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Sustainable and Aware Mobility Explained to Children

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Abstract: Mobility represents a key sector to face climate change and pollution issues. In a broad context of initiatives aimed at making mobility as sustainable as possible, meaningful actions can be oriented to educate people and to encourage their choices towards greener habits. This paper presents an educational package for primary school children to make them aware of sustainable mobility. It is also intended to help stakeholders (researchers, teachers, educators) to increase the sensitivity of children for sustainable mobility. This should support children in adopting more sustainable behaviors. Thus, a detailed description of the educational package, intended as a formative stand-alone module, is provided. This is made up of a brief theoretical explanation and a series of transition educational games. The theoretical part is designed for a young audience and with references to their local context, to make it simple and understandable. The educational games want to make children experience the concepts explained, in a funny way. This educational package was performed three times, involving more than 300 children. The outcomes recorded after each use, with positive feedback from both students and teachers, led to its final configuration. The qualitative results of the three performed experiences are presented here. The educational package is going to be repeated and structured within a wider learning process designed by Politecnico di Milano for primary school children.

Keywords: sustainability; sustainable mobility; mobility; education; game; traffic

1. Introduction

The challenges related to climate change can highly benefit from actions, measures, and initiatives in the field of mobility. Addressing the development of mobility in the direction of sustainability represents a challenge, but at the same time, a milestone towards a wider concept of sustainable development. The relevance of mobility in this context, as well as the instruments and the approaches to increase sustainability, are deeply recognized and investigated. These can refer to numerous areas: Innovation and technology, planning, human behavior, management, education [1].

In the wider context of sustainable development, education is acknowledged as fundamental. In particular, UNESCO developed the program "Education for Sustainable Development". This program is intended to transform society, empowering learners, with no distinction of age or education, to adopt sustainable lifestyles. This applies to different areas: Climate change, biodiversity, disaster risk reduction, sustainable consumption and production, and many others [2,3].

Moreover, education as an essential element for a sustainable world is supported by the definition of the Sustainable Development Goals (SDGs). Goals that are set to be achieved within 2030. Goal number 4, "Quality education", states that all learners should "acquire the knowledge and skills needed to promote sustainable development" [4].

Furthermore, the Incheon Education Declaration recognized "the important role of education as a main driver of development and in achieving the other proposed SDGs" [5]. This is also true for the UN SDG number 11, "Sustainable cities and communities, make cities inclusive, safe, resilient and sustainable" which also concerns the issues of mobility. A collection of experiences, insights and reflections about the relevance of education towards sustainable development is also provided by the outcomes of the workshop "The Role of Early Childhood Education for a Sustainable Society" [6].

Besides this framework of strategical references, the scientific community also investigates the issue of education towards sustainability. Samuelsson and Park [7] provide an exhaustive overview of how the concept of sustainability should affect and be addressed in children's education. Among the outcomes, the element that arose from the paper is the need to address sustainability through the education of the next generation, particularly towards children. The paper also showed that, economically, investing in the youngest generations ensures higher profits, compared to those obtained with older individuals [8].

The education of children and the attempt to increase their sensitivity in sustainable development could clearly determine long-term benefits. Children educated and made aware of sustainability will probably grow up to be more sustainability-conscious adults.

Immediate effects could also be observed since children are already fully part of society and they highly influence adult habits and behaviors. For example, they determine the need for different mobility, to reach school and after-school activities, and they also produce waste. Educating children not only causes a more sustainable behavior of the children themselves, but it also creates a domino effect. They are highly able to influence adults around them, parents and relatives firstly, towards sustainable choices in their everyday activities. This is true in many fields such as recycling [9,10] and mobility [11].

Because of this recognized relevance of education in the field of sustainability, different initiatives and actions have been taken. In the field of mobility, two main references are the initiative "Do The Right Mix—Sustainable Urban Mobility", promoted by the European Commission—DG Mobility and Transport [12], and "The Traffic Snake Game", a project co-funded by the Intelligent Energy-Europe II Program [13].

"Do The Right Mix" provides useful materials, including effective and funny cartoon videos, to explain how to move efficiently using all the different means of transport available. The main message is the idea of finding the "right mix" of transport solutions (walking, cycling, public transport services and, if necessary, driving). The video also easily explains the benefits of the "right mix" with reference to environment, economy, and well-being [12].

