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The Development of Hallwachs Miracle Novel as a Media Science Literacy in Learning Photoelectric Topic

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Abstract

This study aims to develop a novel entitled "The Miracle of Hallwachs" as a medium for enhancing scientific literacy, particularly focusing on the physics concept of the photoelectric effect for third-grade high school students. The research employs the Research and Development (R&D) approach, utilizing the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) development model. Data were collected through observation, interviews, and questionnaires, and both qualitative and quantitative analyses were conducted. Product testing involved assessments by material experts, media experts, and 31 students. The study's outcomes resulted in the creation of learning media in the form of audiobooks accessible through various devices. The media's feasibility was evaluated by experts in the field, including material experts, media experts, and Indonesian language teachers, as well as through a field trial with 31 students. Expert validation indicated a high level of appropriateness, with a 97% approval rate for material validation and a 94.29% approval rate for learning media validation. Based on this comprehensive assessment, it can be concluded that the novel under development is well-suited as a medium for enhancing media literacy in science, specifically in teaching physics with a focus on the photoelectric effect.

Keywords: media science literacy, novel, photoelectricity, physics learning

INTRODUCTION

Physics learning which fosters students' scientific literacy requires the right media, teacher should bringing new media into the science classroom (Brakhage 2023). Selection of appropriate learning media can support students' motivation and creativity in learning (Hidayat 2022). Presentation of physics learning regarding photoelectricity that supports scientific literacy is a necessity for students in third-grade high school. However, based on a needs analysis in third-grade high school, novel learning media had never been used because relevant novels were difficult to find. The low reading interest of students in learning Physics also causes student learning outcomes to be less than optimal (Santayasa, Rapi and Sara 2020). The reason students are lazy to read Physics textbooks is because the variety of language used is not attractive and does not motivate students.

In addition, students need to know the other side of photoelectricity, namely Hallwachs to inspire students to study physics about photoelectricity (Wheaton 2009). Hallwachs is a physicist from Germany who can motivate students because they have done research without giving up (and this also applies to all scientists). Hallwachs researched and correctly interpreted the photoelectric effect.

Hallwachs graduated from the University of Leipzig, Germany and became a professor of physics at the University of Dresden and the University of Giessen. Originating from his interest in this research after discovering in 1877 Hertz's work that when UV light striking the cathode provided a jump of an electric spark between the electrodes of the cathode ray tube, Hallwachs investigated the phenomenon (Permana et al. 2021). A year later, Hallwachs found that the effect also manifests itself in the light of increased energy, that is, with high-frequency electromagnetic radiation (Marrara 2021). It is appropriate to give a correct description of the photoelectric effect as the discharge of electricity from a negatively charged metal object when it is struck by electromagnetic radiation. Other researchers of the time, such as Lenard and Stoletov, came to the same conclusion. Albert Einstein was finally able to provide an explanation of causation in 1905, using Planck's very new Quantum Theory.

Unfortunately this motivating story is not presented. The results of the needs analysis yield information that students feel bored, lack concentration, and it is difficult if learning only focuses on the knowledge that is conveyed directly. On the other hand, this high school student has a high interest in reading novels (Nuridayu, Elfitra and Pujiastuti 2021). This shows that there is a need for students towards novels as a medium for scientific literacy. Research in the last 10 years is integrating physics and literacy learning in physics subjects, not only for students, but even for prospective teachers (van Zee et al. 2013). This is done because the ability to listen carefully, speak clearly, write coherently, read with understanding, and to create and present media in the context of science is essential for effective science teaching. So that teachers must also be equipped with the ability to teach physics and literacy who are proficient. After completing the research, several teacher candidates had new views about teaching physics and linked it to improving students' literacy skills. One of them is by considering the use of teaching media.

The presence of learning media facilitates the presentation of educational material, offering a tangible and consistent learning experience for students. In the context of teaching in the digital age, it is imperative for educators to adeptly develop learning media (Myers and Adams-Budde 2017). Learning media serves as a powerful tool to overcome spatial, temporal, and sensory limitations, enabling students to grasp complex concepts that may be challenging to convey directly (Kallunki et al. 2023).

