"Physics Club" program to strengthen high school students' physics identity

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Abstract
Students often struggle to identify and position themselves in physics class which is known as the conceptualization of physics identity. One of the contributing factors is the limited learning environment that fosters engagement and a sense of belonging in physics. This study aims to develop, validate, and test the practicality of physics learning tools in a non-formal context, specifically through a physics club. The research employs the Research and Development (R&D) design with the 4D model (Define, Design, Develop, and Disseminate). The instruments were validity and practicality questionnaires. The content validity was assessed by two experts: one physics lecturer and one physics teacher. In addition, the practicality testing involved one physics teacher and 36 students from Laboratory Senior High School UM (Universitas Negeri Malang). Data were analyzed through descriptive statistic by presenting the percentage of the validity and the aspect of practicality. The developed products include a physics club program book, a physics club activity module, and a physics club material book. The validity results showed that the program content achieved 94% (highly valid), the media and material validity of the physics club activity module scored 81% and 89% respectively (highly valid), and the media and material validity of the physics club material book scored 89% and 91% (highly valid). Practicality tests by teachers and students yielded scores of 97% (highly practical) and 77% (practical), respectively. Based on these results, the physics club learning tools are declared valid and practical for use in order to strengthen students' physics identity.

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1. Introduction

Physics education at the high school level plays an important role in shaping scientific thinking, problem-solving skills, and readiness to face technology and science-based challenges (Putri et al., 2024; Yunita & Mandasari, 2025). This aligns with 21st-century skills, which include as higher-order thinking skills, deeper learning outcomes, and communication abilities (Putri et al., 2024). In the 21st-century skills framework, students must master the 4 Cs: (1) critical thinking and problem-solving, (2) communication, (3) collaboration, and (4) creativity and innovation (Mahrunnisya, 2023; Rahmani & Hikmawan, 2025). The Indonesian government has made several efforts to support this development. These include curriculum refinement (Alhamduddin, 2016; Amalia & Asyari, 2023; Zulaiha et al., 2022) and improving the quality of human resources as educators (teachers) (Mustaquim, 2023; Rosmiati et al., 2024). In addition, various learning models have been implemented. These include problem-based learning (Herlinda et al., 2017; Umamah & Andi, 2019; Windari & Yanti, 2021), project-based learning (Aini et al., 2018; Handayani, 2019; Qadafi et al., 2022), and inquiry-based learning (Agustina et al., 2020; Ismawati et al., 2023). Furthermore, researchers have developed various learning media, including teaching modules (Astiti, 2019; Bakri et al., 2015; Idamayanti & Sakti, 2025), multimedia learning tools (Masyithah et al., 2017; Sevtia et al., 2022), and educational games (Simaremare et al., 2022; Wati & Istiqomah, 2019). However, most of these efforts focus only on improving cognitive academic achievement. These efforts are still centralized in the classroom as part of the formal learning system. Ideally, physics learning should also foster affective aspects, motivation, and students' emotional connection to physics. This process is known as the formation of physics identity (Hazari et al., 2010).

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Physics identity refers to a constructed identity that reflects the extent to which an individual perceives themselves as "a physics person" (Wulff et al., 2018). In other words, physics identity describes hor to students perceive their competence in physics. It also relates to how much they feel interested, actively engaged, and experiences a sense of belonging to the physics community (Lock et al., 2019). Physics identity is consists of four key components: interest, competence, performance, and recognition (Hazari et al., 2010). Research usually average these four components to serve as a proxy for physics identity (Hazari et al., 2015). These components contribute to learning motivation, academic self-confidence, and emotional attachment to physics. Students with a stronger physics identity tend to show greater interest, higher engagement, and a stronger inclination to pursue further studies and careers in physics (Cheng et al., 2018). Lock (2013) also emphasizes that pursuing a career in physics depends on two key factors: physics interest and recognition (Lock et al., 2013). Thus, low physics identity correlates strongly with negative attitudes toward physics (Hazari et al., 2020).

Negative attitudes toward physics manifest in several ways. Students many lack of interest in attending classes, show reluctance to listen to the teacher feel unmotivated, or experience boredom during physics lessons (Maison et al., 2018). This problem contributes to a declining trends in physics related career paths. Riskawati (2021) found a sharp decline in enrolment in physics education programs over three years (2018–2020). In 2020, only two out of eight public universities (PTN) had a balanced number of applicants compared to their capacity. The other six universities failed to attract enough students to meet their quotas (Riskawati et al., 2021). Similarly, Putra (2019) reported that although 68% of high school students in Jambi expressed some interest in physics, most still hesitated to persue a physics-related career. Only 8.8% of students (11 out of 125) showed high interest in continuing their physics studies (Putra & Wiza, 2019). Furthermore, Maison (2018) revealed that students had almost no interest in becoming physics teachers or scientist (Maison et al., 2018).

