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Development of Environmental Health Competencies through Compulsory Education. A Polyhedral Approach Based on the SDGs

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Abstract: This paper focuses on the competencies in environmental health acquired by students during compulsory education. Questionnaires addressing environmental health problems were completed by 923 students of primary and secondary schools from five different Spanish regions. The results for five challenging situations related to hunger, consumerism, climate change, pollution in the cities and allergies are analysed according to the internal coherence of each sub-competency, i.e., addressing knowledge, skills and attitudes towards these topics. Our results show that problems related to air and water pollution were the most commonly described by the students. Focusing on competency achievement, the higher the educational level, the higher the score students obtained, especially regarding pollution and climate change, two problems that appear directly in the school curriculum. The complexity of the concept of environmental health matches with the necessary holistic perspective of the Sustainable Development Goals in a polyhedral approach including as many factors (facets) as necessary to complete the approach to this evolving concept.

Keywords: competency; compulsory education; climate change; pollution; consumerism; hunger; allergies; SDG

1. Introduction

The current situation of planetary emergency [1] marked by a series of closely-related and mutually-reinforcing socio-environmental and health problems (climate change, poverty, demographic explosion, major social inequalities, pollution and degradation of ecosystems, depletion and destruction of vital resources, unsustainable imbalances, epidemics and pandemics, etc.) is posing an immense and serious challenge to the continuity of our species on planet Earth. The approval of the 17 Sustainable Development Goals (SDGs) and the 169 targets at the 2015 United Nations Summit embodied in the 2030 Agenda (UN, 2019) stands out as the most important international initiative in recent years to address the immense challenge that our species is facing. The current development model is causing a significant environmental degradation, which leads to numerous problems with negative impact, not only on natural areas, but also on social, economic and health aspects of our lives [2,3]. Since Rachel Carson's *Silent Spring* [4], the interplay between environmental factors, human activities and health has increased social unrest and it has undergone extensive research [5–9]. This relationship between human's health and the environment is known as environmental health (EH).

The concept of EH is more than the addition of terms health and environment, just as an ecosystem is a superior entity to the addition of the biocenosis and biotope and is nourished by the research on the

complexity of the concept of sustainability and its holistic vision [10]. It emerges from three conceptual shifts: (a) the evolution of the concept of health from ‘the state of complete physical, mental and social well-being’ [11], to more dynamic, ecological and globalizing visions, which include the environment either from an individual or social perspective [12–15]; (b) the consideration of the environment as all that surrounds us, including the relationships established between its components (physical, biological, cultural, social and economic) [16]. Thus, the city, the neighbourhood, the air we breathe, the water we drink, the work we do, the unemployment, hunger, wars, food supplies become part of our environment [17–20]. Moreover, in the same way that the environment influences people, people also influence the environment, modifying or creating it. Lastly, (c) the increasing global awareness of human effect on the environment and the need of a sustainable development, in which the relationships between human groups and with the environment are reconsidered. Sustainability has become one of ‘the most central unifying ideas at this moment in the history of mankind’ to face the situation of planetary emergency [1,21]. Summing up, EH refers not only to the elements of the environment that affect people’s health, but also the individual and social actions that affect the environment.

Environmental health literacy (EHL) is an emerging framework [22] that aims to promote competent citizens that are able to know, give value and contribute to the creation of a healthy environment and to improve the quality of life [23,24]. Despite having a different objective, EHL shares similarities with other literacies like health literacy (HL) or environmental literacy (EL) [23]. However, contrary to HL or EL, the assessment of EHL has received little attention [25,26], and in many cases, this assessment has been constrained to the knowledge, attitudes and behaviour of different communities regarding specific environmental health problems. In the same line, the number of tools to measure EHL is scarcer [27,28].

In many countries, at the end of compulsory education, students should have acquired sufficient knowledge about the environment and health as the official curricula include topics related to the human body, health and ecology. Moreover, some schools are enrolled in programs to promote healthy lifestyles or to be environmentally responsible [29–32]. However, the inclusion of EH topics in primary and secondary schools is still limited (e.g., [33,34]). The question that arises is whether the mere acquisition of environmental and health contents is enough to develop competencies in EH. Moreover, becoming competent (being able to mobilize knowledge to solve problems in an autonomous and creative way and adapted to the context) requires not only the acquisition of concepts (knowledge), but also the development of skills and attitudes. Thus, the development of a competency on EH during primary and secondary school requires that these three dimensions (knowledge, skills and attitudes/behaviours (KSA)) must be attended. Nowadays, there are few examples of evaluation of EHL along compulsory education (e.g., [35–38]) and more information is needed about how these KSA dimensions regarding EH are developed during compulsory education. This information can help to approach more effective EH problems—educational or real problems addressed from a formative perspective—that specifically target the KSA dimensions that need to be reinforced.

