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Evaluation of the Road Safety Education “E-drive Academy” Interactive Program in Greek Elementary Schools: A Study of 834 Fourth Grade Students

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Abstract

Road safety constitutes a crucial public health issue and there is growing research on road safety school interventions that promote responsible road use. The current experimental study explored the effectiveness of a three-month implementation of the interactive road safety education program “E-drive Academy” with fourth-grade elementary students in Greek schools of Attica prefecture. The sample consisted of 834 students (experimental group: 629; control group: 205). The evaluation questionnaire included demographics and a road safety questionnaire for use by primary education students, specifically designed to test the effectiveness of the taught modules, namely i) walking safely, ii) using the means of transport and being a passenger in a car, iii) riding a bicycle safely, iv) being a passenger in a school bus, v) locus of control, vi) knowing the traffic lights, vii) incorporating movement into daily life, and viii) orienting oneself. The data analysis revealed that the experimental group exhibited significant ($p < 0.05$) improvement in all taught and investigated traffic-related knowledge, skills, and attitudes post-intervention, whereas the control group did not. The present e-health intervention confirms that properly designed universal road safety education could enhance safety skills and help prevent problem behaviours.

Key findings

- Evaluation of ‘E-drive Academy’ a road safety education program for primary and secondary students
- Program significantly improved 4th grade students’ knowledge, skills, and attitudes on: walking safely; being a passenger; riding a bicycle safely; locus of control; knowing the traffic lights; incorporating movement into daily life, and; orienting oneself.

Introduction

Injuries due to crashes on the road constitute a crucial global public health issue, according to the World Health Organization (WHO, 2015); approximately 1.3 million people die yearly in crashes on the roads. Road crash related injuries are the leading cause of death globally among people aged between 5 and 29 years and the eighth leading cause of death among all ages (WHO, 2022). Children aged 5 to 14 years are at higher risk of injury as pedestrians and cyclists

(Lavoie et al., 2014), and their injuries from crashes on the road are caused by adopting risky behaviours or having inadequate knowledge of road safety rules (Dong et al., 2010). The percentage of crashes on the road involving young children has been found to be significantly higher than adults, four times higher for children aged 6 to 10 years (Zare et al., 2019). According to the 2019 Road Safety Annual Organisation for Economic Co-operation and Development (OECD, 2019) Report, there was a substantial decrease of children’s injuries from road crashes in the second decade of the 21st

century. However, the safety of children in traffic in low and middle-income countries still “remains a major concern” (p. 27).

Moreover, the financial cost associated with treating injuries resulting from crashes has been considerable, particularly when the injury impedes economic wellbeing and macroeconomic performance (Chen et al., 2019). Consequently, the need for taking measures to improve road safety and enhance relevant knowledge and skills has been broadly acknowledged (WHO, 2022).

Extensive research has been conducted on preventive interventions to promote responsible road use (Albert & Dolgin, 2010; Zare et al., 2018). According to Alonso and colleagues, Road Safety Education (RSE) is defined as “any permanent educational action that stimulates the development of knowledge, skills, habits, behaviours, values, and attitudes that improve the behaviour of pedestrian, passenger or driver (in other words, every potential road user) with the ultimate aim of reducing the potential risk of suffering an accident and, ultimately, its rates” (Alonso Plá et al., 2016, pp. 63–64). RSE is considered the most crucial assurance of the future concerning road safety prevention and promotion (Alonso Plá et al., 2016) and has been recognised as a priority by OECD countries since 2004 (OECD 2004). As Gounaridou and her colleagues (2021) state “the allocation of attention, the responsible attitude, and the behaviour on the streets by pedestrians and drivers are skills that can be acquired within coordinated and well-targeted training (p.2).