This situation reflects a broader issue within the Indonesian education system, where physics learning remains heavily focused on cognitive achievement (Asriati, 2022; Widiarini et al., 2025). National studies indicate that formal classroom instruction often neglects students' affective engagement and fails to foster emotional connections with physics(Asriati, 2022; Seprianto et al., 2024). Students rarely experience exploratory (Mardiyah & Kamariyah, 2022) or contextual learning activities (Samudra et al., 2014) making physics learning feel distant from real-life situations. This condition leads to low student motivation to pursue careers in physics and contributes to the shortage of professional physicists at the national level (Putra & Wiza, 2019; Riskawati et al., 2021).

Unfortunately, physics identity has not yet become a main focus in learning practices. In this context, alternative learning spaces can offer complementary solutions. One of these alternatives is a structured physics club program or physics community (Da et al., 2022). Physics club allows students to engage in exploratory, collaborative, and real-world physics activities (Fracchiolla et al., 2020; Martín-García et al., 2024). Through non-formal learning, students can interact with physics in a flexible and enjoyable way. They do not face the evaluative pressures commonly found in formal classrooms (Eshach, 2007).

However, developing an effective and impactful physics club requires appropriate learning tools. These tools must be engaging, practical, and validated by experts. They should include hands-on activity modules, contextual material book, and structured programs that help students feel competent, interested, and accepted in the physics community. So far, reseach on developing and validating physics learning tools in non-formal contexts like physics club is still very limited in Indonesian (Legiman, 2019). In particular, few studied integred physics identity explicitly into the design of non-formal programs. Existing research in Indonesia, such as physics olympiad training programs (Munawir et al., 2022) and scientific paper writing activities (Aeni et al., 2023), still focuses on the development of students' cognitive aspects. In addition, unlike previous studies, this research explicitly integrates a physics identity reinforcement approach into the design of learning tools for non-formal physics club programs in Indonesia. While prior studies have generally emphasized cognitive aspects, this study directly targets the enhancement of four components of physics identity: interest, competence, performance, and recognition, as the primary goals in its instructional design.

Learning tools also require validation and practicality testing to ensure their suitability for implementation (Anggraini et al., 2022). Validation ensures that content is feasibility, coherence, and aligned with learning objectives (Laili et al., 2021). Meanwhile, practicality testing assesses whether teachers and students can effectively implement the learning tools (Anggraini et al., 2022). Therefore, this study aims to develop, validate, and test the practicality of physics club learning tools in a non-formal educational setting. The validation process examines content, media, and material aspects through expert review. The practicality testing involves both high school teachers and students. This research is expected to contribute to the development of non-formal physics learning spaces, particularly physics clubs, as a means to strengthen high school students' physics identity.

2. Method

This research uses a development research type. The development model used in this research is the 4D model, which consists of: define, design, develop, and disseminate (Thiagarajan, 1974). The define stage is carried out by analyzing field studies and preliminary studies. The field study uses a questionnaire filled out by 69 grade XI MIPA (Natural Sciences) high school students. The questionnaire is used to determine students' interest in physics, the need for a physics club, types of physics club activities of interest, obstacles and support, as well as expectations for physics club activities. The preliminary study is conducted through literature review by examining relevant literature and scientific journals related to declining interest in physics.

The design stage begins with the development process of the initial physics club program. This plan includes three main interrelated components. These components consist of the physics club program design, the student and teacher work modules, and the physics club material book. The physics club work program guidebook is compiled as a guideline for teachers and mentors in carrying out club activities. The physics club work module is specifically designed to guide both teachers and students. However, the difference between the student and teacher work modules lies only in the presence or absence of answers in the data processing section. The physics club material book contains more in-depth theoretical explanations related to experimental and project topics. This book aims to enrich students' conceptual understanding and serve as a reference in answering the questions in the module.

The development stage is carried out using the initial drafts of the physics club program book, the physics club work module, and the physics club material book produced during the design stage, which will go through the following steps: (1) validation by one physics expert lecturer and one physics teacher using a questionnaire that generates quantitative data through Likert scale scoring to determine the validity of the physics club instruments, and (2) practicality testing by teachers and students using a practicality questionnaire with a Likert scale to determine the practicality of the physics club program instruments. The data obtained from the validity and practicality tests were analyzed using the average Formula 1 and with criteria as shown in Table 1.

$$Np = \frac{n}{S_m} x\ 100\% \quad (1)$$

Description:

Np = Percentage value

n = Product assessment score obtained

S_m = Maximum score

Table 1. Validity and Practicality Criteria

Score	Validity/Practicality Criteria
81% < Np < 100%	Very Valid/Practical
61% < Np <80%	Valid/Practical
41% < Np < 60%	Moderately Valid/Practical
21% < Np <40%	Less Valid/Practical
Np <20%	Not Valid/Practical

(Arikunto, 2010)

3. Results and Discussion

The development process of the physics club instruments follows the 4D stages (Define, Design, Develop, and Disseminate). The scope of the development process in this article is in the develop stage. We present the results starting from define stage.