The Spanish educational context regarding EH is not different for what was mentioned above. Most of the health and environmental content during compulsory education (primary education: 6 courses from age 6 to 12, secondary education: 4 courses from age 12 to 16) is covered in those subjects related either to biology (i.e., Knowledge of the Natural, Social and Cultural Environment, Natural Sciences, Biology and Geology, etc.) or physical education [39]. Moreover, topics like the problem of consumerism, the consequences of catastrophes (natural or caused by human beings, such as wars, hunger, etc.), the importance of environmental quality on health, the effect of radiation, gases, particles or pollen, the recognition of the environmental cost of goods and services of usual consumption, solidarity with vulnerable people, etc., are not usually raised in the official curricula [40].

The objective of this research is to know if Spanish students who complete primary and secondary education have developed competencies in EH that allow them to integrate into a society in continuous change. We explore (a) the level of awareness on environmental health problems, (b) the level of competency achievement and (c) the internal coherence of the KSA dimensions of competency.

In particular, we approach EH from a pentagonal point of view, considering five facets of the polyhedron: climate change, consumerism, pollution of cities, allergies and world hunger. We also explore the possible influence of different variables such as educational level, school typology and gender on the acquisition of these competencies.

2. Materials and Methods

A questionnaire was developed in order to study the level of awareness towards environmental health and competency achievement regarding five specific EH problems. This questionnaire was validated through three steps: expert validation, pilot test and single-case validation. Internal consistency was evaluated using Cronbach's α [41] and total omega (ω) [42]. Both reliability indices were calculated using R package psych [43].

Demographic variables such as age and gender, educational level (primary or secondary) and school typology (rural or urban) were documented. The rural/urban distinction was based on populations size (fewer or more than 20,000 inhabitants) as defined by the Spanish Law 45/2007 for the Sustainable Development of Rural Areas [44]). The study included students in the last year of either primary (age \approx 12) or secondary education (age \approx 16). The sampling method consisted in a convenience group which included students from 16 primary/secondary schools from five regions across Spain (País Vasco, Cuenca, Las Palmas, Teruel and Valencia).

Environmental health awareness was measured using an open question survey asking students about what EH problems they were aware of. The environmental health problems pointed out by the students were grouped into general categories. Independency tests were carried out to determine differences among these categories and the variables educational level, gender and school typology. Fisher exact test for R x C tables were used. Differences in the number of problems detected due to educational level, gender and school typology were also assessed using Kruskal-Wallis rank sum test. In both cases a Holm correction for multiple comparisons [45] was applied. Effect size was calculated for both types of tests [46]: Cramer's V for the contingency tables using R package vcd [47] and η^2 for the Kruskal-Wallis test.

The level of achievement of EH competency was measured using open questions regarding five different environmental health problems: climate change, consumerism, pollution of cities, allergies and world hunger (Appendix A). Each of the environmental health problematic situations links with at least one different Sustainability Development Goal as shown in Figure 1. Our approach to environmental health competencies is made from a polygonal approach, in this occasion from a pentagonal point of view.



Figure 1. Relationship between environmental health problems approached in this study and five Sustainability Development Goals.

The questions about each environmental problem included three sub-questions were students were asked for the three dimensions of competency: (1) what they know about the problem (knowledge),

(2) what they can do (skills/procedures) and (3) which attitude they show towards the problem (attitudes). Answers to each of the three sub-questions within each question regarding the three competency dimensions were scored using a 0-1-2 scale: 0 when no answer was provided or the answer was not addressing the question, 1 when only one correct answer/opinion was provided and 2 when two or more answers were provided or the answer included the implications both from an individual and a collective perspective. Scores were agreed by at least two researchers. A total question score (ranging from 0 to 6) for each of the five open questions was obtained by adding the sub-questions scores. Thus, a score of 6 will indicate the competency (i.e., knowledge, skills and attitudes) is fully acquired. Differences in question score due to type of environmental problem, educational level, gender and school typology were assessed using a general linear model, which included all main effects, all possible double interactions, and all triple interactions that include type of environmental problem. Normality of residuals of the model was assessed using Shapiro-Wilk normality test. As normality was not accomplished, a robust ANOVA was used to test the linear model using the robust R package [48]. Tukey's HSD test was used for post-hoc comparisons. Partial effect sizes (η^2) were computed using R package *lsr* [49]. To assess the score differences between sub-competencies (knowledge, skills and attitudes) for each of the five problems, an ordinal logistic regression was performed using R package *MASS* [50]. All statistical tests were performed using R statistical software v 3.2.3 [51].

