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PRIMARY SCHOOL STUDENTS' COGNITIVE AWARENESS ON BICYCLING AS ENERGY LITERACY IN THE CONTEXT OF EDUCATION FOR SUSTAINABILITY

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SUMMARY

Regarding students' energy literacy, research was conducted about cycling in the 4th, 5th and 6th grade of Rhodes primary schools in Greece, following planned and implemented didactic and experiential approaches. The main purpose was to determine the pupils' knowledge, views and intentions regarding the usefulness and benefits of using a bicycle and the considerable difficulties of its widespread adoption as a means of transport. The findings indicate positive views, good intentions and extensive knowledge of the great environmental and social benefits that result from the bicycle's use as well as a serious intent of its utility as a means of transport. Concurrently, the results highlight issues related to the overall lack of cycling standards within the urban fabric of the town of Rhodes and the local government should ensure the conditions for enhancing and promoting the widespread use of bicycles through infrastructure projects.

Keywords: Energy literacy, cycling, energy saving, knowledge, behavior

1. INTRODUCTION

Modern industrial, economic and social development is still supported by the widespread use of energy (Greenstone et al., 2019) which is one of the greatest challenges that humanity is currently facing, as it touches all aspects of modern life (UNDP, 2009). Integrated energy is a valuable source in daily life and, thus, being an important issue (Pierce & Paulos, 2009), as well as its transformation into a visible entity (Darby, 2001). Concurrently, the necessary amounts of energy production and use are increasing significantly. Its use is part of daily processes and habits (Shove, 2003) which are difficult for humans to associate with specific behaviours or actions as consumption patterns of energy behavior and these are then correlated and consciously linked to energy demand.

Energy resources exist in different forms. Some exist in the form of stocks and are depleted while others are more environmentally friendly, they exist as flows and are inexhaustible (RESET, 2015). Emissions of large amounts of carbon dioxide and other pollutants into the atmosphere (Ritchie & Roser, 2017) force people to look for new and alternative ways of producing energy. They must be environmentally friendly, efficient, accessible and economical. Energy is widely available and in various forms that are eco-friendly and people it in ways that are consistent with their sustainable management model.

Concurrently, urbanization has created a a broad number of issues and transport, has significant and long-term environmental, social and economic consequences, in the context of urban sustainability (Morency, 2013; Tolley, 2003). These include uncontrolled driving, travel costs, the use of fossil fuels and renewable energy sources, demand management accountable, public health and safety, education, etc. (UN, 2010). More specifically, transport is accountable for one-third of carbon dioxide (CO_2) emissions (De Nazelle & Rodriguez, 2009). Consequently, it is vital that an approach based on the life-cycle adapted which identifies the negative environmental impacts of the use of materials and energy throughout the life cycle of products and services and determines their respective importance (EEA, 2007).

The use of bicycle is one of the friendliest ways for people to go to work or for leisure. It brings significant benefits the environment and the economy (Götschi, et al., 2016; Zahabi et al., 2016). It is a healthy and cost-effective alternative to reduce greenhouse gas emissions (Mizdrak et al., 2020; Hopkins & Mandic, 2017). Concurrently, it lowers "grey energy" (ECF, 2011) and Its use induces more personal exercise, wellness and energy savings. As a result, lowering liquid fuels consumption contributes to reducing the impact of traffic congestion on urban road network as well as increasing significantly the sustainable development. (Pucher & Buehler, 2017; Civitas, 2016). Bicycling and walking are widely considered to replace, at least, some motorized forms of travel and contribute significantly to reducing energy use and carbon dioxide (CO_2) emissions into the atmosphere (Mizdrak et al., 2020; ECF, 2011). In particular, within the urban fabric, where short car journeys have a greater impact per kilometre on the environment, sustainable mobility by walking or cycling reduces significantly these effects (Neves & Brand, 2019). It should not be overlooked that almost half of intra-city car journeys are less than 5 km (EU, 2021). Undoubtedly, cycling itself can not be considered a method of transporting "zero carbon dioxide emissions" - in the sense of grey energy - but nevertheless it can be considered ten times more environmentally friendly than vehicle mobility (ECF, 2011).

