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Original Research Article

Assessing the Readability of Renewable Energy Education Material from Geothermal Resources in Vocational High School Textbooks: A Case Study in Indonesia

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ABSTRACT

The transition to renewable energy is hindered by the level of acceptance in society. The role of education in schools is crucial, and while numerous studies have been conducted, there is still a lack of exploration into the depth of the materials. This research was carried out to assess the readability level of material on renewable energy from geothermal resources in Vocational High School textbooks. The descriptive quantitative method was used, conducted in 19 Vocational High School with a study program in Technology and Engineering in Surakarta. The sample size was 340 respondents. Data were collected from textbooks and questionnaire results. The Gunning Fog Index scores indicated the material had low readability level with scores of 20, 18, and 21 for texts 1, 2, and 3. Text 1 is taken from book titled 'Energy Conversion Machines', Text 2 from 'Sustainable Energy Saving through Building', and Text 3 from 'Basic Knowledge of Mechanical Engineering. Additionally, the responses of readers indicated that more than 50% of respondents could easily comprehend the content in texts 2 and 3. Resulting, for text 1, over 50% of respondents reported understanding the content with some difficulty. These three books are also commonly used, making this research a valuable recommendation for stakeholders in curriculum design and educational planning.

KEYWORDS

Readability, Textbooks, Geothermal, Renewable energy, Vocational high school.

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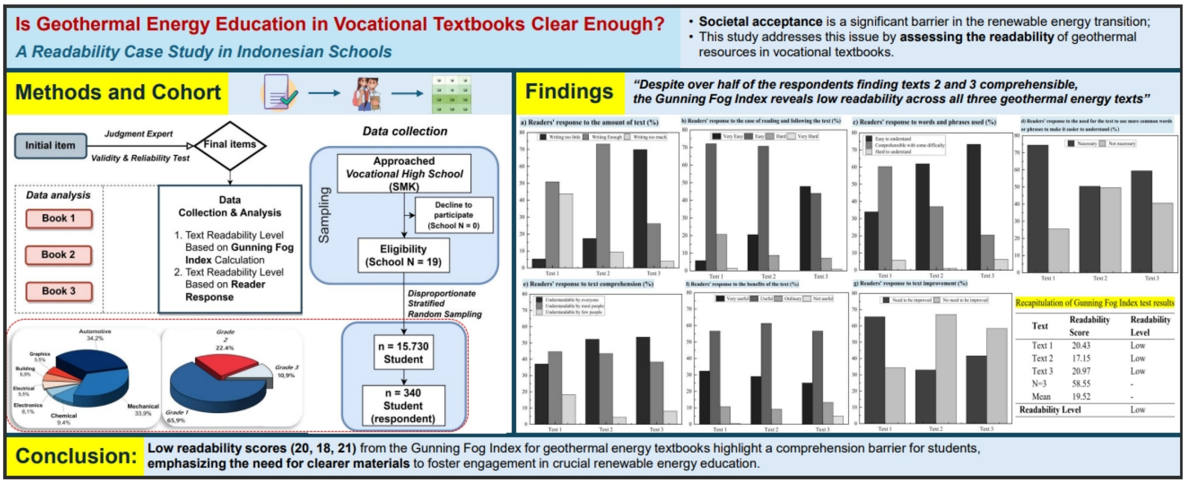
GRAPHICAL ABSTRACT



INTRODUCTION

Energy consumption increases yearly due to population growth, development, and infrastructure expansion. Historically, global energy demands have been met by converting fossil resources into various forms of energy, including mechanical, electrical, and thermal. However, the depletion of fossil reserves occurs much faster than their formation, leading to a growing disparity between energy supply and demand. The increase in energy consumption is primarily driven by the undergoing sustained and substantial economic growth in developed and developing countries. In addition, global energy consumption was projected to rise by 28% between 2015 and 2040, with fossil fuels expected to remain the dominant source, accounting for 80% of the world's energy supply during this period [1].

Indonesia heavily depends on fossil energy, mainly crude oil, to fulfill its domestic needs. In 2022, the country's total energy consumption amounted to 1185.56 million barrels of oil equivalent (BOE), with crude oil, gas, and coal contributing 40.30%, 6.29%, and 25.24%, respectively [2], [3]. Relying heavily on fossil fuels raises worries about the future, suggesting a possible crisis due to sustainability challenges linked to ongoing dependence on finite resources.

In 2022, the national reserves of fossil energy, comprising crude oil, natural gas, and coal, stand at 568.55, 1370.75, and 222.72 million tonnes of oil equivalent (MTOE), respectively. With the current crude oil production rate of 30.03 MTOE, it is anticipated that oil reserves will be depleted in less than 19 years. Natural gas reserves, with a production rate of 59 MTOE, are expected to be exhausted within 23 years. Meanwhile, coal reserves, with a production rate of approximately 4.58 MTOE, are projected to run out in 49 years [3], [4].

Natural gas, such as fossil energy poses a crisis and significantly contributes to the rise in CO_2 emissions. This increase is closely linked to global warming, climate change, and environmental degradation, presenting considerable challenges for future generations. Consequently, numerous countries are actively developing carbon-neutral initiatives and implementing other measures to reduce CO_2 emissions [5]. In 2017, 32 countries signed the Carbon Neutrality Coalition (2019), while the UN Climate Action Summit announced their intention to achieve global net-zero emissions in the same year [6]. International organizations, governments, and companies also openly express their desire to achieve carbon neutrality or adopt climate-positive actions. Therefore, renewable energy is a potential solution as they offer abundant and environmentally friendly energy.

Indonesia possesses abundant renewable energy such as bioethanol (as a substitute for gasoline), biodiesel (as a substitute for diesel), geothermal, micro-hydro, solar, and wind power, including waste for electricity generation. However, the development and utilization of renewable energy resources in the country have not been fully optimized. The realization of

Indonesia's abundant renewable energy potential faces several challenges, including high investment costs, relatively low technological efficiency, diverse resource locations, and social factors within communities that impact energy utilization [7], [8].

Geothermal, a highly abundant and environmentally friendly renewable energy source in Indonesia, is significantly supported by the unique geographical location of the country within the most active tectonic boundaries of the Indo-Australian, Pacific, Philippine, and Eurasian plates. Despite its potential, geothermal, even as the sole source for meeting 100% of human energy needs, represents only a small fraction of the world's total energy resources. This natural resource plays a significant role in securing future sustainable energy due to its consistent availability and load factors that are independent of external sources. According to the Ministry of Energy and Mineral Resources, 40% of the global geothermal potential is concentrated in Indonesia, with only approximately 6% or 1924.5 MW being used. This indicates that the renewable energy potential is currently not being utilized optimally [9].

The common challenges associated with geothermal development in a country include government policies, regulations, human resources, and incentive infrastructure [10]. The suboptimal utilization of reneable energy potential was also attributed to various factors during its implementation, particularly social considerations within communities as energy users. Therefore, there is a recognized need for education to effectively address these challenges and use the untapped potential of geothermal energy.

The late 20th century experinced the inception of various national-level ecological organizations, formed in response to heightened environmental awareness [11]. These institutions have successfully promoted environmental awareness within communities [12]. In this context, Akerlof (2017) [13] stated three crucial factors that can enhance environmental awareness first, individual behaviour needs to be addressed with effective policy instruments. Second, policymaking organizations should be established based on democratic values. And third, there needs to be a direct focus on community-level values and education. In addition, Grossman and Krueger (1991) [14] stated that achieving higher levels of education contributes to increased environmental awareness, compelling policymakers to enact more effective policies.

According to preliminary studies, education plays an important role as an initial step in providing knowledge regarding renewable energy to the community. Education is a powerful agent of social change that can instil awareness of new developments among individuals [15]. Furthermore, education serves a crucial function by providing training and imparting the necessary skills. VHS are part of secondary education that prioritizes developing students' abilities to perform specific types of work. These schools are specifically designed to prepare students for the workforce, with the main aim of instilling a professional attitude as they enter their chosen fields.

Students are also provided with adequate knowledge about renewable energy through learning resources, with textbooks as a central medium. The mandatory reference books used in schools are intended to enhance various aspects of student's development, including faith, morality, character, knowledge and technology proficiency, aesthetic sensitivity and physical potential. However, the textbooks currently used by students tend to be theoretical, focusing on the understanding of subject-related theories. The success of learning is greatly influenced by the ability of students to comprehend the content presented in these textbooks.

One of the metrics used to measure the success or effectiveness of information communicated in a community is readability [16]. The success in question refers to the extent to which individuals understand and read at an optimal speed as well as consider the information interesting. The readability level plays a crucial role in influencing the abilities of students, be it high or low to understand the content of these textbooks [17]. Therefore, the higher readability of the textbooks will also have a good impact on public knowledge and the development of renewable energy in Indonesia. To further illustrate, this framework will be summarized in **Figure 1** as follows:

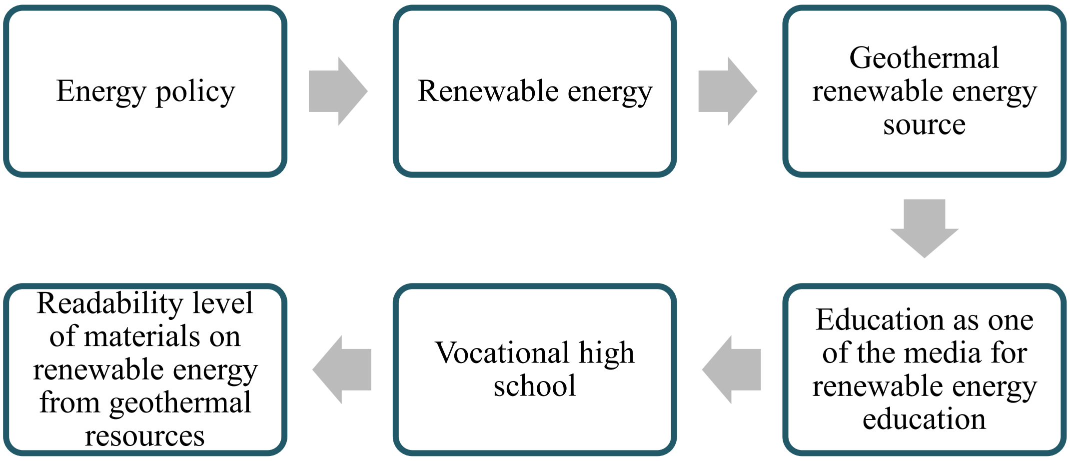


Figure 1. Research framework

Therefore, this research focuses on the readability level of materials on renewable energy from geothermal resources in Vocational High School textbooks in Indonesia.