The present study is part of a broader study on health competencies regarding eight different areas of health education (accidents, addictions, environmental health, hygiene, mental health, nutrition and physical activity and sexuality and health promotion). The five questions regarding EH problems were part of a collection of 24 open questions survey designed to measure student's health competency which was subjected to a thorough validation process [52]. In order to avoid excessive extension and exhaustion of students, questions were grouped into two different questionnaires with 12 questions each one. One of the questionnaires (Model A) included questions regarding climate change, consumerism and hunger, and the other (Model B) questions concerning city pollution and allergies (Appendix A). All questionnaires included the open question regarding EH awareness.

3. Results

A total of 923 students of 16 primary and secondary schools (average 57.7 students per school) from five different Spanish regions (184.6 students per region) answered the survey; 458 completed model A and 465 model B. Age of the participants ranged from 11 to 26 years old (average 12.5 for primary school students and 16.1 for secondary school students). Distribution by gender, educational level and school typology can be found on Table 1. Only one questionnaire out of 923 (0.1%) was discarded as all the questions were left blank. Both questionnaire models showed a high reliability: model A had a Cronbach's $\alpha = 0.80$ and $\omega_t = 0.85$ and model B $\alpha = 0.78$ and $\omega_t = 0.88$.

Table 1. Distribution of number (N) and percentage (%) of participants by educational level, gender and school topology.

Variables		N	%
Educational level	Primary	516	55.9
	Secondary	407	44.1
Gender	Male	464	50.3
	Female	459	49.7
School typology	Rural	396	42.9
	Urban	527	57.1

3.1. Environmental Health Awareness

On average, students identified 0.59 problems (median = 1, range from 0 to 4). Statistically significant differences were found due to educational level (multiple comparisons corrected p-value = 0.003, $\eta^2 = 0.01$) and rural/urban typology (corrected p-value < 0.001, $\eta^2 = 0.03$), but not gender.

On average primary school students detected 0.54 problems vs. 0.67 problems by secondary school students (median 0 vs. 1 of primary and secondary school respectively) and students from urban areas detected 0.69 problems vs. 0.47 of those in rural schools.

In total, students stated 549 problems related to environmental health. 86.5% of them (475) could be grouped into six different categories (Figure 2), being the problems related to air and water pollution the most commonly described (32.6% of the students). Health problems derived from consumerism and catastrophes are hardly considered. Among the problems that could not be grouped deforestation, viral diseases and other types of pollution, were the most mentioned. It should be noted that in most of their descriptions, students, instead of mentioning EH problems, pointed out their effects on human health.

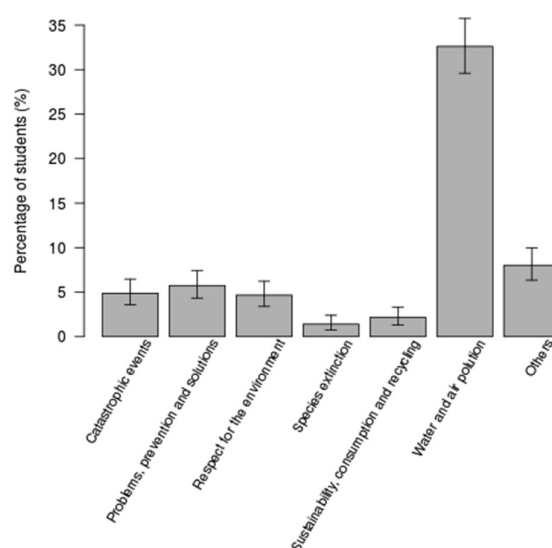


Figure 2. Problems related to environmental health (EH) identified by the students. Error bars represent the 95% confidence interval for the binomial distribution.

When comparing the differences of the frequency of the different categories of problems (Table 2), the Fisher exact test showed that statistically differences exists among educational level (corrected p -value < 0.001, Cramer's $V = 0.296$) and school typology (corrected p -value < 0.001, Cramer's $V = 0.272$), however no statistically significant differences were observed when considering gender. Primary school students highlight more frequently catastrophic events (10.8%) and problems regarding respect for the environment (12.3%) than secondary students (5.2 and 3.3% respectively). On the contrary, secondary school students were more aware of water and air pollution (64.7 vs. 45.1%). Regarding the differences due to school typology, rural students mention catastrophic events (14.6%) and problems, preventions and solutions (14.1%) more than their urban counterparts (4.9 and 7.4% respectively). On the other hand, urban students are more concerned about pollution (61.3 vs. 42.2%).

Table 2. Distribution of the percentage of answers among the different problem categories by educational level, gender and school topology. Total number of answers is shown in brackets.

