Journal of Engineering Science and Technology
Special Issue on AASSEEEC2020, December (2020) 70 - 77


# EXPLORING THE IMPACT OF LOW CARBON LITERACY TO THE INDONESIAN CHILDREN IN ELEMENTARY SCHOOL FOR THE CARBON FOOTPRINT OF HOUSEHOLD ELECTRIC CONSUMPTION AND THE FAMILY LOW CARBON PRACTICE

MUHAMMAD SYAHRUDDIN AMIN*,
ANNA PERMANASARI, AGUS SETIABUDI, IDA HAMIDAH

Universitas Pendidikan Indonesia,
Jl. Dr. Setiabudhi no 299, Bandung, 40154, Indonesia
*Corresponding Author: amien_syahruddin@upi.edu

**Abstract**

The household sector is the largest consumers of electricity and the largest contributor of $CO_2$ emissions in Indonesia. The research question of this study is what is the level of low carbon literacy of elementary school children from middle class families?; and what is the level of family knowledge about the amount of $CO_2$ emissions from electricity consumption at their home?. The questionnaire and semi-structured interviews are used to collect data from children in elementary school level and parents of middle-class families. Overall, the low carbon literacy of children (3rd and 6th grader) of the middle-class families on average are at a good level. But some of the low carbon behavior of the children should continue to receive attention and guidance from parents and teachers that is watching television, wasteful of water, throwing the food when eating, let the socket is connected, and the use of toys and plastic bags. It was also found that the students and parents do not understand how to calculate energy consumption and $CO_2$ emissions from various household appliances in their home. The results of this study can be the basis for teachers in compiling learning and also become guidelines for parents in providing guidance and habituation to build energy and emissions-friendly behaviors in the children.

Keywords: Carbon footprint, Electric, Household, Low carbon practice.

## 1. Introduction

Globally, fossil fuels are the main energy reaching 80% of total energy consumption [1]. The numbers continue to rise even projected to continue until 2040 [2]. In Indonesia, 76 % of the total national coal production is used as fuel to generate electricity in power plants [3, 4]. Indonesia is the largest energy consumer in Southeast Asia, and the fifth in the Asia-Pacific region in primary energy consumption after China, India, Japan, and South Korea [5]. Electricity is the main source of energy that used by Indonesian society especially households, where the number reaches 93.583,52 MW [6]. Its means the households are the largest contributor of $CO_2$ emissions in Indonesia. The level of $CO_2$ emissions continue to rise day to day. Data in September 2019 showed that the average concentration of $CO_2$ in the atmosphere globally at 410.60 ppm [7]. Data in 2018 shows that the global $CO_2$ emissions number reaches 33.890,8 million tons and 543 million tons in Indonesia [8]. To sustain the nature, building public awareness especially the younger generation including students on the environment is much more important than on addressing the environmental damage itself [9].

Carbon footprint is a measure of the total amount of carbon dioxide emissions resulting directly (ex. coal for power plants) and indirect resulting from the use of electricity for household electronic equipment [10]. Thus, establishing a low carbon literacy of societies especially children become indispensable to maintain the sustainability of our life in the future. Embed pro-environmental character should be made as early as possible, starting from the lowest level of education [11]. Integrating issues or environmental substances into education becomes very important, especially materials directly related to the reduction of carbon emissions. The concept of environmental education in Indonesia that had been stuck on 5 topics that are social environment, spatial environment, natural environment, artificial environment, as well as climate change and environmental disasters, must be transformed into a low carbon education (LCE). The comprehensive analysis of low carbon education has also been carried out in previous studies [12]. The main essences are the efficient use of energy, the development of clean energy, and supporting the green development [13].

The purpose is to build the capacity of individuals related to the substance of low carbon to manage the environment in the context of everyday life such as the use of energy (fuel, electricity) and the consumption of natural materials [14]. Wise in using materials that detrimental to the environment is a form of application of environmental literacy [15]. LCE concept can be applied through the continuous process of education at school and home (family).

So far, there is no research about low carbon literacy of children at elementary school. Although there are some researches, they did not report in detail [16, 17]. This study focuses on elementary school children behavior related to low carbon literacy. This study did not explore the detail factors that influence the children low carbon behavior, nor does it delve into the achievement of low carbon literacy in each component such as knowledge, responsibilities, etc. The research question of this study is what is the level of low carbon literacy of elementary school children from middle class families?; and what is the level of family knowledge about the amount of $CO_2$ emissions from electricity consumption at their home?. This study aimed to explore how is the low carbon literacy of children in elementary school

level, and to know how the family from middle level know about how to measure the energy consumption and $CO_2$

## 2.Methods

This is the exploratory qualitative research using a questionnaire and semi-structured interviews. The process of this research shown in Fig. 1. The samples of this study is totaled 41 students from 3rd grader group, and 6th grader group, and 18 students parents, which are detailed in the Table 1.