State of Renewable Energy in Indonesia

The Indonesian government is actively promoting the gradual development of renewable energy as a substitute for fossil energy. To ensure optimal fulfilment of the energy needs in the subsequent decades, various regulations and tariff policies are consistently being implemented. Government Regulation Number 79/2014 on National Energy Policy [18], clearly stated the prioritization of renewable energy usage over fossil-based energy such as solar and coal. In the Electricity supply general plan for 2021 to 2030, the government has set ambitious targets. They aim to increase the contribution of renewable energy to the energy mix for electricity generation by 23% in 2025. This includes reducing reliance on crude oil to less than 25%, ensuring a minimum of 30% and 22% from coal, and natural gas in the total energy mix. Meanwhile, by 2050, the optimal energy mix target includes a minimum contribution of 31% from reneable energy, with less than 20% from crude oil, a minimum of 25% and 24% from coal, and natural gas, respectively in respect to economic needs fulfillment [19].

The term renewable energy refers to the transition from dependence on fossil energy to a scheme that uses sustainable resources [20]. This change serves as a crucial driver for the global transition towards sustainability [21], [22]. Renewable energy is sourced from sustainable resources properly managed, including geothermal, wind, bioenergy, sunlight, water flow and falls, as well as the movement and temperature differences in the ocean layers [23].

Renewable energy is environmentally friendly as they do not generate pollutants and are not contributors to climate change and global warming. The promotion of renewable energy consumption allows for the establishment of sustainable consumption and production patterns, avoiding long-term environmental issues [24]. This energy is derived from sustainable natural processes, and Indonesia, due to its significant astronomical and geographical influence, holds extensive potential for the resources. In general, Indonesia renewable energy potential is divided into solar, geothermal, hydro, wind, seawater, and bioenergy.

Several types of renewable resources exist, which are used to provide sustainable energy solutions and are likely to be dominant until 2050. Some of resources with the potential to fulfil energy needs sustainably include Solar energy, Geothermal energy, Hydro, Wind energy, biomass energy. Assessing the imminent possibilities of each renewable energy type requires understanding the factors influencing their future output. These factors comprise energy return on input, technical potential, land use implications, climate impact, and other environmental changes that affect their availability. It is also essential to evaluate the alternative effects of renewable energy production on the environment [25]. Indonesia has renewable energy as shown in **Table 1** as follows:

Table 1. Renewable energy resources in Indonesia [26]

No.	Energy Types	Resources	Potential (MW)	Installed Capacity
1	Geothermal	-	29,500	2,356 MW
2	Hydro	75,091 MW	94,600	6,100 MW
3	Mini-micro hydro	-	19,385	2,600.76 kW*
4	Biomass	32,654 MW_e*	43,300	1,900 MW
5	Solar	4.80 kWh/m^2/day***	2,898,000	200 MW
6	Offshore wind		589,000	-
7	Onshore wind		19,600	200 MW
8	Uranium	3,000 MW****	-	30 MW****
9	Shale gas	574 TSCF**** 93.36 TSCF*****	-	-
10	Coal methane gas	453 TSCF**** 84.29 TSCF*****	-	-
11	Sea waves	17,989 MW (Practical Potential)	17,900	-
12	Ocean Thermal	41,012 MW (Practical Potential)**		
13	Tides	4,800 MW (Practical Potential)**		

Source: [27]
*) [28]
***) [29]
****) [30]
*****) [31]

Based on the data in Table 1, some commonly used renewable energy types include biomass, hydro, wind, solar, and geothermal energy. Although other types have been discussed, these five are anticipated to remain dominant until 2050.

With a substantial potential of 29,500 MW, Indonesia is rich in geothermal energy. This form of energy is the natural heat originating from the Earth and the decay of radioactive elements transferred beneath the surface through conduction and convection. Geothermal energy is considered renewable as the extracted energy originates from the Earth.

Geothermal energy is widely used by various countries for electricity generation, with a total global capacity of 16,127 MW as shown in Table 2. The United States leads in geothermal energy usage with 3,794 MW, followed by Indonesia (2,356 MW), the Philippines (1,935 MW), Turkey (1,682 MW), New Zealand (1,037 MW), Mexico (963 MW), Italy (944 MW), Kenya (944 MW), Iceland (754 MW), Japan (621 MW), and others (1,097 MW). Top geothermal countries can be listed in Table 2 as follows:

Table 2. Top geothermal countries by the end of 2022 [32]

No.	Country	(MW)
1.	USA	3,794
2.	Indonesia	2,356
3.	Philippines	1,935
4.	Turkey	1,682
5.	New Zealand	1,037
6.	Mexico	963
7.	Italy	944
8.	Kenya	944
9.	Iceland	754
10.	Japan	621
11.	Others	1,097
Total		**16,127**

Table 1 shows that the substantial geothermal potential was estimated at 29,500 MW. This was attributed to the strategic location of Indonesia, within one of the most active tectonic frameworks globally, intersecting the Indo-Australian, Pacific, Philippine, and Eurasian tectonic plate boundaries. Geothermal is the heat stored within the Earth interior, consisting of rocks and fluids. Additionally, Indonesia is known for its geological features, particularly its volcanic regions, as it lies along the Ring of Fire. This volcanic belt stretches from the end of Sumatra through Java, Bali, NTT, and NTB towards the Banda Islands, Halmahera, and Sulawesi. However, the current utilization capacity of geothermal energy in the country remains relatively low, accounting for approximately 8% or 2,356 MW of the total potential. Geothermal power plant updates can be seen in **Table 3** as follows:

Table 3. Update on GPP in Indonesia [10]

Island	Location	GPP Name	Unit	Total Capacity (MW)
Java	Mount Salak, West Java	Mount Salak	Gunung Salak consist of: Units 1 (1994), 2 (1994), and 3 (1997) each have a capacity of 60 MW. Units 4, 5, and 6 started operating in 1997, each have a capacity of 65.6 MW.	376.8
	Kamojang, West Java	Kamojang	Kamojang consist of: Unit 1 (30 MW in 1982). Units 2 and 3 (1988), each have a capacity of 55 MW. Unit 4 (60 MW in 2008). Unit 5 (35 MW in 2015).	235
	Darajat, West Java	Darajat	Darajat consist of: Unit 1 (55 MW in 1994). Unit 2 (94 MW in 2000). Unit 3 (121 MW in 2007).	270
	Wayang Windu, West Java	Wayang Windu	Wayang Windu consist of: Unit 1 (110 MW in 2000). Unit 2 (117 MW in 2009).	227
	Patuha, West Java	Patuha	Patuha consist of: Unit 1 (55 MW in 2014).	55
	Karaha Bodas, West Java	Karaha	Karaha consist of: Unit 1 (30 MW in 2018).	30
	Dieng, Central Java	Dieng	Dieng consist of: Unit 1 (60 MW in 2002). Small Scale Dieng Unit (10 MW in 2020).	70
Sumatera	Sarulla, North Sumatera	Sarulla	Sarulla consist of: Units 1 and 2, which started operating in 2017, alongside 3 (in 2018), each have a capacity of 110 MW.	330
	Sibayak, North Sumatera	Sibayak	Sibayak consist of: Monoblok (2 MW in 1996). Units 1 and 2 started operating in 2008, each have a capacity of 5 MW.	12
	Sorik Marapi, North Sumatera	Sorik Merapi	Sorik Marapi consist of: Unit 1 (42.3 MW in 2019). Unit 2 (45 MW in 2021).	137.3

Island	Location	GPP Name	Unit	Total Capacity (MW)
			Unit 3 (50 MW in 2022).	
	Muara Laboh, West Sumatera	Muaralaboh	Muaralaboh consist of: Unit 1 (85 MW in 2019).	85
	Lumut Balai, South Sumatera	Lumut Balai	Lumut Balai consist of: Unit 1 (55 MW in 2019).	55
	Rantau Dedap, South Sumatera	Rantau Dedap	Rantau Dedap Phase 1 (98.4 MW in 2021).	98.4
	Ulubelu, Lampung	Ulubelu	Ulubelu consist of: Units 1 and 2 started operating in 2012, each have a capacity of of 55 MW. Units 3 (2016) and 4 (2017), each have a capacity of 55 MW.	220
East Nusa Tenggara	Mataloko, East Nusa Tenggara	Mataloko	Mataloko consist of: Unit 1 (2.5 MW in 2013).	2.5
	Ulumbu, East Nusa Tenggara	Ulumbu	Ulumbu consist of: Units 1 and 2 were operated in 2013, each have a capacity of 2.5 MW. Units 3 and 4, were operated in 2014, each have a capacity of 2.5 MW.	10
	Ende, East Nusa Tenggara	Sokoria	Sokoria consist of: Unit 1 (5 MW in 2022).	5
Sulawesi	Lahendong, North Sulawesi	Lahendong	Lahendong consist of: Units 1 (2001), 2 (2007), 3 (2009), 4 (2011), 5 and 6 (2016) each have a capacity of 20 MW.	120

Table 3 shows some of the existing GPP in the country until 2022. Several GPP have been established in various regions, including West and Central Java, North Sumatra, and Sulawesi, alongside East Nusa Tenggara.

Education is recognized as a means to introduce innovative ideas and empower individuals in the context of renewable energy. Through educational institutions, the upcoming generation can deeply comprehend these concepts and play a pivotal role in addressing the challenges posed by climate change. Research conducted by Ioannidis *et al.* (2023) **[33]** examines how people in Greece perceive renewable energy and the Circular Economy concept. It reveals that the willingness to pay more for renewable energy is influenced by one's level of education. Although there is some awareness of the Circular Economy among the Greek population, additional efforts are required to nurture the growth of this concept in the country. Thus, the connection between education, public awareness, and the acceptance of renewable energy is pivotal in facilitating the shift towards sustainable energy sources.

Meanwhile, research conducted by Dong *et al.* (2023) **[34]** determines the analysis of critical success factors for sustainable education in the recovery of green energy resources in China, Japan, and India. The findings reveal that these crucial factors differ across each country. In China, the key elements include green culture, international collaboration, and the learners' attitude. For Japan, success hinges on the learners' attitude, green culture, and support from government institutions related to the environment. Meanwhile, in India, critical factors encompass green culture, government support, and the attitude of teachers. Practical policy suggestions involve fostering international collaboration, leveraging electronic education, and raising awareness about sustainability through media and social networks.

