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RESEARCH ARTICLE

Implementation and Evaluation of R-Safe Race: A play-based Road Safety Education Programme among Primary School Children

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ABSTRACT

Road safety education (RSE) is a vital component of primary school curricula to instil safe road behaviours early. However, traditional classroom-based approaches such as *Pendidikan Keselamatan Jalan Raya* (PKJR) may lack engagement and developmental appropriateness. This study implemented and evaluated the R-Safe Race, a play-based RSE programme designed for Malaysian primary school children aged 10–12, following the ADDIE instructional design model. The programme was conducted as an outdoor exploration race featuring six thematic checkpoints addressing key road safety topics. A total of 164 students participated, and their perceptions of content clarity, relevance, interest, understanding, and learning gains were assessed through a structured questionnaire using a 5-point Likert scale. Findings showed strong engagement and positive perceptions overall, with particularly high ratings for checkpoints on car passengers and cyclist behaviour. Participants reported increased self-efficacy to adopt safer behaviours and found the facilitators effective. However, lower ratings on the transportation and vehicle safety checkpoints suggest areas for improvement. The results support play-based learning as an effective pedagogical approach to enhance engagement, understanding, and self-regulation in RSE. This study highlights the need to diversify RSE delivery methods to align with children's developmental needs, suggesting that outdoor, guided play activities offer significant benefits over traditional approaches.

Contribution/Originality: This study contributes to the existing literature on road safety education by introducing a play-based instructional program structured through checkpoint activities. It is one of very few studies that have investigated race-oriented learning for road safety among children. The paper's primary contribution is finding that structured play enhances the clarity and relevance of road safety knowledge.

1. Introduction

As of 2007, *Pendidikan Keselamatan Jalan Raya*, which is Road Safety Education, has been an official component of the *Bahasa Melayu* subject. The integration of PKJR into the BM curriculum is designed to cover road safety themes while simultaneously fulfilling the learning objectives of the BM subject. This strategy is in line with the World Health Organization's advice to introduce RSE through traditional classroom interventions. Still, RSE has been implemented more recently with a more integrative approach (Franky, 2022) but the Malaysian education system still follows the traditional learning approach, described as face-to-face lectures in a classroom (Dhawan, 2020).

The Malaysian education system currently needs to utilize the findings from research conducted all over the world that reported the many benefits of play-based learning, such as guided play, games, and active outdoor play (Zosh et al., 2018; Yogman et al., 2018; Bento & Dias, 2017). As previous research findings reported many benefits of play based learning, such as improved executive functions, better self-regulation, and improved social skills, strongly correlated to school readiness and better academic achievement (Allee-Herndon & Roberts, 2021). Other instructional methods and approaches, such as a play-based learning approach, should be adopted to ensure the holistic development of children and encourage the development of motor, cognitive, social, and emotional skills (Lalani, 2020).

Therefore, RSE in Malaysia should also be conducted in other approaches, such as a play-based learning approach to ensure the holistic development of children, which will encourage the development of motor, cognitive and social, and emotional skills (Lalani, 2020). Hence, a play-based RSE program is developed following the ADDIE model. The ADDIE model is a systematic approach to designing and developing a learning program or curriculum that consists of phases of Analysis, Design, Development, Implementation, and Evaluation Process (Widyasusanti & Susiana, 2019). The ADDIE model is one of the most used models because it provides a simple and easy-to-use framework for designing instruction (Khalil & Elkhider, 2016; Widyasusanti & Susiana, 2019).

The play-based RSE has been developed following each step of instructional design according to the model and up to the development phase. However, the implementation and evaluation phase has not been conducted. Therefore, the main focus of this current study is to implement and evaluate the play-based RSE program.

1.1. Research Objectives

i. To assess the clarity of the content of R-Safe Race among groups of primary school students aged 10 to 12.
ii. To determine the relevancy of the content of R-Safe Race among groups of primary school students aged 10 to 12.