Many RSE programs were developed using various strategic approaches and have been delivered by schools, to reduce the risk of crashes on the road and improve the safe behaviour of children in traffic environments. An important prerequisite for the success of RSE programs is teaching students awareness of dangers (Valentová et al., 2021). Some RSE programs aim at fostering the development of attitudes, since it has been shown that the unsafe behaviour of children between 10 and 15 years has been caused by failure to apply knowledge of safe practices instead of lacking the knowledge itself (Zeedyk & Wallace, 2003). In a national study conducted in Spain, Alonso et al. (2018) discovered a connection among various factors – such as knowledge of traffic rules, positive attitudes towards road safety, and risk perception – and stressed their vital significance in RSE interventions. Sheeran and Orbell (1999) argue that it is essential to emphasise behavioural intention in predicting behaviour. Heath and Gifford (2002) suggest that focusing on external social and internal norms is beneficial to generating voluntary, safe behaviours. However, the attitude toward an intentional risky behaviour, the subjective norm, and the perceived control over one’s behaviour, play a critical role.

Another important factor for the effectiveness of school RSE programs is teacher’s training in traffic safety instruction. Teacher’s training is considered a principal factor in preparing teachers to implement health promotion programs, because their attitudes and knowledge are critical elements in their intention to work with health-related is-

ssues. Thus, training helps shape their identities as educators and subject experts (SHE, 2013).

During the last two decades, several public e-health interventions concerning road safety have been designed and implemented (e.g., Dunwell et al., 2014; Rawi et al., 2015; Shaari et al., 2015). Interactive multimedia (IMM), based on the cognitive theory of Multimedia Learning, has become a promising approach to traffic safety education (Glang et al., 2005). After all, game-based learning is an attractive tool through which large populations of children can be reached and thus respond to this informal method of instruction (Dunwell et al., 2014). Furthermore, combining traffic theory and knowledge with practising traffic skills through e-games in simulated road environments seems a promising approach (Gounaridou et al., 2021).

However, issues of effectiveness, practicality, and feasibility of various types of school-based RSE programs remain unclear due to diverse factors, such as lack of adequate control of sample biases by conducting randomised trials, absence of control group, and deprivation of resources and financial support (Raftery et al., 2011). Despite the comprehensive research, robust findings concerning the essential elements of RSE programs remain limited, because evidence-based decision-making in public health has yet to be established, and rigorous studies are needed to provide evidence on the effectiveness and sustainability of relevant programs (Fung et al., 2012).

Currently, many countries have put into effect RSE programs in primary and secondary schools, although some have failed to include them in their official curricula (Alonso Plá et al., 2016). In Greece, road safety or traffic safety education comprises one of many topics suggested for optional implementation in Greek primary and secondary schools, such as healthy eating, oral hygiene, smoking prevention, bullying-prevention, life skills, etc. Nonetheless, its instruction to first to fourth-grade students in elementary schools became mandatory on a pilot basis which lasted for two years, from September 2018 to June 2020.

Since no comprehensive and structured evaluated curricula were available at the time as teaching tools for students of different grades, the Greek Ministry of Infrastructure, Transport, and Networks designed a universal, teacher-taught RSE e-program for primary and secondary students on a web portal named “e-DRIVE Academy” (<http://edrive.yme.gov.gr/>). The present study concerns the modules taught to fourth-grade elementary students and aims to assess the “e-DRIVE Academy” program’s effectiveness on students’ traffic skills, knowledge and attitudes. Evaluation of fourth-grade students, and not older children or adolescents, was chosen by the Greek Ministry of Infrastructure, Transport, and Networks as RSE was mandatory only up to that grade at the time. The Ministry also took into account that fourth grade students are able to understand traffic rules and situations, namely a factor which is important for successful RSE (Assailly, 2017), and that they belong to the age group of 5 to 14 years when children are at higher risk of injury as pedestrians and cyclists (Lavoie et al., 2014).

We hypothesised that the students, attending the “e-DRIVE Academy” program for one trimester, would have a greater improvement concerning i) walking safely, ii) using the means of transport and being a passenger in a car, iii) riding a bicycle safely, iv) being a passenger in a school bus, v) locus of control, vi) knowing the traffic lights, vii) incorporating movement into daily life and viii) orienting oneself.