	Educational Level		Gender		Typology	
	Primary	Secondary	Male	Female	Rural	Urban
Catastrophic events	10.8 (30)	5.2 (14)	10.2 (28)	6.2 (17)	14.6 (27)	4.9 (18)
Problems, prevention and solutions	8.3 (23)	11.2 (30)	9.1 (25)	10.2 (28)	14.1 (26)	7.4 (27)
Respect for the environment	12.3 (34)	3.3 (9)	7.3 (20)	8.4 (23)	6.5 (12)	8.5 (31)
Species extinction	0.7 (2)	4.1 (11)	2.9 (8)	1.8 (5)	1.1 (2)	3.0 (11)
Sustainability, consumption and recycling	5.8 (16)	1.5 (4)	3.6 (10)	3.6 (10)	1.1 (2)	4.9 (18)
Water and air pollution	45.1 (125)	64.7 (174)	51.6 (142)	58 (159)	42.2 (78)	61.3 (223)
Others	17.0 (47)	10.0 (27)	15.3 (42)	11.7 (32)	20.5 (38)	9.9 (36)

3.2. Environmental Health Competency Achievement

The competency achievement varied among the different problems (Figure 3a). The global score of achievement was found to be affected by type of problem, educational level, gender and school typology. The robust ANOVA revealed that the triple interaction (type of problem × educational level × school typology), two out of three double interactions (type of problem × educational level and type of problem × school typology) and all main factors have a significant statistical effect (Table 3). The post-hoc test (Figure 3a) showed that in the questions regarding hunger and city pollution students achieved the highest level of competency (25.9% and 31.7% of students scored higher than 4, respectively) (Figure 3b), whereas the question regarding climate change is the one with the lowest achievement of competency and only a 10.6% of students scored more than 4 points (Figure 3b).

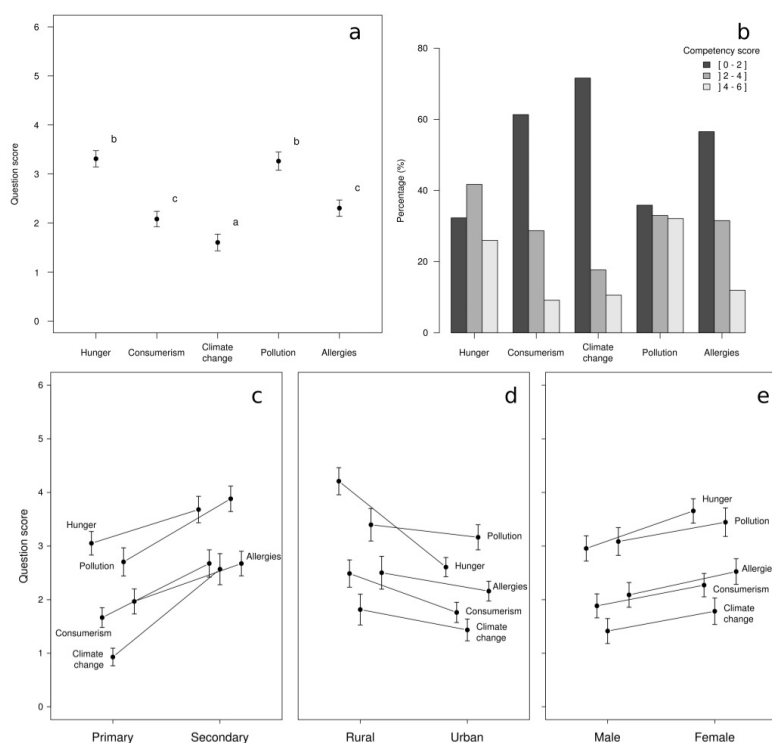


Figure 3. Competency achievement among the different problems: (a) Question score for each of the five EH problems; (b) Distribution of scores for each problem; (c–e) Differences in question score for each EH problem due to educational level, school typology and gender. Whiskers show the confidence interval at 95%.

As expected, the higher the educational level, the higher the score (Figure 3c): secondary school students obtained a higher question score than primary students. However, the improvement varied among problems, and the questions regarding climate change and city pollution showed a higher increase. In the case of hunger and consumerism students from rural areas performed better than students from urban areas (Figure 3d). For the other questions, no differences were found between rural/urban students. Regarding gender, no interactions were found with type of questions, although in general, females tended to outperform males in all questions (Figure 3e).

Table 3. Results of robust analysis of variance (ANOVA). Effect of EH problem, educational level, gender and school typology on level of competency achievement measured as question score.