2. Literature Review

2.1. RSE Contents and Approaches

RSE is one of the most famous methods focusing on changing school students' behaviour and increasing their road safety knowledge. The aim of having RSE is usually to improve road safety behaviour, to change the perception of the importance of road safety, and to

increase knowledge related to road safety (Dragutinovic & Twisk, 2006). RSE has become popular in many countries, especially developed countries. This is supported by data from the WHO, in which developed countries remain to have fewer deaths caused by road crashes compared to developing and third-world countries (WHO, 2018). Education on road safety has also been identified as one of the actions that are important to create a safe road use environment that is part of the Safe Systems Approach that is recommended by WHO, and educators and researchers are urged to take part in the more significant objectives to reduce fatalities caused by road crashes (WHO, 2021).

Elkington and Hunter's work, which drew upon a 2005 report funded by the European Commission detailing Europe's best practices in Road Safety Education, showcased several key programs (Riaz et al., 2019). Among these were pedestrian safety training programs, such as one in Denmark involving a pedestrian crossing test, RSE initiatives for preschoolers in Lyon, France, and campaigns like "Look and Buckle Up", "Let's Decide Walkwise," and "Right Start" in the United Kingdom (Riaz et al., 2019). The report further noted the effectiveness of practical pedestrian safety training in teaching school children to judge vehicle speeds, citing programs like "Watch Out" from Germany and "Top Rider" and "Hello Auto" from Austria (Riaz et al., 2019). Therefore, Malaysia's integration of RSE as an official road safety measure is aligned with international best practices, despite potential differences in how the program is executed and the instructional methods employed.

These examples highlight the diverse approaches to RSE programs worldwide. An innovative method was proposed by Ahmad et al., who utilized a bilingual pictorial storybook, Biloongra, to facilitate interactive discussions on road traffic injury prevention (Ahmad et al., 2018; Tupetz et al., 2020). Yet, within the Malaysian primary school curriculum, much of the children's learning occurs exclusively in the classroom. This means that RSE in Malaysia is still predominantly delivered in a conventional, in-person classroom environment.

Alonso et al. (2020) concluded that education on road safety among young road users is crucial for acquiring safe habits, patterns, and behaviours. Moreover, many findings showed that RSE remains essential for teaching road safety knowledge and instilling the importance of valuing road safety culture (Masilamani et al., 2022; Bojesen & Rayce, 2020; Cuenen et al., 2016; Feenstra et al., 2014; Ahmad et al., 2018). Meanwhile, the debate on the most appropriate pedagogy for primary school children's learning has become more intense, with the navigation between explicit, objective-directed learning and more flexible-driven exploration becoming the main issue (Yu et al., 2018). On the other hand, concerning teaching RSE, Dragutinovic and Twisk (2006) stressed that to teach students road safety knowledge and skills successfully, it is essential to fully understand the characteristics, current knowledge and limitation of the targeted group and their developmental stages. In addition, Lachapelle et al. (2013) also supported this notion. They mentioned that understanding the developmental stages could identify a suitable instructional method, and knowledge and skill transfers will occur more strategically and successfully. Hence, the current implementation of RSE in Malaysia requires a critical analysis of whether we are teaching RSE according to students' needs and developmentally appropriate such as the examples of successful programmes conducted listed in Table 1.

Table 1: Examples of Successfully Implemented Developmentally Appropriate RSE Programmes Across Countries

Programme	Country	Age of participants	Approach used
Bike Ed	Australia	9 to 14 years old	Three phases of implementation: Basic bicycle traffic rules in the classroom, using models and toy vehicles to stimulate road environments. Practical exercise of riding a bicycle in the school yard focusing on improving handling skills and learning safe traffic behaviour by simulating the road environment. Supervised practical exercises on local streets and ended with road tests.
Bike Smart	United States of America	Kindergarten until third-grade students.	eHealth product which uses videos, animations and still images to train children skills for bicycle safety.
New Jersey Bike School Programme	United States of America	Students aged 8 – 12	On bicycle, lessons teach riding skills such as starting and stopping, practising hand signals, basic bicycle handling skills and traffic rules. Off bicycle, lessons include teaching the importance of wearing helmets, basic bicycle principles, maintenance skills and negotiating intersections. and

Note: As cited in Carlin et al. (1998), Lachapelle et al. (2013), and McLaughlin and Glang (2010).

