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Acceptability of Children Road Safety Education in Pakistan: A Mixed-Method Approach to Exploring Parents' and Teachers' Perspectives

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Abstract: In Pakistan, implementing road safety education (RSE) initiatives is vital in tackling the concerning rates of road accidents. Since parents and teachers are crucial in moulding children's road safety behaviours, this study investigated the perspectives of parents and teachers regarding the acceptability of RSE programs in Pakistan. Using a mixed-methods approach, the research combines quantitative data from questionnaires (n = 63 teachers, n = 97 parents) with qualitative insights from interviews (five teachers, four parents). The study reveals significant gaps in RSE implementation across educational levels (i.e., primary, secondary, and high school), with not even half of the teachers reporting dedicated RSE programs in their curriculum, majorly in secondary and high schools. Both parents and teachers express dissatisfaction with current RSE effectiveness, highlighting a critical need for improvement. Key barriers to RSE implementation include cultural norms, inadequate infrastructure, and limited teacher training. However, the study also identifies a strong interest from parents and teachers in participating in effective RSE programs. Parents favour a mixed approach to RSE delivery, combining online and physical formats, and prefer short, frequent sessions for their children. The research underscores the need for a multidimensional RSE approach, addressing educational content, societal perceptions, and infrastructure improvements. These findings provide valuable insights for policymakers and educators to enhance RSE and improve children's road safety knowledge in Pakistan.

Keywords: road safety education; traffic safety awareness; parent's involvement; child road safety; teachers' perspectives; mixed method approach

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1. Introduction

According to the World Health Organization [1], road traffic accidents constitute a significant cause of mortality worldwide, particularly affecting countries with lower and middle incomes. It significantly impacts the economy and has enormous economic and social repercussions [2]. Developing nations frequently encounter obstacles due to inadequate infrastructure, increased pedestrian and motorcycle activity, and ineffective enforcement of traffic regulations [3]. Given this backdrop, encouraging responsible road behaviour among children holds significant importance.

Road safety education (RSE) is a critical component of road safety strategies aimed at reducing the number of road traffic crashes and injuries [4,5]. It continues to be a vital component of global road safety efforts as nations, whether developed or developing, deploy diverse strategies to increase public consciousness and reduce traffic incidents [6]. In countries such as Sweden, the Vision Zero initiative serves as a model for a comprehensive approach to RSE and infrastructure planning to eradicate fatalities and severe injuries on the

roads [7,8]. Through extensive educational campaigns prioritising safe driving behaviours and mutual respect among road users, Sweden has witnessed substantial decreases in traffic-related fatalities over time [9]. Likewise, in Japan, robust driver education initiatives, such as the Shonan Traffic Safety Association's driving simulator courses, have significantly decreased traffic accidents and fatalities [10].

On the contrary, numerous developing nations encounter obstacles when executing efficient RSE initiatives, primarily due to limited resources and infrastructure deficiencies. However, initiatives like road safety programs in India can improve road safety awareness among students, reducing accidents caused by wrong overtaking, high-speed collisions and mobile usage while overtaking [11,12].

Recent advancements in road safety education (RSE) have highlighted the importance of leveraging technology, stakeholder collaboration, and targeted parental involvement to address the persistent challenges in developing countries [13]. The Global Status Report on Road Safety 2023 [14] underscores the need for coordinated efforts between governments and communities, emphasizing that comprehensive strategies are essential for reducing road traffic injuries globally. Innovative approaches, such as using augmented reality via social media platforms, have effectively engaged parents and educated children about road safety, as shown in recent research on technological integration in education [15]. Additionally, studies analyzing government-community collaboration in OECD countries reveal that joint efforts are critical for implementing successful road safety measures, providing valuable insights for similar socio-economic contexts [16].

Developing nations are also advancing in this regard. Ghana's "Safe Ways" program provides teachers with tools to deliver engaging lessons on pedestrian safety, resulting in a noticeable enhancement in children's awareness of safe practices [17]. Moreover, Bačkalić et al. (2020) [18] implemented a cycling safety education program for primary school children without cycle training in Serbia. The study involved fourth-grade students and aimed to enhance knowledge and skills related to cycling safety. The results revealed that the education program improved the children's learning about road signs, age requirements and risky behaviour.

Additionally, Yankson et al. (2020) [19] conducted an observational study to observe the road behaviour of urban primary school children in Ghana. It showed that girls behave more safely than boys and recommended the need for child RSE in school and community. Likewise, India's "Safety Sarathy" initiative employs classroom sessions and community gatherings to educate children about the significance of wearing helmets and adhering to traffic signals. This focus is particularly crucial for children who often ride as passengers on motorcycles, a prevalent means of transportation [20]. These examples illustrate that successful RSE initiatives can be applied across various settings, creating a safer atmosphere for children globally.