The “e-DRIVE Academy” program

The e-Drive Academy (<http://edrive.yme.gov.gr/>) is an innovative online educational platform for training in safe, smart, ecological and sustainable mobility and driving. Created by the Hellenic Institute of Transport (HIT) of the National Centre for Research and Technological Development and operating under the auspices of the Greek Ministry of Infrastructure, Transport and Networks, it offers comprehensive training services to foster a mature road culture which will ensure safe movement for all road users, inclusive of their age, education and economic status. The integrated lifelong training program utilises electronic books, leaflets, interactive SCORM-compliant e-learning multimedia, and game-based e-learning to support learners. Each of these tools comprises both training and assessment components tailored to the specific needs and characteristics of each group of trainees.

The training content is developed based on three criteria: maximising knowledge transfer, trainee’s age, and trainee’s current level of experience. The training sessions, starting from primary and continuing into secondary education levels, aim to facilitate the systematic acquisition of provisional knowledge on road safety and mobility. This contributes to the gradual establishment of a secure and environmentally conscious driving and mobility culture. The web portal includes modules appropriately designed for students of different grades, adapted to their needs and age characteristics, and teaches them the fundamental rules for traffic safety and mobility on the streets and the surrounding environment. For example, modules for fourth grade students include “Walking safely in the city”, “Traveling safely by tram”, “Cycling safely in the city”, “Riding the school bus safely”, etc. Each module is approached through e-lessons, presentations, videos, and e-games. As also stated by the Ministry in the web portal, “in the context of an integrated primary and secondary education on road safety and mobility, complementary manuals for the parents and teachers have also been developed” (<https://www.imet.gr/index.php/en/projects-en-2/indicative-sector-a-projects-en/190-e-drive-academy-en>).

Method

Procedure

This study applied a mixed measures experimental research design.

The evaluation study was conducted in the last trimester of the 2018-19 school year, in 35 fourth-grade classes of 19 schools in Eastern Attica, under the supervision of the

School of Pedagogical and Technological Education, with the cooperation and support of Eastern Attica’s Directorate of Primary Education. Twenty-seven classes originated from public schools and eight from private ones. The participating schools were situated in urban, rural, and even industrial areas, representing high, middle- and low-income. Since the intervention aimed to evaluate the effectiveness of a universal road safety program, classes and not individual students were randomly assigned to the experimental and control groups. Regarding the sampling procedure, the Directorate’s Health Education Coordinator randomly assigned the classes to experimental or control. To assure anonymity personal codes for every participant were used. The questionnaire’s administration to the students was permitted by the Greek Institute of Educational Policy (Ref. Φ.15/8244/13462/Δ1/29-01-19) and a signed consent form was collected from the student’s parents before it was completed. Both groups completed the study questionnaires, pre- and post-intervention, namely in March and June 2019.

Facilitators’ Training

Teachers of the experimental groups became the facilitators of the curriculum and received training prior to the implementation. Teachers of the control groups were promised to receive it during the following school year. This practice is common regarding school-based prevention programs, as reported in meta-analyses (e.g. Diekstra & Gravesteyn, 2008; Durlak et al., 2011). To be trained, the intervention teachers attended a training day seminar where the program’s guidelines and components were analytically presented, and they had the chance to test the portal themselves.

Implementation and Implementation Fidelity

Students in the experimental groups attended the curriculum’s structured two-hour weekly lessons, facilitated by their teachers. To ensure the fidelity of the implementation, the following measures were followed:

1. Clear and detailed implementation instructions were analytically discussed during the training seminar.
2. Teacher of the experimental groups completed an implementation and evaluation form after each lesson-teaching.
3. The Health Education Coordinator supervised the conduct of the study and visited the intervention classes to inspect the implementation procedure, ensuring the program was taught as designed.