2.2. The Developmentally Appropriate Play Based Learning for Primary School Children

Play based learning has also sparked many interests of scientists and practitioners, where vast numbers of scientific pieces of literature have been produced that focus on the multi-disciplinary perspectives of play (Bubikova-Moan et al., 2019). More recently, play is often chosen as a practical pedagogical approach because of its engaging properties, where children participate actively in their learning (Murtagh, Sawalma & Martin, 2022). Zosh et al. (2018) defined play as a spectrum ranging from free play to guided play and games, highlighting that play can take many forms and serve many functions. In terms of conducting RSE, the type that might be suitable is guided play and games. Guided play allows the child to explore by themselves by directing the play but with adults offering scaffolding and guidance. At the same time, games have similar characteristics to guided play but with extra attributes such as completing tasks to achieve specific goals set by the adults (Zosh et al., 2018; Yu et al., 2018). Hypothetically, these two types of play are suitable for RSE programmes due to their engaging properties, and they activate the mind while making meaning to ensure maximum learning (Zosh et al., 2018).

In addition, play based learning can benefit children more as play encourages holistic development, which targets the development of cognitive, physical, social, and emotional well-being, which is why play based learning is identified as a better approach (Bento & Dias, 2017). Ultimately, all types of play benefit executive functioning, which allows better cognitive flexibility, inhibitory control and working memory, which supports better attention, filtering distracting details, improved self-regulation and self-control and better problem-solving (Yogman et al., 2018). In addition, purposeful play or guided play also provides the students with time for exploration and discovery, which supports learning and environment and is linked to better academic achievement and school readiness (Allee-Herndon & Roberts, 2021). However, the sample targeted by the study, the primary school students aged 10 – 12, are in the developmental stage where they have reached certain developmental milestones as they have become independent and able to self-regulate (Yogman et al., 2018). Policymakers should use these milestones to incorporate activities that allow them to exert and practice their independence and self-regulation ability.

One of the opportunities to let them exert independence is through physical and outdoor play. Hence, the current RSE programme should use physical and outdoor play as one of the environments used to conduct activities. Physical and outdoor play can benefit primary school children and improve their sensory integration skills when actively participating (Yogman et al., 2018). Primary school students should also be allowed to be involved in more outdoor play since purposeful outdoor play seems to be declining in the current social and educational settings (Coates & Pimlott-Wilson, 2018). Outdoor play offers a unique stimulus from the natural environment that leads children to explore their curiosity and learn, and outdoor play also allows children to engage in risky play (Bento & Dias, 2017). Risky play allows school children to challenge themselves by doing something that exceeds their limits and allow them to reflect on their novel experiential learning (Coates & Pimlott-Wilson, 2018). Therefore, children in primary school should be able to learn in a playful learning landscape that provides an active, meaningful, and socially interactive setting with the best learning experience (Bustamante et al., 2020).

Therefore, a playful learning landscape would provide primary school children with better academic skills and academic achievement, mainly encompassed in guided play or games (Zosh et al., 2018). In addition, games with self-imposed restriction features can also support moral reasoning development, where these self-imposed restriction features will narrow down the permissible actions and facilitate social interaction. (Henricks, 2020). Similarly, outdoor play, which allows kinaesthetic engagement with the environment, is also proven to improve social skills by developing collaboration and teamwork skills (Coates & Pimlott-Wilson, 2018).

