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A Systematic Literature Review on Citizen Awareness of Energy

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ABSTRACT

Education is the key to sustaining our natural resources. Thus, community awareness is extremely important in order to make changes and reduce climate change, specifically global warming, and to curb the increase of carbon dioxide emissions which have caused the greenhouse effect. Although there are various studies on public awareness of energy literacy, analytically reviewing works on this research topic has been challenging as scholars have yet to integrate the SLR review technique into the process. This article intends to perform a systematic literature review on how to increase the public's knowledge of energy literacy. The systematic literature review method comprised five key procedures guided by the review protocol. The process involved formulating the research questions, identifying the searching and screening methods, deciding the inclusion and exclusion criteria, appraising content quality, and extracting data. The articles for review were retrieved from established databases, specifically Scopus and Web of Science (WoS). Thematic analysis of the articles discovered five main themes, which were (1) energy literacy; (2) renewable energy; (3) programmes, training, and campaigns; (4) fostering strong social relationships in teaching energy literacy; and (5) teaching techniques. These five themes were divided into 11 sub-themes. Findings from this systematic review will provide in-depth info to our community and specifically to educationalists, enabling them to develop more effective, efficient, and sustainable strategies that will shape future globally competent citizens in justifying and adapting energy literacy issues.

Contribution/Originality: This study contributes to literature review by using SLR on education to create public's awareness of energy literacy globally. Focusing from curriculum development to teaching technique in education for educator as energy becoming crucial worldwide issue in education.

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1. Introduction

Many facts that relate to climate change, such as the emission of carbon dioxide in the greenhouse effect, are related to energy-generating processes. Knowledge about energy is therefore essential and necessary in learning about climate change. Anthropogenic activities or human activities are the main causes of climate change due to a lack of awareness of energy literacy. Human activity is the main factor that causes the greenhouse effect, especially when we use fossil fuels with high emissions of carbon dioxide. Education, beginning from childhood, may help to change human awareness and behaviour in our consumption of energy sources, especially non-renewable energy sources that emit a lot of carbon dioxide. Thus, one objective of the innovation of green technology is for humanity to produce less carbon-using products in order to conserve our ecosystem.

As energy and renewable energy has become a critical issue worldwide, this, along with other important issues, has been incorporated into the concept and vision of Agenda 2030, which consists of 17 Sustainable Development Goals (SDGs). A universal view on the development of energy is provided by the SDGs, the objective of which is to transform the world by dealing with several tasks and difficulties confronted by humanity to ensure fine environmental safety and economic wealth through education. Moreover, the interlinkages between the 17 aims are starting to be examined through multiple studies, which serves to give greater emphasis to this important topic (Martínez-Borreguero et al., 2020). For example, some of these studies are concerning social inclusion for affordable and clean energy to promote human well-being (Breuer et al., 2019).

Universities are also increasingly engaging in energy research, especially in the fields of educational research; research on professional practices in education; and science research (Thoyre & Harrison, 2016). Besides that, good energy education would increase energy literacy; sustainable behaviour; and critical thinking, which would help to address the issue of climate change (Mažeikienė & Norkutė, 2021). In Taiwan, a study showed that energy literacy increased with the participants' level of education (Yeh et al., 2017). Energy literacy education is one strategy taken to create awareness among citizens about green energy. Youths are critical citizens, because they will be the ones who will have to adapt to the effects of the impending scarcity of energy resources (Jamaludin et al., 2020; Yeh et al., 2017). The learning and abilities obtained by younger citizens will drive them to preserve our environment (United Nations, 1992). Energy literacy is an integral component of the science curricula as well as those of other subjects such as Geography in primary and secondary schools. However, the most significant factor is the curriculum content of energy literacy change education itself. Curricula from kindergarten to high school are being designed in alignment with the SDGs (Reimers, 2021). However, the efficiency of energy education curricula are not yet optimum, and students' levels of energy awareness are still minimal (Nugroho et al., 2019). Thus, most countries have a well-highlighted objective to transition to greener, more environmentally-friendly sources of energy. Indeed, the successfulness of inculcating energy literacy will be determined by governmental decision-making on the implementation of energy education.

As energy literacy has become one of the most important subtopics in science textbooks, pedagogical challenges in teaching and learning energy literacy are faced (Mažeikienė & Norkutė, 2021). Many textbooks do not convey the information about energy thematically, and the new energy paradigm which is needed for the development of a new

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green economy is not clear. Teachers should use various pedagogical skills, teaching materials, and positive learning environments as they teach energy literacy (Yeh et al., 2017). Various teaching strategies are used by educators to attract pupils to learn about energy literacy. The teacher's guidance will increase energy literacy in their daily life activities. For example, in one study, students observed and measured the professed environmental impact of their family members compared to other households (Gatersleben et al., 2002). The findings showed that they had a strong awareness of the relative environmental impact of their personal energy literacy and awareness, such as degrees of car usage; computer usage; and frequency of holidays compared to other households. However, they tended to misjudge the relative environmental impact of their cooking activities (Gatersleben et al., 2002). Students that learn about various dimensions of energy literacy education and develop the appropriate skills and exact techniques to discern, evaluate, and change their energy usage habits and those of their households will gain a good awareness of energy literacy and green development. This will eventually help to create awareness amongst them of the need to practise a more environmental-friendly routine. A multidimensional and holistic view on teaching and learning energy literacy needs to be studied critically and analytically by doing a systematic review on this topic.

Based on the issues outlined above, the purpose of this research is to summarise and analyse the emphases and research lacunae of studies that focus on strategies for energy literacy education, specifically in science education for global communities. The research questions are:

i. What are the strategies for teaching energy literacy in education?
ii. What are the educational strategies to improve energy literacy among the global community?

2. Procedures

2.1. Review Procedure-PRISMA

A stringent and academically rigorous procedure was used to report the chosen articles related to energy literacy in global education. The systematic literature review (SLR) presented in this paper was conducted following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). PRISMA seeks to reinforce and provide procedures for managing the review analysis to improve the clarity of arguments. Even though the SLR in this study is focused on energy literacy and PRISMA was established primarily for medical issues, this review could also follow PRISMA procedure as PRISMA was established to transversely harmonise the distinctions and heterogeneity of conditions and examine the process of synthesis. According to (Moher et al., 2009), PRISMA can be used as a basis in reporting systematic reviews for other types of research. Moreover, PRISMA can also be used in the environmental management field to identify inclusion and exclusion criteria for a particular study (Sierra-Correa & Cantera Kintz, 2015). Furthermore, PRISMA analyses an extensive database of scientific literature within a given period that allows the search for suitable terms to be performed in relation to the variables of education and energy literacy. Specification items were included to prove that there were evident good reasons for not reporting certain items and that they were not excluded because of the researcher's bias, as well as to make it clear that more information was needed to assess the reliability of other survey items (Moher et al., 2009). PRISMA gives specific features, which are: defining clear research questions that accommodate for systematic studies; identifying conditions for inclusion and exclusion; and trying to analyse vast scientific literature databases by the use of a search engine in a

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specific period of time setting (Moher et al., 2016). The PRISMA Statement allows for a rigorous search for terms related to the integration of energy literacy in education in general, or specifically in science education. The methodology can be used to obtain implementations of energy literacy that can be used in an attractive variety of educational disciplines. The selected papers went through various stages of data extraction and analysis. The primary research question guided the data extraction process, while a qualitative data synthesis method (thematic synthesis) was used to analyse the data.