"The Traffic Snake Game" is a campaign to promote walking and cycling to school for children aged 4 to 12, their parents, and teachers. In the years 2014–2017 the Traffic Snake Game Network was established to enable cities and schools to share experiences and best practices [13]. During these years, the campaign was attended by 11,192 schools in 507 cities of 19 European countries [13,14]. Every time a child walks, cycles, uses public transport or shares a car journey, he gets a sustainable mobility sticker. The game lasts two weeks, and the stickers are collected on a banner. The activities also provide rewards for classes that met their initial objectives. Even the assessment of the impacts of the initiatives through the monitoring of the habits of pupils before, during, and after the campaign is covered [13,14].

This overview showed the lack of existing quick and easy initiatives to use in schools. Thus, the idea of developing an "educational package" arose. This educational package is intended as a stand-alone initiative for children, with limited temporal and economic efforts for the primary schools. The educational package consists of theoretical explications, mixed with transition educational games, so to present concepts in a funny and accessible way. Its purpose is to give children a background able to make them understand the main concepts of sustainable mobility and increase their awareness in this field. Therefore, once they become adults and first-hand subjects of mobility, they will most likely adopt more sustainable behaviors. However, positive effects are expected even sooner. The children could train and inform their parents and relatives. This could promote more sustainable mobility behaviors in their families in the short-term.

The aim of this paper is to describe the educational package developed and to provide information and instructions to make the initiative replicable. This will help stakeholders, such as researchers, teachers, and educators, supplying them with a reference once they have similar experiences.

Section 2, Materials and Methods, provides the description of the package, presenting its features, the organization of the different moments that form it, and the material needed for the activities.

Section 3, Results, describes how children in Italy tested the educational package and how their teachers perceived it.

Section 4, Discussion, reports a critical assessment of the experience, with pros and cons identified, as well as the next steps and future developments of the work.

2. Materials and Methods

The first step in designing the educational package was defining boundaries of application both of the age limits and of the number of children simultaneously involved. Reflections on these two elements suggested:

- A target of children around ten years old. This means, in the Italian school system, the involvement of students of the third, fourth and fifth class of primary schools. These children have already experienced basic concepts related to mobility: The need to move from two different points because of varied aims, using different means of transport, in different moments. For this reason, sufficient comprehensibility of the package can be achieved, encouraging its effectiveness.
- A total number of children between 30 and 60. For the effective use of the educational package, involving this number of children is functional. It grants the possibility to experience, during the transition games, concepts like traffic and congestion in managed and not too confusing conditions. Fewer children would not have been enough to experience congestion. Whereas, more than 60 children would have caused difficulties in their managing in an exciting activity.

After the definition of these two fundamental boundaries, the structure of the educational package was defined. Particular attention was paid to design a formative moment able to avoid children being bored. For this reason, the package was organized in different phases:

- Phase 1: Theoretical introduction;
- Phase 2: Educational game;
- Phase 3: Summary and conclusion.

Contents and materials needed for each of these phases are described in this section.

The package is designed to be used by instructors already accustomed to this topic. However, no topic touched is difficult enough to be considered unreachable by teachers of primary schools with some prior preparation.

2.1. Phase 1—Theoretical Introduction

The first phase is supported by slides and performed in a suitable indoor space. It aims at introducing children to some theoretical elements related to sustainable and aware mobility, with references to their experience.