Factor	df	Robust F	Pr(F)	η^2	η_{partial}^2
Problem	4	90.62	<0.001 *	0.115	0.136
Level	1	209.34	<0.001 *	0.075	0.093
Gender	1	27.44	<0.001 *	0.009	0.012
Typology	1	125.77	<0.001 *	0.041	0.053
Problem \times Level	4	6.50	<0.001 *	0.007	0.010
Problem \times Gender	4	1.11	0.350	0.002	0.003
Problem \times Typology	4	11.75	<0.001 *	0.015	0.020
Level \times Gender	1	0.89	0.345	0.000	0.000
Level \times Typology	1	0.36	0.548	0.000	0.000
Gender \times Typology	1	1.14	0.286	0.000	0.001
Problem \times Level \times Gender	4	0.75	0.560	0.001	0.001
Problem \times Gender \times Typology	4	1.05	0.382	0.001	0.002
Problem \times Level \times Typology	4	5.04	<0.001 *	0.007	0.009

* Statistically significant at $\alpha = 0.05$.

3.3. Student's Answers to Environmental Health Problems

Students answers were classified and categorized for each problematic situation. Some patterns could be found, the main results are presented below.

- **Hunger.** Two trends were found in their answers: an individual and subjective (e.g., 'I feel sad', 'it is due to selfishness', 'it should not exist'), and another more social, pointing out injustice, inequality, exploitation of poor countries, right to food, etc. When asked about their skills and procedures, the answers kept in the personal level, mentioning actions directed towards volunteering: helping NGOs, sponsoring a child, offering food, not throwing away food, etc. When attitudinal aspects were approached, the answers concentrated on giving opinion 'it's wrong', 'you have to donate', 'you have to think about others', justifying the answers in most of the cases.
- **Consumerism.** Approximately 30% of the students did not know and less than 10% mentioned the environmental effects of problems related to consumerism. Those who answered presented two aspects in their responses, a personal one: 'I lose money', 'I waste time', 'the addiction that it entails', and another more social, since they mentioned child exploitation, excessive consumption or pollution. When addressing procedural (knowing-how-to-do) issues, most of them offered answers of personal behaviour: 'not consuming', 'continue using devices while they work', 'you have to settle for what you have', etc. However, others added general or social aspects: 'money should not be wasted', 'my parents will not let me', 'it is about whims'. In response to the question directed towards attitudes or expressing opinions, some responses were focused on the awareness of people: 'we must raise awareness among young people', 'try not to exploit the poor', while other responses were more social: 'avoid planned obsolescence', 'reduce production', 'do not take so many models', 'raise the market price', etc.
- **Climate change.** 60% of responses showed an absence of knowledge, either by leaving questions unanswered or considering their mistakes. Most of the answers focused on the effects of climate change on the environment: 'temperature increase', 'acid rain', 'greenhouse effect', 'loss of biodiversity', etc. About 20% mentioned individual health consequences (cancer, respiratory problems, skin burns, etc.). The answers that focused on what can be done were all in the personal sphere, with predominance of the three Rs (reduce, reuse and recycle), also pointing out the importance of keeping clean streets, or the environment, not wasting water and using public transport. When asked about knowing-how-to-be or their attitude, the answers were more social and collective: 'make people aware', 'pay attention to scientists', 'increase information in the media' or 'carry out collective actions'.

- Pollution in the cities. Considering the conceptual dimension of the problem, student responses showed two aspects, the first referring to the environment itself, and most of them stated atmospheric or air pollution, but also acoustic and light pollution; less mentioned were the decrease of the ozone layer, global warming, pointing the use of cars as the great cause. The least mentioned type of pollution is soil pollution. The other aspect referred to health problems generated by these environmental alterations, mentioning heart, respiratory and skin problems, insomnia, bad mood, stress, deafness, etc. When asked on what can be done, most of the answers inclined towards the adoption of personal behaviours, such as saving electricity, using electric cars, using litter bins, mentioning once more the importance of the three Rs, including also global behaviours and governmental measures such as collaboration between countries, limiting the use of private cars, promoting alternative energies, carrying out awareness campaigns to reduce garbage, etc. When faced with the question of attitudinal aspects or knowing-how-to-be, the great majority pointed out the alarming situation of our planet due to global warming, greenhouse effect, ice melting at the poles, situations that can still get worse. With a social vision they pointed out the need to promote people's awareness, to pay attention to scientists insisting on the fact that the permanence of this problem means the deterioration of our planet and with it our own extinction.
- Allergies. When asked about conceptual issues, most noted both the causes of allergies (dust, acarus, certain bacteria) and the effects on the body: breathing difficulties, sneezing and mucus, skin reactions, headaches, eye redness, etc. When asked about skills or procedures, on the one hand, they pointed out the adoption of preventive actions such as getting vaccinated, cleaning up more, going to the countryside to breathe fresh air and, on the other hand, actions to avoid polluting sources such as 'getting away from places with dust', 'avoiding certain cleaning jobs', etc. When asked about attitudinal predisposition, the answers were directed towards possible causes such as not having immunity, avoiding transgenics, and excessive cleaning, this last appointed at the same time as improper hygiene.