2.2. Organised Searching Approaches

This review was performed in June 2021. The systematic review process consisted of three phases, identification; screening; and eligibility, to ensure that only the appropriate articles were retrieved from the databases. Implementing this procedure ensured that the writers systematically found and synthesised the most suitable research papers to produce a well-planned and transparent SLR article answering the final research question: What are the educational strategies to improve energy literacy among the global community?.

2.2.1. Identification

Three important keywords were identified based on the research questions: "energy literacy," "science education," and "renewable energy." Papers highlighting these important keywords were also identified by including alternative words, linking words, and options found in the online thesaurus or thesaurus.com to ensure that studies related to these keywords could be retrieved. Moreover, the researcher also considered the recommended keywords in Scopus and consulted several experts. Using this technique, important keywords like "energy literacy," "science education," "knowledge," "plan," "readiness," "awareness," "sustainability," and "renewable" were included in the searching process. These important keywords were sorted out through the search functions in the selected search engine, including field code functions, word searching, wildcards, truncation, and Boolean operators in two databases, Scopus and Web of Science (see Table 1).

Table 1: Search string used in the selected database

Database	String
Scopus	((energy literacy*) AND (science education*) AND (knowledge* OR plan* OR read* OR aware* OR alert* OR precaution OR green* OR sustainable OR "renewable energy"))
Web of Science	((energy literacy*) AND (science education*) AND (knowledge * OR plan*OR read* OR aware* OR alert*OR precaution OR green* OR sustainable OR "renewable energy"))

This study limited the screening procedure to retrieve only papers published between 2017 and 2021. This timeframe was limited because it was necessary to have a suitable number of published studies to implement a descriptive SLR review. The researcher selected empirical research papers for the review because they present primary data. Only articles written in English were chosen. Since the objective of this SLR article is related to community awareness, the review focused on social science papers. The researcher also used a manual searching procedure known as "handpicking" in the

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searching process. The researcher used this method when finding the articles in databases like Scopus and Web of Science. In total, 111 prospective papers were retrieved from the databases.

2.2.2. Screening

The second procedure was the screening process. Articles were retrieved and selected based on the search engine recommendation or by "handpicking" studies based on a particular set of conditions (see Table 2). Based on the "research field maturity" highlighted by Kraus et al. (2020), this review restricted the screening to only include articles published between 2017 and 2021. Only papers from the last four years were included, providing that the number of published research papers was adequate for a descriptive SLR. Another inclusion criterion was that the papers should present empirical research, since those studies would contain primary data. Only papers in English were included to prevent misinterpretation. Moreover, since the SLR is focused on community education, social science studies were selected, as they mostly focused on improving the community's knowledge of energy literacy. 96 papers were retrieved from Web of Science (WOS), and 15 articles were retrieved from Scopus. The papers excluded were not in line with the inclusion criteria. Subsequently, a total of 111 papers were retained for analysis in the following phase.

Table 2: Screening Condition

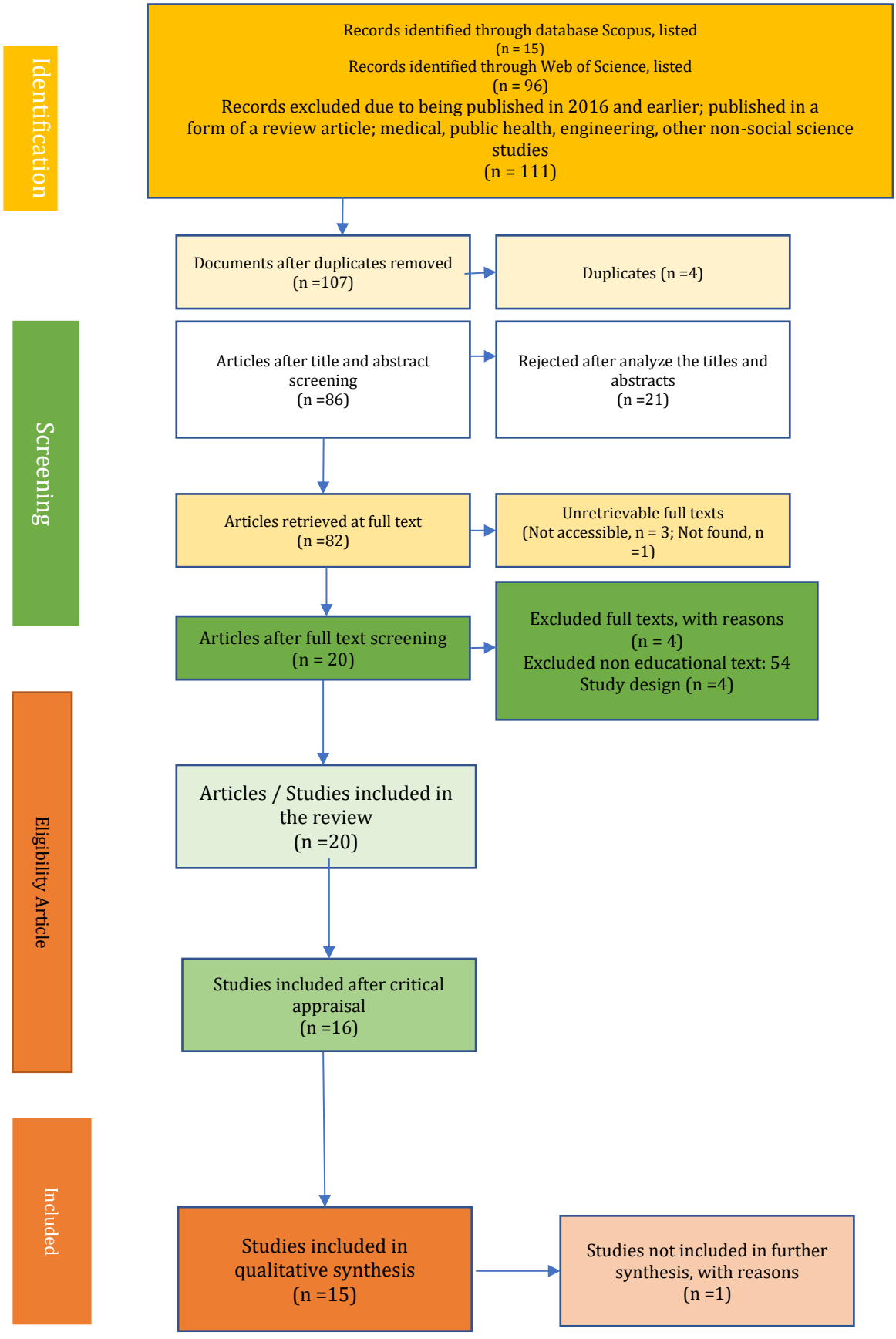
Conditions	Inclusion	Elimination
Year	2017-2021	2016 and earlier
Type of document	Article	Books or chapters of books
Language	English	Non-English

