, and draw conclusions collectively, facilitating discussion, idea exchange, and the development of critical thinking and group responsibility. Each phase of the scientific approach is integrated with collaborative skill indicators: observing promotes shared focus (positive interdependence), questioning fosters idea communication, experimenting trains responsibility and coordination, reasoning builds negotiation skills, and communicating reinforces group accountability. Observation data show that using structured student worksheets made students more active in discussions and task-sharing. Teachers also reported that the worksheets made it easier to assign roles and guide students through the learning process. These findings are in line with (Johnson & Johnson, 2008), who emphasized that structured scientific activities are effective in enhancing meaningful collaboration in 21st-century learning.

Thus, the collaborative skills developed through the printed Scientific Approach-based LKPD on the sensory system material provide a tangible contribution to enhancing students' collaboration abilities. Although printed, this LKPD has strong potential to create an active, explorative, and participatory learning

environment—essential for preparing students to face the challenges of the information era. Therefore, the development of contextual and Scientific Approach-integrated printed teaching materials should continue to be promoted, especially in madrasah contexts where adaptive and effective learning media are needed.

The implementation of the Scientific Approach-based LKPD in the sensory system lessons has proven effective in increasing student engagement and collaboration during learning. This is evident from the differences between pretest and posttest scores after using the LKPD. The scientific approach in the LKPD guides students through the stages of observing, questioning, gathering data, reasoning, and communicating, all of which are designed to train students in critical thinking and cooperation. Through these stages, students are not only individually active but also trained to interact with their peers, discuss, and exchange ideas to find solutions to given biology problems. These activities strengthen students' social skills, especially in scientific communication and inter-group collaboration.

The printed Scientific Approach-based LKPD in the sensory system lessons has been proven to enhance learning activeness and students' collaboration skills. This is because the Scientific Approach systematically directs students through observing, questioning, gathering data, reasoning, and communicating to train collaboration. This aligns with research by Irawan et al. (2023), who found that Scientific Approach-based LKPD helps students build conceptual understanding independently and strengthens active engagement in learning. (Jehadut et al., 2022) affirmed that LKPDs designed according to Scientific Approach syntax effectively improve students' communication and social interaction skills, especially in group discussions. In the sensory system context, students are encouraged to observe parts of human sensory organs and analyze their functions collaboratively, making learning more contextual and meaningful.

Other research by Ain et al. (2024) also supports that printed Scientific Approach-based LKPD can hone students' cooperation through observation-based problem-solving activities. Students are actively involved in exploring sensory system concepts through group discussions, simple experiments, and group presentation of findings. Amthari et al., (2021) revealed that LKPD with a Scientific Approach provides a systematic learning experience and reinforces student collaboration in completing tasks. Meanwhile, Mukhlis et al., (2023) emphasized that this approach not only supports cognitive learning outcomes but also fosters collaborative and communication character—highly needed in 21st-century education. Therefore, the printed Scientific Approach-based LKPD is a viable alternative teaching material that is both effective and relevant for improving the quality of biology education, specifically on the sensory system topic.

## CONCLUSION

Based on the research findings, the development of student worksheets (LKPD) based on the Scientific Approach for the sensory system topic was proven to be valid, practical, and effective in enhancing students' collaboration skills. The LKPD was designed following the stages of the Scientific Approach—observing, questioning,

experimenting, reasoning, and communicating—which encourage active engagement and teamwork in the learning process. Validation results showed a material score of 92.72% and a median score of 93.33%, both categorized as very valid. The practicality was also high, with scores of 91.38% from teachers and 91.77% from students. Effectiveness was demonstrated through an average N-Gain score of 0.84, which falls into the high category. Scientifically, this study offers novelty through the explicit integration of Scientific Approach syntax with 21st-century collaboration indicators in printed media. Unlike previous studies that primarily focused on cognitive aspects or digital media, these findings highlight that printed LKPDs remain relevant and can effectively support collaborative learning. However, limitations still exist, such as manual activities and a narrow scope of material. Therefore, future research is recommended to develop digital LKPDs with broader content coverage to promote more interactive and efficient learning.

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