3.4. Knowledge, Skills and Attitudes on Environmental Health

When considering the level of competency achievement on each of the competency dimensions (knowledge, skills and attitude (KSA)), the results showed that all three components were correlated within problem (average correlation 0.44, all p -values < 0.001). Despite some level of variation, this correlation was similar among the five different environmental problems (range from 0.28 to 0.57). The ordinal logistic regression (Figure 4) shows significant differences among components; 11 out of 15 possible comparisons (3 dimensions \times 5 problems) were statistically significant (odds ratio \neq 1, p -value < 0.05), although the effect of the dimensions was not the same in all problems.

Regarding the problems related to climate change, city pollution and allergies, both, the skills and attitude dimensions showed odd ratios (OR) lower than one when compared with the knowledge dimension (i.e., students were more likely to perform better in the knowledge dimension than in the other two). The same relationship (OR < 1) was found when comparing attitude versus skills. In the case of allergies these differences were quite pronounced, mainly due to the low level of competency achievement in the attitudinal dimension. In the case of hunger and consumerism, the relationship between the KSA dimensions was different. When comparing the achievement on the skill dimension to knowledge, higher scores were expected for the consumerism problem (i.e., student are more able to do things than the knowledge they possess), but no difference was expected in relation to hunger issues. Regarding attitude vs. knowledge, OR > 1 were found for both problems (i.e., students have a better attitude/behaviour than knowledge about those problems). Finally, in the attitude vs. skills dimension the pattern is reversed, higher scores were expected for hunger problem, but no differences were expected regarding consumerism problem. Interestingly, the same results for all five problems were found when analysing separately primary and secondary school students.

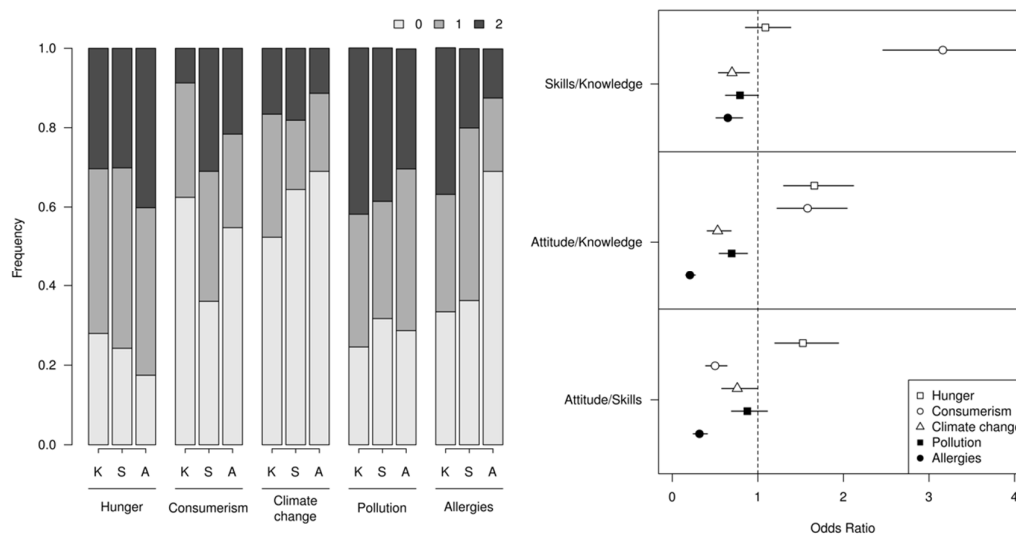


Figure 4. Distribution of sub-question scores (left panel) and odds ratios of the ordinal logistic model of the effect of knowledge, skills and attitude components on competency achievement (right panel).

4. Discussion

The proper development of environmental health competencies in their three dimensions (knowledge, skills and attitudes) is essential to form educated citizens able to participate and act within a society in continuous change, particularly under the challenge of a planetary emergency situation. Extensive studies of the level of EH literacy achievement, which are currently scarce, and the creation and validation of instruments able to measure it are crucial to take evidence-based actions that can help to improve EHL. In this paper we explore whether compulsory education in Spain is able to fulfil this educational and formative need through an instrument to measure the level of achievement of these competencies in their KSA dimensions.