Research by Daoudi (2024) [35] offers a thorough overview of renewable energy education in the Moroccan context and its importance in the 2030 Energy Transition Project. It explores various aspects, including the role of education in steering the energy transition, the specific target audiences of renewable energy education initiatives, teaching approaches, educational tools, and the necessary training for educators. The article underscores community involvement and awareness as pivotal factors in renewable energy education, along with an assessment of its impact on Morocco's progress toward Sustainable Development Goals (SDGs). Lastly, the article discusses future possibilities and potential advancements in renewable energy education, intending to provide valuable insights for further enhancement in Morocco.

METHODS

This research focuses on assessing the responses of readers to obtain readability scores from textbooks. A quantitative approach was adopted, specifically the Gunning Fox Index, developed for its common application in modern linguistics [36] the Gunning Fox Index measures the number of years of education needed to understand a text in a single reading, with a focus on sentence length and word complexity as the main indicators. Furthermore, the longer and more complex the text, the harder it is to comprehend. Data sources include textbooks and responses from VHS students in Indonesia. The selected books, namely Energy Conversion Machinery, Energy Conservation for Sustainable Environment through Building Design, and Basic Knowledge in Mechanical Engineering, each contain materials on renewable energy from geothermal resources.

For the technical evaluation of data, descriptive statistical analysis was used to describe the characteristics of the population. The main aim is to objectively depict the readability level of material on geothermal renewable energy in VHS textbooks used in Indonesia. The research systematically presents, describes, and explains the acquired data objectively. The acquired information was tabulated and evaluated quantitatively, with the analytical process conducted interactively and continuously throughout the investigation, from data collection to conclusion.

A combination of field investigations, literature reviews, and surveys were adopted to determine the population for distributing questionnaires. Specifically, the focus is on VHS in the technology and engineering program, with authorization from the Surakarta City Education Office.

Population and sample

The total population comprises 19 VHS, with a collective potential of 15,730 respondents. The sample size was determined using the Isaac and Michael sample size table with a 5% margin of error, resulting in 340 respondents. The selected sampling method is disproportionate stratified random sampling, which considers population stratification but does not strictly adhere to the proportions.

Data collection and analysis

The data collection method required closed-ended survey questionnaires to ensure focused and easily answerable responses from the respondents. These questionnaires are designed with questions relevant to the research theme. During the data collection process, the validity and reliability of the instruments were tested, and once verified, they were used to systematically collect data, which was then categorized based on predetermined criteria. In the analysis phase, questionnaire scores were calculated using specified indicators, while respondent answers were carefully recorded in the data processing document. Statistical insights were derived through the calculation of the frequency distribution of responses. The results of the variables are then explained descriptively, providing a comprehensive interpretation of the processed data. This systematic method ensures a comprehensive understanding of the collected data.

Research procedure

The research procedure is shown in **Figure 2** and includes a series of stages from initiation to completion. These stages are designed to facilitate the systematic collection and analysis of data. The planned activities are preparation, data collection, processing analysis, and presenting conclusions.

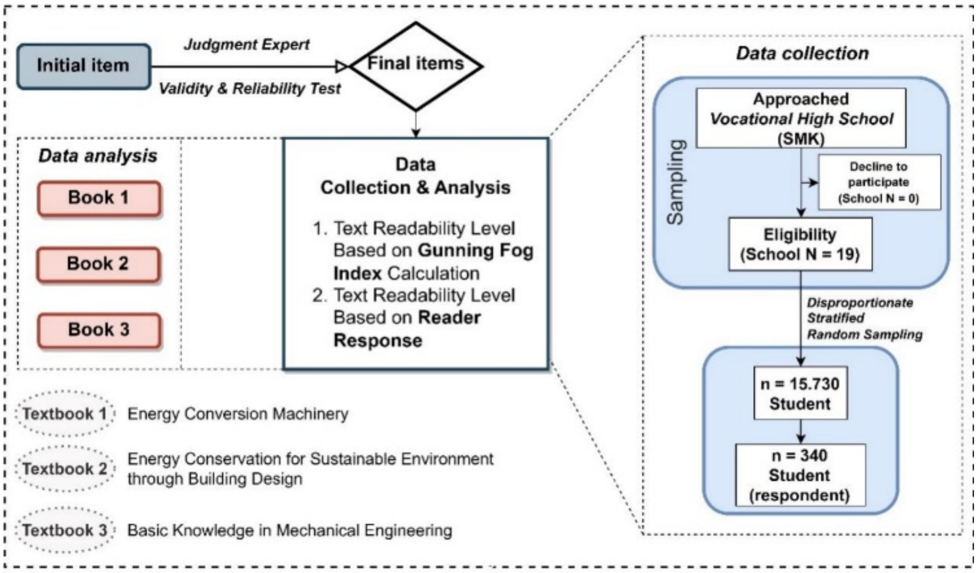


Figure 2. Data collection and analysis

The research started with the preparation stage, comprising schedule development, source reference searches, analysis and selection of textbooks in the school library, and identifying subtopics on geothermal energy. Subsequently, research instruments and strategies were developed, along with creating a proposal to be disseminated. The next phase is data collection, including instrument trials, validity and reliability tests, and information gathering. The data analysis and processing stage includes calculating questionnaire scores, data grouping, and providing descriptive explanations for each variable. Finally, conclusions and solutions were formulated based on the findings obtained throughout the investigation.

RESULTS AND DISCUSSION

In Surakarta, one of the states VHS conducted an observation on three textbooks that focus on the subject of renewable energy from geothermal resources. These books are titled Energy Conversion Machinery, Energy Conservation for Sustainable Environment through Building Design, and Basic Knowledge in Mechanical Engineering (alternatively known as Basic Knowledge of Mechanical Engineering). The selection of these three books was considered due to their widespread and long-standing use in various schools and their coverage of geothermal discussions.

The present research relies on two primary data sources, namely the Gunning Fog Index and the readers response. The assessment of readability using the Gunning Fog Index was performed through internet-based tools and manual calculations using specific formulas. Meanwhile, reader's responses were assessed through the distribution of questionnaires using readability instruments tested and applied in previous research. Before completing the questionnaires, students were instructed to read the provided texts in line with the research objective, which is to understand readers responses to the textbook content. A relevant prior investigation conducted by Biddinika MK *et al.* (2017) entitled "survey on readability of online information for upgrading understandability of biomass energy technology" **[37]** and similar research by Yuliani Fitri on "the readability analysis of Indonesian language and literature textbooks based on the curriculum 2006 for grade VII/1 in junior high schools" are taken into consideration [38]. The percentage of respondents can be seen in Figure 3 as follows:

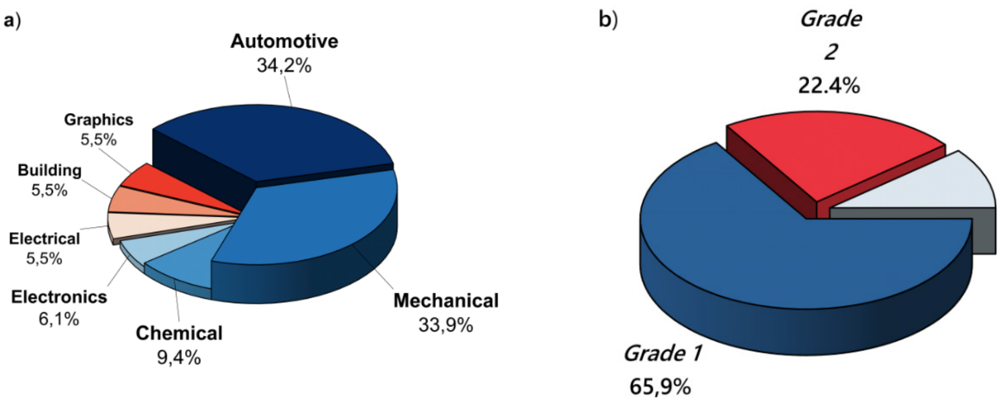


Figure 3. Percentage of participants in: a) study program and b) their grades in SMK

Based on Figure 3 (a), the respondents are VHS students specializing in various engineering fields, namely Mechanical Engineering (33.9%), Electronics Engineering (6.1%), Electrical Engineering (5.5%), Building Engineering (5.5%), Graphic Engineering (5.5%), and Chemical Engineering (9.4%). Figure 3 (b) shows the grade levels of the respondents, with the majority in Grade X (65.9%), followed by XI (22.4%) and XII (10.9%).

Readability levels based on Gunning Fog Index calculation and readers response

There are two main approaches to assessing the readability level of a discourse or text, namely readability formulas and readers responses. An examination of readers responses helps identify the factors influencing the readability level of the discourse or text.

Generally, the readability level of Vocational High School textbooks which contain material about renewable energy from geothermal sources can be calculated using the Gunning Fog Score formula as follows:

$$0.4 \text{ x } [\left(\frac{\text{total words}}{\text{total sentences}}\right) + 100 \left(\frac{\text{complex words}}{\text{total words}}\right)]$$

Apart from calculating manually using the formula above, GFI can also be found via the internet network or the official website of the Gunning Fog Index, at the address http://gunning-fog-index.com/index.html. The resulting score is then compared with the fog index scoring standard.

In accordance with Table 4, the Gunning Fog Index calculations focus on distinct readability levels for the evaluated texts. Text 1, with a readability index of 20.43, signifies a low readability level or suggests difficulty in comprehension. Text 2 follows closely with a readability index of 17.15, indicating a similarly low readability level. Meanwhile, despite having fewer words, text 3 has a higher readability index of 20.97. These results suggested that the readability level of the discourse or text on renewable energy from geothermal resources in VHS textbooks is relatively low. It simply implies that the language used in the text is difficult to understand.