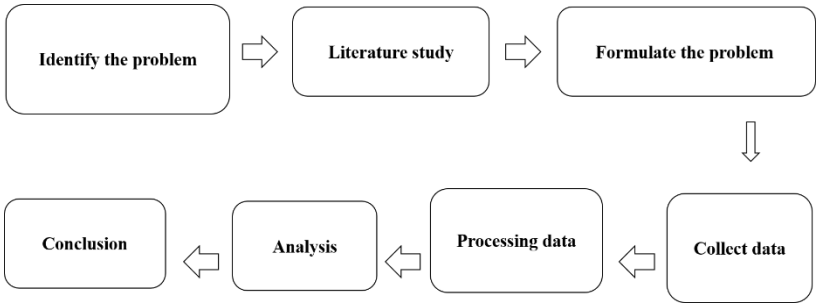


**Fig. 1. Research procedures.**

**Table 1. Description of participant.**

| Age group | Boys | Girl | Family level |
|---|---|---|---|
| **3rd grader** | 6 | 15 | mid class |
| **6th grader** | 10 | 10 | mid class |

Most of the students' parents work as farmers, a small number have various professions such as traders, government employees, and teachers. The questionnaire used consists of 18 items in 9 years-old students and 14 items in 12-year-old students, covering 4 substances namely electricity use, water use, plastic and waste management, and the use of motor vehicles. And the interview for parents includes 3 substances electric power, relation between electricity and $CO_2$ emissions, and calculating ability of electricity and $CO_2$ emissions. The calculation of the electricity consumption and the $CO_2$ emissions of middle-class household is calculated using a standard equation [18] that is:

$$Consumption\ of\ elecricity = P.t \quad (1)$$

where consumption of electricity is the electricity used (kWh), $P$ is the power of electric device (W), and $t$ is the usage time (h).

$$CO_2 \text{ emission} = EC.CEF \quad (2)$$

where $CO_2$ *emission* is the amount of carbon dioxide that wasted (kg/month), *EC* is the total electric consumption (kWh), and *CEF* is the carbon emission factor of electricity (kg $CO_2$/kWh). Electricity carbon emission factors is 0.725 kg $CO_2$/kWh [19].

## 3. Results and Discussion

The data collection was conducted gradually and separately, starting from the 3rd grade, then the 6th grade, and the last one was data from the randomly selected

parents of students. The data underwent several analysis processes, first analysis of students low carbon levels globally, analyzed in more detail in every aspect (the use of electricity, water, waste and plastic management), and the use of motor vehicles. The last one is analyzing parents' ability to measure electricity use and calculate $CO_2$ emissions produced in their homes.

## 3.1. The behavior of low carbon practice of 3rd grader children

The data on this study contained the children habits associated with the utilization of energy and materials in their daily lives, including 3 substances consisting of electricity use, water use, waste and plastic management. Overall, most of children have been able to implement low carbon in their daily activities. The total response of children on each category of 21 children was then analyzed. From 18 items asked, 74.60% of students responses showed that they were able to apply low carbon behavior in their activities, 13.20% of students responses stated that they did not apply low carbon behavior in their activities, and 12.20% of student responses showed that they were unsure of the behavior of low carbon in their activities.

Low carbon literacy that has not been practiced by many students in daily activities, first 24% of the students watching television in a long time. This behaviour cannot be separated from the easy access of children to television. In the literature, 1 of 6 children aged 6-7 years has a television in his own room [20]. It certainly correlates directly to the use of electricity and the amount of $CO_2$ emissions. This condition should be the concern of parents because watching television for too long will have an impact on the level of knowledge [21], social and behavioural development of children [22]. The role of parents in guiding, directing and familiarizing the child to apply the principle of low carbon in their daily activities is very important to build children low carbon literacy. Second, the behaviour of the bath, there are approximately 38% who use excessive water when bathing. This will increased the electricity consumption to pump water, and reduce water reserves in the earth. Third, many students throw away food when eating that ultimately pollute the environment. Fourth, 47.60% of students dispose the toys that have been used, this will increase the volume of plastic waste, even though plastic waste has become a serious problem in Indonesia [23].