Widespread cycling adoption is now recognized as a viable transportation choice that leads to the reduction of greenhouse gases (Neves & Brand, 2019) and as a consequence to Operational Energy saving. In addition, it induces a significant reduction in "Grey energy" as it is extremely limited compared to that required for the manufacture of motor vehicles with complex electrical and mechanical systems. This issue is also a very important challenge in favour of the adoption of cycling culture, without it being absolutely necessary naturally, a broad knowledge of the technical and manufacture parameters of the industrial sector is required for the construction of internal combustion vehicles or bicycles.

Several countries, especially in northern Europe such as the Netherlands, Denmark and Germany, have already adopted walking and cycling to a significant degree and can be considered pioneers in cycling (EU, 2020; Pucher & Buehler, 2008). In some countries, most adults have a bicycle. For example, 70% of the adults in Norway and 69% of the adults in Switzerland respectively own a bicycle (EC, n.d.). It is an extremely important parameter, but there is no European cycling strategy, no specific goal at a European Union level and no specific legal framework that includes cycling exclusively in Europe (EU, 2020). Another important issue, indirectly against the widespread acceptance and adoption of cycling at the level of implementation, is the non-existence of cycling standards in the urban design of cities, that is, the non-existence of cycling and walking culture. On the other hand, bicycle-sharing systems have been developed worldwide in recent years (Shui & Szeto, 2020), an encouraging element in the direction of cycling adoption.

Greek reality, the urban planning of most cities did not take into account the specifications needed for future cycling infrastructure. Few cities have promoted such a cycling culture enabling citizens to adopt cycling behaviour while indirectly enhancing their cycling consciousness through non-formal education. The town of Trikala, though, is a typical example of adapting successfully bicycling as "*an environmetally and health friendly mode of transportation*" (Wang & Szeto, 2018), a move that must adopted at a national level. This contributes significantly the non-use of fuel, the non-emission of exhaust gases into the atmosphere, the reduction of the traffic issue, the existence of free spaces in the urban fabric of the city, its better aesthetics, noise reduction, health, exercise and the physical and mental well-being of its inhabitants.

2. CYCLING CULTURE AND EDUCATION

Education is modern society's most important defence against such unconscious human threats that can have negative consequences in the future if they are not dealt with in time (Saribas et al., 2014). For this reason, it is vital to focus on the promotion of the cycling's use as a safe and environmentally friendly travel mode (KaraNikola et al., 2018) this can be achieved in primary schools where students and later on adults will be oriented towards the bicycle's daily use. In the 6-to-12 age group, which is considered unsafe for autonomous cycling in public and as a mean of transport, the best method to enhance both children and parents' cycling culture is that parents comply with the road safety rules when escorting their children. School education, thus, indirectly tends to cause osmosis to parents by emphasizing the philosophy of cycling to students. Nevertheless, children should be supervised when cycling on the road even if they are competent cyclists as they can make wrong decisions related to road safety rules (Hazael, 2017).

By designing and implementing cycling awareness in school programs, the future citizen is educated to a great degree in the field of education for the environment and sustainability, developing all those skills and views that will guide him consciously and decisively in shaping his future choices (Papavasileiou et al., 2018)

Nonetheless, there are some objections regarding cycling safety and this is an important factor in questioning the adoption of bicycling as a mode of transport (Sesli et al., 2019). Hence, cycling skills training is important as a strategic approach not only increase children's confidence in cycling (Goodman et al., 2016) but also in learning and complying with traffic rules and regulations

3. METHODOLOGY

The present research is part of a broader research approach of multiple investigations in the context of students' energy literacy in the middle and upper grades of Primary School. In the context of education for sustainable development and in combination with the curriculum regarding energy, didactic experiential approaches were initially implemented in children of the 4th, 5th and 6th grade of Primary School. These relate to traffic and environmental education and the benefits of using a bicycle in the man-made and natural environment. Traffic scenarios were implemented in a traffic education park using bicycles and groups of children who played roles with the guidance of a traffic specialist after having been trained. An environmentalist then informed the children about the health and natural benefits of cycling.