Table 4. Recapitulation of Gunning Fog Index test results

		Readability Level
Text 1	20.43	Low
Text 2	17.15	Low
Text 3	20.97	Low
N=3	58.55	-
Mean	19.52	-
Readability Level		**Low**

The observed low readability level attributed to word choice and sentence structure in the textbook is also revealed through readers responses obtained from questionnaires completed by the students. These responses focused on the challenges VHS students face in understanding complicated and complex word choices and sentence structures within the text. Readers' responses to the ease of reading and following the text can be seen in **Figure 4** as follows:

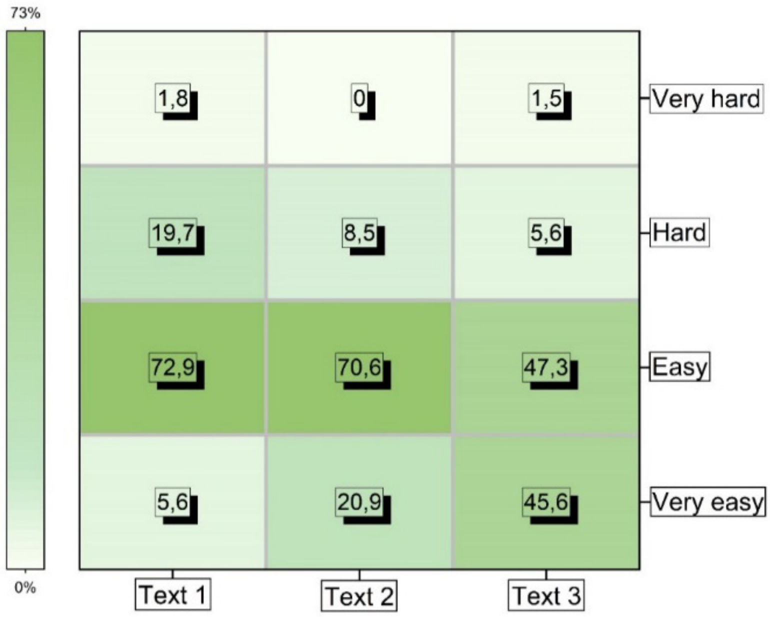


Figure 4. Readers' responses to the ease of reading and following the text (%)

The results of the questionnaire generally indicate a diverse level of student understanding. As shown in **Figure 4**, regarding text 1, 5.6% of students find the text easy to read, 72.9% consider it moderately easy, 19.7% find it difficult, and only 1.8% consider the text very difficult. With respect to text 2, 20.9% find it very easy, 70.6% find it easy, 8.5% find it difficult, and none (0%) find it very difficult. Meanwhile, for text 3, 45.6% find it very easy, 47.3% find it easy, 5.6% find it challenging, and only 1.5% find it very difficult. This pattern suggests that the textbook has a high readability level.

Readers' responses to words and phrases used can be seen in **Figure 5** as follows:

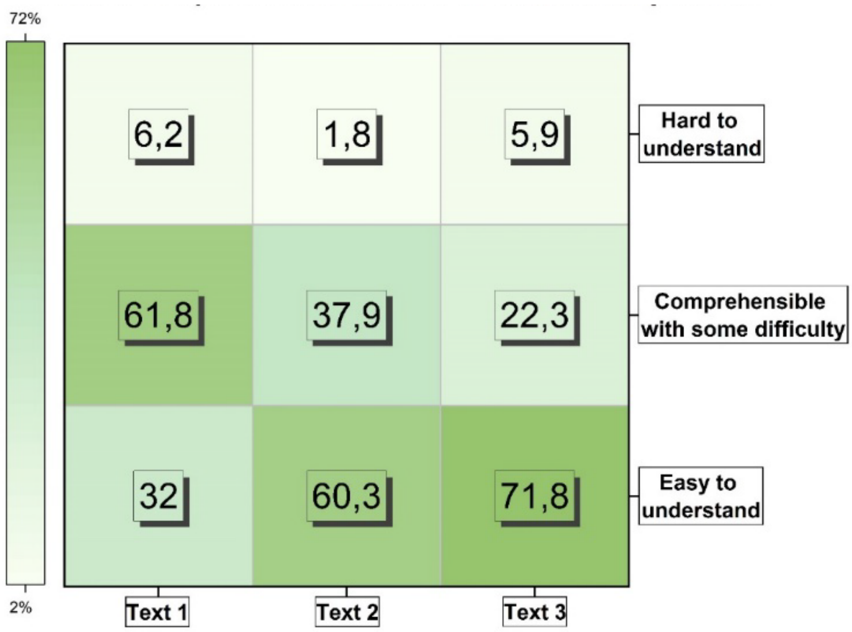


Figure 5. Reader's response to words and phrases used (%)

According to **Figure 5**, the majority of the students find Texts 2 and 3 easy to comprehend, with a frequency exceeding 50%. Meanwhile, for text 1, they found it easy to understand but with some difficulty, as indicated by the figure 61.8%. Readers' responses to the amount of texts can be seen in **Figure 6** as follows:

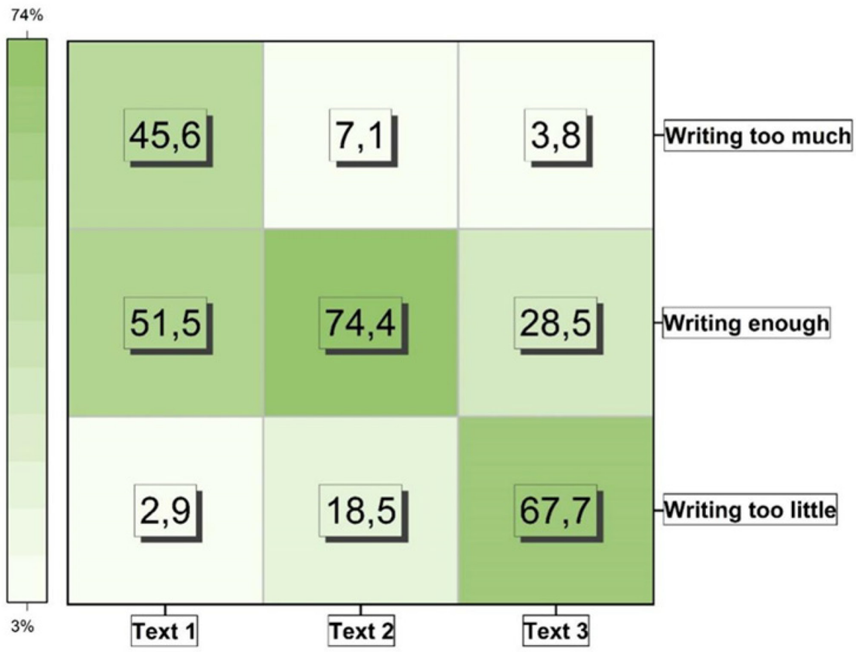


Figure 6. Readers' responses to the amount of texts (%)

Figure 6 shows that 45.6% of readers responses consider text 1 to contain too many texts, influencing students understanding of the content. This resulted in the majority of the students finding it difficult to comprehend the text. Meanwhile, the responses for texts 2 and 3 indicated that only 7.1% and 3.8% of readers had an issue with excessive text. These percentages are significantly lower compared to the corresponding value for Text 1.

This is in line with readers responses, as shown by **Figure 7**, where 68.5%, stated that Text 1 still needs improvement. Meanwhile, readers responses for Texts 2 and 3 still need improvement, as reported by 37.9% and 45.6% of the respondents, respectively.

The difference in the outcomes obtained using the Gunning Fog Index calculation and the questionnaire indicated that the test results are inconsistent with the experimental findings. Tests are generalizations or formulations of previous experimental results, while experiments represent real outcomes within the respondent group. This disparity introduced a new perspective, suggesting that word choices and sentence structures perceived as easy by students may not always be accurate. This phenomenon has long been observed in the Indonesian academic environment.

From the analysis of the three texts, the readability level of textbooks is significantly influenced by the choice of words and sentence structures used. Sentences characterized as easy are those with simple structures and do not contain complex or difficult words that might impede student comprehension. With a low vocabulary readability level, the selection of words in composing textbooks becomes one of the causes of the challenges encountered by the students during the learning process, arising from their lack of understanding of the presented material.

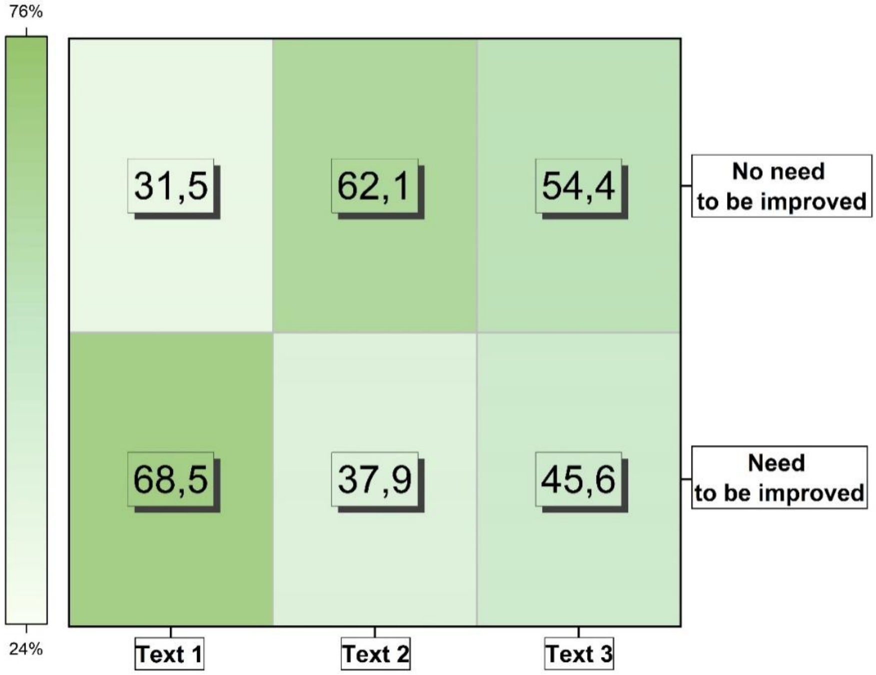


Figure 7. Readers' responses to text improvement (%)

Based on readers responses to texts 1, 2, and 3, all three had frequencies exceeding 50%, indicating the need for more common phrases or words for easier comprehension by SMK students. Therefore, when writing these textbooks, careful consideration should be given to the cognitive development of students. The choice of vocabulary used should not be unnecessarily complicated, and sentence structures need not be too long or short.