Additionally, learning media holds the potential to capture students' attention and foster interest in learning. In the current educational landscape, there is a plethora of learning media options that can be tailored to meet the specific needs and characteristics of students. Some learning media even allows students to engage independently. Utilizing such resources, teachers can effectively convey challenging material, thereby increasing their own teaching enthusiasm. It is with this rationale that we aim to develop teaching media in the form of novels, envisioning an enhancement in students' literacy skills. Furthermore, considering students' intrinsic interest in reading novels, we aspire that the developed novels will not only cultivate an appreciation for physics but also alleviate potential boredom associated with studying the subject.

METHODS

Research and development methods have various development models. The development model that will be used by our team is the ADDIE model (Indrasari, Budi and Fadilla 2022). This model consists of five steps, namely: (1) analyze (analysis), (2) design (design), (3) development (development) (4) implementation (implementation), (5) evaluation (evaluation). The first stage in the ADDIE model is the analysis stage. The analysis stage is the stage where the we conducts initial analysis, such as problem analysis or needs analysis, curriculum analysis and so on. The second stage is design, at this stage the design of the product to be developed is carried out. The third stage is the development stage, namely realizing the development plan that has been made previously into a real product which is then tested for product validity to experts. The fourth stage is implementation. Products that have been validated are then implemented in the learning process, by conducting trials on students. In the ADDIE model, evaluation is carried out at each stage of the ADDIE model and this step is also a step for making final improvements to the product being developed shown in FIGURE 1 and finally, the we submitted the ISBN for the novel book being developed.

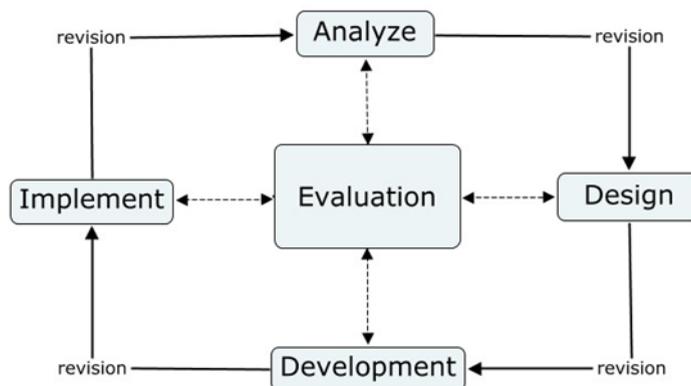


FIGURE 1. ADDIE model instructional design

Data collection techniques used by our team in developing audiobook learning media based on this scientific approach are observation, interviews, and questionnaires. Observations and interviews were carried out to collect initial data, namely to conduct a needs analysis. We observed online learning carried out in third-grade high school, the learning media used by the teacher, and students' attitudes in accepting learning. We also conducted interviews with third-grade high school teachers to find out how learning was at school.

In collecting data, We need measuring instruments in conducting research and development, namely in the form of data collection instruments. The data collection instrument used by the our team was in the form of an interview guide sheet for the analysis of the needs of high school teachers and a questionnaire sheet. The questionnaire was used by our team for the expert validation stage and the audiobook trial stage. The questionnaire for the expert validation stage (expert review), namely learning media experts, material experts, and Indonesian language teachers uses a rating scale. With a rating scale, the raw data obtained in the form of numbers will be interpreted in a qualitative sense. We interprets the raw data in the form of numbers to mean that (1) is not very good, (2) is not good, (3) is good enough, (4) is good, and (5) is very good. Quantitative data that has been processed will later be interpreted into proportions and levels of feasibility shown in TABLE 1. Product trials on students, We conducted small group tests with a total of 31 students (small group evaluation). Product trials for research students also used an interview.

TABLE 1. Assessment of Material Experts (Astra et al. 2023)

Score	Interpretation
81% - 100%	Very Appropriate
61% - 80%	Appropriate
41%-60%	Appropriate Enough
21%-40%	Less Appropriate
1%-20%	Not Feasible

RESULTS AND DISCUSSION

At the analyzing stage carried out by the researcher, namely analyzing teacher needs, analyzing student needs, and analyzing basic competencies. The results of the analysis of students' needs yielded information that students felt bored, lacked concentration, and found it difficult during the learning process of photoelectric material physics with novel media. The results of the analysis of teacher needs show that teachers in schools currently still use the Independent Curriculum as a guideline for developing learning tools. The deficiency in the method used by the teacher is when looking for learning media for photoelectric physics. One of the deficiencies in the learning method is scientific literacy which cannot be presented in class (Suroso and Mudakir 2021).