Parallelism presented to children is based on a comparison between health and the condition of roads. In this phase, the package distinguishes two different conditions in the status of roads. These two conditions are "traffic", as the physiological flow of vehicles on the streets, and "congestion", the excess of vehicles compared to the street capacity. Showing videos of roads well known to the students, presenting both these conditions is very effective to clarify the distinction. It is possible to film these videos directly, customizing them to the local reality. Filming the same road section during peak hours will show the condition of "congestion". Whereas filming during off-peak hours, the normal condition of "traffic". Examples of the two conditions are reported in Figures 1 and 2.
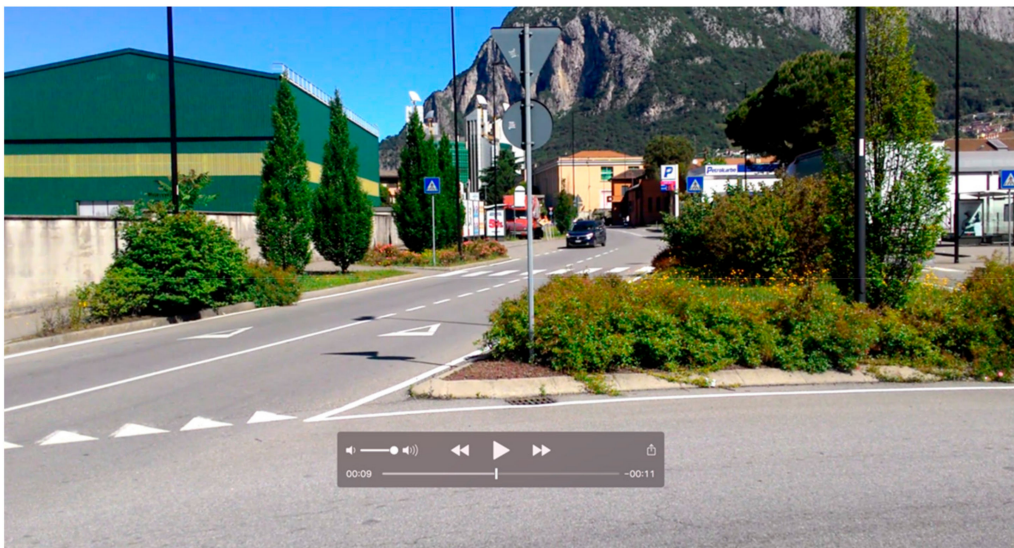
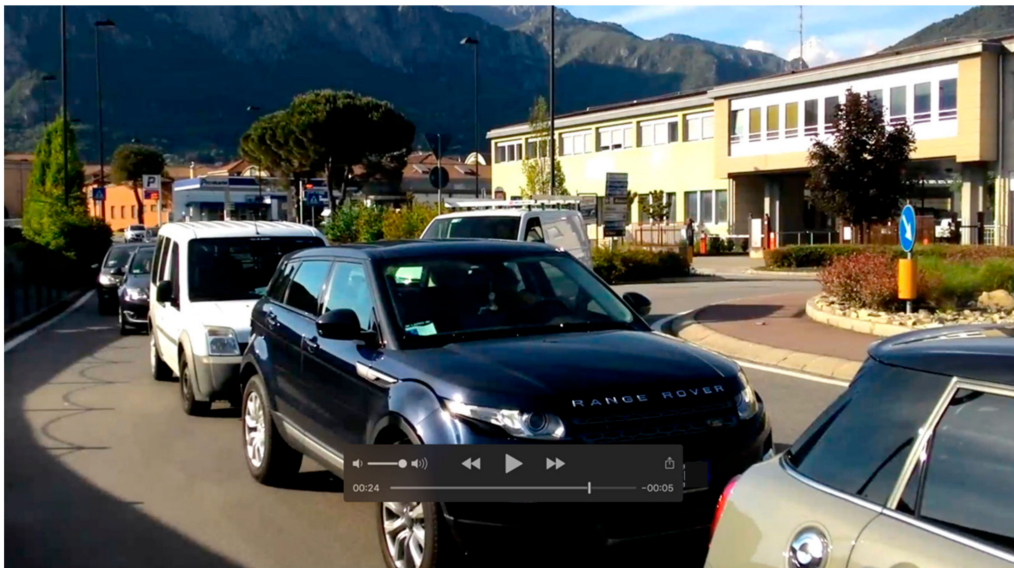**Figure 1.** Customized video of a road section in Lecco—off-peak hour—"traffic" condition.

Figure 2. Customized video of a road section in Lecco—peak hour—"congestion" condition.

The second condition can be compared to a "disease" affecting roads. This causes negative symptoms on families and, from a wider perspective, on society. Children and their families are directly affected by a significant waste of time. Instead of performing fun activities together, like going to the park or to the cinema, they spend that time in queues of cars. Society must face a series of problems connected to congestion. An example is the pollution and its effects on health. These issues imply efforts, also economic ones, that subtract resources from other aims. Aims like comfortable schools or more fun games in parks. Thus, the road disease "congestion" needs to be cured. Causes of the illness must be identified, to find an effective therapy. These are summarized as:

- People need to move;
- Towards the same destination;
- In the same moment;
- Using cars, and often alone.