Textbooks play a crucial role in education, mainly concentrating on theoretical concepts to help students understand the subjects being delivered or fields of study. Despite this, there is an underutilization of EBT resources due to various constraints in its implementation. Given that students are integral members of the community and future energy consumers, it becomes imperative for education to equip them with the knowledge of effectively utilizing renewable energy. Education, a powerful agent of social change, can create awareness of new societal developments. Recognizing the impact of textbook content on students learning success, particularly in the Technology and Engineering fields, there is an urgent need to enhance the readability of materials on renewable energy. Presenting this content at a high readability level, ensures easy comprehension for VHS students, thereby contributing to their understanding and application of renewable energy concepts in future endeavours.

This research uses the Gunning Fog Index to determine the readability level of VHS textbooks on geothermal energy, as well as the analysis of readers responses.

Reader's responses to text 1

Examining **Figure 8** reveals insights from readers in chemical and graphic engineering programs, indicating concerns about the length of text 1. Specifically, 77% and 55.60% of respondents from these programs feel that the text contains excessive content. However, contrasting opinions arise from students offering other programs such as mechanical, automotive, construction, electronics, and electrical engineering, who find the length of the text to be appropriate. In terms of readability and comprehension, feedback across all programs was generally positive, with over 50% of respondents expressing ease in understanding the text. Regarding the understanding of words and phrases used, 72.2% of students in the Building Engineering program had no difficulty in comprehending text 1.

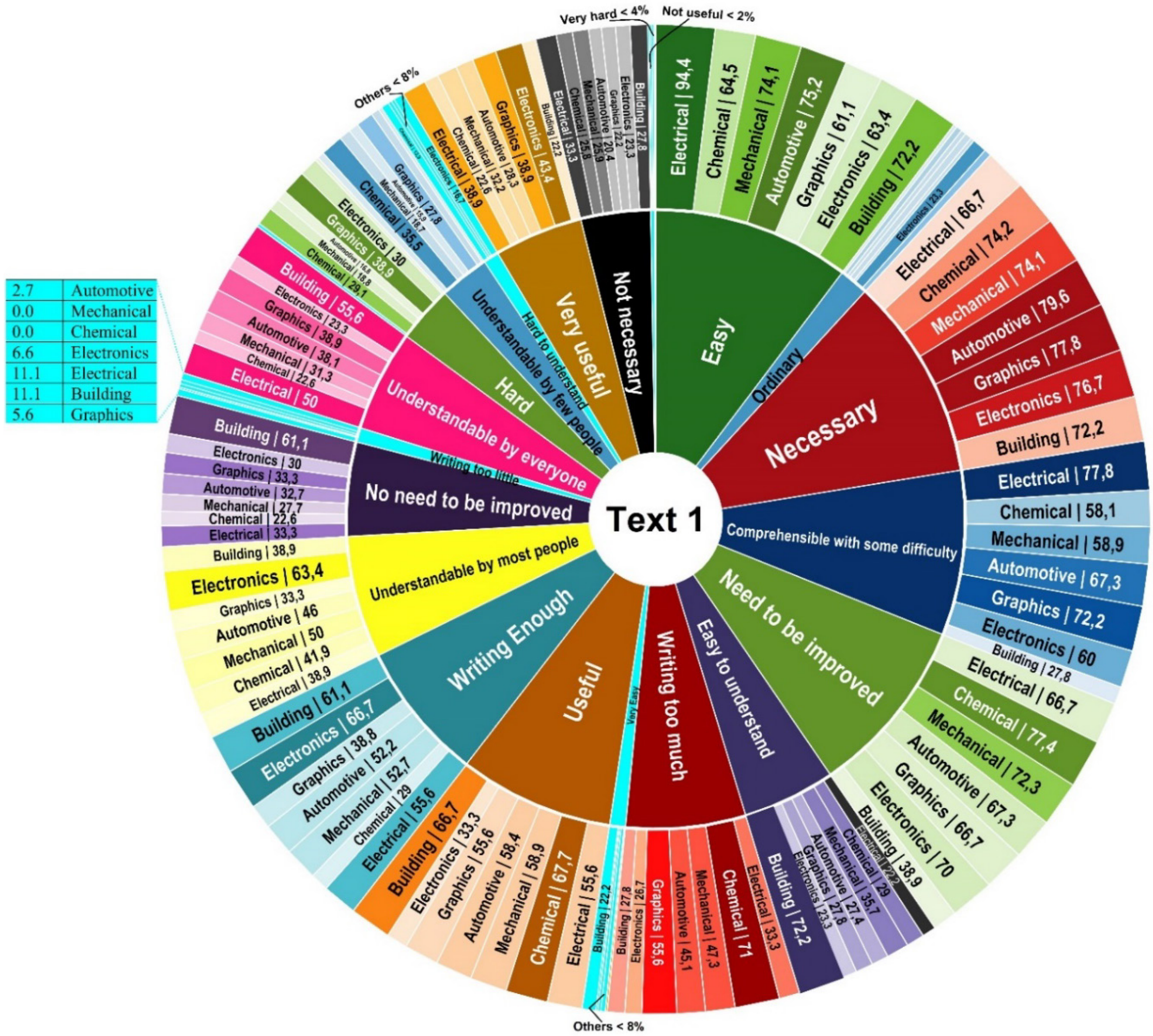


Figure 8. Readers' responses to the materials and their percentage item distribution in text 1

In contrast, respondents from other programs exceeding 50% reported some level of difficulty. Reader's responses regarding the need for the text to use more common phrases or words indicate that the students offering all programs considered it important for better comprehension. Regarding general text comprehension, the majority of respondents exceeding 50%, offering various programs, such as mechanical and electrical engineering, reported a satisfactory understanding. Those in building engineering and electronics stated that everyone understood the text. Examining the perceived benefits of the text, almost all the students offering the diverse programs reported positive feedback, with over 50% of respondents acknowledging its usefulness. However, the electrical engineering program was prominent with a slightly lower percentage of 33.3%. All programs stated that text 1 needs improvement based on the outlined considerations.

This phenomenon is based on the observation that students in chemical engineering and graphic design programs are more accustomed to practice-oriented and visual learning. Consequently, they tend to feel that long and dense texts are less effective compared to visual or interactive materials. In contrast, the curriculum for chemical engineering and graphic design programs often emphasizes the synthesis and understanding of concepts through case studies and projects. This differs from other programs that place more importance on deep theoretical understanding, requiring longer and more detailed texts.

Furthermore, the material discussed in the text should be more aligned with the background and needs of students from other programs. This makes them find the length of the text appropriate. However, students in chemical engineering and graphic design often feel that the material is not relevant or too detailed for their needs. Therefore, differences in learning methods and curriculum expectations between chemical engineering and graphic design programs compared to other programs affect students' perceptions of text length.

Reader's responses to text 2

Figure 9 provides a comprehensive view of readers responses to text 2 across various programs. Meanwhile, all programs uniformly agreed that the amount of text in the material was deemed adequate, with percentages consistently exceeding 50%. This suggested that the students do not have an issue with the length of text in the material. Further analysis of readers responses regarding the ease of reading and comprehension of text 2 showed a similar trend.

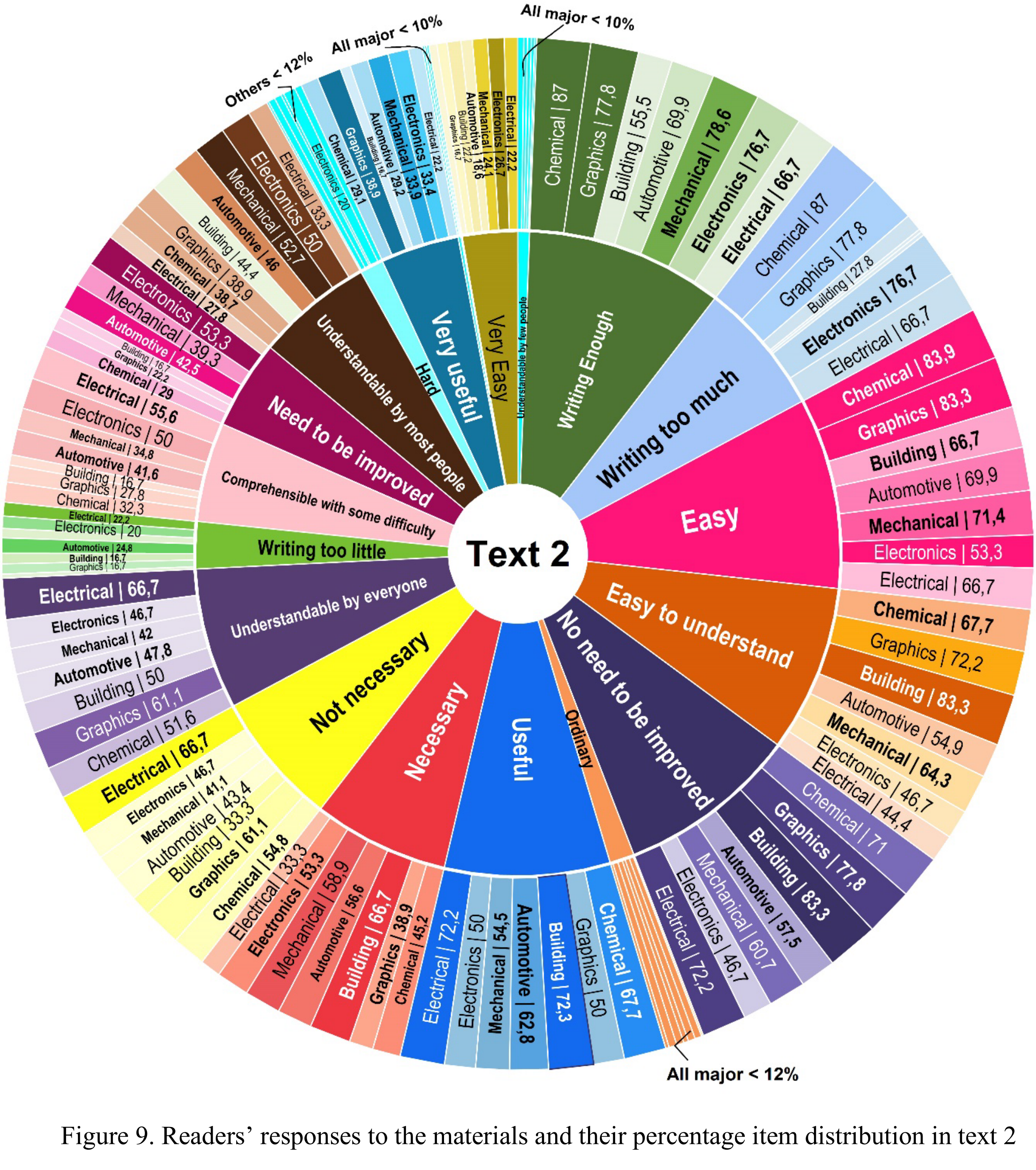


Figure 9. Readers' responses to the materials and their percentage item distribution in text 2

The students offering all programs expressed satisfaction, stating that there is an adequate amount of text, with percentages exceeding 50%. This focused on the widespread agreement that readers from diverse programs are able to understand the words and phrases in text 2, with percentages exceeding 50%. However, those offering electronic and electrical engineering programs stated that the text could be easily understood. Reader responses regarding the need for the text to use more common phrases or words indicated that those offering almost all programs considered it important for better comprehension. Students enrolled in electronic and electrical engineering, as well as chemistry, stated that it is not essential. Assessing readers responses regarding text comprehension showed that the text was easily understood by everyone in the respective programs, with percentages exceeding 50%. Meanwhile, the majority of those offering these programs stated that text 2 is beneficial, but students enrolled in electrical engineering programs expressed the need for improvement.