2.2.3. Eligibility (Systematic Review Process)

The eligibility step involved the researcher "handpicking" the remaining articles for analysis based on their title, abstract, or content to determine whether the papers matched the established inclusion criteria. Four articles were excluded as duplicates. 10 articles were excluded during the title screening stage, and during the abstract screening stage,11 articles were eliminated. Of the remaining 82 papers, only 4 papers not had full text available; and of those, the researcher was only able to retrieve the full text for 82 papers. One more paper was excluded when the authors reviewed the selected papers' content. In total, 96 papers were excluded in this phase because they were duplicates, they did not highlight education and did not focus on energy literacy, or they were review papers. The final number of articles retained after the eligibility process was 15 (see Figure 1). Figure 1: Flow diagram detailing the application of PRISMA to the qualitative synthesis of published studies for energy literacy in education. Adapted from Liberati et al. (2009).

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Figure 1: Review Procedure- PRISMA



Source: adapted from Moher et al. (2009)

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2.2.4. Data Abstraction and Studies

The review involved a qualitative synthesis process where the selected papers were assessed thematically. This process could deal with diverse research designs and was deemed the best way to integrate the differences (Whittemore & Knafl, 2005). While several methods of qualitative synthesis could have been used, the present analysis relied on the methodology of thematic synthesis because of its emphasised appropriateness for synthesising data from diverse research designs due to its adaptable approach (Flemming et al., 2019). Thematic analysis is a method that attempts to recognise and notify the design of present studies by finding connections or associations with existing data (Braun & Clarke, 2019). This SLR used thematic analysis methodology (Kiger & Varpio, 2020). The 15 articles were analysed according to the assessment benchmarks in Table 3.

Table 3: Research Design Criteria

Research design	Assessment benchmarks
Qualitative	QA1—Is the qualitative method suitable to resolve the research question? QA2—Are the qualitative data collection methods suitable for the research question? QA3- Are the conclusions effectively derived from the data? QA4- Is the explanation of results succinctly demonstrated by data? QA5—Is there coherence between qualitative data sources, collection, analysis and interpretation?
Quantitative (descriptive)	QA1—Is the sampling strategy suitable to address the research question? QA2- Is the sample representative of the target population? QA3- Are the measurements suitable? QA4- Is the risk of nonresponse bias low? QA5- Is the statistical analysis suitable to answer the research question?
Quantitative (non-randomised)	QA1- Are the respondents representative of the target population? QA2- Are measurements regarding both the outcome and intervention (or exposure) suitable? QA3- Are there complete outcome data? QA4- Are the confounders accounted for in the design and analysis? QA5- During the study period, was the intervention administered (or did the exposure occur) as planned?
Mixed methods	QA1- Is there a satisfactory rationale for using a mixed-methods design to address the research question? QA2- Are the different components of the study effectively integrated to answer the research question?

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	QA3- Are the outputs of integrating qualitative and quantitative components effectively interpreted? QA4- Are divergences and inconsistencies between quantitative and qualitative results effectively delivered? QA5- Do the different components of the study stick to the quality criteria of each tradition of the methods involved?

Source: Kiger and Varpio (2020)

The review determined the number of criteria in line with the research design of each article. Table 4 presents the research design of each paper reviewed.

Table 4: Number of criteria Satisfied According to Research design

Research paper	Research Design	QA1	QA2	QA3	QA4	QA5	Quantity of criteria satisfied	Adding in the review
Edsand & Broich (2020)	QL	/	/	/	/	/	5/5	/
Martínez-Borreguero et al. (2020)	MX	/	/	/	/		4/5	/
Pestana et al. (2021)	QL	/	/	/	/		4/5	/
Yang et al. (2017)	QN	/	/	/	/	/	5/5	/
Nugroho et al. (2019)	QN	/	/	/	/	/	5/5	/
Chodkowska-Miszczuk et al. (2021)	QL	/	/	/	/	/	5/5	/
Yeh et al. (2017)	QN	/	/	/	/	/	5/5	/
Cotton et al. (2021)	QN	/	/	/		/	4/5	/
Jamaludin et al. (2020)	QN	/	/	/		/	4/5	/
Merritt et al. (2019)	QL	/	/	/	/	/	5/5	/
Deveci & Karteri (2020)	MX	/	/	/			3/5	/
Chatterjee et al. (2019)	QL	/	/	/			3/5	/
Aguirre-Bielschowsky et al. (2018)	QL	/	/	/			3/5	/
Gołębiowska (2020)	QN	/	/	/			3/5	/
Martín-Gámez & Erduran (2018)	QN	/	/	/			3/5	/