1.1. Parental and Teacher Involvement in RSE

Parents and teachers are crucial in moulding children's road safety behaviours as it is one of the fundamental indicators of their wellbeing [21]. Parents are primary role models, impacting children through their traffic habits and compliance with other traffic regulations. Greenwood and Hickman (1991) [22] discussed the importance of parent involvement in RSE and its implications for teacher education. It clearly states that the home environment plays a significant role in influencing student learning and behaviour, and its impact is at least equal to that of the teacher and the school. Anderson and Minke (2007) [23] further explored parental involvement in education, emphasizing the importance of comprehending parents' decision-making processes.

Furthermore, one study in Vietnam, the Helmet for Kids program, emphasizes that parents and teachers should increase helmet use among students [24]. Around 24 elementary schools in Vietnam conducted an observational study over two weeks. The results suggest that the compliance rates increased from 25% during pre-observation to 94% during post-observation. Oplatka (2013) [25] explored the principal's responsibility to encourage teachers' additional efforts, particularly concerning RSE in Israel. The study was conducted on 30 teachers and 10 principals in the state education system. It was found that the principal influenced teachers' behaviour in safety education by caring for teachers' needs, devising a school policy that prioritized RSE and supporting teachers' initiatives.

Similarly, parents' and teachers' involvement in RSE effectively reduces traffic accidents among children. Research has indicated that wearing helmets during bicycle or motorcycle rides is the most effective method for minimizing head injuries in children [26]. Additionally, road safety educational interventions led by teachers involving interactive activities have demonstrated improvements in children's knowledge, attitudes, and self-reported adherence to road safety practices [27]. In addition, Bakhtari Aghdam et al. (2020) [28] focused on developing a National Road Traffic Safety Education Program in Iran, emphasizing the crucial role of education in mitigating road traffic injuries. The in-depth and focus group discussions were conducted among different groups, including field experts, teachers, and parents. As a result, six themes were generated from the analysis: target group, program content, educational methods, instructors, resources and evaluation to develop an RSE program.

Furthermore, recent literature has reaffirmed parental involvement [29], highlighting how family engagement directly correlates with improved educational outcomes, including RSE. This is supported by the National Center for Education Statistics Report in 2023 [13], which identifies parental and family involvement as pivotal in fostering student engagement and program acceptance. Finally, Rajčević et al., (2024) [30] emphasize the importance of healthcare professionals in educating parents using a cross-sectional study while creating a questionnaire about child road safety, highlighting the imperative for increased knowledge in this field. Together, these studies highlight the essential contributions of parents and teachers to RSE. They underscore the significance of working together and implementing effective educational strategies to promote safe behaviours among children.

This study offers a unique contribution to the existing body of research on RSE by providing an exploratory investigation into the perspectives of both parents and teachers in Pakistan, a relatively underexplored context. Unlike prior studies that primarily focus on children [21,31,32] or institutional approaches, this research identifies and examines the specific cultural, infrastructural, and societal barriers that hinder the acceptance and implementation of RSE among parents and teachers in Pakistan. Furthermore, the study employs a mixed-methods approach [33], combining quantitative data from structured surveys with qualitative insights from in-depth interviews, offering a holistic understanding of the factors influencing RSE. In conclusion, the involvement of parents and teachers in RSE programs is vital and can lead to improved safety knowledge and behaviours among children. These findings underscore the potential benefits of engaging parents and teachers in RSE initiatives to enhance the effectiveness of these programs.

1.2. The State of RSE in Pakistan

In Pakistan, implementing RSE initiatives is vital in tackling the concerning rates of road accidents. These efforts aim to equip youth and adults with essential knowledge and skills for safer mobility. Although it is not common in Pakistan, some studies have been carried out to raise awareness among the community, especially among youth and children [31,32]. A study in Karachi by Khan et al. (2022) [34] focused on the video-based

hazard perception tool for children to improve their road safety skills. The study involves an interactive web tool including 12 real-world traffic scenarios and hazard detection, i.e., sidewalks, crossing the road using zebra crossing, and it was piloted in public and private schools of Karachi by registering 500 children from grades 8 to 10 (14–16 years old).