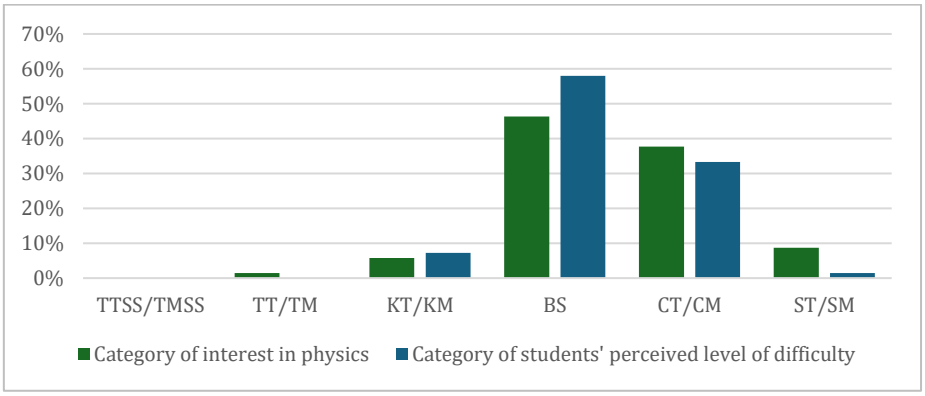
3.1. Define Stage

The define stage in the development of the physics club program was started with analyzing field study activities and preliminary studies through existing literature in this area. This step was carried out to develop a program that is appropriate and effective.

3.1.1. Field Study Stage

The field study was conducted by distributing questionnaires to 69 11th-grade science (MIPA) students at Laboratory Senior High School UM (SMA Laboratorium UM). This questionnaire aimed to reveal five important aspects related to students' needs and interests in the physics club activities, namely: students' interest in physics, the need for a physics club, types of activities preferred in the physics club, obstacles in implementing the activities, and students' expectations of the physics club program.

Based on the data analysis, students' average interest and perceived level of difficulty in physics vary, as shown in Figure 1.



Description:

TTSS/TMSS	:	Not Interested at All / Not Challenging at All	BS	:	Neutral
TT/TM	:	Not Interested / Not Challenging	CT/CM	:	Quite Interested / Quite Challenging
KT/KM	:	Less Interesting / Less Challenging	ST/SM	:	Very Interested / Very Challenging

Figure 1. Distribution of students' interest in physics and their perceived level of difficulty in learning physics.

Based on the data analysis, 46% of students stated that they were neutral, while 38% expressed moderate interest, 9% showed high interest, and the rest stated that they were not interested or slightly interested. This data indicates that most students fall into the neutral and moderately interested categories, suggesting that classroom learning approaches have not fully sparked students' interest. In addition, 58% of students perceived physics as a moderately challenging subject, and 33% considered it very challenging. The remaining students viewed physics as an average subject or not challenging at all. This is because a small number of students reported studying physics beyond school hours, such as attending tutoring sessions or receiving private lessons at home, to help them better understand the subject.

Based on the needs analysis data collected through a questionnaire, 76% of students stated that a Physics Club is needed at school. This high percentage indicates that students have a strong desire for an alternative and more enjoyable learning space outside of formal lessons. The activities students expect from the club are shown in Figure 2.