Children are then invited to reflect and to find a solution for such causes. Their considerations are guided for the causes reported. Possible solutions, for each of them, could be:

- People need to move.

  Is there any solution able to mitigate this need? Actions on this need can be highly effective, but clearly not easy to develop. However, some possible solutions can be considered. For example, remote working for some of the children's parents/relatives.

- Towards the same destination.

  Is there the possibility to change trip destinations? Some journeys have a non-changeable destination (school, job, etc.), but others can present more flexibility, such as those performed for shopping or fun.

- In the same moment.

  Is there a chance to move at different times? Like the previous issue, this is not possible for some journeys. However, many can be planned in order to avoid congestion. Holiday trips are an effective example of this kind of travel. They can be undertaken in moments suitable for this purpose.

- Using cars, and often alone.

  Is there any alternative to cars available? Is there a chance to travel together, filling the car? This issue presents the widest set of solutions. Children are made aware that the needs of mobility can be answered with a wide variety of solutions. These range from walking to driving a private car, according to the philosophy of the initiative "Do The Right Mix—Sustainable Urban Mobility" [8]. A very effective cartoon video provided by this initiative is thus shown to children. This helps them understand the concept.

The video "Do The Right Mix" concludes the first phase of the educational package. This phase lasts around 20/30 min.

2.2. Phase 2—Educational Game

The second phase, composed of games, is intended to allow children to have a direct experience of the concepts presented in phase 1. The game designed envisages children using an imaginary road with imaginary vehicles. This is done by employing different scenarios that are described in this section.

The imaginary road can be realized outdoors or in a suitable indoor space. A ribbon and road works cones represent and delimit this road. The road section should have a length of 30/50 m. This length grants children the possibility of an effective experience of the scenarios, and teachers sufficient ease to manage the game.

The imaginary vehicles are made of simple cardboard boxes, open in the upper and lower side, large enough to contain one or two children. During the game, children enter the boxes, and they move along the imaginary road. To encourage the children's engagement, boxes can be given to them even before the actual start of the activity. Thus, children can customize their vehicles with plates, lights, and other accessories (Figure 3).

Figure 3. Customization of "vehicles" by children.

2.2.1. Scenario 1—Basic Scenario

The basic scenario is intended to simulate the choice of moving alone by car. The scenario is reported in Figure 4.

This scenario sees all the children, within their vehicles/boxes, simultaneously moving from one side to the other. They "drive" (i.e., walking) on the imaginary road. Moving together, they can experience how the interaction causes congestion, except for the vehicles starting first. Maybe, even some small collisions can occur. At the end of the journey, children are invited to "park" their vehicles/boxes. This highlights how much space parking areas need, another, not negligible, issue related to private motorized mobility.
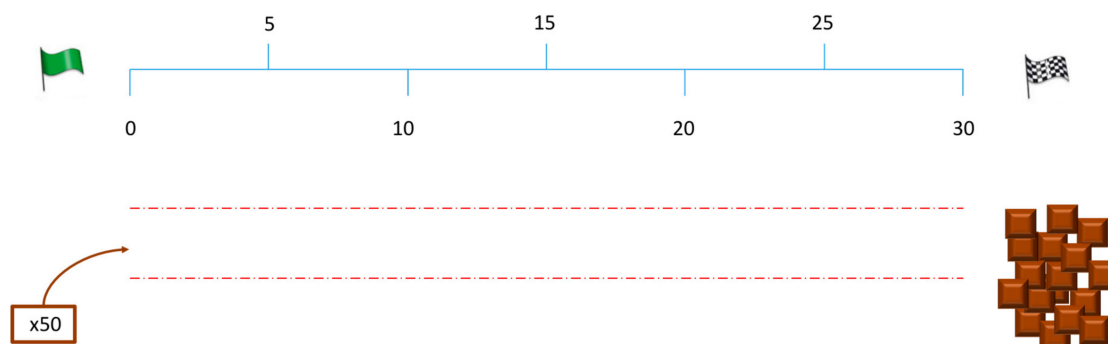

Figure 4. Layout of scenario 1.

2.2.2. Scenario 2—Basic Scenario with Interruption

Scenario 2 stresses the creation of congestion by introducing a perturbation on the imaginary road. The scenario is reported in Figure 5.