Similarly, a pilot study was conducted in one of the schools of Lahore to teach traffic rules to children using a Cozmo robot [35]. Using Cozmo, an interactive board with six traffic signs was created. Initially, the children were shown the traffic sign and asked whether they recognized any sign. Later, the robot was run on a physical model where six signs were placed in different locations, and the children needed to identify whether the robot was following the traffic signs. It was found that children enjoyed learning with Cozmo, and most learned about traffic signs. Hence, the study's primary aim was- achieved since the objective is to enhance RSE among children in a fun and interactive manner. Also, the curriculum was created to teach major traffic rules in schools. In addition to this, the Islamabad traffic police significantly enhance road safety awareness among drivers through specific radio programs and traffic safety information [36]. Moreover, research emphasised that RSE, road awareness programs and effective law enforcement are crucial in controlling traffic law violations and minimizing road accidents in Pakistan [37].

1.3. Research Objective

The study's primary aim was to explore the perspective of parents and teachers about the acceptability of RSE in Pakistan. Therefore, the objectives of this exploratory study are as follows:

1. To evaluate the current level of RSE programs for children among parents and teachers of primary, secondary, and high school children in Pakistan.
2. To identify the factors influencing the acceptance and support of RSE among parents and teachers, including demographic and socio-economic variables.
3. To explore the perceptions of parents and teachers towards the importance and implementation of RSE in the school curriculum.

2. Materials and Methods

The study consists of two parts: quantitative and qualitative. The questionnaires were developed separately to explore parent and teacher involvement in the quantitative research. Similarly, in-depth interviews were conducted with parents and teachers for a qualitative study.

2.1. Development of Questionnaire

An online questionnaire was developed via a digital tool, Qualtrics [38,39], for parents and teachers to evaluate their road safety knowledge and willingness to participate in RSE initiatives. The target respondents were the parents and teachers of children who went to school on a cycle or motorbike. Both questionnaires address the critical aspects of acceptability, i.e., the importance of RSE, their role in promoting road safety education and willingness to participate in RSE programs.

2.1.1. Parents Involvement Questionnaire

A structured questionnaire was designed to explore parental involvement and experiences regarding RSE for children in Pakistan. Most questions were closed-ended, i.e., related to road safety knowledge, occupation, awareness, etc. The questionnaire consisted of 10 sections covering demographics, road safety knowledge, transportation habits, awareness and concerns, personal experiences, community involvement, technology and road safety, emergency preparedness, satisfaction, recommendations and willingness for

involvement. Parents Road safety knowledge section included questions about parents' confidence in their children's understanding of road safety. Then, parents were asked about their preference for following RSE for their children, whether they prefer at home or school or are comfortable with both. In addition to this, they were also asked about the preferable location for their children for RSE, i.e., online, physical, or both. Similarly, parents were then asked about their participation in any RSE workshop; traffic signs were found to be the most difficult for their children.

2.1.2. Teachers Involvement Questionnaire

The study was designed to investigate the ongoing practices and perceptions of RSE among school teachers. After reviewing existing research and discussing it with some road safety experts, a structured questionnaire was designed to ensure its effectiveness. Most of the questions asked here were closed-ended (i.e., teaching experience, road safety lessons). Likert scales were also used to know the satisfaction level of the current RSE. The questionnaire was categorized into various sections, including demographic data, RSE in curriculum, teaching methods, professional development, frequency of road safety lessons, incorporating technology, suggestions for improvement and overall satisfaction. The teachers were asked about integrating RSE into the curriculum, methods to impart RSE, and frequency of road safety lessons.

2.2. Development of Interviews

Semi-structured interviews were conducted with five teachers and four parents to complement the quantitative data from the questionnaires. The interview development process involved designing a flexible yet structured guide to ensure consistent coverage of key topics while allowing participants to share in-depth insights. Questions were formulated based on the study objectives, focusing on barriers to RSE implementation, perceptions of road safety education, and potential strategies for improvement. Interviews were conducted via telephone or email, depending on the participants' preferences. Each session began with obtaining informed consent and ensuring participants' comfort with the process. Interviews were audio-recorded (where permitted) and transcribed verbatim to capture rich qualitative data for thematic analysis. The average duration of each interview was approximately 25–30 min. Participants were also encouraged to elaborate on their experiences and share specific examples to deepen the insights gathered.

2.3. Sampling

2.3.1. Quantitative Data (Questionnaire)

Two distinct sampling approaches were employed to ensure a diverse and representative sample for the study. Convenience sampling was used to target parents and teachers from various urban and rural schools for the quantitative data collected via questionnaires. The inclusion criteria required participants to have children who commute by motorbike or bicycle (parents) or actively teach road safety topics (teachers). Two approaches were used to reach diverse respondents. Firstly, different social media platforms were utilized to share the link of the questionnaires with a targeted group to reach a diverse range of participants. Secondly, the link was shared with different schools in different regions and directly with teachers and parents. The data collection occurred over one month (March 2024). The reason for collecting this month is that the academic year ends in April-May, so this time is perfect for data collection as most teachers and parents do not have much of a burden from schools.