We also observing since February 2023. Based on the observations obtained in the learning process, the teacher has not utilized novel learning media that can develop students' scientific literacy to the fullest. The media that has been used so far is only Physics textbooks, this media is not varied and less effective (Kadic et al. 2019). Students tend to get bored and not conducive when the teacher explains the material using the lecture method based on the textbook (Puspitarini and Hanif 2019).

To complete the analysis of learning media needs data for students in listening to science fiction novels in the form of audiobooks which are the focus of the research, we conducted interviews with teachers and 10 students as well as basic competency analysis which was carried out in February 2023. The following are the findings of the analysis of teacher needs, analysis of student needs based on interview results, and analysis of basic competencies that have been summarized by researchers. Teachers use the Independent Curriculum as a guideline for developing learning tools. The deficiency in the method used by the teacher is when looking for novel media that develops scientific literacy which cannot be presented in class using other media. The limitation of this learning media is one of the teacher's difficulties in the learning process, teachers usually only rely on Physics textbooks to increase scientific literacy. Students need learning media in the form of novels that are interesting in content, format, and variety of languages.

Based on the results of the data collection, we planned to make this novel media by determining the material according to the Achievements of Physics Learning Phase F for third-grade of high school. At this stage, the design of the teaching materials to be made is carried out. This Design Stage contains a PDF novel design shown in FIGURE 2. The developed novel consists of six parts, namely four main chapters, Hallwachs memoirs, and author and editor biodata. The titles of each chapter are as follows: Chapter 1 Falling in Love, Chapter 2 Experiments, Chapter 3 Spreading Miracles, and Chapter 4 Visits.

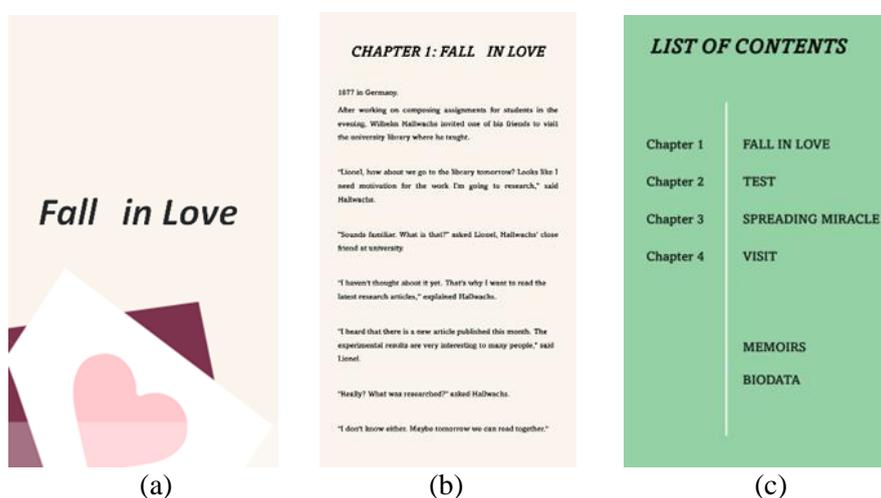


FIGURE 2. (a) Cover of a chapter of the novel “Jatuh Cinta”, (b) One page of the contents of the novel from the chapter of “Jatuh Cinta”, (c) Table of contents page

The next step after becoming a PDF, the product is validated by material experts, media experts, and Indonesian language teachers. The expert validation consists of material expert validation and media validation. The material expert validation stage regarding novel learning media by the Literature Lecturer, The assessment instrument totals twenty points in three indicators, the assessment with a score range of 1-5. The aspects assessed are presentation aspects, content aspects, and scientific approach aspects. TABLE 2 is the results of the assessment from material experts in the form of quantitative data. See the full question items presented in Appendix 1.

TABLE 2. Assessment of Material Experts

No	Indicator evaluation	Average score	Percentage (%)	Criteria
1	Presentation aspect	4.75	95	Very Appropriate
2	Content aspect	5	100	Very Appropriate
3	Scientific approach aspect	4.8	96	Very Appropriate
	Average Score	4.85	97	Very Appropriate

Based on TABLE 2 the observations made by the material experts reached 97% overall. Thus it can be said according to the product criteria table that the total score obtained is included in the very appropriate criteria. As for qualitative data by material experts, namely in the form of comments or responses regarding novel products containing material that is considered very good because it can increase student motivation and enthusiasm for learning. In addition, the novels chosen by researchers

in research are also very rare because they have the theme of science and science that help students gain knowledge. Presenting scientific knowledge in the form of a novel is currently a trend in book development, aimed at fostering the interest of young audiences in science as they grow up (Gailey 2020).