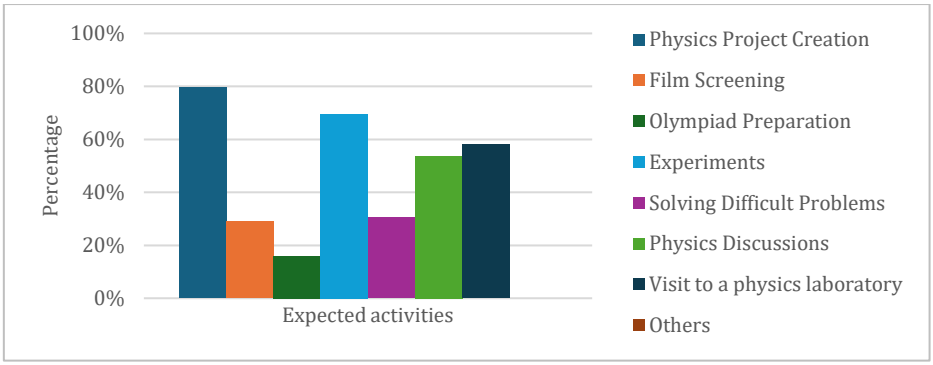


Figure 2. Activities students expect in the Physics Club

Based on these expectations, it can be concluded that most students need a learning space outside of formal education, which includes physics project creation, experimental activities, laboratory visits, and physics discussions. In line with this, Hazari (2020) states that students need a broader learning environment that involves activities which utilize their interests and innovative potential (Hazari et al., 2020). Therefore, the Physics Club program includes activities consisting of 2 experiments, 3 project-based activities, and 2 scientific activities such as visits to a physics laboratory and discussions with physics experts. This design considers the benefits of each non-formal activity, as experiments and real-world projects help students recognize the relevance of physics in everyday life (Da et al., 2022). Scientific activities such as visits to physics laboratories can spark a sense of wonder, interest, enthusiasm, motivation, and learning spirit (Affeldt et al., 2015). Meanwhile, discussions with experts in physics help students shape and revise their understanding of physics concepts (Zhang et al., 2017).

Regarding the schedule, most students prefer the Physics Club to be held twice a week, while the rest have not yet made a definite choice. This is due to some students having difficulty managing time between non-formal and formal programs. Therefore, the Physics Club program is designed to be held twice a week, with careful scheduling to ensure consistency without interfering with students' formal academic responsibilities.

3.1.2. Preliminary Study Stage

The preliminary study was conducted through a literature review of relevant literature and scientific journals. The results of this review indicate that the decline in student interest in physics is a serious issue both in Indonesia and globally. In Japan, Naganuma (2023) stated that students' positive attitudes toward science particularly physics and chemistry have declined significantly starting from the secondary school level (junior and senior high school), which has led to a decrease in the number of students pursuing these fields (Naganuma, 2023). A similar evidance also occurs in England, especially at the upper-secondary education level, where physics tends to be less favored compared to biology and chemistry (Sheldrake et al., 2019). Meanwhile, in the United States, Gary (2024) reported a 30% decline in the number of university students majoring in physics between 2018 and 2022 (Gary, 2024).

This condition also occurs in Indonesia, where several national media outlets such as Jawa Pos, Detik Jatim, and Jawa Pos Radar Malang from 2023 to 2024 reported a decline in the number of applicants in physics (Ulum, 2024). This decline in interest is also reflected in physics ranking fifth among the lowest number of applicants in the Computer-Based Written Examination (UTBK) at a university in Malang, Indonesia, in 2024 (Caesaria & Ihsan, 2024). This decreasing interest was also revealed by the Director of Dissemination and Utilization of Science and Technology (Minatsaintek) at the Ministry of Higher Education of Science and Technology (Kemendiktisaintik), who stated that students today are increasingly less interested in studying mathematics, physics, chemistry, and biology. Among these fields, the greatest decline in interest occurred in the physics study program, which even caused the closure of several physics programs at various universities (Prodjo, 2025). Moreover, based on data from the Higher Education Database Pangkalan Data Pendidikan Tinggi (PDDikti), several universities in Malang with physics study programs also experienced a decline in the number of students from odd to even semesters every year. This phenomenon is not only happening in Indonesia but also in the United States, as revealed by Porter et al. (2024) in their study

titled “Attrition and Persistence in Undergraduate Physics Programs.” The study identified several factors contributing to the shift in interest, such as attraction to other majors, negative experiences in the physics program, low self-efficacy, lack of social interaction and support, and the perception that physics careers are limited only to research or teaching (Porter et al., 2024).

Several studies also show that the decline in interest in physics is not only due to academic factors but also because of unpleasant learning experiences. Hazari et al (2020) revealed that learning approaches in formal classrooms have become increasingly specific and technical, which limits students’ ability to engage in activities that foster their interest development. As reported Munfaridah et al. (2022), eventhough the application of specific learning model, such as the use Multiple Representation approach (Munfaridah & Goedhart, 2022) in the classroom context indicate the development of students’ physics identity, the specific aspect of learning process in the classroom still remains unclear. Other research indicates students’ negative perceptions of physics as a difficult, unenjoyable subject that is more suitable for boys (Avraamidou, 2022; Danielsson, 2012; Hazari et al., 2014). Moreover, Naganuma (2023) also added other factors such as misunderstanding of concepts, low exam scores, the presence of mathematics in physics, and negative relationships with teachers as causes for the decline in students’ interest in physics.