Program implementation

Students in the experimental groups attended a weekly two-hour session and were taught the relevant modules using the “e-Drive Academy” presentations, e-lessons, and videos. Also, during the ICT (Information and Communication Technology) hour, which is a weekly two-hour course as well, they engaged in playing the “e-Drive Academy” e-

Table 1. Sample Characteristics of the Control and Intervention Group

	Intervention group N=629		Control group N=205		P Pearson's χ^2 test
	N	%	N	(%)	
Gender					
Boys	327	52.3	90	44.6	0.055
Girls	298	47.7	112	55.4	
Age, mean (SD)	9.1	0.3	9.1	0.5	0.132++
Going to school					
On foot	163	26.2	46	22.4	0.319
By bicycle	6	1.0	0	0	0.345+
By school bus	165	26.5	59	29.2	0.450
By car	405	65.0	129	63.9	0.767
Ever attended other program for traffic education	301	50.3	101	51.5	0.756

+Fisher's exact test ++Student's t-test

games which corresponded to the taught modules. Students in the control groups attended the mainstream curriculum. At the end of the program students of both groups were administered the questionnaire to determine the intervention effectiveness.

Participants

The sample consisted of 834 fourth-grade students with an average age of 9.1 years (experimental group: $n=629$; control groups, $n=205$). Sample characteristics of both study groups are shown in [Table 1](#) and are similar between the two study groups. Gender was almost even in both the intervention groups (female: $n=298$, 47.7%; males, $n=327$, 52.3%) and the control groups (female: $n=112$, 55.4%; males, $n=90$, 44.6%). Also, 50.3 percent of students in the intervention group had never attended another traffic education program, while the corresponding proportion was 51.5 percent for the control.

Measures

To assess basic demographic information we used a students' self-report questionnaire comprising demographics and questions about whether the student had attended another RSE program prior to the intervention.

The intervention effectiveness was assessed by a road safety questionnaire for use in primary education students, namely the RSE “E-drive Academy” Questionnaire, specifically designed to test the effectiveness of the taught modules. This questionnaire was primarily based on the relevant program posted on the Greek Ministry of Infrastructure, Transport and Network's E-Drive Academy web page. It included 54 items and used a three-point scale ranging from 1 (“Never true”) to 3 (“Always true”) investigating knowledge and ability, as well as behaviour and attitude ([Table 2](#)).

Initially, a trial version of the RSE “E-drive Academy” Questionnaire was administered to two classes of 35 fourth-grade students to receive feedback concerning sev-

eral issues, such as the instructions, the questions, and the duration of the completion and appropriate improvements were made.

Data Analysis

Quantitative variables were expressed as mean values (SD), while qualitative variables were expressed as absolute and relative frequencies. Chi-square and Fisher's exact tests were used to compare proportions concerning the baseline characteristics of the two study groups. Student's t-tests were also computed to compare mean age between intervention and control group. Exploratory factor analysis was performed to evaluate the construct validity of the questionnaire and eliminate the number of items. Principal component analysis (PCA) was chosen as an extraction method using Varimax rotation. The cut-off point for factor loadings was 0.40, and for eigenvalues, 1.00. The Cronbach's α determined the internal consistency of the questionnaire. Scales with reliabilities equal to or greater than 0.70 were acceptable (Nunnally & Bernstein, 1994). Inter-correlations (Pearson's r) among the scales belonging to the same questionnaire were also tested. The correlation coefficient between 0.1 and 0.3 are considered low, 0.31 and 0.5 moderate, and above 0.5 high. Pre- and post-measurements of the factors determined from factor analysis were compared separately for intervention and control group using paired t-tests. To further assess evaluate changes in study factors after the intervention, we fitted mixed linear regression models explaining multiple measurements per individual obtained at different time points. All analyses were conducted using a random coefficient model with the intercept being random and a covariance structure of variance components. All reported p values are two-tailed. Statistical significance was set at $p<0.05$, and analyses were conducted using SPSS statistical software (version 22.0).