2.3.2. Qualitative Data (Interviews)

To complement the questionnaire data, purposive sampling was employed to recruit five teachers and four parents for the interviews, ensuring a targeted approach for gathering in-depth qualitative insights. The sample included respondents from all grades of schools, i.e., primary, secondary and high school. This approach ensured a diversity of insights, with five teachers and four parents participating in in-depth interviews.

2.4. Data Collection

For the quantitative data, 160 respondents participated, comprising 63 teachers and 97 parents. The sample size was sufficient to capture diverse perspectives while maintaining manageability during data analysis. Similarly, the qualitative data involved nine participants, including five teachers and four parents, who provided detailed understandings through interviews.

Although the qualitative sample size may appear small, it aligns with past studies' recommendations, emphasizing depth over breadth in qualitative research [40]. Comparable mixed-method studies, such as those by Bačkalić et al. (2020) [18] and Pham et al. (2024) [41], have demonstrated the validity and richness of findings even with small sample sizes. These studies affirm that smaller samples provide a rich understanding of specific educational interventions when analyzed rigorously using qualitative and quantitative techniques. This combined approach ensured that both the breadth of perspectives (quantitative) and the depth of understanding (qualitative) were effectively addressed in the study.

2.5. Data Analysis

For questionnaires, IBM SPSS 29.0 was used to analyse the data. Descriptive statistics were used to summarise the general attitudes of parents and teachers. In addition, the Spearman correlation was applied to determine the correlation between different variables. The reason for using the Spearman correlation is that the ordinal data were collected through a Likert-scale survey on RSE. Furthermore, Spearman's correlation allows us to quantify both the strength and direction of the relationship between parental attitudes and children's road safety knowledge. The level of significance for analysis was set at $p < 0.05$.

The NVIVO 14 license, obtained from Hasselt Belgium, was used to analyse the data for interviews. Thematic analysis was employed. According to Nowell et al. (2017) [42] this qualitative tool enhances research precision, consistency, and exhaustiveness by documenting, organising, and detailing analysis methods and results, allowing readers to assess the process's credibility and validity. The technique chosen is inspired by Braun and Clarke's (2006) [43] six-step approach for thematic analysis. Initially, all interview recordings were transcribed verbatim, allowing for a thorough familiarization with the data. The next step involved coding the transcripts, where meaningful text segments were identified and labelled, generating 61 codes for teacher data and 51 for parent data. These codes were then organized into broader themes based on recurring patterns. For example, teachers' data revealed themes such as curriculum integration, community involvement, and teaching strategies, while parents' data highlighted barriers to participation and community engagement. Themes were iteratively reviewed and refined to ensure consistency and relevance. Below Figure 1 overviews the methodological framework used in this study.