This scenario is realized by placing an obstacle, made of cones, that represents different situations that could occur while driving, like accidents or road works. The children inside their vehicles/boxes are invited to "drive" (i.e., walking) from one side of the imaginary road to the opposite one. They face heavy congestion because of the obstacle.
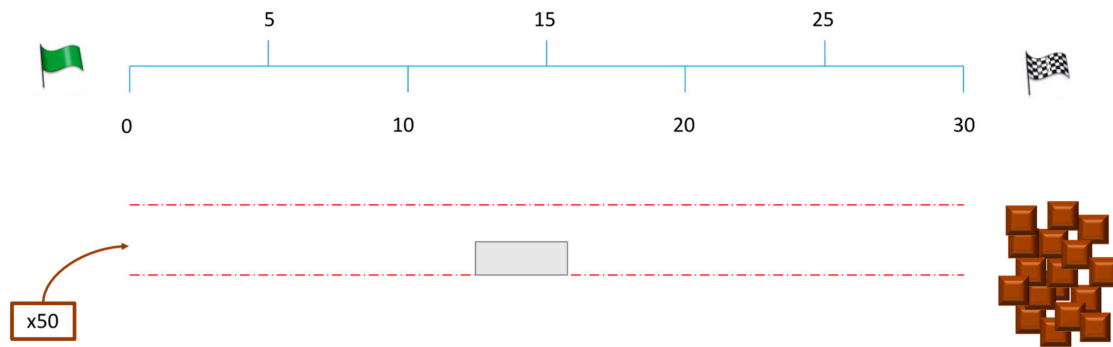
Figure 5. Layout of scenario 2.

2.2.3. Scenario 3—Spaced Departures

Scenario 3 simulates planned journeys, aimed at spreading departures over time to reduce congestion. The scenario is reported in Figure 6.

The children inside their vehicles/boxes are invited to "drive" (i.e., walking) from one side to the opposite one of the imaginary road. They are divided into homogeneous groups that start the journey one after the other. Thanks to this rational approach, they face a condition of circulation nearer the idea of "traffic" rather than "congestion".
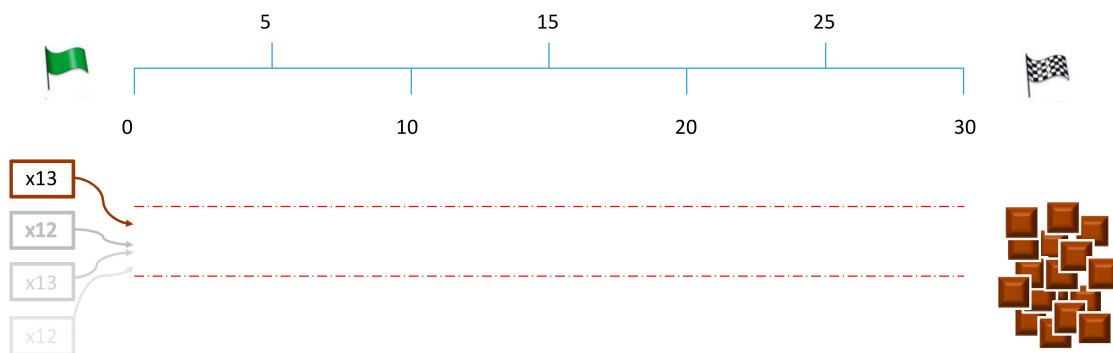

Figure 6. Layout of scenario 3.

2.2.4. Scenario 4—Carpooling

Scenario 4 simulates the organization of travel according to the idea of carpooling. The scenario is reported in Figure 7.