Table 2. Skills and indicative items of the questionnaire by targeted outcome

Skills	Examples of the questionnaire's items	Targeted outcome
i) walking safely	“I can recognize the pedestrian crossings, wherever there are such” “I walk only on the sidewalk, when there is one”	Knowledge/ability Behaviour
ii) using the means of transport and being a passenger in a car	“It is obligatory to wear my seat belt, even when I am seated in the back seat of my parents’ car” “When I use the subway, the tram, or the suburban train, I stand in front of the door in order to be able to get out, if necessary”	Knowledge Behaviour
iii) riding a bicycle safely	“I know about the brakes and the air of my bicycle tyres and I am able to check them” “I wear a helmet every time I ride a bicycle” “It is safe to ride a bicycle and eat at the same time”	Knowledge/ability) Behaviour Attitude
iv) being a passenger in a school bus	“When I am on the school bus, I do not need to wear a seat belt” “I do not put my hands or my head out of a car or bus window”	Knowledge Behaviour
v) locus of control	“Avoiding a road accident depends on how careful I am” “Whatever is going to happen on the way to school will happen, I cannot do anything about it”	Attitude Attitude
vi) knowing the traffic lights	“School crossing attendants do not have the right to regulate traffic”	Knowledge
vii) incorporating movement into daily life	“Walking to school clears my mind and makes me think better”	Attitude
viii) orienting oneself	“I can locate the four cardinal points”	Knowledge/ability

Results

Intervention Effectiveness Inventory structure

With respect to the scale’s structure, an exploratory factor analysis (Table 3) with the principal component method and varimax rotation was conducted on the initial sample. An eight-factor structure was identified using the latent root criterion of retaining factors with eigenvalues greater than 1.0, with the extracted factors explaining 65.4% of the total variance. The proportion of variance explained by each factor was 9.9% for “Walking safely, 9.5%, for “Using the means of transport and being a passenger in a car,” 8.8% for “Riding a bicycle safely,” 8.3% for “Being a passenger in a school bus,” 7.8% for “Locus of control,” 7.3% for “Knowing the traffic lights,” 7.0% for “Incorporating movement into daily life”, and 6.8% for “Orienting oneself.” Factor loadings of the rotated solution are shown in Table 2, with all factor loadings more than 0.40. Items 5, 6, 15, 33, 51, and 53 were not successfully loaded and omitted from the final factor solution. All the factors exceeded the minimum reliability standard of 0.70.

Correlations between factors

Additionally, almost all the correlations between pairs of factors (Table 4) were statistically significant ($p < 0.05$), positive, and ranged from low to high, indicating that as students’ knowledge increased in one section, a higher level of knowledge was indicated in almost all other sections. The correlation between locus of control and the other factors was negative while the strongest correlation was found be-

tween walking safely and using the means of transport / being a passenger in a car.

Pre- and post-intervention differences

Moreover, paired comparisons of the factors for pre- and post-measurements – namely measurements that took place in March and June 2019 – for the intervention and control group are depicted in Table 5. All factors had a significant ($p < 0.05$) improvement in the intervention group, and no changes were recorded in the control group.

Mixed-model regression analysis

Furthermore, results of mixed-model regression analysis for changes after the intervention are presented in Table 6. At baseline, the control group had similar scores for all factors. The interaction of the intervention with time was significant ($p < 0.001$), indicating that the subjects of the intervention group, except for locus of control, had a more significant increase in all factors than those of the control group, with the strongest being the increase of the knowledge of the traffic lights. Similar results were obtained when adjusted for sex, age, and having attended another program on traffic education prior to the intervention.

Discussion

Our study aimed to evaluate the “e-DRIVE Academy” RSE Elementary Program effectiveness on students’ traffic skills, knowledge and attitudes. We hypothesised that students attending the program would exhibit a greater im-