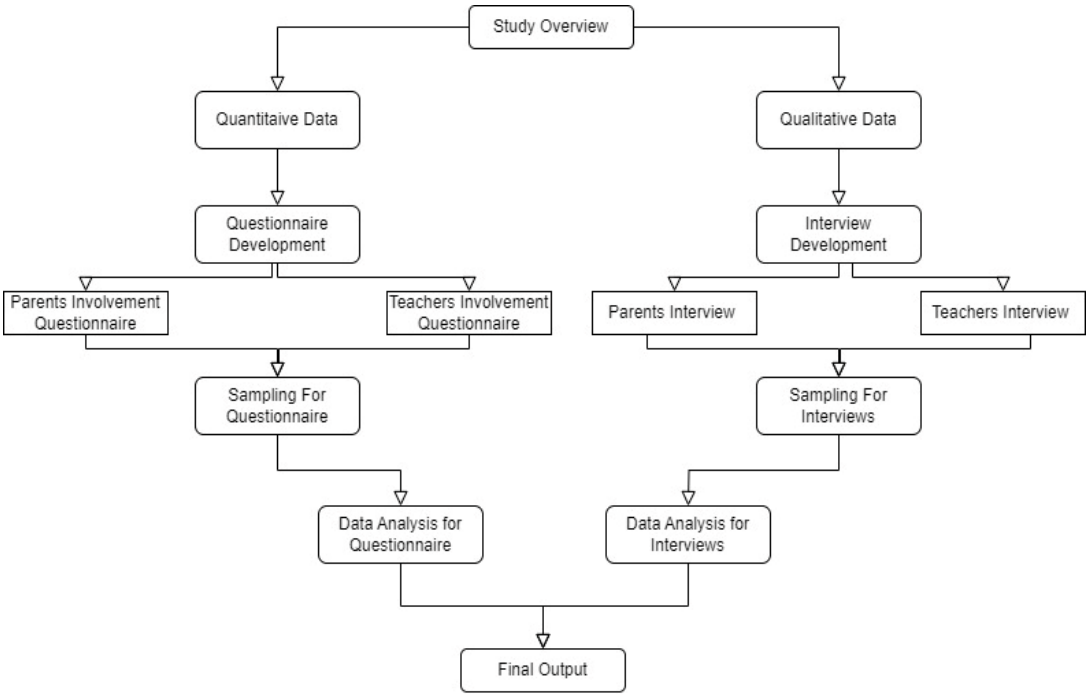

Figure 1. Methodological framework of the study.

3. Results

3.1. Teachers Questionnaire Data

3.1.1. Demographic Characteristics of Teachers About RSE for Children

In total, 85 teachers from different grades participated in the survey, and out of 85, 63 filled it out completely. Therefore, the response rate for teachers filling out the survey was 74%. The surveyed teachers are from high school (38%), secondary school (37%) and primary school (25%).

Teachers report the presence of a dedicated RSE program in their curriculum, with percentages differing across teaching levels: 44% in high school, 37% in primary school, and 19% in secondary school. Furthermore, teachers conduct workshops or informational sessions for parents. Across teaching levels, percentages vary: 48% in high school, 33% in primary school, and 19% in secondary school.

Additionally, teachers demonstrate a commitment to professional development in RSE, with varying percentages across teaching levels: 43% in high school, 33% in primary school, and 24% in secondary school. Moreover, the integration of RSE into other subjects within the curriculum varies across teaching levels, with percentages reflecting different levels of integration: 46% in high school, 35% in secondary school, and 19% in primary school. Additionally, the frequency of road safety lessons conducted in classrooms exhibits diverse patterns, with two-thirds of teachers conducting lessons occasionally or not at all across different teaching levels. However, 73% of teachers perceive the frequency of road safety lessons as adequate for reinforcing critical concepts among students, although perceptions vary across teaching levels.

Lastly, the proportion of teachers who use technology to complement RSE varies by teaching level, with varying percentages indicating using technology extensively (13%), moderately (27%), rarely (21%), occasionally (19%), and never (21%). This shows that more than half of the respondents used the technology in RSE occasionally, rarely, or never. These findings highlight teachers' various efforts and practices in delivering RSE and have implications for future projects to increase student road safety awareness and practices. Figure 2 shows the status of road safety training and technology integration.

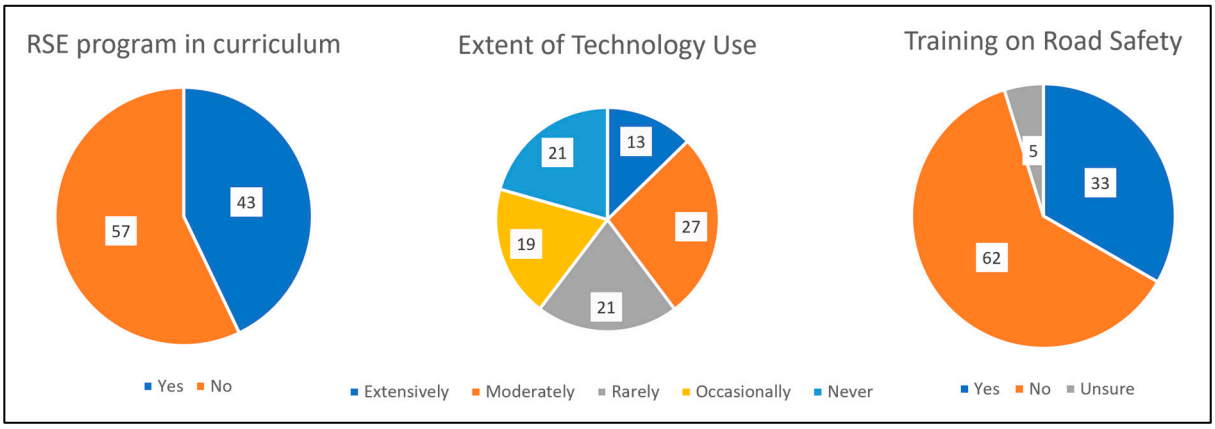

Figure 2. Overview of road safety education and technology use.