Therefore, the current study aims to analyse the approach used to teach RSE in Malaysia and the elements of play based learning that is developmentally appropriate for primary school children aged 10 to 12. The current study also aims to design and develop a suitable play-based RSE Programme for the targeted group. As mentioned earlier, the R-Safe Race is an outdoor game promoting physical activity for primary school children aged 10 – 12. The play based road safety education programme is an exploration race that was conducted in an outdoor environment, which will provide the school children with opportunities to engage in physical play where running and completing tasks are needed to reach the learning outcomes. The R-Safe Race will provide an opportunity to promote the holistic development of primary school children's cognitive, physical, social and emotional.

3. Research Methods

This study employed a quantitative research approach utilizing an instructional design and evaluation framework. The quantitative approach was specifically chosen to enable the systematic measurement of the clarity, relevance, and suitability of a play-based road safety instructional program. This was achieved through structured evaluation instruments. Quantitative methods were deemed appropriate as the study's primary aim was to assess the effectiveness of the instructional content and activities against predefined criteria, rather than to explore subjective experiences in depth.

The research was systematically structured based on the ADDIE instructional design model. While all phases implicitly guided the program's creation, the study placed specific emphasis on the Implementation and Evaluation phases. Evaluation was intricately embedded throughout the entire instructional design process, occurring within phases, between phases, and after implementation, consistent with established ADDIE principles.

Formative evaluation was conducted continuously during the program's development and initial implementation phases. This ongoing assessment allowed for iterative refinement of instructional content and activities, ensuring optimal quality and alignment with objectives prior to final program deployment. Summative evaluation was performed following the full implementation of the program. Its purpose was to comprehensively assess the overall effectiveness and efficiency of the play-based instructional intervention. Data derived from the summative evaluation were crucial for informing decisions regarding the program's suitability, potential for broader adoption, and areas for future enhancement.

3.1. Research Location

The study was conducted in three primary schools situated in the District of Semenyih, Selangor, Malaysia. This specific location was selected due to these schools' active implementation of the Pendidikan Keselamatan Jalan Raya program as an integral part of their curriculum. Opting for schools already providing formal road safety education ensured that participating students possessed a baseline knowledge of road safety concepts, allowing the study to rigorously examine whether the novel play-based racing program enhanced understanding and engagement beyond conventional instructional approaches.

3.2. Research Population

The target population for this study consisted of primary school children aged 9 to 12 years, typically Standard 3 to Standard 6 who had been exposed to PKJR. The accessible population comprised pupils from the selected schools within the Semenyih district who met the inclusion criteria of prior exposure to formal road safety education at school.

3.3. Sample Size

A total of 164 students participated in the study. The sample size was determined primarily based on practical considerations and accessibility within the selected schools. This number was considered adequate to ensure sufficient representation for quantitative descriptive analysis, allowing for stable estimates of clarity and relevance across multiple instructional components and checkpoints of the program.

3.4. Sampling Method

The study employed purposive sampling, a non-probability sampling technique wherein samples are selected based on specific characteristics directly relevant to the research objectives. According to Zikmund et al. (2003), purposive sampling allows experienced researchers to select participants who are most suitable for the study. In this research, schools were purposively selected specifically because of their established implementation of the PKJR program, thereby ensuring that all participants had prior exposure to foundational road safety concepts. This sampling approach directly supported the study's aim to determine whether the play-based racing intervention could generate more meaningful learning outcomes related to road safety. It is important to note that while purposive sampling is highly effective for targeting specific populations, the generalizability of findings to broader populations should be considered with this sampling method in mind.