The media expert validation stage regarding Novel learning media by the Physics Lecturer. The assessment instrument consists of 25 items in two indicators, scoring with a score range of 1-5. The aspects that are assessed are presentation aspects and graphical aspects. TABLE 3 is the results of the assessment from media experts in the form of quantitative data. See the full question items presented in Appendix 2.

TABLE 3. Assessment of Media Experts

No	Indicator evaluation	Average score	Percentage (%)	Criteria
1	Presentation aspect	5	100	Very Appropriate
2	Graphic aspect	4.43	88.57	Very Appropriate
	Average Score	4.72	94.29	Very Appropriate

Based on TABLE 3, the observations made by material experts reached 94.29% overall. So thus it can be said according to the product criteria table that the total score obtained is included in the very appropriate criteria. As for qualitative data by media experts, namely in the form of comments or responses about the novel that already contains material that is considered very good because from a graphical aspect, many colors and images are considered attractive so that it attracts students' interest to see, read, and understand photoelectric material. The development of learning media at this stage was validated by a third-grade high school physics teacher. As for the qualitative data by the Physics teacher, namely in the form of comments or responses regarding the Science Fiction Prose Audiobook product, it can help the learning process of listening to novel texts because it attracts and motivates students. Apart from that, with the Audiobook, learning is no longer boring because students can listen to audio and see pictures as well as writing contained in the novel.

At this stage implementation is carried out. After carrying out the development stage, the product is tested. Trials were conducted to find out student responses or responses to learning media. The results of the qualitative obtained based on student responses totaling 31 students of third class of high school in the form of comments or student responses regarding the novel product is in Appendix 3. In the general, the evaluation stage is carried out in all stages (FIGURE 1). After the implementation researcher evaluates again. The evaluation stage is the final stage in product development. After passing through the analysis, design, development, and implementation stages, it enters the evaluation stage. Based on the results of the previous stage it can be said that novel learning media is feasible to use. The learning media contains material on the nature and linguistic elements of the text of the novel, steps for compiling a novel, a science fiction novel entitled *The Hallwachs Miracle*.

To compare the impact of reading materials related to the Photoelectric Effect on high school students, specifically comparing traditional physics textbooks with a novel we developed. Our analysis focused on the examination of physics textbooks for high school grades one, two, and three in Indonesia. The findings revealed a predominant emphasis on cognitive aspects over epistemic, affective, and sociocultural aspects in these textbooks. While the nature of science was underscored, the textbooks leaned towards portraying science primarily as a cognitive-epistemic system (Halawa, Hsu and Zhang 2023).

Moreover, our investigation highlighted a preference for structured investigations over guided and confirmed inquiries. Notably, structured inquiry in the three textbooks prioritized inquiry skills rather than inquiry understanding. Conversely, observing and communicating skills were given more prominence in physics activities (Dogan 2021). These findings align with the outcomes of a needs analysis, indicating that physics students perceive the subject as challenging and unengaging. The existing textbooks also lack consistent features that could make the content more supportive, accessible, and intriguing, such as narrative elements, descriptions, and scene details (Eutsler 2021). Given that our novel, though a type of book, differs by providing an audiobook version, we aspire for it to serve as an innovative teaching media that addresses the identified shortcomings. We anticipate that this novel will contribute to enhancing scientific literacy skills, especially those pertaining to physics, offering a valuable alternative to traditional textbooks.

CONCLUSION

Based on the validation results, this novel is said to be suitable for use as teaching material. The Hallwachs Miracle novel learning media can be used in Physics learning about photoelectricity so students don't feel bored with textbooks that use a variety of scientific languages in presenting their knowledge. At the same time, this media also fosters scientific literacy because students find this novel interesting and inspiring. With this learning media, the material presented is more interesting and flexible with language style novels as a form of literary work. The suggestion for the future is that it is necessary to conduct further classroom action research related to increasing scientific literacy, especially on the topic of the photoelectric effect. The treatment that was carried out was to give an experimental class to this novel book. Currently this novel has also been published with ISBN number 978-623-6063-69-9.