Table 3. Results from exploratory factor analysis

Item	Walking safely	Using the means of transport / Being a passenger in a car	Riding a bicycle safely	Being a passenger in a school bus	Locus of control	Knowing the traffic lights	Incorporating movement into daily life	Orienting oneself
3							0.41	
36							0.49	
54							0.46	
14								0.51
40								0.48
41								0.45
8						-0.51		
19						0.56		
32						-0.41		
39						0.49		
2	0.47							
7	-0.52							
10	-0.64							
13	0.47							
18	-0.49							
24	0.64							
26	-0.56							
30	0.40							
42	-0.45							
43	-0.49							
45	0.45							
46	-0.62							
47	-0.63							
49	-0.46							
12			-0.52					
21			0.54					
29			0.61					
35			0.65					
38			0.50					
48			-0.49					
4		0.48						
9		0.73						
11		-0.54						
16		0.04						
20		-0.42						
22		0.58						
28		-0.43						
44		-0.54						
23		-0.46						
31		0.40						
34		-0.41						
37		-0.62						
25				-0.57				
50				-0.43				
52				-0.47				
1					0.45			
17					0.45			
27					0.43			
% of variance explained	9.90	9.50	8.80	8.30	7.80	7.30	7.00	6.80

Table 4. Pearson’s correlations’ coefficients among all study factors

	Orienting oneself	Knowing the traffic lights	Walking safely	Riding a bicycle safely	Using the means of transport / Passenger in a car	Passenger in a school bus	Locus of control
Incorporating movement into daily life /	0.22***	0.27***	0.28***	0.25***	0.15***	0.23***	-0.03
Orienting oneself	1.00	0.22**	0.29***	0.33***	0.14***	0.20**	-0.22**
Knowing the traffic lights		1.00	0.26***	0.29***	0.27***	0.34***	-0.06
Walking safely			1.00	0.26***	0.53***	0.35***	-0.20***
Riding a bicycle safely				1.00	0.37***	0.24***	-0.27***
Using the means of transport / Being a passenger in a car					1.00	0.36***	-0.21**
Being a passenger in a school bus						1.00	-0.22***

*p<0.05; **p<0.01; ***p<0.001

Table 5. Paired comparisons Pre- and Post-Measurement factors for the Intervention and Control Group

	Intervention group		P Paired t-test	Control group		P Paired t-test
	Pre	Post		Pre	Post	
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
Incorporating movement into daily life	2.22 (0.48)	2.37 (0.48)	<0.001	2.19 (0.42)	2.19 (0.5)	0.623
Orienting oneself	2.18 (0.48)	2.31 (0.47)	<0.001	2.18 (0.5)	2.16 (0.45)	0.467
Knowing the traffic lights	2.42 (0.33)	2.57 (0.33)	<0.001	2.41 (0.43)	2.37 (0.44)	0.308
Walking safely	2.23 (0.19)	2.33 (0.21)	<0.001	2.25 (0.23)	2.24 (0.23)	0.320
Riding a bicycle safely	2.58 (0.36)	2.72 (0.34)	<0.001	2.59 (0.38)	2.63 (0.41)	0.280
Using the means of transport / Being a passenger in a car	3.04 (0.36)	3.22 (0.36)	<0.001	3.02 (0.42)	3.08 (0.39)	0.118
Being a passenger in a school bus	2.68 (0.41)	2.78 (0.36)	<0.001	2.65 (0.48)	2.68 (0.4)	0.313
Locus of control	1.98 (0.37)	1.83 (0.37)	<0.001	2.02 (0.41)	2.01 (0.43)	0.191

provement than those attending the regular curriculum, in the following factors: i) walking safely, ii) using the means of transport and being a passenger in a car, iii) riding a bicycle safely, iv) being a passenger in a school bus, v) locus of control, vi) knowing the traffic lights, vii) incorporating movement into daily life, and viii) orienting oneself. Our hypothesis was confirmed.

The data analyses revealed a substantial improvement in the intervention group and no changes in the control. The improvement corroborated Gounaridou’s and her colleagues’ finding that experiences in the virtual environment can systematically turn into practical, real-life knowledge, thus steadily cultivating traffic awareness and responsible behaviour (2021, p. 18). Besides, Valentova and her colleagues (2021) strongly recommended the application of training in a virtual environment for the improvement of higher and lower order thinking skills in traffic education for fourth graders.