3.1.2. Effective Teaching Methods for Delivering RSE

The teachers were asked about the effective teaching methods to deliver RSE to children. In their response, practical demonstrations emerge as the most favoured approach (23%), offering hands-on experiences that enhance comprehension and retention of road safety concepts. Classroom lectures (19%) remain famous for delivering foundational knowledge, while educational videos (17%) and interactive games (14%) provide interactive and visually engaging avenues for learning. Role-playing exercises (13%) and guest speaker sessions (12%) also feature prominently, catering to diverse learning styles and enhancing student engagement. Figure 3 shows the proportional distribution of teaching methods to impart RSE.

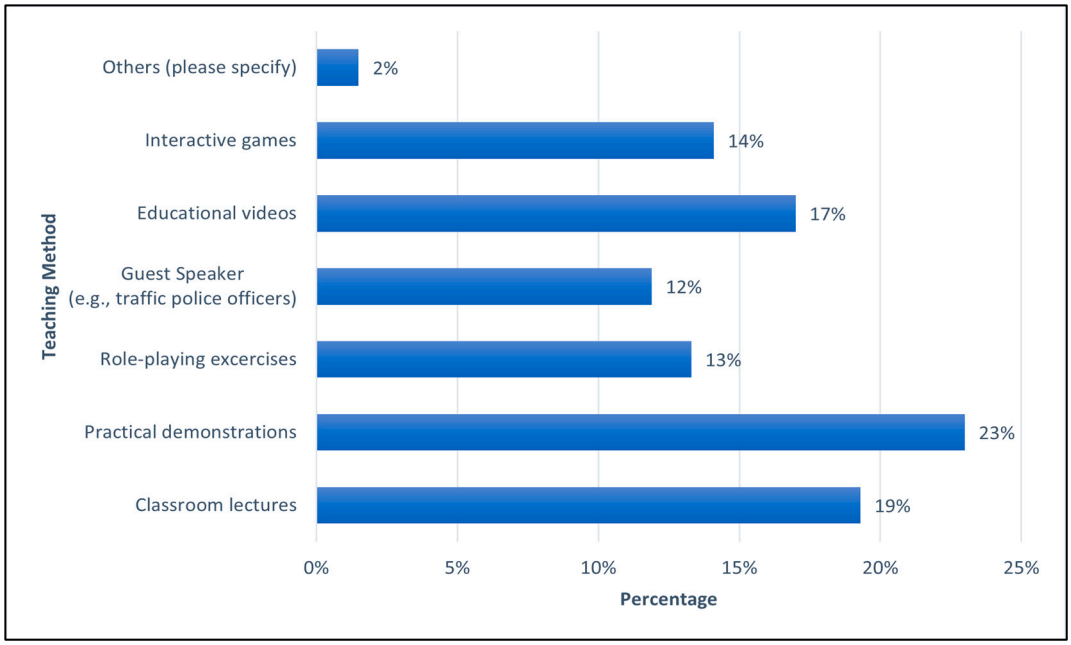

Figure 3. Proportional distribution of teaching methods.

3.1.3. Teachers Perception of Giving Road Safety Feedback to Parents

Teachers were further asked about their perception of giving RSE to child parents. The data reveal that regular parent–teacher meetings are the most prevalent method (39%) for communicating road safety feedback to parents, facilitating personalized discussions on students' road safety progress and collaborative efforts to reinforce safe behaviours. Dedicated workshops (24%) and progress reports (22%) represent prominent feedback

channels. Other channels, such as newsletters (8%) and others (5%), i.e., virtual reality, offer additional avenues for communication and engagement with parents.

3.1.4. Teachers' Opinions on Enhancing Road Safety for Children at School

Teachers advocate for various measures to enhance road safety for children within the school environment, as seen in Figure 4. The most prominent opinion, supported by 39.4% of respondents, is the implementation of regular safety awareness programs. These programs serve as proactive educational initiatives to equip students with the knowledge, skills, and attitudes necessary for navigating roads safely. Additionally, 22.1% of teachers emphasize the importance of designated school zones with reduced speed limits, highlighting the need for targeted measures to mitigate the risk of accidents in areas with high pedestrian activity. In addition, 21.2% of respondents support the installation of more traffic signs to give pedestrians and bicycles clear guidance and instructions. However, fewer common recommendations like speed bumps or breakers close to the school (15.4%) highlight teachers' concerns about making roads safer and more suitable for students' wellbeing.