This study reveals that text 2 successfully conveys information in a way that is accessible to students from various academic backgrounds. The choice of words, sentence structure, and presentation of concepts within the text are designed to ensure that students from diverse study programs can easily extract the knowledge provided. For example, the description of geothermal energy is conveyed by linking complex concepts with natural phenomena that may already be familiar to the students, such as "*The heat of the earth is a source of thermal energy contained in hot water, steam, and rocks stored in the earth* (english)" This sentence not only defines the source of geothermal energy but also explains how this heat is stored and accessed from the earth.

Furthermore, the text clearly explains the advantages of using geothermal energy by stating, "*Geothermal power plants hardly cause pollution or emissions* (english)" The comparison with other energy sources, such as fossil fuel power plants that only produce 65-75% of their raw materials, underscores the higher efficiency of geothermal energy. The fact that geothermal power plants generate electricity at about 90% of their raw materials offers an easily understandable quantitative perspective and strengthens the argument for the superiority of geothermal energy. Additionally, it is acknowledged that although Indonesia is rich in geothermal reserves, there are still challenges to be overcome, such as "Some technical difficulties, such as the provision of equipment and experts," which hinder the full utilization of this potential. The presentation of this information raises students' awareness of practical issues in the utilization of geothermal energy.

The pedagogical approach used in text 2, as evidenced by the positive responses from students across programs, can serve as a model for the development of other teaching materials that aim to achieve similar readability. The use of empirical data in the text, such as the core temperature of the earth and energy efficiency, facilitates understanding and sharpens students' critical thinking. Narratives like this not only enhance students' knowledge of geothermal energy but also inspire them to think about solutions to the technical problems that still occur in the utilization of this renewable energy.

Reader’s responses to text 3

Figure 10 shows a consistent perspective among readers across diverse skill programs regarding the quality of text 3. The majority of readers responses from almost all skill programs stated that there are few texts, with percentages exceeding 50%. However, those offering the building technical skills program were an exception, stating satisfaction with the adequacy of writing in the text. Additionally, considering the ease of reading and understanding, the responses from the students offering almost all skill programs consistently reported a positive outlook. The majority found text 3 easy to understand, indicating a favourable perception of its readability and clarity. Similarly, when considering readers responses to the words and phrases used in text 3, a unanimous agreement was obtained across all skill programs. More than 50% of the respondents reported having no difficulty understanding the words and phrases used in the text.

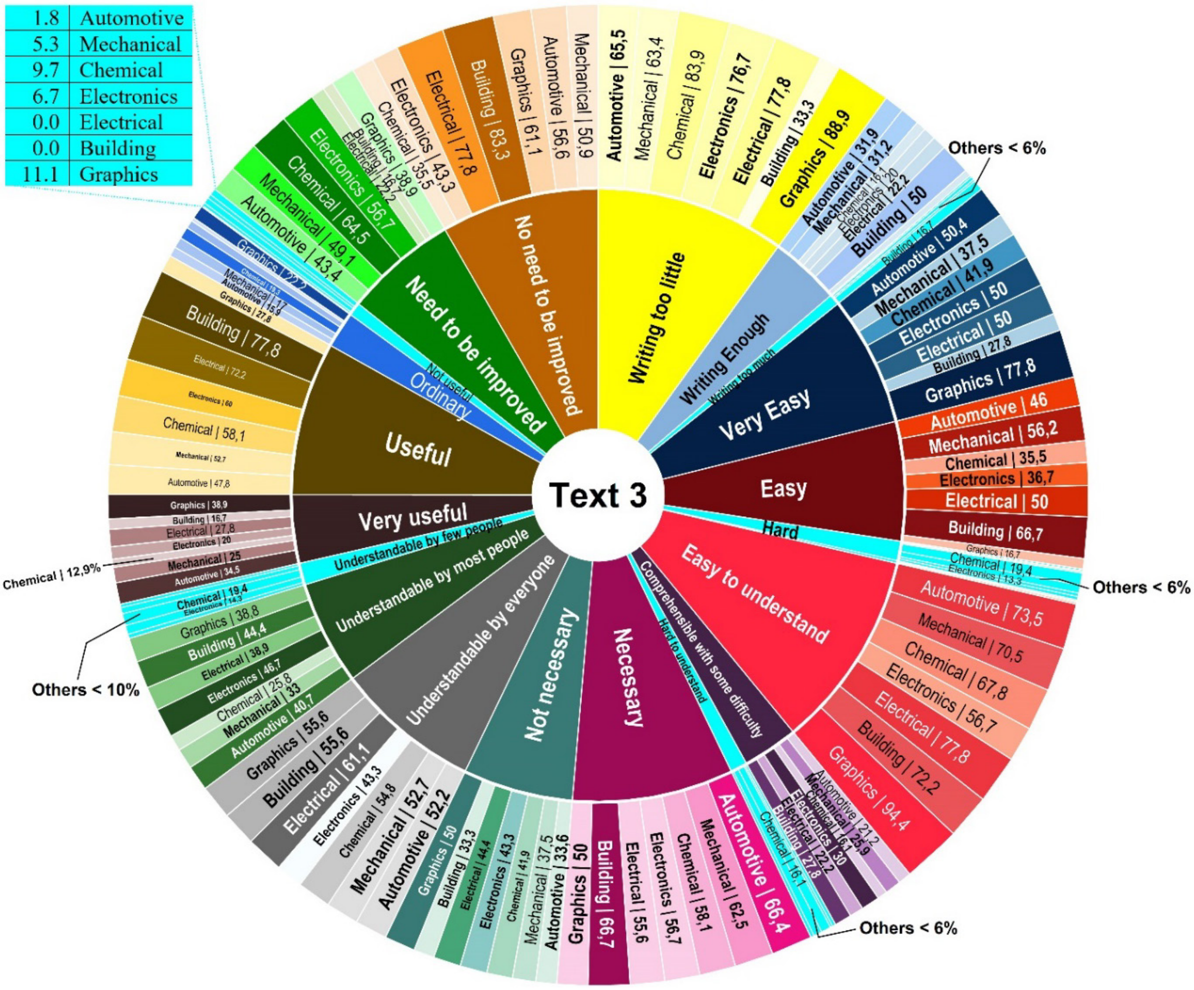


Figure 10. Readers' responses to the materials and their percentage item distribution in text 3

Examining readers responses on the need to use more common or familiar words and phrases in the text for better understanding showed a unanimous agreement across all skill programs. The majority, exceeding 50%, stated the significance of using accessible language. In terms of text comprehension, a positive trend persists, with most students offering the skill programs reporting that the text was easily understood, with a percentage of more than 50%. However, those enrolled in the electrical skills program expressed a slightly lower confidence level, stating that a rate of 46.7% believes most people can understand the text. Exploring readers responses to the text benefits, the students offering almost all skill programs acknowledged its positive impact, with the majority, exceeding 50%, finding it valuable. Therefore, almost all skill programs believed that text 3 does not need improvement, as indicated by a percentage exceeding 50%. The students enrolled in the electrical and chemistry skill programs suggested the need for improvement in the text.

The preceding discussion indicated that readers with expertise in Mechanical Engineering serve as a representative sample for the general responses within the field of Technology and Engineering. This was closely followed by the Automotive Engineering program, suggesting a higher compatibility of the material on renewable energy from geothermal resources with these specific skill programs. However, it is not impossible to include this material in other skill programs in the Technology and Engineering field. Given the importance of educating students on renewable energy, especially in SMK textbooks, there is potential for adapting and integrating this content across various skill programs.

CONCLUSION

In conclusion, the readability level of a text is closely related to the comprehension level of its readers. Students' comprehension of a text varied according to their intelligence levels and the sentence structure used. The readability of VHS textbooks on geothermal-based renewable energy was assessed based on how well students understood the text. A text was deemed to have a high readability level, assuming the number of respondents who found it easily exceeded those who found it challenging. The Gunning Fog Index was used to calculate the readability level, resulting in scores of 20, 18, and 21 for texts 1, 2, and 3, respectively. Based on feedback from readers in the Technology and Engineering field, more than half of the respondents found the content in texts 2 and 3 easy to comprehend. Meanwhile, for text 1, more than 50% of respondents encountered some difficulties in understanding the content.

A low readability level in VHS textbooks addressing renewable energy from geothermal resources, as determined by the Gunning Fog Index, created challenges for students trying to comprehend the material. The challenge emerged because of complicated sentence structures and word choices, making it difficult for effective teaching and learning processes in schools. Consequently, students tend to lose interest in learning, discouraged by the complexity of understanding the textbook content. When they struggle to understand a subject, especially one as crucial as renewable energy from geothermal resources, it becomes a significant obstacle to their overall comprehension. The repercussions extend beyond individual challenges, as the collective understanding of renewable energy is essential for future societal development. Students play a significant role in society and are future consumers, focusing on the importance of assessing the readability level of SMK textbooks. While more than half of the respondents found texts 2 and 3 easy to comprehend, indicating a perceived high readability level, the Gunning Fog Index results reveal that all three texts have a low readability level. This discrepancy highlights the importance of considering both subjective feedback and objective linguistic measures in evaluating the readability of educational materials. This understanding is instrumental in supporting the success of the teaching and learning process in schools.