REFERENCES

- Astra, IM, Tumijan, P, Uskenat, K & Henukh, A 2023, 'The Development of STEM-Based Science Teaching Materials on Simple Electrical Circuit Materials', *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, vol. 9, no. 1, pp. 127-138, doi: 10.21009/1.09112.
- Brakhage, H, Gröschner, A, Gläser-Zikuda, M et al. 2023, 'Fostering Students' Situational Interest in Physics: Results from a Classroom-Based Intervention Study', *Research in Science Education*, vol. 53, no. 5, pp. 993-1008, <https://doi.org/10.1007/s11165-023-10120-x>.
- Dogan, OK 2021, 'Methodological? Or dialectical?: Reflections of scientific inquiry in biology textbooks', *International Journal of Science and Mathematics Education*, vol. 19, no. 8, pp. 1563-1585.
- Eutsler, L 2021, 'Making Space for Visual Literacy in Literacy Teacher Preparation: Preservice Teachers Coding to Design Digital Books', *TechTrends*, vol. 65, no. 5, pp. 833-846, <https://doi.org/10.1007/s11528-021-00629-1>.
- Gailey, CD 2020, 'Newtonian and Quantum Physics for Babies: A Quirky Gimmick for Adults or Pre-science for Toddlers?', *Translating and transmediating children's literature*, pp. 319-332.
- Halawa, S, Hsu, YS & Zhang, WX 2023, 'Analysis of Physics Textbooks Through the Lens of Inquiry Practices', *Asia-Pacific Education Research*, vol. 32, pp. 497-506, <https://doi.org/10.1007/s40299-022-00671-4>.
- Hidayat, A 2022, 'SECTIONS Model Analysis for Pre-Service English Teachers' Media Selection in Pandemic COVID-19', *International Journal of Instruction*, vol. 15, no. 3, pp. 599-610.
- Indrasari, W, Budi, AS & Fadilla, DP 2022, 'The Development of Educational Aids for Restitution Coefficient Experiment Using Microcontroller', *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, vol. 8, no. 1, pp. 95-104, doi: 10.21009/1.08109.
- Kadic, M, Milton, GW, Van Hecke, M & Wegener, M 2019, '3D metamaterials', *Nature Reviews Physics*, vol. 1, no. 3, pp. 198-210.
- Kallunki, V, Katajavuori, N, Kinnunen, P et al. 2023, 'Comparison of voluntary and forced digital leaps in higher education - Teachers' experiences of the added value of using digital tools in teaching and learning', *Education and Information Technologies*, pp. 1-26, <https://doi.org/10.1007/s10639-022-11559-7>.
- Marrara, S, Semprebello, A & Vasi, S 2021, 'Physical and historical principles of ionizing radiations with the flipped classroom method', *Atti della Accademia Peloritana dei Pericolanti-Classe di Scienze Fisiche, Matematiche e Naturali*, vol. 99, p. 38.
- Myers, J, Adams-Budde, M 2017, 'Teaching literacy in the digital age: Inspiration for all levels and literacies', *International Society for Technology in Education, Eugene, OR*, vol. 63, pp. 769-772, <https://doi.org/10.1007/s11159-017-9649-y>.

- Nuridayu, N, Elfitra, L & Pujiastuti, I 2021, 'Minat Baca Siswa Kelas XI SMA Negeri 2 Tanjungpinang Tahun Pelajaran 2020/2021', *Student Online Journal (SOJ) UMRAH-Keguruan dan Ilmu Pendidikan*, vol. 2, no. 1, pp. 115-119.
- Permana, H, Purwahida, R, Mulyati, D, Rahmadini, D, Ambarwulan, D & Siswoyo, S 2021, 'Hallwachs and the negatively charged particles'-the development of education comics', *Physics Education*, vol. 56, no. 5, p. 055038.
- Puspitarini, YD & Hanif, M 2019, 'Using Learning Media to Increase Learning Motivation in Elementary School', *Anatolian Journal of Education*, vol. 4, no. 2, pp. 53-60.
- Santyasa, IW, Rapi, NK & Sara, I 2020, 'Project based learning and academic procrastination of students in learning physics', *International Journal of instruction*, vol. 13, no. 1, pp. 489-508.
- Suroso, J & Mudakir, I 2021, 'Profile of high school students science literacy in east java', *In Journal of Physics: Conference Series*, vol. 1832, no. 1, p. 012040.
- van Zee, EH, Jansen, H, Winograd, K et al. 2013, 'Integrating Physics and Literacy Learning in a Physics Course for Prospective Elementary and Middle School Teachers', *Journal of Science Teacher Education*, vol. 24, no. 4, pp. 665-691, <https://doi.org/10.1007/s10972-012-9323-y>.
- Wheaton, BR 2009, 'Photoelectric effect', *In Compendium of Quantum Physics*, Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 472-475.