QN = Quantitative; QL = Qualitative; MX = Mixed-Method; C = Can't tell

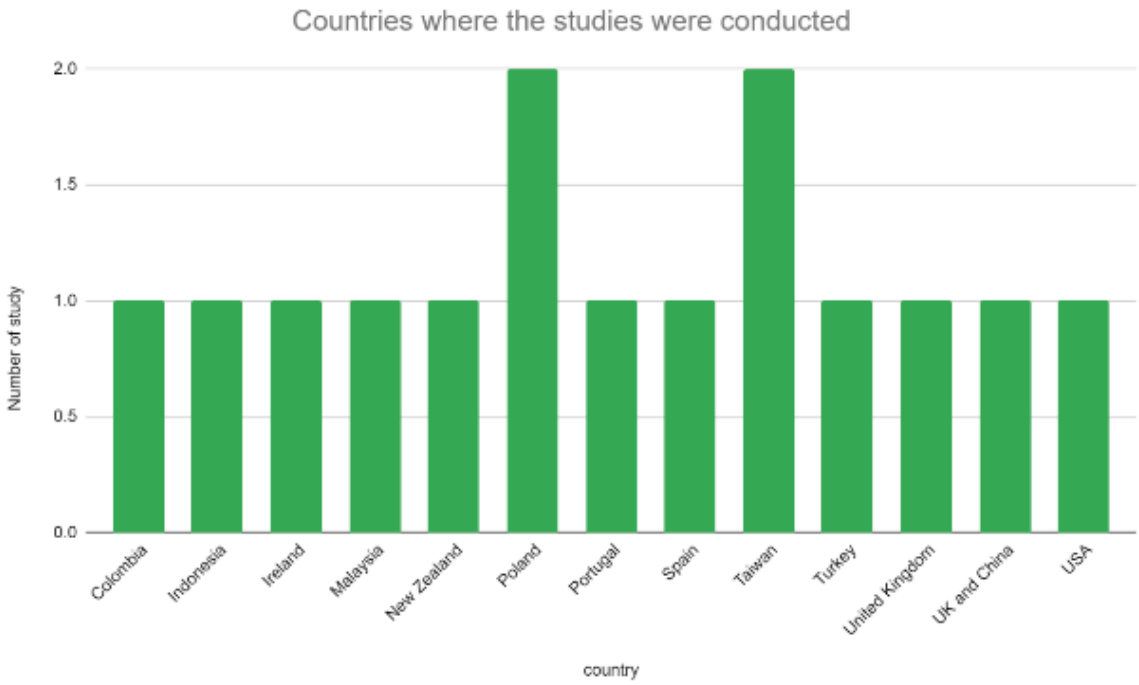
3. Results and Discussion

3.1. Background of Chosen Research Paper

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Out of the 15 papers reviewed, two papers focused on Taiwanese studies by Yang et al. (2017) and Yeh et al. (2017); two were based in Poland (Chodkowska-Miszczuk et al., 2021; Gołębiowska, 2020); and one study was conducted respectively in Columbian Edsand & Broich, (2020), Indonesia (Nugroho et al., 2019), Ireland (Chatterjee et al., 2019), Malaysia (Jamaludin et al., 2020), New Zealand (Aguirre-Bielschowsky et al., 2018), Portugal (Pestana et al., 2021), Spain (Martínez-Borreguero et al., 2020), the United Kingdom (Martín-Gámez & Erduran, 2018), the United States of America (Merritt et al., 2019), and in Turkey (Deveci & Karteri, 2020). Lastly, Cotton et al. (2021) conducted a study in the United Kingdom and China, as shown in Figure 2.

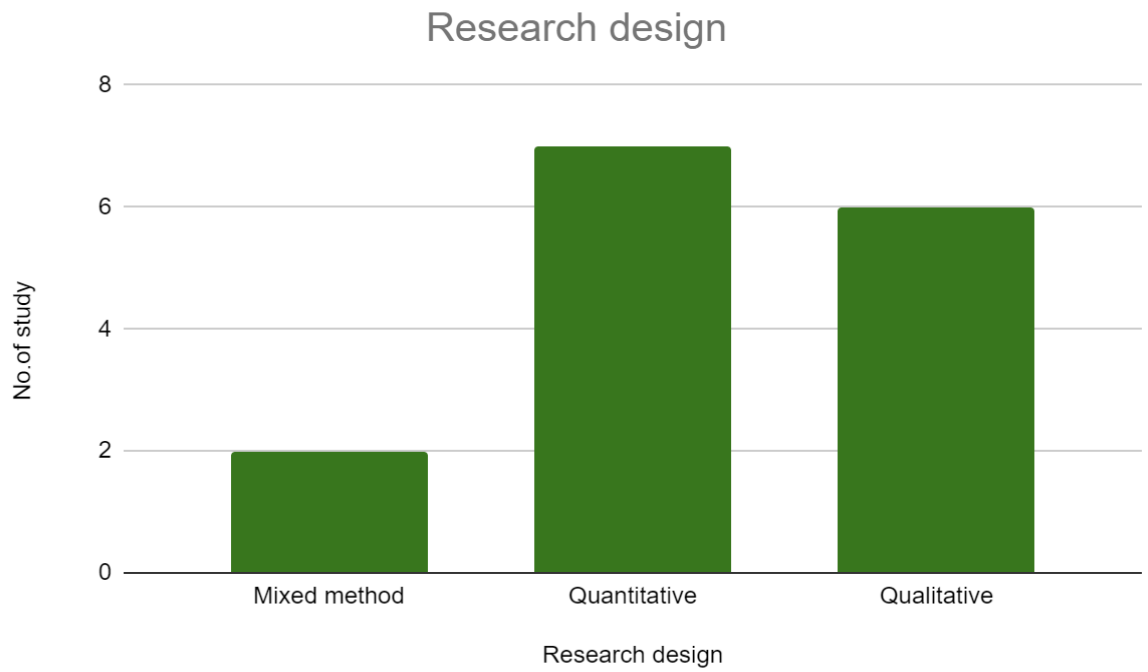
Figure 2: Number of Studies conducted According to Country



The analysis verified that seven studies used quantitative methodologies, which are Cotton et al. (2021); Gołębiowska (2020); Jamaludin et al. (2020); Martín-Gámez & Erduran (2018); Nugroho et al. (2019); Yang et al. (2017); and Yeh et al. (2017). Meanwhile, the other six studies used qualitative methodologies (Aguirre-Bielschowsky et al., 2018; Chatterjee et al., 2019; Chodkowska-Miszczuk et al., 2021; Edsand & Broich, 2020; Merritt et al., 2019; Pestana et al., 2021). Two articles employed the mixed-method approach (Martínez-Borreguero et al., 2020; Deveci & Karteri, 2020), as shown in Figure 3.

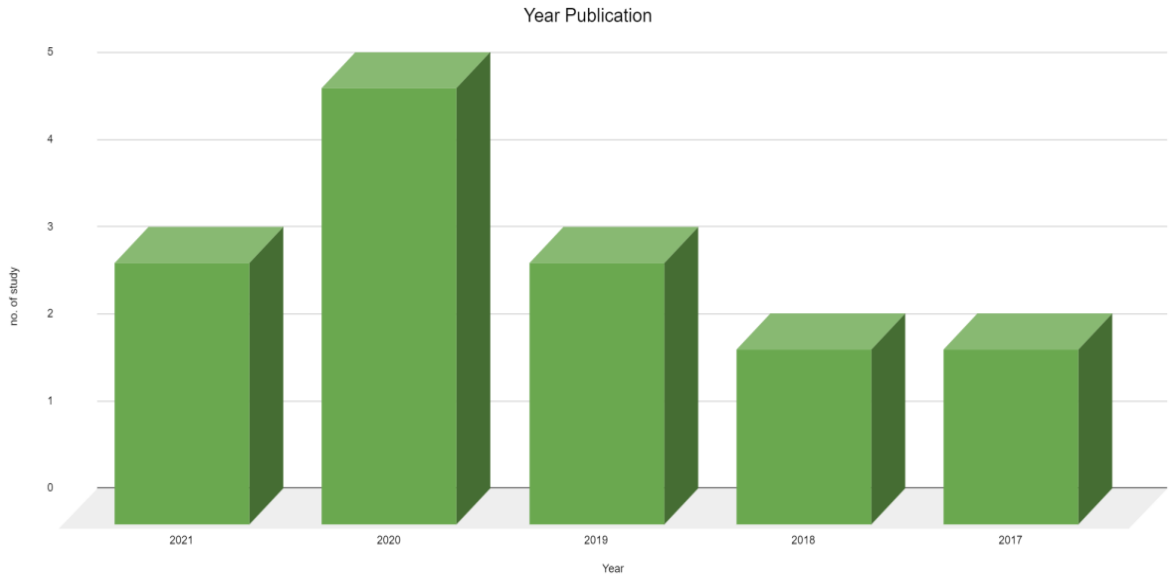
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Figure 3: Number of Studies According to Research Design