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APPENDIX A.

Step-by-step procedure

1. Preparation

   This preparation activity is the initial step in conducting the research. The following are the preparation activities for this research:
   a. Developing a research schedule.
   b. Searching for reference sources from books, journals, and other studies related to this research as a reference.
   c. Analyzing textbooks in the school library.
   d. Determining the textbooks used for the lessons.
   e. Identifying subtopics on renewable energy from geothermal sources in the textbooks.
   f. Developing research instruments and strategies to be implemented.

2. Data Collection
   a. Conducting instrument trials.
   b. Performing validity and reliability tests of the instrument to ensure it is suitable for data collection.
   c. Collecting data through the final instrument that has been created.
   d. Grouping data based on each data category.

3. Data Processing and Analysis
   a. Calculating the questionnaire scores based on each indicator.
   b. Entering the questionnaire scores answered by respondents into a document for data processing.
   c. Calculating the percentage frequency distribution of alternative answers in the questionnaire for each indicator.
   d. Describing the results of each variable descriptively.

4. Data Analysis and Processing

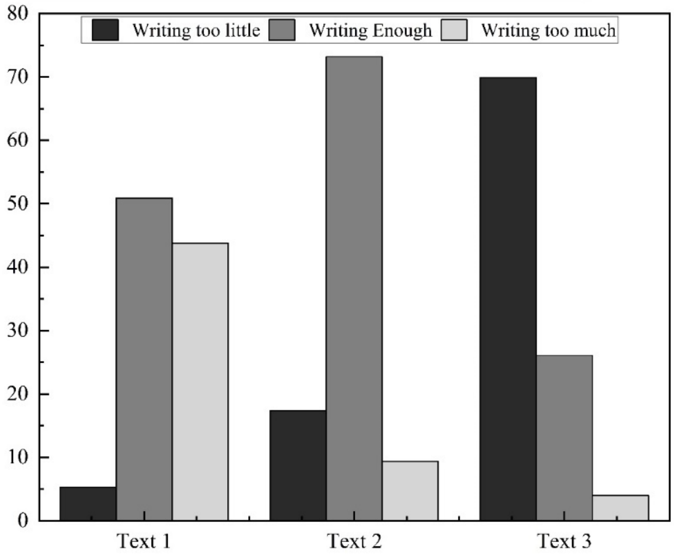
   This step involves the application of advanced statistical techniques and data analysis to ensure the integrity and validity of the research findings. We use:
   a. Descriptive Statistical Analysis: This includes the calculation of mean, median, and mode to identify the distribution of questionnaire scores. Variance and standard deviation are calculated to assess data dispersion.
   b. Factor and Principal Component Analysis: We apply factor analysis to identify the underlying structure of the measured variables. This helps in understanding the dimensions of unobserved concepts that may influence research outcomes.

c. Reliability Test: Cronbach's alpha test is used to assess the internal consistency of the questionnaire instrument, ensuring that the questionnaire items consistently measure the same construct.
d. Validity Test: Content and construct validity are verified through confirmatory factor analysis, and predictive validity is determined through convergent and discriminant validity tests.

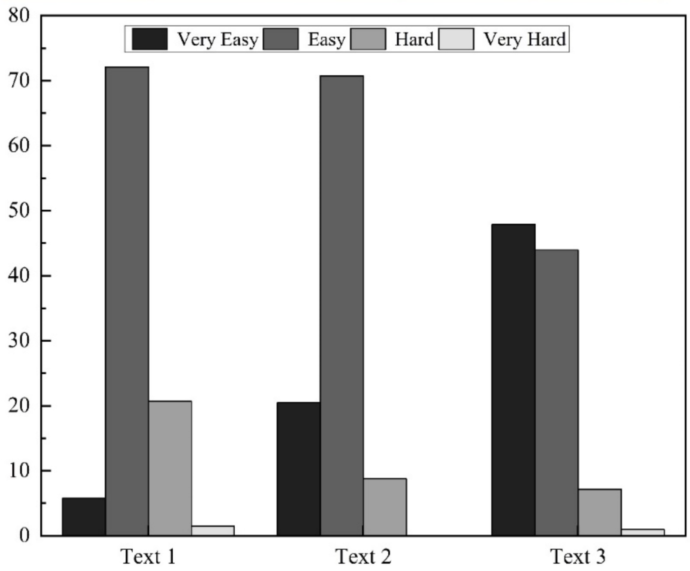
APPENDIX B.

Readers's responses to the material and their behavior

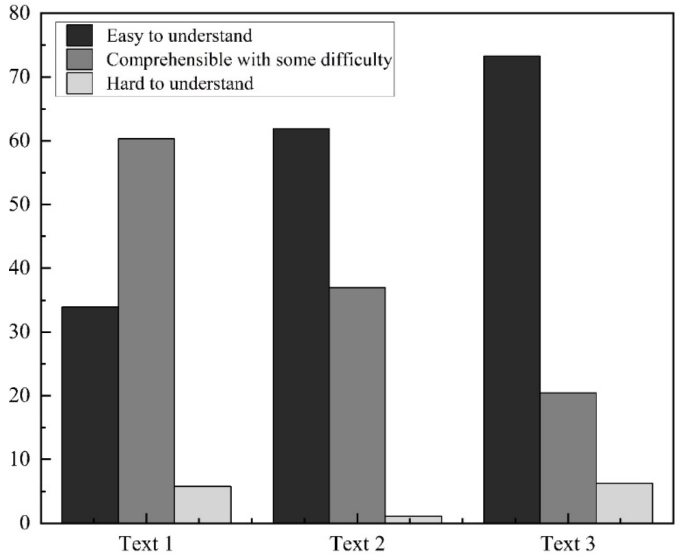
a) Readers' response to the amount of text (%)



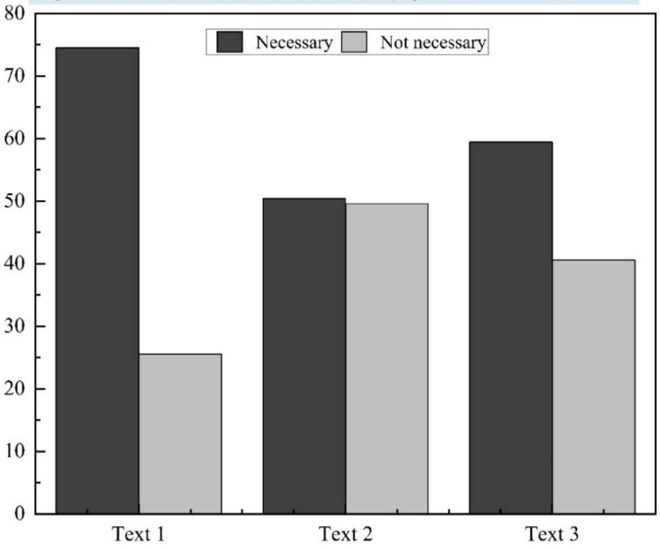
b) Readers' response to the ease of reading and following the text (%)



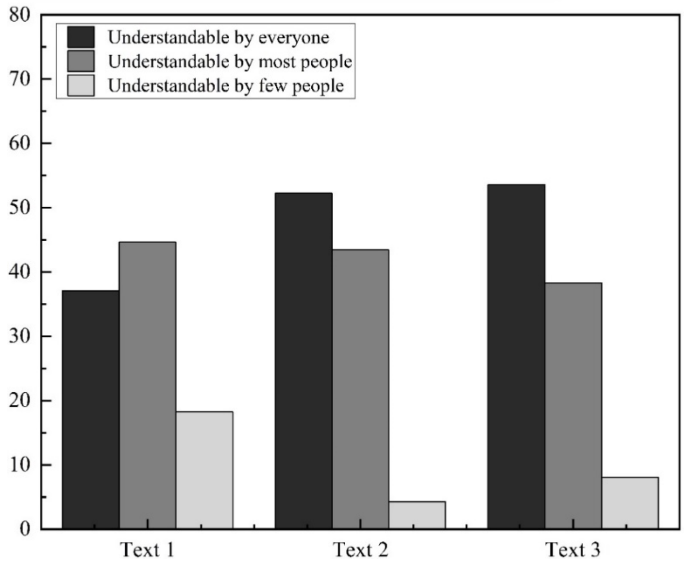
c) Readers' response to words and phrases used (%)

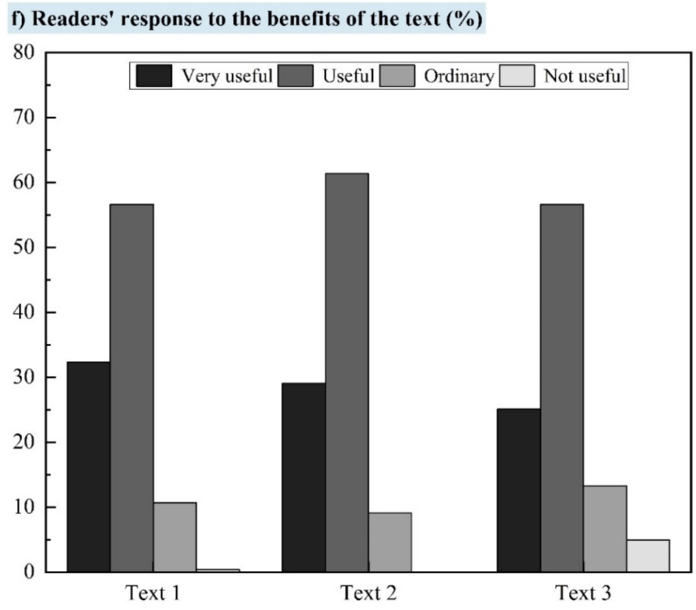


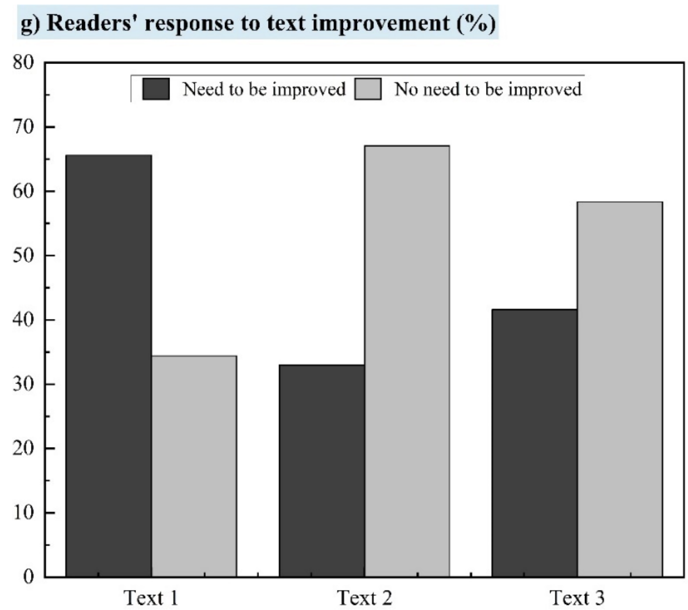
d) Readers' response to the need for the text to use more common words or phrases to make it easier to understand (%)



e) Readers' response to text comprehension (%)







a. Readers' response to the amount of text (%)