## 3.2. The behavior of low carbon practice 6th grader children

The data of 6th grade children are obtained from 14 item of questionnaire which includes 4 substances that is the use of electricity, water use, waste and plastic management, and the use of motor vehicles. Table 2 shows the total response of children on each category of 20 children. From 14 items asked, 85.30% of children shows that they were able to practice the LCP behavior in the various activities even in activities such as turning off the television and lights when not in use, saving water when bathing and brushing teeth, and sorting the waste. On the other side, 4.30% of children shows that they rarely applying the low carbon behavior in their activities, 9% of children shows that they do not implement the low carbon behavior in their activities, and also of 1.40% of children it seems that they do not know about the low carbon behavior. The role of environmental education by parents at home and teachers at school is very important to establish the environmental awareness character in students since an early age [24].

Collaboration between school and family makes it very easy for the child to build and develop low carbon literacy in him and apply it in everyday behavior.

There are some behaviors of 6th grade that is not in harmony with the low carbon principles. First, 35% of students leave electrical appliances such as televisions stays attached to the socket. Habituation is one of the best ways to educate and build children's characters [25]. Second, there are 20% of students still let the air conditioner stays on for 24 h. Furthermore, there are still 30% of students' waste water when bathing using a bathtub. Fourth, there are 25% of students still often use plastic bags to wrap food or groceries.

**Table 2. Low carbon practices of 6th grader.**

| Response | Total | Percentage |
|---|---|---|
| **Yes** | 239 | 85,3% |
| **Sometimes** | 12 | 4,3% |
| **Don't know** | 4 | 1,4% |
| **No** | 25 | 9% |

### 3.3. Measures the household electricity consumption and $CO_2$ emissions

Besides the children low carbon behavior, the study explored parents' ability to calculate the electricity consumption of their home appliances and $CO_2$ emissions of their home. Figure 2 shows most of the parents apparently did not understand that the electricity consumption causes the $CO_2$ emissions. The most interesting things is the ability to measure the power consumption of parents who answered "know" it is measuring the electricity of kWh meters instead of calculating the power of the whole household appliances [26]. So, to facilitate them in doing that, here we present an example of calculation of electricity consumption and $CO_2$ emissions of the middle-class household. A household appliances that owned by a middle-class family according to their needs for cooking (rice cooker and refrigerator), cooling (fan), lighting (lamps), entertainment (TV), and others (iron) [27].

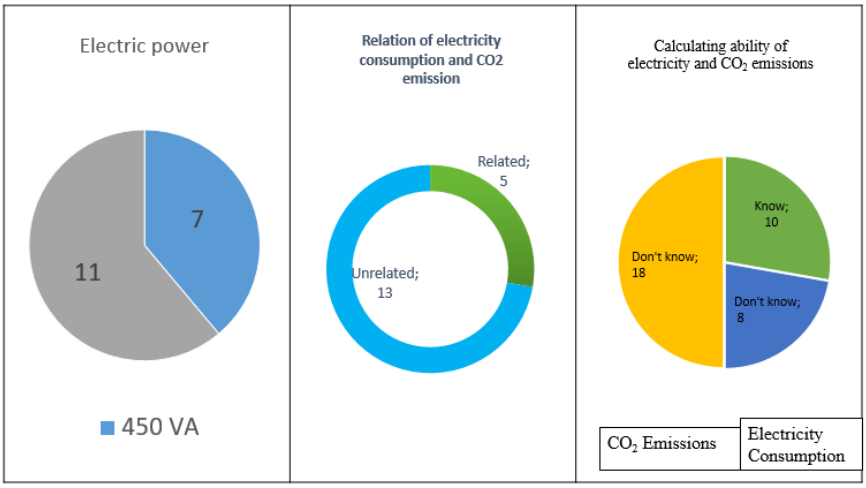


**Fig. 2. The parents ability to calculate electricity and $CO_2$ emissions.**

The electricity consumption of these tools can be calculated as follows:

i. Lighting, average time per day of a lamp is 8 hours, then:
   Consumption of electricity = Power×Time = 73×8 = 0,584 kWh/day. Total consumption of electricity for the lights is 0,584×30 = 17,52 kWh / month.
ii. Electric Iron, with power @ 350 W and use time 10 hours per month, then: Consumption of electricity = Power x Time = 350×10 = 3,5 kWh / month
iii. Refrigerator, which has 165 W, and uses time 500 hours in one month, then: Consumption of electricity = Power×Time = 165×500 = 82,5 kWh
iv. TV 21"; with the power of 100 W, and uses time 240 hours/month, then: Consumption of electricity = Power×Time = 240×100 = 24 kWh / month
v. Rice Cooker; the power that used to cook rice is 300 W and a lifetime 2 hours a day (60 hours/month), then:
   Consumption of electricity = Power×Time = 300 x 60 = 18 kWh/month
   And for heating, the power needed only 35 W, and the effective time 20 hours/day (600 hours/month), then: Power×Time = 35×600 = 21 kWh/month. So, the total electricity used for rice cookers is 39 kWh/month
vi. Fan; have power 45 W with a lifetime of 4 hours/day (120 hours/month), then: Consumption of electricity = Power×Time = 45×120 hours = 5,4 kWh/month

Total electricity that used by a middle-class household in 1 month is 171.92 kWh. As we known the emissions factor of electricity is 0,725 kg $CO_2$/kWh, then the total $CO_2$ emissions of middle-class household in 1 month is:

$CO_2$ *emissions* = *EC*. *CEF* = 124.642 kg/month/house

Details of $CO_2$ emissions of each electronic device at home for 1 month are presented in Table 3.

**Table 3. $CO_2$ emissions of electronic devices.**

| Electronic devices | Electricity consumption (kWh) | $CO_2$ emissions (kg) |
|---|---|---|
| **Lamp** | 17.52 | 12.70 |
| **Iron** | 3.50 | 2.54 |
| **Refrigerator** | 82.50 | 59.81 |
| **Television** | 24.00 | 17.40 |
| **Rice Cooker** | 39.00 | 28.28 |
| **Fan** | 5.40 | 3.92 |

From previous findings and descriptions, it appears that both the school (teacher) and the family (parents) have the same contribution in the process of forming low carbon literacy in the child [27]. So, in the future, we need a study on the effectiveness of collaboration between parents and teachers towards the process of developing low carbon literacy of students. In addition, it can also be learned about the direct relationship between the parents low carbon literacy level and the children low carbon literacy level.

## 4. Conclusion

From the behavioral survey related to low carbon that carried out on the 3rd and 6th grader, it was found that the low carbon literacy of children from middle-class families were on average at a good level. But the child needs further attention and guidance on some behaviors such as watching television, wasteful of water,

throwing the food when eating, let the socket is connected, and the use of toys and plastic bags. Actually, the students and parents do not understand how to calculate energy consumption and $CO_2$ emissions from various household appliances in their home. This finding could be an illustration that in order to develop low carbon literacy of students, it can not only be through class learning alone, but must be accompanied by guidance, and habituation process. And also, it cannot be done alone, but it has to collaborate with parents. In the future, it is necessary to conduct a research on the direct relationship between the parents low carbon literacy level and the children low carbon literacy level.

## References

1. Mardani, A.; Streimikiene, D.; Cavallaro, F.; Loganathan, N.; and Khoshnoudi, M. (2019). Carbon dioxide ($CO_2$) emission and economic growth: A systematic review of two decades of research from 1995 to 2017. *Science of the Total Environment*, 649(2019), 31-49.
2. Vandaele, N.; and Porter, W. (2015). Renewable energy in developing and developed nations: Outlooks to 2040. *Journal of Undergraduate Research*, 15(3), 1-7.
3. Cronshaw, I. (2015). World energy outlook 2014 projections to 2040: Natural gas and coal trade, and the role of China. *Australian Journal of Agricultural and Resource Economics*, 59(4), 571-585.
4. Haryadi, H.; and Suciyanti, M. (2018). Analisis perkiraan kebutuhan batubara untuk industri domestik tahun 2020-2035 dalam mendukung kebijakan domestic market obligation dan kebijakan energi nasional. *Jurnal Teknologi Mineral Dan Batubara*, 14(1), 59-73.
5. Kumar, S. (2016). Assessment of renewables for energy security and carbon mitigation in Southeast Asia: The case of Indonesia and Thailand. *Applied Energy*, 163(2016), 63-70.
6. Santika, W.G.; Urmee, T.; Simsek, Y.; Bahri, P.A.; and Anisuzzaman, M. (2020). An assessment of energy policy impacts on achieving Sustainable Development Goal 7 in Indonesia. *Energy for Sustainable Development*, 59(2020), 33-48.
7. Fernández-Duque, B.; Pérez, I.A.; García, M.Á.; Pardo, N.; and Sánchez, M.L. (2019). Annual and seasonal cycles of $CO_2$ and $CH_4$ in a Mediterranean Spanish environment using different kernel functions. *Stochastic Environmental Research and Risk Assessment*, 33(3), 915-930.
8. Andrew, R.M. (2019). Global $CO_2$ emissions from cement production, 1928-2018. *Earth System Science Data*, 11(4), 1675-1710.
9. Amini, R. (2015). Outdoor based environmental education learning and its effect in caring attitude toward environment. *Jurnal Pendidikan IPA Indonesia*, 4(1), 43-47.
10. Sasmita, A.; Asmura, J.; and Andesgur, I. (2018). Analisis carbon footprint yang dihasilkan dari aktivitas rumah tangga di kelurahan limbungan baru kota pekanbaru. *Jurnal Teknik Waktu*, 16(01), 96-105.
11. Priyatna, A.; Meilinawati, L.; and Subekti, M. (2017). Pengenalan pola hidup berwawasan lingkungan pada ibu dan anak di PAUD Siti Fatimah kota Cirebon. *Jurnal Pengabdian Kepada Masyarakat*, 1(6), 348-351.