In terms of year of publication, two articles were published in 2017 (Yang et al., 2017; Yeh et al., 2017), two in 2018 (Aguirre-Bielschowsky et al., 2018; Martín-Gámez & Erduran, 2018), three articles were published in 2019 (Chatterjee et al., 2019; Lodico et al., 2019; Merritt et al., 2019), and five papers were published in 2020 (Deveci & Karteri, 2020; Edsand & Broich, 2020; Gołębiowska, 2020; Jamaludin et al., 2020; Martínez-Borreguero et al., 2020). Lastly, three papers were published in 2021 (Chodkowska-Miszczuk et al., 2021; Cotton et al., 2021; Pestana et al., 2021) as shown in Figure 4.

Figure 4: Number of Studies According to Year of Publication



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3.2. The established themes

To answer the research question, thematic analysis was carried out on the 15 selected articles. From this thematic analysis, five principal main themes emerged: (1) energy literacy, (2) renewable energy; (3) related programmes, trainings, and campaigns; (4) strong social relationships; (5) teaching techniques. These five principal themes branched out into 11 minor subthemes (see Table 5). Therefore, from the results of the thematic analysis, these five main themes and 11 subthemes delivered solutions to the two important research questions of this SLR,

The emergent themes and sub-themes of this review's findings are explained in the next section. The factors that contribute to energy literacy in education are divided into five main themes: energy literacy (divided into three sub-themes: definition, curriculum, and social awareness among citizens); renewable energy (divided into three sub-themes: definition, examples, and benefits); related programmes, trainings and campaigns (divided into two sub-themes: examples, and explanations of programmes); strong social relationships and energy literacy (divided into two sub-themes: awareness of effects, and attitude of responsibility); as well as teaching techniques (consists of one sub-theme: models/methods) (Figure 5, Table 5).

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Table 5: Established Themes

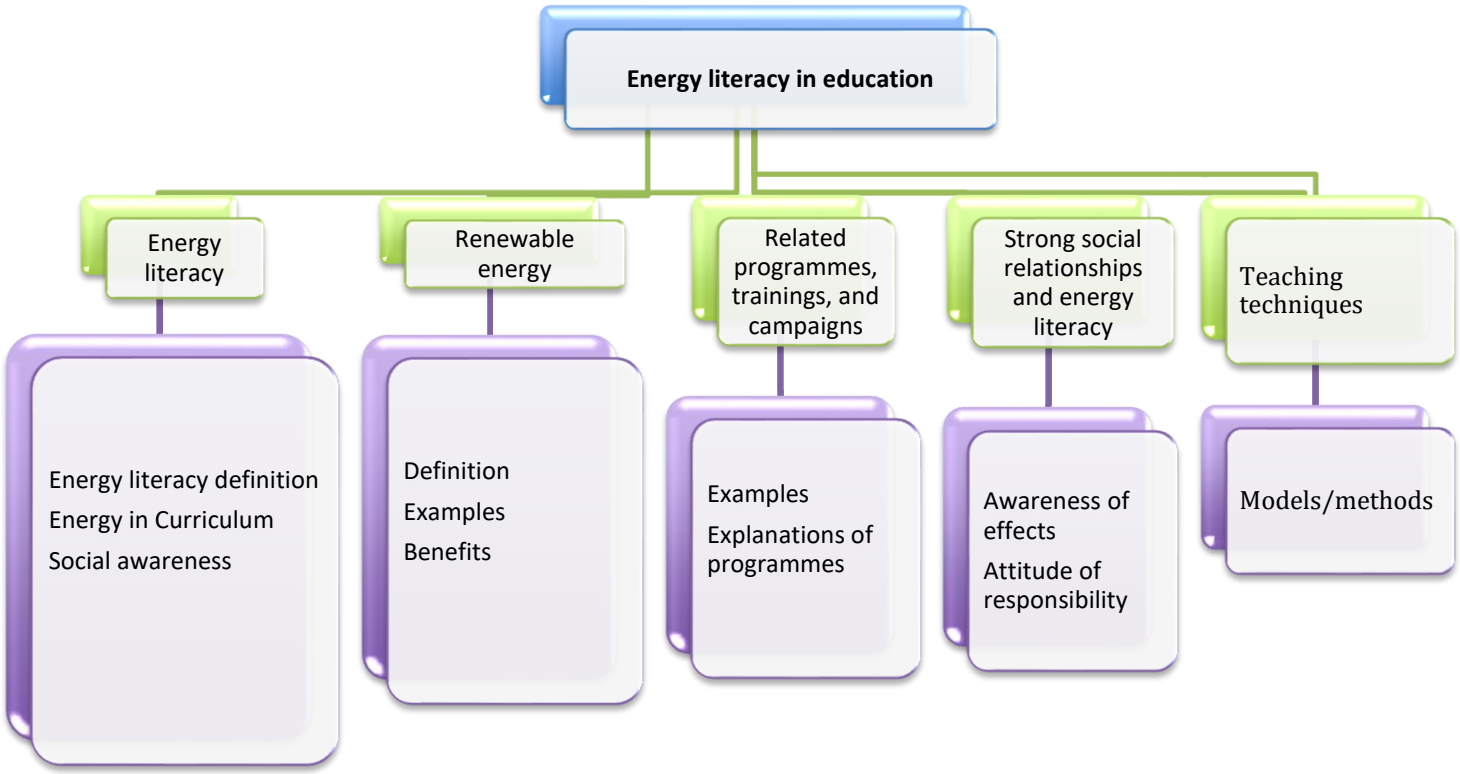
Themes / Authors		Energy literacy			Renewable energy			Related programmes, trainings and campaigns		Strong social relationships and energy literacy		Teaching techniques
	Sub-themes	Definition	Energy in Curriculum	Social awareness	Definition	Examples	Benefits	Examples	Explanations of programmes	Awareness of effects	Attitude of responsibility	Models/Methods
1	Martínez-Borreguero et al. (2020)		Primary School		/	/	/	/		/	/	
2	Deveci & Karteri (2020)		science curriculum					/	/	/	/	/
3	Yang et al. (2017)			/		/	/					game-based
4	Edsand & Broich (2020)		science curriculum	/		/	/	/	/	/	/	/
5	Pestana et al. (2021)			/		/	/	/	/	/		/
6	Chodkowska-Miszczuk et al. (2021)	/		/		/	/	/	/	/	/	
7	Merritt et al. (2019)	/	upper elementary students	/	/	/	/	/	/	/	/	service learning