A questionnaire adapted to the students' language background was, then, designed as the most appropriate research tool for the subjects of the study (Young, 2015). It was completed by 117 students of the 4th, 5th and 6th grade of Primary School in the urban area of Rhodes town, which does not have bicycle traffic infrastructure. It includes 24 mainly closed type statements. The data were analyzed with the statistical program SPSS Statistics 23. The study explores the knowledge, habits and views of children on the issue of the current and future use of the bicycle and its acceptance as an environmentally friendly means of transportation, linking it with the issue of energy's non-use or its reduction, at a time when energy consumption governs all human processes and plays a central role the modern economic and social development, but causing serious problems in the environment. The research is a case study. The results of the study are analyzed and presented with percentage descriptive analysis and inductive statistics using the index x^2 and degree of significance <0.05.

4. RESULTS

The children are distributed almost proportionally in the 3 classes of the school. In particular, 32.5% of children belong to the 4th grade, 31.6% to the 5th grade and the remaining children (35.9%) to the 6th grade of the school. 41.9% of the students are boys while 58.1% are girls.

When asked if they have a bicycle, many children (75.2%) state that they do have a bicycle, while fewer children do not (24.8%). When asked if they would choose to use it as a means of transportation, regardless of whether or not they own a bicycle, many children (76.1%) mentioned they would choose it as their main means of transportation daily, while other children (23.9%) would not they chose it. It is stated that 26.1% of the children would use bicycle daily, 71.8% would frequently use it whereas only 1.7% would not use it at all.

When asked if cycling has a financial cost, several children say there is no financial cost (41%) linking travel to fuel costs, while many children (59%) mention there is a financial burden when cycling, linking the issue of cycling to the cost of purchasing a bicycle and the necessary equipment for cycling.

They are aware to a great extent of the bicycle's use for short trips as the majority of children agree with it (95.7%), while few disagree (4.3%). Moreover, regarding the cycling friendly mobility and the reduction of traffic congestion in cities, many children (66.7%) agree that the traffic problem is significantly reduced while the rest disagree (33.3%). This is an issue that needs retraining to properly capture the dynamics of reducing congestion especially to the children who do not the matter in question properly.

They agree to a great extent (82.1%) that bicycle makes their movements independent of the travel commitments as opposed to using public transport or a family car for their transportation while enabling flexibility as well as being relatively time-saving. Few children (17.9%) disagree with this statement. Especially on the issue of managing parking space in the urban fabric of the city when travelling, the vast majority of children (97.4%) agree that parking bicycles is a very easy and not at all time-consuming process, while few children (2.6%) do not share this point of view.

Regarding the possible travel costs when travelling by bicycle, many children (59%) state that there are not any at all, the remainder (41%) declare that there is a cost, confusing the purchase cost with the non-existent operating energy cost through fuel. Regarding this question as well as the previous one, cost statements refer to the cost of purchasing bicycles and equipment and not to non-existent energy and environmental costs related to operating energy, such as other vehicle fuels.

The vast majority of children (95.7%) significantly recognize the non-production of exhaust gases from the use of bicycles, while few children (4.3%) have misunderstandings in this matter. Respectively, while acknowledging bicycling as eco-friendly to a large extent, almost all children (94.9%) report it as an environmentally friendly means of transportation, while few children (5.1%) again have misunderstandings on this issue.

When asked if bicycle use reduces carbon dioxide emissions, most children (61.5%) say that carbon dioxide emissions are indeed reduced, while many children (38.5%) disagree. This is a matter of repeating didactic approaches aimed at removing misunderstandings. It is observed that while they strongly agree on the non-emission of exhaust gases from the use of bicycles in an earlier statement, they do not link this greenhouse gas so highly with the exhaust gases in general.

On the issue of reducing fossil fuels when using a bicycle, there seems to be limited knowledge as about half of the children (49.6%) report that the use of fossil fuels is actually reduced by using a bicycle while the other half (50.4%) state that fuel use is not lowered an issue that must be considered for targeted training interventions, as operating energy costs are confused with energy costs (grey energy).