3.5. Instructional Program and Instruments

The instructional program was conceptualized as a play-based, race-oriented learning activity. In this setup, children engaged in competitive tasks at multiple checkpoints, each specifically designed to address various road safety topics. Each checkpoint focused on a distinct aspect crucial for road users, such as hazard awareness, safe decision-making processes, and appropriate road behavior. Evaluation instruments were meticulously developed to assess three key dimensions which are clarity, relevancy and suitability of each checkpoiints. Since the program is a play based programs, the way it is developed is for the children to race each other to complete tasks that is revolving around road safety topics. Each checkpoint will focus on different aspects of becoming a road user. Therefore, the instruments developed should be able to measure whether each topics are suitable and relevant in the play-based program. These instruments were newly developed for this study and underwent a pilot testing phase with a small group of students not included in the main study to ensure clarity of instructions and questions, and to identify any potential ambiguities. They were further reviewed by subject matter experts to establish content validity, ensuring that they accurately captured participants' responses to each checkpoint and effectively measured the achievement of the instructional objectives.

3.6. Data Analysis

Data collected from the evaluation instruments were analyzed using descriptive statistical analysis. Descriptive statistics, including frequencies, percentages, and mean scores, were employed to summarize participants' responses and to identify overall trends related to the clarity, relevance, and suitability of the instructional program. All data analysis was conducted using IBM SPSS Statistics software to ensure accuracy, consistency, and reliability of the statistical computations.

3.7. Ethical Considerations

Ethical considerations were carefully addressed in this study. Approval to conduct the research was obtained from the relevant school authorities prior to data collection. As the participants were minors, informed consent was obtained from school administrators and parents or guardians, while assent was obtained from the students. Participation was voluntary, and participants were informed that they could withdraw from the study at

any time. Confidentiality and anonymity of all participants were maintained throughout the research process.

4. Results

4.1. Demographic Data of Participants

A total of 164 participants were included in this study. Table 2 presents the distribution of participants by year of study and gender. The highest proportion of participants were from Year 5 (49.4%), followed by Year 4 (26.8%) and Year 6 (23.8%). In terms of gender, female participants constituted 51.2% of the sample, while male participants made up 48.8%.

Table 2: Distribution of Participants by Year of Study and Gender (n = 164)

Category	Frequency (n)	Percentage (%)
Year of Study		
Year 4	44	26.8
Year 5	81	49.4
Year 6	39	23.8
Gender		
Female	84	51.2
Male	80	48.8
Total	164	100.0

4.2. Participants' Perceptions of The Topic and Activities in R-Safe Race Module

The purpose of this study was to determine participants' perceptions of the topic and activities within the R-Safe Race module, which aimed to teach road safety through interactive, play-based checkpoints. The module comprised six thematic checkpoints addressing various aspects of road safety: transportation (Checkpoint 1), car passengers (Checkpoint 2), road environment (Checkpoint 3), pedestrian behaviour (Checkpoint 4), cyclist behaviour (Checkpoint 5), and vehicle safety (Checkpoint 6). A total of 164 primary school children shared their experiences based on five key domains: topic interest, understanding, suitability, interest in checkpoint activities, and perceived learning. Participants' responses were assessed across five key domains: perceived interest in the topic, understanding of the topic, topic suitability, interest in checkpoint activities, and perceived learning gains. These responses were measured using a 5-point Likert scale, ranging from Strongly Disagree to Strongly Agree. Table 3 presents the frequency distribution and mean scores for each checkpoint based on the five key domains mentioned above.

4.2.1. Domain 1: Perceived Interest in the Topic

Table 3 illustrates that across all checkpoints, participants generally reported strong interest in the topics. The percentage of agreement ranged from 63.42% (Checkpoint 6) to 74.39% (Checkpoint 2), indicating that participants found the topics engaging. The highest percentage of disagreement was observed in Checkpoint 3 (7.93%).