Regarding each investigated skill, our results align with other studies (e.g., Barton et al., 2007) which showed that teachers can effectively train students in school settings in

traffic skills. Expressly, our findings on the skills of walking safely, knowing the traffic lights, and being a passenger in a car agree with previous research indicating the successful implementation of traffic safety intervention programs and the following improvement in the pedestrian safety knowledge of school-age children (Delouche et al., 2019; Vayssier et al., 2016). Additionally, the traffic skills taught to the experimental group of students in our study coincide with the fundamental skills that Foot et al. (1999) believe children need to acquire for safe road-crossing, such as detecting traffic presence, recognising safe and dangerous locations, and visual timing.

Dragutinovic and Twisk (2006) suggested that the educational objectives for RSE programs should include enhancing knowledge about traffic and rule learning, changing the attitudes toward safety, and developing new appropriate traffic skills, including walking safely and being a passenger in a car. Dunbar et al. (1999) have also accentuated the importance of the skills related to the perception of danger while walking safely back and forth to school and Schwebel et al. (2014), in a meta-analysis, suggested that

Table 6. Results of mixed-model regression analysis for changes after the intervention

	β^+	SE ⁺⁺	P
Incorporating movement into daily life			
Group: Control (reference)			
Intervention	0.03	0.04	0.475
Time: Pre (reference)			
Post	-0.01	0.04	0.799
Interaction of Group*Time	0.14	0.04	<0.001
Orienting oneself			
Group: Control (reference)			
Intervention	-0.01	0.04	0.831
Time: Pre (reference)			
Post	-0.03	0.04	0.497
Interaction of Group*Time	0.12	0.04	<0.001
Knowing the traffic lights			
Group: Control (reference)			
Intervention	0.01	0.03	0.701
Time: Pre (reference)			
Post	-0.04	0.04	0.284
Interaction of Group*Time	0.19	0.04	<0.001
Walking safely			
Group: Control (reference)			
Intervention	-0.02	0.02	0.31
Time: Pre (reference)			
Post	-0.02	0.02	0.392
Interaction of Group*Time	0.11	0.02	<0.001
Riding a bicycle safely			
Group: Control (reference)			
Intervention	-0.02	0.03	0.543
Time: Pre (reference)			
Post	0.04	0.03	0.185
Interaction of Group*Time	0.10	0.03	0.003
Using the means of transport / Being a passenger in a car			
Group: Control (reference)			
Intervention	0.02	0.03	0.469
Time: Pre (reference)			
Post	0.06	0.03	0.041
Interaction of Group*Time	0.11	0.03	<0.001
Being a passenger in a school bus			
Group: Control (reference)			
Intervention	0.03	0.03	0.371
Time: Pre (reference)			
Post	0.03	0.03	0.316
Interaction of Group*Time	0.09	0.04	0.029
Locus of control			
Group: Control (reference)			
Intervention	-0.03	0.03	0.285
Time: Pre (reference)			
Post	-0.12	0.03	0.001
Interaction of Group*Time	-0.10	0.04	<0.001

+Regression Coefficient; ++Standard Error

interventions designed to teach children to be more accurate, when they select safe traffic gaps to cross, can be effective. Moreover, Morrongiello and Kiriakou (2006) found that even single-session safety programs may positively affect pedestrian safety and seat belt safety knowledge for primary school children. All these findings seem promising for tackling the issue that children pedestrians and car passengers are the most vulnerable group in Europe (European Transport Safety Council, 2022). This is especially significant for Greece, since, as stated by the European Road Safety Observatory (2022), in Romania and Greece more than one in two fatalities among children between 2011 and 2020 was a pedestrian.

Concerning the above-mentioned traffic skills, and the one regarding riding a bicycle safely, our study corroborated the findings of Dong et al. (2010) who highlighted road safety knowledge's role in avoiding walking and cycling-related risk behaviours and in protecting against road traffic injuries. The finding is promising and of significant importance regarding RSE in Greece; in an analysis exploring injury severity of children and adolescents involved in traffic crashes in Greece (Theofilatos et al., 2021) it was found that crashes involving bicycles or powered-two-wheelers are associated with higher injury severity.