Studies have shown that one way to address the declining interest in physics among students is by strengthening their physics identity (Gonsalves & Danielsson, 2020). Hazari et al. (2010) identified a strong relationship between physics identity and students’ choice to pursue careers in physics-related fields (Hazari et al., 2010). Their findings also indicated that analyzing physics identity can serve as a key predictor of whether students will continue their studies or careers in physics in the long term (Dewitt et al., 2019). Consistent with this, other studies have implicitly suggested that individuals with a strong physics identity are more likely to persist in studying physics and to choose careers in the field (Bøe, 2023; Hazari et al., 2010).

One promising approach to fostering students’ physics identity and mitigating their declining interest in the subject is through non-formal learning activities, also known as out-of-class learning (Halonen & Aksela, 2018; Stăncescu et al., 2018). Prior research has reported that participation in such non-formal learning experiences can: a) increase students’ curiosity and enthusiasm toward physics (Adeyemo, 2010), b) offer a more relaxed, interest-driven learning environment (Giannakos, 2020; Grenier et al., 2022), c) support project-based learning, experimentation, and scientific activities (Krapp & Prenzel, 2011), and d) strengthen students’ physics identity through engagement in physics communities (Fracchiolla et al., 2020). Accordingly, we developed a non-formal program called the "Physics Club," designed as a physics community to strategically enhance students’ physics identity and, consequently, their interest in the subject.

3.2. Design Stage

The design stage begins with the process of developing the non-formal “Physics Club” program based on the analysis results from the define stage. This design includes three interrelated learning components: the physics club work program book, the physics club work module, and the physics club material book. First, the physics club program book is prepared to serve as a guideline for teachers and mentors in conducting physics club activities. This book contains the background of the physics club’s formation, its vision, mission, objectives, activity plans, overall implementation schedule and schedules for each meeting, as well as budget plans and a closing section.

Second, the physics club work module is specifically designed to guide both teachers and students in carrying out activities. The difference between the teacher’s and student’s modules lies only in the presence or absence of answers in the data processing sections. This module contains worksheets consisting of 7 activities, including 2 experimental activities, 3 project-making activities, and 2 scientific activities. The experimental activities include experiments on series-parallel circuits using solar panels and alternative energy from lime and potatoes. The project activities consist of making a simple projector using a light bulb, building a pom-pom boat from used cans, and creating a miniature hydraulic arm from used cardboard and syringes. Meanwhile, the two scientific activities include discussions with physics experts and visits to physics laboratories.

The work module for experimental and project activities is organized in a systematic format, including an introduction, experiment objectives, tools and materials, experimental procedures

accompanied by illustrations, observation data, data processing, conclusions, and references. For scientific activities, the format includes the activity name, date, location, speaker, speaker's topic, material summary, interesting points, questions, personal reflections, conclusions, and documentation. Specifically, for visits to physics laboratories or museums, the format is adjusted by replacing the "speaker" and "speaker's topic" columns with "activities," and changing "material summary" to "findings." All activities in the physics club are designed as simple practical experiments aimed at understanding basic physics concepts, using simple and easily accessible materials found in students' surroundings. This approach is expected to provide students with a deeper and more relevant contextual understanding.

Third, the physics club material book contains more in-depth theoretical explanations related to the topics of experiments and projects. This book aims to enrich students' conceptual understanding and serve as a reference for answering questions in the module. These three books complement each other in supporting the implementation of the physics club program, covering activity planning, execution, and reflection on learning outcomes. The materials and activities presented are designed to create a fun, engaging, and meaningful learning experience for students. Through active participation in this program, students are expected to build and strengthen their physics identity. This aligns with research findings showing that students who perceive a positive learning environment tend to have higher motivation and engagement, as well as better academic achievement (Binning et al., 2020; Shaffer, 2019; Whitcomb et al., 2023). Research conducted in Brazil also indicates that non-formal learning spaces such as the Baquora Science Community can significantly contribute to enhancing students' physics identity (Da et al., 2022). This enhancement of physics identity ultimately encourages students to remain consistent and motivated to continue their studies and careers in physics (Lock et al., 2013).

3.3. Develop Stage

The Develop stage is a continuation of the design process from the Design phase, focusing on refining and finalizing the three physics club learning tools in the non-formal setting so that they are ready for validation and practicality testing. In this stage, we presents the results as follows: (a) the final products of the physics club program; (b) the validity of the products; and (c) the practicality test.

3.3.1. Final Product of the Physics Club Program

The final products produced at this stage consist of three main learning tools in the physics club program, which are presented in the following section.

Physics Club Program Book

This book has been fully and finally developed, encompassing comprehensive information regarding the vision, mission, activity objectives, activity plans, overall implementation schedule and schedule for each meeting, as well as the budget plan and closing section. At this stage, the book's visual design has also been refined using the Canva application to create an attractive appearance. The final result of the physics club work program book is shown in Figure 3.