The majority of children (85.5%) recognize that cycling exercises and improves their fitness while few children (14.5%) have adverse opinion on the matter. Respectively, many children (64.1%) state that all people should use it as a means of transportation, while several children (35.9%) have a different opinion, recognizing the impossibility of certain groups of people using cycling. Similarly, when asked "who can use a bicycle," the vast majority of children (97.4%) say that everyone can potentially use it.

When asked if the bicycle is a pleasant means of transportation, many children (92.3%) agree with this statement, while few (7.7%) disagree with this. Regarding whether they are afraid of cycling, the majority of children (84.6%) state that they are not, while 15% state that they are afraid when cycling. Few children state that the bicycle can be used only by children (0.9%) or by adults (1.7%). The vast majority of children (97.4%) state that the bicycle can be used by all people.

In the next question about whether there are municipal bicycle parking spaces in the city, several children (30.8%) state that there is bicycle parking but many children (69.2%) declare that there are no bicycle parking spaces within the urban fabric of the city. This is also an additional deterrent to the use of bicycles by residents. The usefulness of having bicycle parking spaces is identified by many children (82.1%) while the rest (17.9%) consider that the existence of corresponding spaces is not very necessary.

Next, regarding whether there are special bike lanes in the city where they live, most children (67.5%) state that there are not any as there is no care for this issue, while some children (32.5%) state - where appropriate- that there is concern for cycling in the areas they live.

Regarding the intention to use bicycles in their later adult life, many children (78.6%) state that they intend to while the remainder (21.4%) do not have such an intention for their daily movements.

4.1. Statistically significant findings

Regarding the most important findings from the students' answers in accordance with the independent and dependent variables, it seems that girls comprehend better than boys ($X^2 = 9.288$ df = 1 p. = 0.002) that bicycle use reduces the traffic problem in the city as well as travel expenses of the citizens ($X^2 = 5.048$ df = 1 p. = 0.025). Moreover, girls show a great intent to travel by bicycle within the city as adults later ($X^2 = 4.288$ df = 1 p. = 0.038).

Older children are more likely to associate bicycle use with reduced carbon dioxide emissions, especially E-class students ($X^2 = 12.036$ df = 2 p. = 0.002). Also, on the issue of limiting / or the non fuel use during cycling, it seems that the children of D class have incomplete knowledge˙the 5th class students have

the most thorough understanding of the issue while the F class students comprehend the matter clearly (X^2 = 14.695 df = 2 p. = 0.001).

The possession of bicycle by children indicates that it reinforces their views on some issues. The children who use bicycles have a better understanding that bicycling is time-saving unlike those who do not use it (X^2 = 10.454 df = 1 p. = 0.001). Moreover, they comprehend clearly the issue of cycling's limited cost (X^2 = 4.545 df = 1 p. = 0.033). In addition, they understand the need of constructing bicycle lanes as the safest transportation within the city (X^2 = 7.157 df = 1 p. = 0.007)

The positive view of cycling reducing traffic congestion is also associated significantly with the reduction of travel cost (X^2 = 3.974 df = 1 p. = 0.046), as well as the cut of CO_2 emissions. Carbon in the atmosphere (X^2 = 5.850 df = 1 p. = 0.016) as well as with the reduction of fossil fuel waste (X^2 = 8.274 df = 1 p. = 0.004) and the need of having basic quality design principles for cycle infrastructure and transport network (X^2 = 4.179 df = 1 p. = 0.041).

Regarding the question of whether its use reduces the waste of fossil fuels or not, statistically significant correlations emerge that are positively related to the view that movement in the city reduces the traffic congestion (X^2 = 8.274 df = 1 p. = 0.004) and that cycling does not cost money (X^2 = 16.467 df = 1 p. = 0.001), moreover, it reduces carbon dioxide emissions in the atmosphere (X^2 = 21.882 df = 1 p. = 0.001) and improves physical health (X^2 = 5.397 df = 1 p. = 0.020).

Despite the children's statements that cycle lanes do not exist in cities to a large extent, does not affect or enhance the possible feeling of fear of children for cycling (X^2 = 7.031 df = 1 p. = 0.008). There is also a statistically significant correlation of the absence of bike lanes and bicycle parking in the city (X^2 = 12.628 df = 1 p. = 0.001).