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8	Chatterjee et al. (2019)					/	/	/	/	/	/	
9	Aguirre-Bielschowsky et al. (2018)		Year 5	/				/			/	/
10	Nugroho et al. (2019)		High School	/				/	/	/		Text book
11	Yeh et al. (2017)	/	High School	/	/	/	/	/	/	/	/	/
12	Cotton et al. (2021)	/	/	/	/	/	/	/	/	/	/	/
13	Jamaludin et al. (2020)			/	/	/	/	/	/	/	/	
14	Gołębiowska (2020)	/		/		/	/	/			/	
15	Martín-Gámez & Erduran (2018)		science curriculum			/	/	/	/	/	/	/

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Figure 5: Energy literacy in education



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3.3. Energy Literacy

Energy literacy has been studied worldwide for different objectives. This study found that the first sub-theme in the main theme of energy literacy found in the reviewed literature was the meaning or definition of energy literacy. Energy literacy is an the ability to understand the nature and the multidimensional roles of energy and its utilisation in our lives, whether in the personal or corporate dimension (Chodkowska-Miszczuk et al., 2021; Merritt et al., 2019). When people understand energy literacy, global problems about energy, global warming, and climate change could be addressed. Citizens with awareness about energy literacy are projected to behave in reliable ways corresponding to their adjusted understanding and structured behaviour. Therefore, increasing energy literacy is a critical task. Having well-informed and well-educated citizens is the basis for designing and implementing smart and exploratory approaches to solve these problems (Yeh et al., 2017).

The second sub-theme was related to energy literacy in the curriculum. Many curricula in education have integrated energy literacy from preschool to tertiary education due to its importance. The efficiency of the curricula to improve energy responsiveness is not yet optimum (Nugroho et al., 2019). For instance, in Turkey, environmental subjects are taught by incorporating them into the science and chemistry curricula (Deveci & Karteri, 2020). In the United States, most students get information about energy from curricula that teachers have used to teach students in the classroom (Merritt et al., 2019). Rather than being integrated into science and chemistry, Edsand and Broich (2020) found that extra-curricular environmental teaching in primary schools strongly affects environmental knowledge and attitudes towards the environment. In New Zealand, there seems to be a lack of proper teaching methods for energy literacy. Furthermore, while energy literacy is part of the recommendations for the Year 5 curriculum, it is non-compulsory for teachers to teach it (Aguirre-Bielschowsky et al., 2018).

The third sub-theme under energy literacy was social awareness. Energy literacy, related to environmental literacy, is not only about academic knowledge that can answer examination questions; it is multi-disciplinary. It encompasses cognitive, affective and behavioural components that incorporate various skills and thoughts (Chodkowska-Miszczuk et al., 2021; DeWaters & Powers, 2013; Yeh et al., 2017). Chodkowska-Miszczuk et al. (2021) reported on the level of energy literacy in countryside environments based on three key elements: awareness, attitude, and behaviour, not just based on examination questions.

3.3.1. Renewable Energy

The second theme which emerged from the systematic review was renewable energy. Studies on renewable energy emphasised the challenges in distinguishing trustworthy from untrustworthy knowledge, particularly when local communities have their own rules and conditions for renewable energy technology innovation (Pestana et al., 2021). Renewable energy is a vital part of energy literacy. The first sub-theme under this theme was the definition of renewable energy. Two goals for renewable energy are for everyone

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worldwide to have access to affordable, reliable, and clean energy, which is SDG 7, and for sustainable energy production and consumption patterns to be promoted, as enshrined in SDG 12 (Pestana et al., 2021). Many younger scholars argue for or against the effects of using electrical energy or consuming renewable energy sources on climate change. It was also observed that the potential effect of education on renewable energy usage had been extensively discussed in Australia compared to Oman or Turkey (Martínez-Borreguero et al., 2020). The main theme highlighted in most past articles was the alternative use of renewable energy as a mitigation plan in handling the energy sector issue. This theme was highlighted in thirteen articles.

The second sub-theme was examples of renewable energy. The use of these sources of energy such as nuclear energy, thermal energy, solar energy, water energy and wind energy has been implemented in many countries as alternative sources of energy to generate electricity. For example, windmills have been used in the Netherlands and Taiwan to generate electricity, and the use of heat pumps or solar energy panels has generated interest in renewable energy (Chodkowska-Miszczuk et al., 2021; Yang et al., 2017). Most citizens in Taiwan agreed that wind turbines should be used more extensively to replace thermal electricity (Yeh et al., 2017). Besides solar energy, various techno-economic findings are reported. Chatterjee et al. (2019) presented effective optimisation methods for hybrid renewable energy resources that could be used by households, streetlights, and public health centres in off-grid neighbourhoods. This study was conducted in Jharkhand, India, where a "Hybrid Renewable Energy System" (HRES) was developed and used in a primary school with a need capacity of 4.3 kWh/d, a highest capacity of 1.1 kW, and a capacity factor of 0.16 (Chatterjee et al., 2019). In the meantime, most German citizens were found to overvalue the contribution of nuclear energy while undervaluing fossil fuels and renewable energy sources (Yeh et al., 2017). Students and the public should be educated on renewable energy, upcoming progress and new technological products for renewable energy. The growing concern over climate change has intensified attention towards renewable energy education and new modern technologies.

The third sub-theme was the benefits of renewable energy. One benefit from an increase in intensity in the invention of ways to access and expend renewable energy is a wider approval of sustainable lifestyles. The process of evolution from the usage of the contemporary electrical system, which is usually centralised and uses fossil fuel as the main power source, to a new electrical system principally built on distributed renewable energy production, is projected to play an imperative role in the decarbonisation of the energy sector to avoid releasing greenhouse gases, and finally, to fight climate change (Pestana et al., 2021). Moreover, most countries focus on converting energy systems to decarbonised ones as one of the modification goals aimed at, as presently, various sources report that energy-associated GHG emissions account for more than 60% of the global inventory (Kuzemko et al., 2016). It was also argued that using non-renewable energy such as fossil fuels can further contribute to climate change (Yeh et al., 2017). Therefore, decarbonisation can be applied in the electricity energy sector as one of the climate change improvement plans because at present, most electricity is still produced from fossil fuels.