Table 3: Participants' Perceptions of The Topic and Activities in R-Safe Race (n = 164)

Domain	Checkpoint	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	M	SD
Topic as interesting	1	1.83	1.83	23.17	27.44	45.73	3.87	0.86
	2	1.22	4.27	18.90	28.66	45.73	4.15	0.96
	3	2.44	5.49	18.29	32.32	41.46	3.96	1.00
	4	1.83	7.93	23.17	25.61	41.46	3.81	1.00
	5	2.44	3.05	20.12	25.61	48.17	4.09	1.04
	6	2.44	5.49	28.66	28.66	34.76	3.88	1.03
Understanding of the topic	1	1.22	4.88	24.39	28.05	40.24	3.90	0.92
	2	0.61	6.10	18.90	34.76	39.63	4.07	0.94
	3	1.22	6.71	21.34	26.22	43.29	3.86	0.95
	4	1.22	7.93	18.90	29.88	42.07	4.04	1.02
	5	2.44	5.49	14.02	38.41	39.63	4.07	0.99
	6	3.05	4.88	20.12	35.37	36.59	3.98	1.02
Suitability of the topic	1	5.49	10.37	21.34	29.88	32.93	3.51	1.12
	2	3.05	8.54	24.39	30.49	32.32	3.80	1.10
	3	4.27	6.10	26.83	27.44	35.37	3.73	1.09
	4	2.44	6.10	23.17	29.27	37.80	3.86	0.99
	5	2.44	3.05	17.68	35.98	40.85	4.01	1.10
	6	3.66	7.32	23.17	29.27	35.37	3.80	1.06
Interest in checkpoint activities	1	3.05	5.49	16.46	31.71	41.46	3.91	1.07
	2	0.61	7.32	14.63	29.88	47.56	4.16	0.97
	3	2.44	3.66	17.07	30.49	46.34	4.15	0.99
	4	3.05	4.88	23.78	33.54	34.76	3.91	1.02
	5	1.22	6.71	17.68	24.39	50.00	4.15	1.02
	6	4.27	6.71	26.22	29.88	31.71	3.08	1.10
Learn new things	1	3.66	7.93	10.98	28.05	48.78	4.09	1.16
	2	2.44	4.27	12.80	32.93	47.56	4.19	0.98
	3	3.05	3.66	14.63	31.10	46.34	4..15	1.01
	4	1.83	5.49	16.46	28.66	47.56	4.15	1.01
	5	3.05	9.15	14.02	30.49	42.68	4.01	1.11
	6	3.05	7.32	18.29	28.05	43.29	4.01	1.10

4.2.2. Domain 2: Understanding the Topic

Participants reported high levels of understanding across all checkpoints. Mean scores were consistently high, with Checkpoint 2 and Checkpoint 5 both rated at M = 4.07 (SD = 0.94 and 0.99, respectively), indicating strong perceived understanding of the module content. Disagreement remained relatively low across all checkpoints, ranging from 1.83% to 8.93% (Refer to Table 3).

4.2.3. Domain 3: Perceived Suitability of the Topic

Table 3 shows that topic suitability showed slightly more variation among checkpoints. Checkpoint 5 (Cyclist Behaviour) received the highest rating (M = 4.01, SD = 1.10), followed by Checkpoint 4 (M = 3.86, SD = 0.99). Checkpoint 1 (Transportation) recorded the lowest mean rating (M = 3.51, SD = 1.12), with only 62.81% agreement and a higher rate of disagreement (15.86%), suggesting mixed perceptions on the relevance of this topic.

4.2.4. Domain 4: Interest in Checkpoint Activities

As shown in Table 3, participants expressed a high level of interest in the activities designed for each checkpoint. The highest agreement was noted for Checkpoints 2 and 3, each with over 76% agreement and mean scores of M = 4.15 (SDs = 0.97–1.02). Checkpoint 6 (Vehicle Safety) stood out with the lowest level of engagement (M = 3.08, SD = 1.10), with only 61.59% agreement and a comparatively high 10.98% disagreement. This indicates potential room for improvement in the design or delivery of activities in this area.

4.2.5. Domain 5: Perceived Learning Gains

Table 3 indicates that participants largely agreed that they learned new things through the R-Safe Race module. Agreement was highest in Checkpoint 2, with corresponding mean score of M = 4.19 (SD = 0.98). Even the lowest rated checkpoint 6 had substantial agreement (71.34%), suggesting that learning outcomes were achieved consistently across the module.