The children inside their vehicles/boxes are invited to share their journey with others. Thus, each of them welcomes a friend on board, halving the number of vehicles/boxes on the imaginary road. They "drive" (i.e., walking) from one side to the opposite one of the imaginary road. Thanks to this change, children experience a condition of circulation nearer the idea of "traffic" rather than "congestion". At the end of the journey, children are invited to "park" their vehicles/boxes. This action is intended to highlight the reduction of the amount of space needed for parking areas, with respect to the condition of scenario 1.
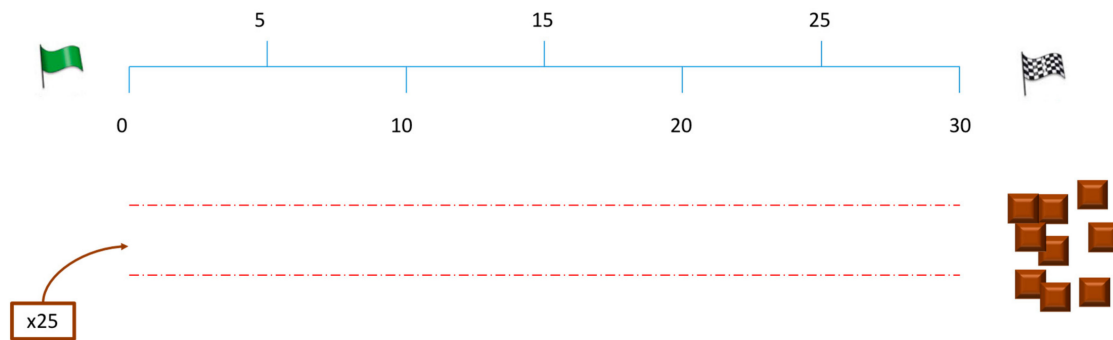
Figure 7. Layout of scenario 4.

2.2.5. Scenario 5—Public Transport

Scenario 5, finally, simulates the choice of completing the journey using public transports. The scenario is reported in Figure 8.

The children get on an imaginary bus, realized with a circle made of a belt/cord or a rectangle made of a wooden slat. This needs to be large enough to contain a group or even all the students (depending on the total number of children involved). Teachers/instructors "drive" the bus, walking from one side to the opposite one of the imaginary road. The children experience no congestion and the advantages of traveling together (talking, having fun, etc.), even if mitigated by small disadvantages (unpleasant crowd onboard). At the end of the journey, when getting off the bus, children are invited to take notice of the total lack of need for parking areas. The bus indeed leaves them and goes away to provide another service. The space intended for the vehicle/box storage before can now be used for other purposes. For example, for a soccer/basketball/volleyball field that can only easily require placing temporary portable structures such as goals and baskets.
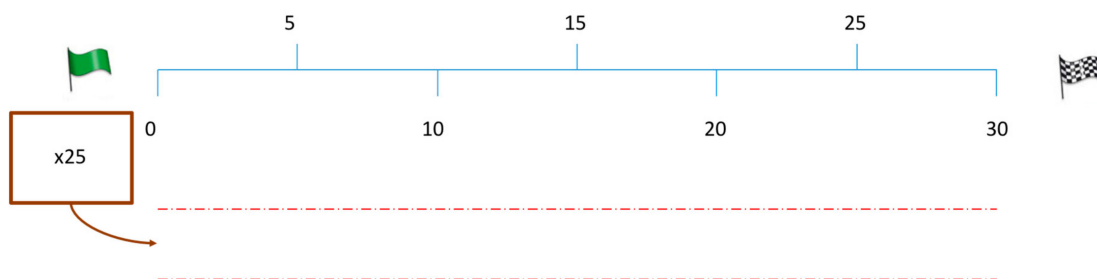

Figure 8. Layout of the scenario 5.

2.3. Phase 3—Summary and Conclusions

The last phase, performed in the same indoor space of phase 1, has children reflect on the experience they had outdoor performing the five scenarios. The third phase opens with a debate in which children are encouraged to raise observations, comments, doubts, and questions about the scenarios. Teachers/instructors can answer and explain.

Then, to stimulate children's interest, an overview of innovative, curious, and unusual solutions or means of transport is presented. Examples typically provided are the "walking bus" to reach schools, urban cableway transport networks, bus rapid transit systems (BRT), and other transport solutions used all over the world.

The final moment consists of the "test and graduation". Debate with primary school teachers suggested the need for a final moment intended to check the understanding of the experience by children. Thus, an easy test with a few (4/5) easy multiple-choice questions is submitted. Answers are then checked together and children can verify them. Then, all the students are rewarded with a symbolic diploma. The certificate attests their participation in the initiatives and the acquisition of the knowledge and competences in the field of sustainable and aware mobility.

3. Results

The final configuration of the package, as described in the section Materials and Methods, is the result of the fine-tuning activity, carried out after the actual use of the initiative. The educational package was tested three times within different initiatives for primary school children in Italy.