Figure 3. Several Final Displays of the Physics Club Program Book

Physics Club Workbook Module

This module includes seven main activities: two experiments, three projects, and two scientific activities. Each activity has been organized in a systematic format, starting from the introduction, experiment objectives, tools and materials, experiment procedures accompanied by illustrations, observation data, data processing, conclusions, and reference sources. The final result of the physics club work module is shown in Figure 4.

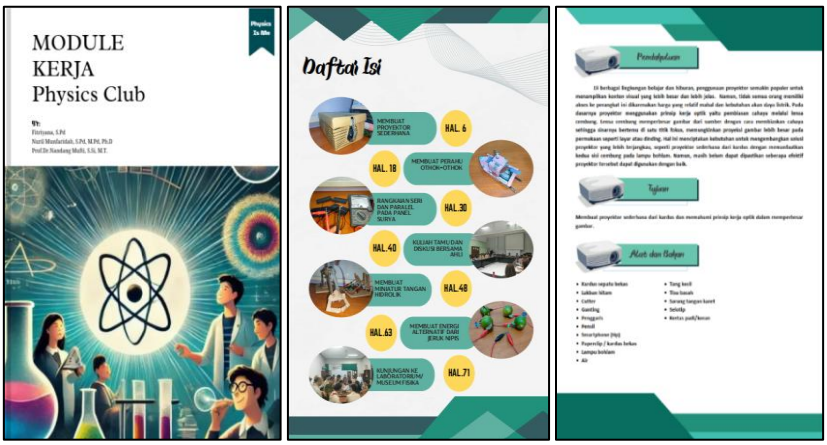


Figure 4. Some Final Displays of the Physics Club Workbook Module

Physics Club Material Book

This book contains theoretical explanations to strengthen the understanding of physics concepts related to the module activities. The book was developed with a communicative approach, using easy-to-understand language, and is complemented by visual illustrations to enrich students' comprehension. The final result of the physics club material book is shown in Figure 5.

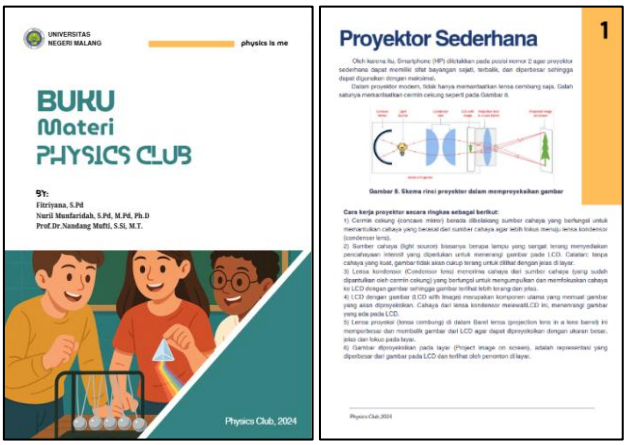


Figure 5. Final Appearance of the Physics Club Material Book

3.3.2. Validity Testing

Validity testing was conducted to obtain assessments of the product design or teaching materials provided by experts in their respective fields (Fadhillah & Andromeda, 2020). The products validated included the physics club program book, the physics club work module book, and the physics club material book. The validity data were obtained through questionnaires filled out by experts, including a physics lecturer from FMIPA UM and a physics teacher from Laboratory Senior High School UM (SMA Laboratorium UM). The following are the validation results for each of these learning tools.

Physics Club Program Book

The physics club program book was validated only for its content. The results of the content validity test for the physics club program are presented in Table 2.

Table 2. Results of Construct Validity Test for the Physics Club Program

Aspect	Percentage	Criteria
alignment with objectives	95%	Very Valid
completeness of activities	90%	Very Valid
relevance of activities	95%	Very Valid
involvement and interaction	100%	Very Valid
program sustainability	90%	Very Valid
feasibility	95%	Very Valid
Total	94%	Very Valid

Based on the results in Table 2, the validity score for alignment with objectives was 95%, indicating that the designed program corresponds well with the established goals of the physics club. The completeness of activities aspect scored 90%, suggesting that the activities presented in the physics club program book are comprehensive and well-structured. The relevance of activities received a score of 95%, indicating that the activities are suitable for the high school level and effectively enrich students' physics knowledge, positively impacting their future careers in physics. The involvement and interaction aspect achieved 100%, demonstrating that the designed activities successfully increase student engagement and foster communication, teamwork, and scientific analysis skills through group work. The program sustainability aspect scored 90%, showing that the program can be carried out continuously according to the predetermined schedule. Meanwhile, the feasibility aspect scored 95%, confirming that the designed program is suitable for implementation. From all aspects, the average content validity percentage was 94%, categorized as very valid. This result indicates that the physics club program book can be used in activities without requiring any revisions.