Per locus of control, it seemed that the more the students improved their traffic skills, the less they thought events were under the control of external factors. Our finding is consistent with that of Özkan et al. (2005) who concluded that external locus of control relates to lack of caution and crashes, and the one of Ahlin and Lobo Antunes (2015) who found that internal locus of control contributes to positive youth outcomes.

As for incorporating movement into daily life and adopting an active way of movement, Brustio et al. (2018) discovered a similar finding following an intervention designed to motivate students to undertake physical activity.

Finally, with regard to geographical orientation, the interventions demonstrated by Fleming and Mitchell (2017) were also found to improve spatial thinking skills. Furthermore, a case-study analysis by Valentova et al., (2021) showed that fourth grade students' level of knowledge in the field is age-adequate but there is room for improvement in application of higher order thinking skills and risk assessment.

Strengths and Limitations

The study has several strengths, with its relatively large sample size being one. Additionally, all types of income and areas were represented in the study, including urban, rural, and industrial areas, as well as high, middle, and low-income ones. Furthermore, the study was conducted in Attica, the prefecture where Greece's capital, Athens, is located and where 35.5 percent of the Greek population resides. Apart from the representative sample and its size, another strong point of the presented study was monitoring and evaluating the implementation fidelity.

However, limitations also existed; the use of teachers as the intervention facilitators may be considered as a disadvantage, even though such an approach is often used by

researchers in universal school programs' evaluations, primarily due to the lack of financing (Ashdown & Bernard, 2012; Brackett et al., 2012; Diekstra & Gravesteyn, 2008; Durlak et al., 2011). Our research also lacks a follow-up study that would investigate the sustainability of its results. Thus, long-term results are not available. Moreover, since a self-report measure is used to assess change in knowledge, skills and attitudes, it is unclear whether the traffic skills learned would indeed be applied to actual road crossings. Therefore, more robust evaluation of the program could be considered in the future. Additionally, a future updated version of the program could incorporate supervised experiences of real traffic situations, because streetside training, although costlier and more tedious, has demonstrated better learning results than the video/website one (Schwebel, McClure, et al., 2014).

Conclusions

The effectiveness study of the “E-drive Academy” school program verified our hypothesis, as all the targeted, taught, and investigated traffic skills, namely i) walking safely, ii) using the means of transport and being a passenger in a car, iii) riding a bicycle safely, iv) being a passenger in a school bus, v) locus of control, vi) knowing the traffic lights, vii) incorporating movement in daily life, and viii) orienting oneself, were significantly improved in the experimental group of elementary students in comparison with the controls. The results corroborate the findings of other researchers concluding that universal RSE can enhance traffic skills and thus contribute to the prevention of problem behaviours (Cross et al., 2003). Concerning the use of IT and e-gaming in enhancing those skills, as stated by Gounari-dou and her colleagues “the clear and positive relations between gaming and traffic behaviour prove that games can be used further to enhance traffic skills and develop an improved traffic safety culture, thus being of great value for society” (2021, pp. 18–19).

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Author contributions

Ntina Kourmoussi, Antonios Kalamatianos and Kalliopi Kounenou designed the study. Ntina Kourmoussi and Antonios Kalamatianos executed the study. Ntina Kourmoussi and Antonios Kalamatianos supervised the experiential training. Kyriakoula Merakou undertook the statistical analysis. Ntina Kourmoussi supervised the implementation of the program. Ntina Kourmoussi and Antonios Kalama-

tianos drafted the manuscript, and all the authors reviewed its final form.

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Human Research Ethics Review

The Research and Management Committee of the ELKE of ASPETE approved the implementation of the project “Evaluation of the operation of the e-Drive Academy platform in the context of teaching the thematic unit ‘Traffic Education and Road Safety’ to meet the needs of the Greek Ministry of Infrastructure, Transport, and Networks” [Act no. 46/12-12-2018 (Th. 5.14)]. The Greek Institute of Educa-

tional Policy (Ref. Φ.15/8244/13462/Δ1/29-01-19) permitted the questionnaire’s administration to the students and a consensus from the student’s parents was collected before it was completed.

Data availability statement

Data, materials and protocols associated with the study can be provided, on request.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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