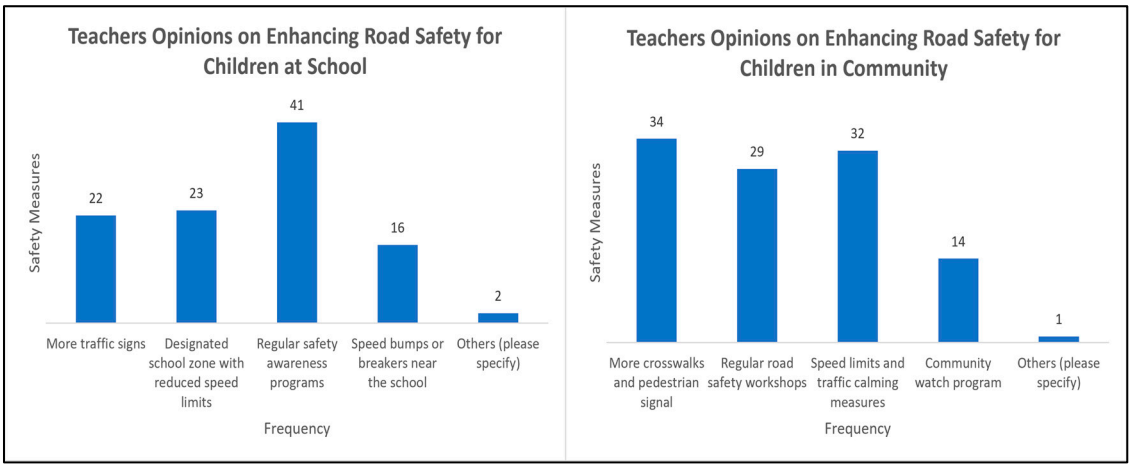

Figure 4. Teachers' opinions on RSE for children in educational and community contexts.

3.1.5. Teachers Opinions in Enhancing Road Safety for Children in the Community

Regarding improving children's road safety, teachers' views go beyond the classroom and include more extensive community-based initiatives. A similar question was asked of teachers to know their opinions on enhancing road safety for children at the community level. The most common viewpoint, backed by 30.9% of respondents, highlights the need for more crosswalks and pedestrian signals to promote safer pedestrian crossings and reduce the likelihood of accidents involving children. Similarly, 29.1% of teachers advise implementing speed restrictions and traffic calming measures in the neighborhood to reduce vehicle speeds and improve road safety. Additionally, 26.4% of respondents emphasize the importance of regular road safety workshops, which provide opportunities for community members to acquire knowledge, skills, and strategies for promoting safe behaviours and preventing road-related injuries among children. A smaller percentage of teachers (12.7%) also support community watch programs, underscoring the value of collaborative efforts and community engagement in enhancing road safety awareness and enforcement. These findings collectively highlight the multi-faceted approach teachers advocate for promoting road safety and protecting children in both school and community settings. Figure 4 represents teachers' opinions on road safety interventions at the school and community levels.

3.1.6. Effectiveness Level of Current RSE Programs

These data show a strong negative impression towards the current RSE program's effectiveness. On the question related to the presence of an RSE program, about two-thirds of the teachers answered that there is no RSE program or they were unsure about it. Regarding the effectiveness level of the current RSE program, a substantial majority of the respondents believe the RSE program is ineffective, with 35% finding it extremely ineffective and 21% considering it ineffective. While 30% hold a neutral stance, a mere 15% view the RSE program positively (13% effective and 2% extremely effective).

3.2. Teachers Interview Data

Around 61 codes were generated using the NVIVO 14 software, and those codes were then categorized into seven themes, i.e., challenges and support needs, curriculum integration and content, parental and community involvement, program design and structure, teaching method and engagement strategies and training and professional development. The table, including key themes, codes and quotes, can be seen in Appendix A.

There were five participant teachers (two male and three female) who participated in an interview about the RSE program. Out of the five, two were from primary, two were from secondary and one was from high school. This analysis of school RSE reveals a multi-faceted approach to enhancing student safety awareness and practices. It identifies several key areas for improvement, including the need for up-to-date resources, consistent engagement from both students and parents and increased institutional support.

3.2.1. Challenges and Support Needs

This theme highlights teachers' challenges in implementing road safety education and the support they require. Teachers encounter challenges such as limited access to resources, difficulties in maintaining consistent engagement, and motivational issues. They also lack proper training and institutional support. One participant noted the following:

> *"I have not followed any professional and teacher training program regarding traffic safety. The main reason is the society and school does not encourage it even there is not appropriate initiative from governments side as well."*

This quote underscores the lack of institutional support and professional development opportunities in road safety education. Another challenge is ensuring consistent engagement, particularly from parents. One respondent mentioned that

> "*a significant challenge is ensuring consistent engagement, as parents' busy schedules can make it difficult for them to participate regularly.*"

This highlights the need for flexible approaches to involve parents and the community in road safety education.