Physics Club Work Module

The validation results of the physics club workbook include media validation and content validation. The results of the media validation test for the physics club workbook are presented in Table 3.

Table 3. Validation Results of the Media for the Physics Club Work Module Book

Aspect	Percentage	Criteria
layout and design	74%	Valid
readability and clarity	86%	Very Valid
media suitability	83%	Very Valid
attractiveness	80%	Valid
Total	81%	Very Valid

The overall media validity of the physics club workbook is declared very valid with a score of 81%. The layout and design aspect scored 74%, indicating that the layout and design have been presented well. The readability and clarity aspect scored 86%, showing that the language and writing used are easy for students to understand. The media suitability aspect scored 83%, demonstrating the appropriateness between text and images. Meanwhile, the attractiveness aspect scored 80%, indicating that the workbook has an appealing design and layout. However, the layout and attractiveness aspects scored lower compared to the other aspects. This is due to the need for revision regarding the use of colors in the workbook, which were too varied, resulting in inconsistency.

Meanwhile, the results of the content validity test for the physics club workbook module are presented in Table 4.

Table 4. Results of Material Validation Test for the Physics Club Work Module Book

Aspect	Percentage	Criteria
alignment with objectives	90%	Very Valid
completeness of material	85%	Very Valid
appropriateness of material	93%	Very Valid
relevance to physics concepts	87%	Very Valid
readability and clarity of presentation	95%	Very Valid
attractiveness	87%	Very Valid
Total	89%	Very Valid

The overall content validity of the physics club workbook module obtained an average score of 89%, indicating that the material presented is highly valid. The aspect of alignment with objectives scored 90%, showing that the module content aligns with the goals of each activity and is consistent with the overall physics club program. The completeness of material aspect scored 85%, indicating that each activity is accompanied by comprehensive guidance and subtopics. The appropriateness of material aspect scored 93%, meaning the material corresponds well to the activity topics and correct physics concepts. The relevance to physics concepts aspect scored 87%, indicating that the activities are relevant to applicable physics principles. The readability and clarity of presentation aspect scored 95%, showing that the language used is easy to understand and the module's presentation is clear and systematic. The attractiveness aspect scored 87%, indicating that the module is engaging, enjoyable, and capable of inspiring students to learn further. These results demonstrate that the material in the module is well presented, although some improvements are needed.

Physics Club Material Book

The validation results of the physics club material book include media validation and content validation. The results of the media validation test for the physics club material book are presented in Table 5.

Table 5. Results of Media Validation for the Physics Club Material Book

Aspect	Percentage	Criteria
layout and design	86%	Very Valid
readability and clarity	87%	Very Valid
media suitability	83%	Very Valid
attractiveness	100%	Very Valid
Total	89%	Very Valid

The media validity of the physics club material book showed results of 86% for the layout and design aspect, indicating that the layout and design were well presented. The readability and clarity aspect scored 87%, signifying that the language and writing used were easily understood by students. The media suitability aspect obtained 83%, showing the consistency between text and images. Meanwhile, the attractiveness aspect scored 100%, demonstrating that the supplementary book for the module has a very appealing design and layout. From the validity test results, the overall average was 89%, categorized as very valid. Therefore, the supplementary material book for the physics club module is considered feasible and can be used in physics club activities, with the condition that improvements are made.

The results of the material validity test for the physics club material book are presented in Table 6.

Table 6. Results of the Content Validation Test of the Physics Club Material Book

Aspect	Percentage	Criteria
suitability with objectives	87%	Very Valid
completeness of material	93%	Very Valid
material suitability	90%	Very Valid
relevance to physics concepts	95%	Very Valid
readability and clarity of presentation	90%	Very Valid
Total	91%	Very Valid

The material validity of the physics club's material book was evaluated across several aspects. The aspect of suitability with the objectives received a score of 87%, indicating that the material was designed in alignment with the goals of each activity and consistent with the overall physics club program. The completeness of the material scored 93%, demonstrating that each activity is supplemented with comprehensive sections and subtopics. The material suitability aspect obtained a 90% score, confirming that the content corresponds accurately to the activity topics and is based on correct physics concepts. Relevance to physics concepts scored 95%, emphasizing that the designed activities closely relate to established physics principles. Readability and clarity of presentation achieved a 90% rating, showing that the language used is easily understandable and the

book's presentation is clear and systematic. Overall, the material validity test yielded an average score of 91%, categorized as very valid. These results indicate that the material in the book has been well-developed and is suitable for use in physics club activities, with some recommended improvements.