Almost 1000 students from primary and secondary schools from different Spanish regions have taken part in this study, which provides a detailed overview of the current situation of compulsory education. During primary and secondary education in Spain, as in many other countries, several subjects cover topics regarding environment and health, however, the inclusion of specific EH topics is still limited. In fact, when the students were asked to specify health problems related to the environment, only 60% were able to mention at least one, and only a few were able to state more than one. The effect of compulsory education is limited: despite students at the end of secondary education can recall more EH problems than primary school students, the median of EH problems that can be identified by student at the end of compulsory education is one. This shows the little interrelation they perceive between health and the environment, that translates into a poor awareness of environmental health problems. The most commonly recognized EH problem (32.6% of students) is air and water pollution. Interestingly, pollution is also the problem where they show a greater degree of competency with great internal coherence—a balanced relationship between knowledge, skills and attitudes. The results concur with other studies that found that pollution is the main environmental issue perceived by different social groups in Spain [53,54]. Heras-Hernández and co-workers [55] point out four groups of styles in risk assessment when addressing climate change of the Spanish population: ‘carefree’, ‘distant’, ‘conscious’ and ‘alarmed’ finding a significant relationship between personal beliefs on climate change and the predisposition to develop actions in favour of climate. We find these same styles and relationships among the youth surveyed according to the answers they offer to the three sub-questions of this problem (sub-dimensions of the competency).

When focusing in EHL achievement regarding the five different environmental health problems (hunger, consumerism, climate change, pollution of cities and allergies), we found that the best results of competency were obtained for pollution, as stated above, and hunger, whereas climate change was

the problem for which students show less competency. Attending to the development of the three competency dimensions (knowledge, skills and attitudes), our results show that pollution and climate change are those with greater balanced development among KSA. In the other three problems, at least one of the dimensions tends to outperform the others. For example, in the case of hunger, students tend to show a better performance regarding attitudes or knowledge is more developed in the case of allergies. In relation to situations of excessive consumption, students show poorer levels of knowledge and attitudes than skills, which could indicate the difficulty in modifying their behaviour. Studies developed more than 20 years ago highlighted in the students the persistence of misconceptions, confusion related to the ozone layer and global warming, and the belief that all acts harmful to the environment cause climate change [56].

Considering all the problems together there is an increase in competency acquisition in secondary school in relation to primary education, especially regarding pollution and climate change, two problems that are addressed at school and that appear directly in the official curriculum. The problems of hunger, consumerism and allergies do not appear explicitly in the curriculum and the increase in competencies that students show during school time is lower; an evidence of the school-curricular action and the effective action of schooling and its educating role.

Beside the primary role of the school curriculum of compulsory education in the acquisition of EH competencies other formative sources should not be underestimated like the potential of the work of teachers and teachers' attitudes and the complement of textbooks, which often fill the gaps that we detect in the official curriculum. However, in order to be effective, a proper teacher training in relation to EH problems is needed. Studies analysing the understanding of these same problems by primary and high school teachers and pre-service teachers often indicate misconceptions and lack of knowledge [57–63]. The extracurricular environment (including social media, families, etc.) also plays an important role in the acquisition of EHL, although it has limitations. In the end, what really matters is competency achievement of students not only as future but also as nowadays' citizens who make decisions in their daily lives that comprise both their health and that of the environment. That is why the focus of this paper included a polygonal point of view including five issues (pentagonal approach) but considering the balance (consistency) of the three dimensions of competencies (KSA), which necessarily forces a polyhedral vision of environmental health (in our case, a pentahedral vision).

5. Conclusions

Science-Environment-Health pedagogy necessarily deals with complex systems in which students have to develop the "art of decision making" [64]. Along this paper we have been working with global and interrelated concepts under construction and in continuous evolution, building a multifaceted model dealing with aspects such as hunger or overconsumption, considered as part of social sustainability. Based on the results of this study, we comprehend that there are issues that have been addressed in greater depth in different investigations, while the abovementioned problems of hunger in the world or consumerism should be analysed in more detail.

It is important to highlight that the results in relation to climate change are of great interest, as they precede the Fridays for Future movement and the emergence of Greta Thunberg as a youth leader on climate change. It would be very interesting to repeat the same questionnaire in the current conditions and see to what extent young people have improved their competencies in relation to climate change issues.

In this sense, more research is required from the sustainability prism considering the wide range of SDGs related to environmental health education with the aim of adding facets to the polyhedron that will provide an increasingly complex vision. Research should be aimed at addressing the perceptions and competencies of students, as well as the contents of official curricula, textbooks and teacher training, the latter being a key element in addressing environmental health issues through the prism of sustainability with a *glocal* perspective [65].