12. Hudha, M.N.; Hamidah, I.; Permanasari, A.; Abdullah, A.G.; Rachman, I.; and Matsumoto, T. (2020). Low carbon education: A review and bibliometric analysis. *European Journal of Educational Research*, 9(1), 319-329.
13. Liu, Y.; He, L., Li, X.; and Zheng, Q. (2019). Innovation practice in engineering management of the Shenzhen international low-carbon city. *Frontiers of Engineering Management*, 6(2), 302-307.
14. Xiaowei, Y.; and Xing, J. (2011). Low-carbon economy and low-carbon food. *Energy Procedia*, 5, 1099-1103.
15. Paige, K. (2016). Educating for sustainability: Environmental pledges as part of tertiary pedagogical practice in science teacher education. *Asia-Pacific Journal of Teacher Education*, 45(3), 285-301.
16. Bennett, K.K.; Weigel, D.J.; and Martin, S.S. (2002). Children's acquisition of early literacy skills: Examining family contributions. *Early Childhood Research Quarterly*, 17(3), 295-317.
17. Amin, M. S.; Permanasari, A.; and Setiabudi, A. (2019). The pattern of environmental education practice at schools and its impact to the level of environmental literacy of school-age student. *IOP Conference Series: Earth and Environmental Science*, 245(1), 1-6.
18. Nandiyanto, A.B.D. (2018). Cost analysis and economic evaluation for the fabrication of activated carbon and silica particles from rice straw waste. *Journal of Engineering Science and Technology* (*JESTEC*), 13(6), 1523-1539.
19. Zhang, S.; and Zhao, T. (2019). Identifying major influencing factors of $CO_2$ emissions in China: Regional disparities analysis based on STIRPAT model from 1996 to 2015. *Atmospheric Environment*, 207(2019), 136-147.
20. Anderson, D.R.; Huston, A.C.; Schmitt, K.L.; Linebarger, D.L.; Wright, J.C.; and Larson, R. (2001). Early childhood television viewing and adolescent behavior: The recontact study. *Monographs of the Society for Research in Child Development*, 66(1), 1-154.
21. Shin, N. (2004). Exploring pathways from television viewing to academic achievement in school age children. *The Journal of Genetic Psychology*, 165(4), 367-382.
22. Astarini, N.; Hamid, S.I.; and Rustini, T. (2017). Studi dampak tayangan televisi terhadap perkembangan perilaku sosial anak. *Jurnal Cakrawala Dini*, 8(1), 1-11.
23. Purwaningrum, P. (2016). Upaya mengurangi timbunan sampah plastik di lingkungan. *Jurnal Teknologi Lingkungan*, 8(2), 141-147.
24. Masruroh. (2018). Membentuk karakter peduli lingkungan dengan pendidikan. *Jurnal Geografi Gea*, 18(2), 130-134.
25. Ayun, Q. (2017). Pola asuh orang tua dan metode pengasuhan dalam membentuk kepribadian anak. *Jurnal ThufuLa*, 5(1), 102-122.
26. Sukarno, I.; Matsumoto, H.; and Susanti, L. (2017). Household lifestyle effect on residential electrical energy consumption in Indonesia: On-site measurement methods. *Urban Climate*, 20(2017), 20-32.
27. Ana, A. (2020). Trends in expert system development: A practicum content analysis in vocational education for over grow pandemic learning problems. *Indonesian Journal of Science and Technology*, 5(2), 71-85.