3.1. First Edition—Politecnico Di Milano

The first edition was carried out in April 2015 at the Bovisa Campus of Politecnico di Milano. The package was part of a series of meetings—Tutti all'università! [15]—organized by Focus Junior, a scientific periodical for children. The meetings were intended to make children get in touch with the academic environment, dealing with a range of different topics, including mobility. The Focus Junior director and three instructors held the meeting with around 200 children. No other adults were present. These conditions did not allow performing the outdoor transition game of phase 2. A quiz game replaced it. In addition, the final moment of "test and graduation" did not take place. The results were encouraging. Children showed interest, as demonstrated by the great number of questions asked in phase 3, and curiosity, in particular during the presentation of innovative and unusual transport solutions. Event organizers and children's parents also gave positive feedback. Despite these positive results, the debriefing highlighted the need for adjustments. Specifically, the necessity to introduce a transitional game, so as to avoid boredom and to allow children to have a more direct experience of the theoretical concepts explained. The idea of the transition game forces however to limit the overall number of students involved. This ensures the effective and safe management of children.

3.2. Second Edition—Polo Territoriale Di Lecco—Politecnico Di Milano

From the first experience, the educational package evolved with the introduction of the transition game. The second edition was carried out within the Polo Territoriale di Lecco of Politecnico di Milano in May 2016. In this instance, the event was open to around 60 children attending the fourth class of three primary schools in Lecco, Italy. This edition confirmed the strengths of the educational package. The effectiveness in terms of comprehensibility of the parallelism road congestion/illness, the fun of the "Do The Right Mix" video, and the ability to raise curiosity offered by the overview of unusual means of transport. The transition game, organized in the courtyard of the university campus, was fully performed. Both students and their teachers highly appreciated and enjoyed it.

3.3. Third Edition—Primary School in Lierna

The last test was performed at the primary school of Lierna, Italy, in May 2017. It was open to the students of the third, fourth, and fifth classes, involving around 50 children. The event was inserted in the local municipality annual training program for primary schools. In this instance, the teachers participated in a brainstorming process to share ideas and optimize the package for a territorial situation different from an urban area densely populated. However, no need for relevant changes was found, but interesting suggestions for additional elements emerged. In particular, the idea of a test arose. A final test intended to verify the comprehension of the contents by students, even if in an easy and funny way. A few multiple choice questions were, therefore, prepared and summarized in a form submitted to children. On this last occasion, the package was used in its final configuration, as presented in Section 2, with appreciation from the children and satisfaction from the teachers. The positive outcomes are also the result of a fruitful effort by teachers in the days before the event. Indeed, the children were involved in customizing their boxes/vehicles and invited to reflect on their habits and behaviors in the field of mobility.

Finally, local news reported the two events performed in Lecco and Lierna [16], granting visibility and award to all the subjects involved.

4. Discussion

The educational package developed and presented is designed to provide an instructive moment to explain to children the main concepts of sustainable and aware mobility. The idea is to increase the sensitivity of children towards these concepts so that, once they are adults, they will adopt sustainable behaviors. Moreover, they could immediately influence their parents and relatives, affecting their daily mobility choices, to push them towards greener conduct.

The need of the package arose since no other reference researched presented the features of ease, quickness and repeatability of use pursued by the authors. Indeed, the requirements were those of a "stand-alone" formative moment. The main available solutions, like "The Traffic Snake Game", imply in fact a more continuous effort by the schools and their teachers.

The three experiences showed increasing positive outcomes. From the first trial, an effective fine-tuning was performed. It suggested changes on how to present theoretical elements, to organize and manage the transition games and to engage and involve both the children and their teachers. The last experience performed at the primary school of Lierna is considered final and effective. The package can be repeated, with small adaptations, in all primary schools.

However, more improvements could be sought. The lack of a rigorous process of collecting feedback is one of the current limits of these experiences. This is not to be considered as mandatory but useful to orient in a more effective way the natural evolution of the educational package. Currently, the instructors received informal encouraging opinions by teachers and students involved. A request to fill an evaluation sheet could follow this moment. It could involve questions to collect quantitative outcomes but also open questions, so to receive suggestions and proposals and continuously improve the product. A first draft of such evaluation sheet is currently under development and it will be used during the next submission of the educational package. This will be performed during the academic year 2018/2019, within the projects "Poli To Kids" [17]. The initiative, created by Politecnico di Milano-Polo Territoriale di Lecco, proposes a series of initiatives to promote scientific and technological culture among young people of Lecco and its province.

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