Appendix 1. Question for Material Experts

No	Question
Presentation aspect	
1.	Material in the novel is presented with Systematic
2.	Learning in the novel is centered on Learners
3.	Novels develop skills Process
4.	The novel consists of an opening and a part Closing
Graphic aspect	
5.	The material in the novel corresponds to Learning Access
6.	The material in the novel is in accordance with the Basic Competency
7.	Material equipment
8.	Material breadth
9.	Material depth
10.	Accuracy of concepts and definitions in the Novel
11.	The accuracy of the pictures and illustrations in the Novel
12.	The accuracy of the video in the novel
13.	Learning support materials in accordance with the development of science and technology
14.	Up-to-date pictures, illustrations and videos
15.	Material attractiveness
Scientific approach aspect	
16.	Novels develop the skill of Observing
17.	Novel develops the skill of Asking
18.	Novels develop information gathering skills
19.	Novels develop Association skills
20.	Novels develop Communicating skills

Appendix 2. Question for Material Experts

No	Question
Presentation aspect	
1.	The novel is presented systematically
2.	Novels are easy to access/use
3.	Medium clarity
4.	The novel consists of easy-to-understand chapters
Graphic aspect	
5.	Suitability of the size of the novel with the standard ISO
6.	Appropriateness of the size with the contents of the novel
7.	The appearance of the layout elements on the front cover, inside and back of the novel harmoniously has a rhythm and unit as well Consistent
8.	Appearance of the center of the field (center point) on novel covers
9.	The composition and size of layout elements (titles, authors, illustrations, logos, etc.) are proportional, balanced and in tune with the content layout (according to pattern)
10.	The color of the elements of the layout is harmonious and clarify specific functions
11.	Placing consistent layout elements within one series
12.	Typography (font, font size, font color) on an attractive cover, easy to read and proportional
13.	The novel describes the content/material and reveal the character of the object
14.	The shape, color, size, proportions of objects are appropriate reality
15.	The placement of layout elements is consistent pattern based
16.	The separator between paragraphs is clear
17.	Don't use too many fonts
18.	Use of letter variations (bold, italic, all capital, and small capital) is not excessive
19.	Normal spacing between letters and between lines
20.	Fields (electronic screens) and margins Proportional
21.	Side-by-side margins Proportional
22.	Spacing between text, illustrations, pictures and novels in accordance
23.	Titles, subtitles and page numbers are clear
24.	Illustrations and captions are clear
25.	Exciting illustrations, drawings and novels

Appendix 3. Students Comments or Suggestion

No	Student's initials	Student response
1.	Student 1	I am helped to understand the lesson with this learning media
2.	Student 2	So happy with photoelectric because this novel conveys it lightly
3.	Student 3	This novel is very good and very interesting for me Study.
4.	Student 4	I think this is a science fiction novel that makes me more comfortable studying Physics
5.	Student 5	Because of this novel, I am even more inspired by Hallwachs intelligence
6.	Student 6	Very useful for me
7.	Student 7	Very nice and creative
8.	Student 8	Good and hopefully there will be a sequel
9.	Student 9	Very good, it suits me
10.	Student 10	I want the next novel like this
11.	Student 11	Oke helped me learn photoelectric
12.	Student 12	Very interesting and inspiring
13.	Student 13	I like. I like.
14.	Student 14	Very good novel. Unique.
15.	Student 15	Very interesting and beneficial.
16.	Student 16	I was greatly helped by the medium of this novel.
17.	Student 17	I love the novel.
18.	Student 18	I find it interesting and unique.
19.	Student 19	Love. Love. Love.
20.	Student 20	I do, Novels about science and this is very inspiring.
21.	Student 21	Very good.
22.	Student 22	Very good. I like.
23.	Student 23	Very unique and inspiring.
24.	Student 24	Really good.
25.	Student 25	Very helpful. I like studying Physics more and more.
26.	Student 26	Wow. Very cool novel.
27.	Student 27	Extraordinary
28.	Student 28	Extraordinary.
29.	Student 29	A very unique and useful novel.
30.	Student 30	Amazing.
31.	Student 31	Extraordinary.