3.3.2. Related Programmes, Trainings, and Campaigns

This study found that the first sub-theme in the main theme of related programmes, trainings, and campaigns found in the reviewed literature was the example of

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programmes. Most of the programmes related to energy literacy is about educational programmes to educate pupils about energy and renewable energy. Educators may use a lot of source such as text books, computer programming or social activity in order to teach pupils about energy and climate changes.

The second sub-theme was explanation of programmes, trainings, and campaigns. Educators need to be updated on recent developments through training programs. They need to know the latest information and need to be exposed to the latest knowledge about global issues such as energy literacy and climate change. Students should be taught to think critically and analytically to promote positive social and political change so that they can defend the conservation of green energy resources (Martínez-Borreguero et al., 2020). Besides educators and students, decision-makers should also be exposed to successfully change their paradigm from dependence on fossil fuel to green energy and other renewable energy sources that can produce low carbon emissions. The latest technological innovations could develop energy literacy among the public (DeWaters et al., 2012; Yeh et al., 2017). A study which involved Chinese respondents both in the UK and China found that participants formed new habits like avoiding charging mobile phones at night and participating in green environmental public programmes, showing that they loved the environment and were concerned about solving the issue of climate change and its effects to the environment (Cotton et al., 2021). For example, they used the visual programming environment Scratch to have students create simulations in context of climate change with a focus on system and computational thinking (Mittenzwei et al., 2019).

3.3.3. Strong Social Relationships

This study found that the first sub-theme in the main theme of strong social relationships found in the reviewed literature was awareness of effects. Another aim of energy literacy is to identify social issues which could positively affect the students (Chatterjee et al., 2019). Hence, energy literacy has a strong relationship with social issues. Energy impacts our daily lives. It is not just about science, but is also related to financial and public knowledge concerns (Chodkowska-Miszczuk et al., 2021; Gołębiowska, 2020; Martín-Gámez & Erduran, 2018; Martínez-Borreguero et al., 2020; Yeh et al., 2017). Ideally, energy literacy curricula should integrate social and emotional learning (Merritt et al., 2019). The sense of personal responsibility for controlling electricity consumption will increase with energy literacy, creating stronger environmental thinkers (Gołębiowska, 2020).

The second sub-theme was attitude of responsibility. Teaching children to save energy through socialisation at a young age is important (Aguirre-Bielschowsky et al., 2018). Socialisation could lead to the formation of new positive habits and behaviours towards the environment (UNESCO, 2016; Martínez-Borreguero et al., 2020). The social and economic development of population data and human behaviour are important elements that should be applied before any new concept is introduced to the community (Jamaludin et al., 2020). Therefore, hybrid technological and social transformation is important to improve energy literacy and to educate the community about the advantages of low carbon technology. It is rooted in the systematic process of rethinking social and technological structures (Cotton et al., 2021).

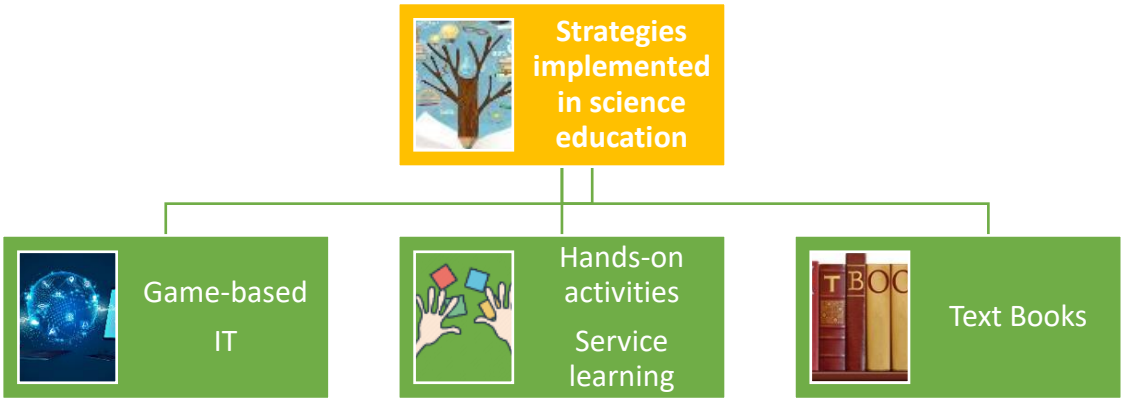
3.3.4. Teaching Techniques

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Energy literacy education should be implemented in communities starting from early childhood education. Education is important as a key element of producing and sharing energy knowledge as a response to climate change (Reimers, 2021). Educators could develop effective teaching and learning strategies regarding green and sustainable environmental development (Martínez-Borreguero et al., 2020). Energy information is essential to equip the public with the fundamental components of energy literacy (Yeh et al., 2017). That argument is further supported by a study by Pestana et al. (2021) which aimed to increase energy literacy and complement the public's knowledge of energy production and consumption. Moreover, one of the goals, SDG 4, focuses on the quality of education among students from early primary, secondary, to high school, as that will have an impact on the positive effects or outcomes in SDG 12, which is Responsible Consumption and Production. Education for youths should emphasize more on sustainable lifestyles and provide them with appropriate information through labelling and usage guidelines, among other things (Martínez-Borreguero et al., 2020).

This main theme of teaching techniques or strategies implemented in science education to impart energy literacy consists of one sub-theme, which is models and methods of teaching. There were three models or methods of teaching found in the reviewed literature, namely the use of game-based IT, hands-on activities, and textbooks (Figure 6). Teachers should strive to create a positive learning experience for their students, as there is a positive correlation between satisfaction with science and eco-friendly mindsets (Edsand & Broich, 2020). Effective pedagogical strategies can increase energy literacy (Martín-Gámez & Erduran, 2018). Moreover, digital learning has the potential to create effective learning strategies and positive learning experiences. The teaching and learning process becomes easier, and the implementation of energy knowledge and fulfilment of behavioural objectives are increased with the assistance of digital platforms (Yang et al., 2017).

Figure 6: Strategies implemented in science education



Besides game-based digital learning, environmental measurement tools should support the context-based learning approach. Studies have found that this strategy could improve prospective science teachers' self-efficacy and environmental literacy (Deveci & Karteri, 2020). For instance, during the teaching and learning process, students should discover energy problems and then work hands-on to design possible solutions (Merritt et al., 2019).