3.3.3. Practicality Test

The practicality test was conducted by implementing the physics club program in a school setting. Practicality data were collected through response questionnaires completed by both teachers and students to assess the level of practicality of the physics club program. The results of the practicality test from the teachers' perspective regarding the physics club program are presented in Table 7.

Table 7. Results of the Practicality Test by Teachers

Aspect	Percentage	Criteria
program planning	96%	Very practical
program implementation	100%	Very practical
program effectiveness	100%	Very practical
program impact	93%	Very practical
Total	97%	Very practical

Based on the results presented in Table 7, the program planning aspect received a score of 96%, indicating that the program was well-designed and aligned with students' needs and learning objectives. The program implementation aspect achieved a perfect score of 100%, demonstrating that the program was executed effectively, including the completeness of activities and student engagement. The program effectiveness aspect also received a score of 100%, highlighting that the program significantly enhanced students' practical understanding and provided an enjoyable learning experience. Meanwhile, the program impact aspect scored 93%, reflecting a positive influence on students' interest and comprehension of physics. Overall, the practicality test conducted by teachers yielded an average score of 97%, categorizing the physics club program as highly practical.

The results of the practicality test conducted by students regarding the physics club program are presented in Table 8.

Table 8. Results of the Practicality Test by Students

Aspect	Percentage	Criteria
program planning	79%	Practical
program implementation	80%	Practical
program effectiveness	79%	Practical
program impact	71%	Practical
Total	77%	Practical

Based on the results presented in Table 8, the overall average score for the practicality test conducted by students was 77%, categorized as practical. Regarding the program planning aspect, a score of 79% was obtained, indicating that the program was well-designed and aligned with the learning objectives, although it was somewhat less aligned with students' needs and interests. Several students suggested that physics club activities be conducted outdoors to add variety and enhance engagement. The program implementation aspect received the highest score of 80%, demonstrating that the program was conducted according to the planned schedule with sufficient equipment, materials, and supervision. The program's effectiveness aspect scored 79%, indicating that the physics club increased students' practical understanding and provided an enjoyable experience. However, the program impact aspect received the lowest score of 71%. This lower rating was attributed to the limited duration of activities, which resulted in insufficient in-depth explanation of physics concepts and the rationale behind each activity. Some students recommended that explanations related to the objectives, connections to physics, and worksheet completion be discussed collaboratively. Such explanations are critical components for fostering student interest in physics. This challenge was addressed by providing reading materials intended to guide students in understanding the reasons and physics concepts underlying each activity. Nevertheless, most

students did not engage with the reading materials thoroughly and completed the worksheets superficially, leading to a perceived lack of understanding of the activities and the underlying physics concepts. In conclusion, although the Physics Club program was rated as very practical by teachers and practical by students, several areas require improvement, such as adjusting the activity duration, incorporating collaborative discussions to explain physics concepts, and enhancing student engagement in understanding the provided materials.

These findings are also consistent with the study by Da et al., (2022) which developed the Clube de Ciências Baquara in Brazil. Their research demonstrated that implementing experimental and project-based activities in non-formal learning spaces can enhance students' intrinsic motivation and foster more positive perceptions of physics. Similarly, Fracchiolla et al., (2020)) emphasized that participation in physics clubs and communities outside the formal classroom setting can strengthen students' sense of belonging, engagement, and identity within the discipline. Although the measurement approaches and social contexts differ, the present study confirms that non-formal and contextual physics activities are not only feasible to implement in Indonesian high schools but also practically support the enhancement of students' motivation and interest in learning physics. The developed Physics Club program has been perceived as clear, manageable, and engaging by both teachers and students, in line with previous studies that highlight the practicality and educational value of non-formal science programs (Da et al., 2022; Fracchiolla et al., 2020)

4. Conclusion

The physics club program, consists of three main components: the physics club program book, the physics club activity module, and the physics club material book. These components have undergone rigorous validation processes, resulting on highly satisfactory category. The construct validity of the physics club program design reached an average score of 94%, categorized as very valid. Content validity assessed by subject matter experts for both the activity module and material book achieved average scores of 89% and 91%, respectively, also classified as very valid. Furthermore, media validity tests for the activity module and material book obtained average scores of 81% and 89%, confirming their very valid status. In terms of practicality, the physics club program was rated as very practical by teachers (97%) and practical by students (77%). These results indicate that the physics club, as a non-formal learning program, is both valid and practical in supporting the development students' physics identity. This study contributes to strengthening the literature on the development of non-formal programs in strengthening students physics identity and offers an innovative physics learning beyond the formal classroom setting. Through this program, it is expected that students' interest in physics will be effectively nurtured and developed. In the future, the testing of the product through the experimental study should be conducted and followed by the dissemination of the products.

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