5. DISCUSSION AND CONCLUSIONS

Children's knowledge, views, attitudes in favour or against widespread use of bicycles highlight the directions in which formal school education should be directed through educational interventions in the context of education for sustainable development. Despite the adoption of programs for the reduction of energy consumption in the public and private life of citizens and businesses as well as the utility of energy-saving devices in modern reality, energy use has increased dramatically. Nevertheless, education should familiarize students with the rational behavior and energy management through a variety of practical energy-saving applications in children's daily lives through multiple teaching approaches (Lefkeli et al., 2018).

In a city that does not have cycling standards for citizens, it seems that, if future planning of relevant cycling infrastructure were taken into account, it would be immediately usable and it would facilitate and reinforce the already existing positive background of children for extensive use and cycling transport.

Bicycle possession, the intention of future use of bicycling as a means of transportation, cycling pleasure and the short duration of cycling for transport purposes are issues which highlight the importance that children attribute to bicycling. Children's positive attitude towards cycling has a promising impact for its future adoption as a mode of transport within the city contributing significantly to urban sustainability. Moreover, the great number of positive views about the contribution of bicycling as an independent and autonomous mode of transportation further reinforces the future trend in favour of urban sustainability. Children's knowledge regarding the benefits of cycling indicates the notion that arises concerning the reduction of travel costs.

In addition, the great importance attributed to the bicycle as an environmentally friendly of transport and children's knowledge about the significant reduction of exhaust emissions from its utility are significant factors that are shaping the future in terms of sustainable energy and highway design as the key to sustainable urban management.

Children's lack of fear of when using a bicycle in an urban area that lacks cycling infrastructure, their knowledge of the benefits of cycling to human health and the view that all people should use it as a means of transportation are additional important elements in the context of education for sustainable development. Furthermore, children's perception that everyone should use bicycle is an additional positive factor to encourage cycling adoption in the future.

State responsibility is also highlighted in terms of will, measures and specifications for the construction of proper cycling infrastructure and, in particular, those related to the lack of bicycle parking and the construction of appropriate parking lots as well as the lack of special bike and tracks within the city.

These infrastructures will offer the citizens the opportunity to develop and implement those elements in their daily life that make the city sustainable for residents and visitors, regarding their transportation, emissions and energy consumption. People's positive attitudes toward the benefits of travels exist to a satisfactory level but the municipal authority itself seems powerless to take serious measures and actions in favor of this dynamic and to promote sustainable urban management which is so necessary.

In terms of education and possible teaching approaches to enhance children's energy and transport literacy through bicycle use, it seems that it should focus on the differences that arise from children's responses to study variables. Especially on the issue of children's gender, girls seem to have a better comprehension about the use of bicycles in terms of reducing costs and traffic congestion in the city while they seem to have a greater intention of using bicycles more frequently in adulthood. Regarding these issues, didactic approaches should be implemented for the educational support and reinforcement of boys, while the children's cognitive background should be enriched in matters where there is a lack of knowledge or misunderstandings. Therefore, the design and implementation of targeted educational approaches and activities with the active participation of children will enrich their knowledge and influence their behaviour change towards cycling (Platis & Romanowicz, 2020).

The results show positive views, clear intentions and sufficient knowledge of the students about the great environmental and social benefits that result from the use of the bicycle. An informed citizen who is also aware of the benefits of cycling is more likely to be actively involved in decision-making processes, be better informed and trained and, thus, will make careful and responsible choices (Polikovsky et al., 2018). Furthermore, the results indicate that that the educational approaches have achieved a significant degree of knowledge enhancement, adoption of attitudes for future use and active citizenship (Papaoikonomou, 2021), but there is still some scope for additional approaches to improve the level of energy literacy concerning the use of bicycles and the reduction of energy consumption. Naturally, the primary goal is to achieve sustainable literacy through education for sustainable development and the creation and maintenance of conditions under which nature and humans can coexist harmoniously for the benefit of both the environment and the future generations (EPA, 2018).

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