Overall, these results indicate that the R-Safe Race module was generally well-received by participants, aligning with the research objective of assessing perceptions toward the module. Participants demonstrated strong engagement, comprehension, and learning across most checkpoints, although certain areas such as vehicle safety (Checkpoint 6) and topic suitability for transportation (Checkpoint 1) may benefit from refinement.

4.3. The Overall Perceptions of R-Safe Race Module

Participants' overall perceptions of the R-Safe Race program were analyzed across four key indicators that include achievement of program objectives, self-efficacy to change behavior, appropriateness of program duration, and effectiveness of facilitators. Table 4 illustrates the distribution of responses, means, and standard deviations.

Many participants perceived that the program met its objectives, with 89.02% agreeing (M = 4.31, SD = 0.80). Similarly, 83.53% of respondents agreed that the program increased their self-efficacy to change behavior, while 1.22% indicated some levels of disagreement. Regarding program duration, opinions were more varied. While 68.29% of participants indicated some levels of agreements that the duration was appropriate, 3.66% disagreed and 26.83% remained neutral. The mean score for this item was comparatively lower (M = 3.97, SD = 1.00), suggesting slightly more ambivalence in perception. Facilitators were rated most positively, with 85.37% of participants agreeing that facilitators contributed positively to their experience (M = 4.36, SD = 0.87), indicating high satisfaction with delivery.

Table 4: Overall Perceptions of R-Safe Race Module (n = 164)

Item	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	M	SD
Program meets its objective	0.61	1.22	8.54	42.68	46.34	4.31	0.80
Self-efficacy to change behaviour	0.61	0.61	14.63	37.80	45.73	4.26	0.79
Programme Duration	1.83	1.83	26.83	30.49	37.80	3.97	0.91
Facilitators	1.22	1.83	11.59	30.49	54.88	4.36	0.87

In summary, these results support the conclusion that the R-Safe Race program was well-developed and well-received, with particularly strong outcomes related to meeting objectives and facilitating behavior change. The findings suggest that R-Safe Race is a suitable approach for educating school children on road safety.

5. Conclusion

The *R-Safe Race* play-based RSE programme was well-received by primary school students, demonstrating its potential to enhance engagement, understanding, and self-efficacy compared to traditional PKJR. The outdoor, guided play format aligns with children's developmental needs and promotes holistic learning, encompassing cognitive, physical, and socio-emotional skills. While the programme met its objectives and was rated highly overall, certain checkpoints, particularly on transportation and vehicle safety, require refinement to ensure all content remains relatable and engaging.

This study recommends scaling up the *R-Safe Race* to more schools and regions to assess its broader applicability and impact. Future implementations should incorporate feedback to improve less engaging components and consider longitudinal follow-up to evaluate whether knowledge and attitudes translate into sustained behaviour change. Educators and policymakers should consider integrating play-based methods into the national RSE curriculum, recognising their value in fostering a culture of road safety among children.

Nonetheless, this study has several limitations. It was conducted in three schools within a single district, limiting generalisability. The findings were based on self-reported perceptions rather than observed behavioural outcomes, and the evaluation captured only short-term responses. Future research should address these limitations by including more diverse samples, employing behavioural observation or testing, and conducting follow-up studies to assess long-term effects.

In conclusion, the *R-Safe Race* demonstrates the promise of play-based learning as an innovative and effective approach to RSE for Malaysian schoolchildren, warranting further refinement and wider adoption.

Ethics Approval and Consent to Participate

Ethical approval for this study was obtained from the MIROS Ethics Committee. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and relevant guidelines. As the participants were minors, informed consent was obtained from parents or legal guardians, with permission from school teachers and administrators prior to data collection. Participation was voluntary, and confidentiality and anonymity of participants were strictly maintained throughout the study.

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Conflict of Interest

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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