Major	Text	Writing too little	Writing Enough	Writing too much
Mechanical Engineering	Text 1	0.0	52.7	47.3
	Text 2	15.2	78.6	6.2
	Text 3	63.4	31.2	5.4
Automotive Engineering	Text 1	2.7	52.2	45.1
	Text 2	24.8	69.9	5.3
	Text 3	65.5	31.9	2.6
Building Engineering	Text 1	11.1	61.1	27.8
	Text 2	16.7	55.5	27.8
	Text 3	33.3	50.0	16.7
Electrical Engineering	Text 1	11.1	55.6	33.3
	Text 2	22.2	66.7	11.1
	Text 3	77.8	22.2	0.0

Major	Text	Writing too little	Writing Enough	Writing too much
Electronics Engineering	Text 1	6.6	66.7	26.7
	Text 2	20.0	76.7	3.3
	Text 3	76.7	20.0	3.3
Chemical Engineering	Text 1	0.0	29.0	71.0
	Text 2	6.5	87.0	6.5
	Text 3	83.9	16.1	0.0
Graphic Engineering	Text 1	5.6	38.8	55.6
	Text 2	16.7	77.8	5.6
	Text 3	88.9	11.1	0.0
Mean	Text 1	5.3	50.9	43.8
	Text 2	17.4	73.2	9.4
	Text 3	69.9	26.1	4.0

b. Readers' response to the ease of reading and following the text (%)

Major	Text	Very Easy	Easy	Hard	Very Hard
Mechanical Engineering	Text 1	7.1	74.1	18.8	0.0
	Text 2	24.1	71.4	4.5	0.0
	Text 3	37.5	56.2	3.6	2.7
Automotive Engineering	Text 1	4.4	75.2	16.8	3.6
	Text 2	18.6	69.9	11.5	0
	Text 3	50.4	46.0	2.7	0.9
Building Engineering	Text 1	22.2	72.2	5.6	0.0
	Text 2	22.2	66.7	11.1	0.0
	Text 3	27.8	66.7	5.5	0.0
Electrical Engineering	Text 1	0.0	94.4	5.6	0.0
	Text 2	22.2	66.7	11.1	0.0
	Text 3	50.0	50.0	0.0	0.0
Electronics Engineering	Text 1	3.3	63.4	30.0	3.3
	Text 2	26.7	53.3	20.0	0.0
	Text 3	50.0	36.7	13.3	0.0
Chemical Engineering	Text 1	3.2	64.5	29.1	3.2
	Text 2	12.9	83.9	3.2	0.0
	Text 3	41.9	35.5	19.4	3.2
Graphic Engineering	Text 1	0.0	61.1	38.9	0.0
	Text 2	16.7	83.3	0.0	0.0
	Text 3	77.8	16.7	5.5	0.0
Mean	Text 1	5.74	72.13	20.69	1.44
	Text 2	20.49	70.74	8.77	0.00
	Text 3	47.91	43.97	7.14	0.97

c. Readers' response to words and phrases used (%)

Major	Text	Easy to understand	Comprehensible with some difficulty	Hard to understand
Mechanical Engineering	Text 1	35.7	58.9	5.4
	Text 2	64.3	34.8	0.9
	Text 3	70.5	25.9	3.6

Major	Text	Easy to understand	Comprehensible with some difficulty	Hard to understand
Automotive Engineering	Text 1	27.4	67.3	5.3
	Text 2	54.9	41.6	3.5
	Text 3	73.5	21.2	5.3
Building Engineering	Text 1	72.2	27.8	0.0
	Text 2	83.3	16.7	0.0
	Text 3	72.2	27.8	0.0
Electrical Engineering	Text 1	22.2	77.8	0.0
	Text 2	44.4	55.6	0.0
	Text 3	77.8	22.2	0.0
Electronics Engineering	Text 1	23.3	60.0	16.7
	Text 2	46.7	50.0	3.3
	Text 3	56.7	30.0	13.3
Chemical Engineering	Text 1	29.0	58.1	12.9
	Text 2	67.7	32.3	0.0
	Text 3	67.8	16.1	16.1
Graphic Engineering	Text 1	27.8	72.2	0.0
	Text 2	72.2	27.8	0.0
	Text 3	94.4	0.0	5.6
Mean	Text 1	33.94	60.30	5.76
	Text 2	61.93	36.97	1.10
	Text 3	73.27	20.46	6.27

d. Readers' response to the need for the text to use more common words or phrases to make it easier to understand (%)

Major	Text	Necessary	Not necessary
Mechanical Engineering	Text 1	74.1	25.9
	Text 2	58.9	41.1
	Text 3	62.5	37.5
Automotive Engineering	Text 1	79.6	20.4
	Text 2	56.6	43.4
	Text 3	66.4	33.6
Building Engineering	Text 1	72.2	27.8
	Text 2	66.7	33.3
	Text 3	66.7	33.3
Electrical Engineering	Text 1	66.7	33.3
	Text 2	33.3	66.7
	Text 3	55.6	44.4
Electronics Engineering	Text 1	76.7	23.3
	Text 2	53.3	46.7
	Text 3	56.7	43.3
Chemical Engineering	Text 1	74.2	25.8
	Text 2	45.2	54.8
	Text 3	58.1	41.9
Graphic Engineering	Text 1	77.8	22.2
	Text 2	38.9	61.1
	Text 3	50.0	50.0

Major	Text	Necessary	Not necessary
Mean	Text 1	74.47	25.53
	Text 2	50.41	49.59
	Text 3	59.43	40.57

e. Readers' response to text comprehension (%)

Major	Text	Understandable by everyone	Understandable by most people	Understandable by few people
Mechanical Engineering	Text 1	31.3	50.0	18.7
	Text 2	42.0	52.7	5.3
	Text 3	52.7	33.0	14.3
Automotive Engineering	Text 1	38.1	46.0	15.9
	Text 2	47.8	46.0	6.2
	Text 3	52.2	40.7	7.1
Building Engineering	Text 1	55.6	38.9	5.5
	Text 2	50.0	44.4	5.6
	Text 3	55.6	44.4	0.0
Electrical Engineering	Text 1	50.0	38.9	11.1
	Text 2	66.7	33.3	0.0
	Text 3	61.1	38.9	0.0
Electronics Engineering	Text 1	23.3	63.4	13.3
	Text 2	46.7	50.0	3.3
	Text 3	43.3	46.7	10.0
Chemical Engineering	Text 1	22.6	41.9	35.5
	Text 2	51.6	38.7	9.7
	Text 3	54.8	25.8	19.4
Graphic Engineering	Text 1	38.9	33.3	27.8
	Text 2	61.1	38.9	0.0
	Text 3	55.6	38.8	5.6
Mean	Text 1	37.11	44.63	18.26
	Text 2	52.27	43.43	4.30
	Text 3	53.61	38.33	8.06

f. Readers' response to the benefits of the text (%)

Major	Text	Very useful	Useful	Ordinary	Not useful
Mechanical Engineering	Text 1	32.2	58.9	8.0	0.9
	Text 2	33.9	54.5	11.6	0.0
	Text 3	25.0	52.7	17.0	5.3
Automotive Engineering	Text 1	28.3	58.4	11.5	1.8
	Text 2	29.2	62.8	8.0	0
	Text 3	34.5	47.8	15.9	1.8
Building Engineering	Text 1	22.2	66.7	11.1	0.0
	Text 2	16.7	72.3	11.1	0.0
	Text 3	16.7	77.8	5.5	0.0
Electrical Engineering	Text 1	38.9	55.6	5.5	0.0
	Text 2	22.2	72.2	5.6	0.0
	Text 3	27.8	72.2	0.0	0.0

Major	Text	Very useful	Useful	Ordinary	Not useful
Electronics Engineering	Text 1	43.4	33.3	23.3	0.0
	Text 2	33.4	50.0	13.3	.3.3
	Text 3	20.0	60.0	13.3	6.7
Chemical Engineering	Text 1	22.6	67.7	9.7	0.0
	Text 2	29.1	67.7	3.2	0.0
	Text 3	12.9	58.1	19.3	9.7
Graphic Engineering	Text 1	38.9	55.6	5.6	0.0
	Text 2	38.9	50.0	11.1	0.0
	Text 3	38.9	27.8	22.2	11.1
Mean	Text 1	32.36	56.60	10.67	0.39
	Text 2	29.06	61.36	9.13	0.00
	Text 3	25.11	56.63	13.31	4.94

g. Readers' response to text improvement (%)

Major	Text	Need to be improved	No need to be improved
Mechanical Engineering	Text 1	72.3	27.7
	Text 2	39.3	60.7
	Text 3	49.1	50.9
Automotive Engineering	Text 1	67.3	32.7
	Text 2	42.5	57.5
	Text 3	43.4	56.6
Building Engineering	Text 1	38.9	61.1
	Text 2	16.7	83.3
	Text 3	16.7	83.3
Electrical Engineering	Text 1	66.7	33.3
	Text 2	27.8	72.2
	Text 3	22.2	77.8
Electronics Engineering	Text 1	70.0	30.0
	Text 2	53.3	46.7
	Text 3	56.7	43.3
Chemical Engineering	Text 1	77.4	22.6
	Text 2	29.0	71.0
	Text 3	64.5	35.5
Graphic Engineering	Text 1	66.7	33.3
	Text 2	22.2	77.8
	Text 3	38.9	61.1
Mean	Text 1	65.61	34.39
	Text 2	32.97	67.03
	Text 3	41.64	58.36

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