The results of this study support the importance of addressing environmental health throughout compulsory education in a holistic way and establishing bases that help students to become citizens capable of discerning among the large amount of information they receive. As some authors have pointed out [66], a greater number of students with low knowledge about certain topics are more likely to trust untrustworthy sources of information, being unable to differentiate between relevant and irrelevant criteria when distinguishing reliable from unreliable sources.

There is no doubt that when addressing environmental health, we are dealing with emerging, complex, interrelated and evolving concepts. The current idea of the environmental health encompasses not only the parameters of the environment (climate, biological diversity, balances, etc.) but extends to the cultural and social issues that human beings construct in their relationships. On the other hand, the vision of health is not limited only to personal or individual aspects, but also encompasses the social and environmental spheres, given the mutual influence they have on each other. That is why science environmental health education needs of a polyhedral approach that includes this variety of elements that conform the complexity of the concept in a holistic way considering the necessary three dimensions (KSA) of competencies. This global perspective is essential when approaching environmental health competencies from the prism of sustainability, by ensuring the overall effects that each individual action has. In this sense, it is convenient to insist on the necessary *glocal* approach which implies keeping touch with the local when responding to global forces or challenges, that is to articulate global needs and requirements with local possibilities and practices. *Glocality* also refers to situations that students encounter in their daily life as polluting fumes, for example, that affect foremost those living in the vicinity of the emitting sources; but those fumes are diluted in the common atmosphere and end up affecting the whole planet. There are no borders to these fumes, there are no boundaries for radioactivity and many other forms of pollution [67,68].

There are currently 17 Sustainable Development Goals and 169 targets proposed by the United Nations to combat the increasingly serious global emergency. We are talking about social sustainability [10], environmental sustainability, health sustainability, etc. The concept becomes more and more polyhedral, with smaller edges, getting closer to a circumference, until it becomes a global and complex vision. In this paper we have addressed the competencies acquired by Spanish students throughout compulsory education with a complex approach in an effort to specify, by means of a questionnaire, those basic aspects of environmental health that primary and secondary school students must face in their daily lives. This polyhedral approach tries to avoid putting each aspect that is studied, each characteristic that is analysed, in a different and isolated box, but rather strengthening some visions through others, offering the spherical view that the situation, and the concepts that they raise, require.

This polyhedral perspective must be considered from an educational viewpoint of the development of competencies, which also requires a global and multi-dimensional focus, since it is necessary not only to achieve knowledge and abilities, but also to achieve a predisposition to informed and well-done action. A globalised educational initiative that considers complex and global issues, considering the three dimensions of competencies (knowledge, procedures and attitudes) is essential. Hence, our educational proposal is aimed at considering as many faces of the polyhedron of sustainability as possible while addressing them from the three dimensions of learning competencies.

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Appendix A. Questionnaires provided to students (translated into English from the Spanish)

ENVIRONMENTAL HEALTH COMPETENCIES Model A

The present questionnaire is anonymous. Think carefully before answering. Thank you very much for your cooperation.

A. Personal information

Gender: • Male • Female Age: _____ School: _____

B. Environmental health problems

Point out those health problems that you know that are related to the Environment _____

C. Actions addressing the problems. What would you do in these cases?

1.- At the end of the break you see pieces of bread and sandwiches on the floor. However, you know that there are children who go hungry and have nothing to eat for lunch.

What can you say about hunger in the world?

What can you do about it?

What do you think about these two situations occurring in today's world?

2.- For a year now you have had a mobile phone that works perfectly. However, an impressive new model that you love has come on the market.

What problems can excessive consumption cause?

What would you do with your old phone? Would you continue with it or replace it? Why?

What measures could be adopted to reduce overconsumption in developed countries?

3.- The idea of climate change is being widely used in the media.

How does climate change arise? What consequences could it have on health?

What can you do to slow down this process?

What opinion do you have about alerts from scientists and the media?

ENVIRONMENTAL HEALTH COMPETENCIES Model B

The present questionnaire is anonymous. Think carefully before answering. Thank you very much for your cooperation.

A. Personal information

Gender: • Male • Female Age: _____ School: _____

B. Environmental health problems

Point out those health problems that you know that are related to the Environment _____

C. Actions addressing the problems. What would you do in these cases?

1.- Pollution in cities is a fact repeatedly highlighted by the media.

What types of pollution do you know? What consequences can it have on citizens?

What do you propose to prevent it?

Do you think it is an alarming situation or is it being exaggerated? Why?

2.- You have a cousin who leaves the room when it's being cleaned. He says he has a "dust allergy".

What does "dust allergy" mean? How is it recognized?

What could be done to minimize his allergy?

The health authorities say that there are more and more people with allergies. What do you think this is due to?

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