In the secondary and higher education levels, constructive learning approaches can be used (Yeh et al., 2017). For example, a study on STEM education highlighted that, to realise

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how renewable energy runs, students should recognise the basic mathematics, science, engineering, and technology, together with the connections between them (Afriana et al., 2016; Wagner et al., 2015; Yeh et al., 2017)Project-based learning should also include civic elements. One such hands-on project could include organising energy exhibitions to inform pupils regarding energy conservation. This activity could help students better understand scientific concepts, as they would have to apply what they have learned in the classroom to true-world challenges (Merritt et al., 2019). For example, the study of geography promotes education that allows students to be familiar with socially and environmentally acceptable practices in everyday life, such as the use of public transport and renewable energy sources in The German Educational Standards for the Intermediate School Certificate (Hemmer et al., 2014). The German government took steps to promote the usage of public transportation because they found that many communities in Germany were observed to misjudge the use of renewable energy resources, and many students and teachers in primary and secondary schools had misconceptions about energy (Kurt, 2013).

Textbooks are where the interpretation of the curriculum's requirements becomes important because of their dominance as vehicles for delivering information, skills, and knowledge in school education (Martínez-Borreguero et al., 2020). Most teachers use textbooks to teach and cover the approved curriculum in the process of teaching and learning lessons in their schools (Reimers, 2021). Therefore, textbooks have usually become an easy and necessary teaching and learning aid that is used by students and teachers to obtain information. Unfortunately, this central position which textbooks enjoy does not help to increase energy literacy when low exposure levels about energy, its sources, its importance, and its effects on the environment were found in students' textbooks (Nugroho et al., 2019). Educators could create meaningful learning opportunities in teaching energy literacy by using better textbooks (Mažeikienė & Norkutė, 2021). Alternatively, they could integrate existing textbooks with ICT (information and communication technology) to create creative and innovative teaching and learning lessons when they teach about energy. ICT-based textbooks or e-textbooks in multimedia model formats could be created using audiobooks and e-books to exhibit the learning content to make the learning process become more attractive and student-friendly.

5. Discussion

It is important to prioritise sustainable green technology by changing our lifestyle, specifically the use of energy in our daily lives (Thoyre & Harrison, 2016). Energy literacy can improve our environmental awareness. This is closely correlated to the environmental issues which we currently face, including the steadily worsening climate change situation. Energy literacy is needed to increase sustainable electricity consumption among the public (Gołębiowska, 2020). An energy literate society will improve their behaviour towards energy use and start using low carbon or renewable technology. All citizens should become energy literate. The inclusion of energy literacy in learning creates awareness in students and improves their cognitive skills as well as their emotional and psychomotor development. It would also increase students' knowledge of energy and the natural environment (Nugroho et al., 2019). Studies have found gaps between students' basic science knowledge and their level of energy literacy. Meanwhile, a study in Greece found that pupils' understanding of renewable energy is lower than experts (Yeh et al., 2017).

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Thus, to improve the awareness of energy literacy amongst citizens and especially amongst students, plans have been formulated by many parties. The best way to educate pupils on this subject is by creating an awareness about energy literacy within the students in our schools, as they are our next generation. Sadly, two studies discovered that pre-service physics and biology teacher candidates themselves had a lack of knowledge regarding energy conservation; they were confused on the concept of energy conservation and they also had minimal metacognitive and cognitive skills (Trumper, 1997; Yusup et al., 2017). With such teachers, it is unsurprising that many students had problems in understanding energy concepts (Chabalengula et al., 2011). Therefore, teachers should be given initial training to teach topics about energy. Besides that, they can also improve their capabilities by self-directed learning, using the internet and reading more books about energy (Mažeikienė & Norkutė, 2021).

One of the important initiatives involved is to insert the information and input regarding energy literacy into the students' syllabi at early ages. This initiative had been started several years before and is currently being adapted to match the students' preferences and interests. For example, teachers may deliver input concerning energy literacy impacts related to electricity consumption, as the children have experienced it in their daily lives at home (Aguirre-Bielschowsky et al., 2018). Rationally, students will have a greater understanding of the topic if they have personal experience of it. Constructivist learning approaches include active learning activities, where students create their own understanding, look for the meaning of what they are learning, and are able to develop and complete new concepts and ideas within their existing framework of thinking (Suparlan, 2019). Active learning or learning by doing is very important. That is why the delivery mechanism of energy literacy input must be varied and creative, to effectively correct the behaviour of students towards saving energy with reasoning. Moreover, by educating children about energy, there is a ripple effect in which the children can also, in turn, educate their siblings and parents in saving electricity. Children can encourage their parents to buy energy-saving light bulbs, dry clothes on the line, and turn off appliances when they are not in use (Tsagarakis et al., 2012).

Effective pedagogical and learning activities are very important to educate students about technology. During the COVID-19 pandemic, mobile learning has been prioritised at all levels, from preschool to higher education (Fitriyani & Mukhlis, 2021). Students tend to favour the use of technology and the online medium of teaching and learning in comparison to other types of learning methods, as it provides more flexibility in learning, time management, and course options offered worldwide (Mohalik & Sahoo, 2020). E-learning can be beneficial in educating students and imparting energy knowledge. There is a need for more research on the effectiveness of online and offline energy games in teaching energy literacy (Yang et al., 2017). This study posits that such endeavours are essential to increase students' energy knowledge with proper and suitable learning models (Nugroho et al., 2019). Finally, it is hoped that this study clarifies the situation on how energy literacy should be taught with efficient approaches. This study can also be used as an aiding tool or catalyst by the related parties to impart strategies in educating students using more student-friendly and efficient methods, pedagogical models, or techniques in teaching energy literacy.

6. Conclusions

The findings from this systematic review of the recent literature on the societal awareness of energy literacy showed that teachers and lecturers worldwide are trying very hard to

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teach energy literacy to society. Moreover, five main themes that fulfilled the two main objectives of this study emerged via a thematic analysis of the current research. The five themes covered the first objective, which is the element of energy literacy education strategies that have been used to create climate change awareness globally. The five main themes encompass the overall aspects of energy literacy education and sustainable development, which are the factors influencing climate change, its impacts towards humanity and other organisms, and the mitigation actions that can be taken in handling it. Moreover, the second objective was about the strategies implemented in science education to educate students globally. Curricula were developed according to the objectives of various SDGs (Reimers, 2021). In many countries, energy literacy has been integrated into the science curriculum in order to educate the national community about energy literacy beginning from early childhood education up to the level of tertiary education. In this light, STEM is the subject most related to energy literacy. Besides that, technology-based, internet-based learning and mobile learning, integrated with learning by doing or constructivist learning, needs to be modernised in educating students. Moreover, energy literacy within the community is related to social skills, awareness, behaviour, and attitude.

Ethics Approval and Consent to Participate

The researchers used the research ethics provided by the Research Ethics Committee of Universiti Kebangsaan Malaysia (RECUKM). All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee. Informed consent was obtained from all participants according to the Declaration of Helsinki.

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Conflict of Interests

The authors declare no conflict of Interest.

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