3.2.2. Curriculum Integration and Content

This theme emphasises the importance of integrating road safety education into the curriculum, combining theoretical and practical knowledge. The content should cover essential topics and be relatable to real-world experiences. One participant noted that effective integration

> "*Makes learning more engaging and relatable to real-world experiences*" and "*Reinforces road safety concepts from multiple angles.*"

This suggests that a multi-faceted approach to curriculum integration can enhance learning outcomes. Regarding content, another respondent stated

"*The content will cover essential topics such as understanding traffic signals, pedestrian safety, the importance of wearing helmets and seat belts, and the dangers of distracted driving.*"

This quote outlines the key areas that should be addressed in a comprehensive road safety education program.

3.2.3. Parental and Community Involvement

This theme stresses the importance of engaging parents and the community in road safety education. It suggests that participation should be mandatory but flexible to accommodate different schedules. One participant strongly advocated for mandatory participation:

"*I would recommend making participation mandatory, as traffic safety is a critical issue.*"

This highlights the perceived importance of parental involvement in road safety education. To address the challenge of busy schedules, another respondent suggested

"*Offering flexible options, such as evening sessions or online resources, can help mitigate this issue.*"

This approach could increase participation rates and reinforce road safety education at home.

3.2.4. Program Design and Structure

This theme focuses on the elements of successful road safety education programs. It emphasizes using interactive, multi-sensory, and media-rich content to model and reinforce safe behaviours. One participant shared a successful strategy:

"*One successful strategy I have observed is involving parents in interactive workshops where they can learn alongside their children.*"

This approach combines parental involvement with engaging learning methods. Another respondent highlighted the importance of practical application:

"*Encouraging children to practice what they learn at school in real-life situations helps reinforce their understanding and makes safety habits second nature.*"

This suggests that effective programs should bridge the gap between classroom learning and real-world application. The use of diverse resources was also recommended:

"*Resources such as interactive digital content, real-life case studies, and simulation tools can make lessons more engaging and impactful.*"

This indicates that various teaching tools can enhance the effectiveness of road safety education.

3.2.5. Teaching Method and Engagement Strategies

This theme explores various teaching methods and strategies to engage learners effectively. It emphasizes activity-based learning, collaborative environments, guest speakers, and a mix of hands-on and hybrid delivery formats. One participant noted the benefits of in-person sessions:

"*In-person sessions can provide hands-on demonstrations and foster a sense of community among parents, making the learning experience more impactful.*"

This suggests that face-to-face interactions can enhance engagement and learning outcomes. Another respondent advocated for a hybrid approach:

"*Preferably a combination of physical and online sessions (recordings available for future reference).*"

This flexibility can accommodate different learning styles and schedules. A successful example was shared:

> "*The program was offered in a hybrid format, with initial theoretical lessons conducted online and practical workshops held physically.*"

This approach combines the benefits of both online and in-person learning.

3.2.6. Training and Professional Development

This final theme focuses on the importance of continuous professional development for teachers in road safety education. It emphasizes the need for ongoing training, expert involvement, and government support. One participant stressed the importance of continuous learning:

> "*Offering continuous professional development opportunities throughout the year would also keep teachers updated on the latest traffic safety protocols and teaching methodologies.*"

This suggests that road safety education requires ongoing updates and skill development. The benefits of professional development were outlined as follows:

> "*Gaining knowledge and understanding of rules and situations*" and "*Developing and improving skills through training and experience.*"

These quotes highlight the dual aspects of knowledge acquisition and skill development in teacher training. Institutional support was also emphasized:

> "*Schools and educational institutions can support teachers by providing dedicated time for professional development on road safety.*"

This indicates that successful implementation of road safety education requires commitment at the institutional level.

Overall, the study emphasizes the importance of integrating road safety concepts across various academic subjects and combining theoretical knowledge with practical applications to create a comprehensive learning experience. Parental and community involvement is highlighted as crucial for reinforcing safety concepts learned in school. The analysis advocates for diverse teaching methods, including interactive digital content, simulation tools, and hands-on activities, to model safe behaviour and provide opportunities for effective practical application. Additionally, it stresses the importance of ongoing professional development for educators, recommending continuous training and expert involvement to enhance teaching skills in this critical area. This comprehensive approach to RSE aims to create a more effective, engaging, and wide-reaching program that can significantly improve students' road safety awareness and practices.

3.3. Parents Questionnaire Data

3.3.1. Demographic Data

A majority of the respondents (60.8%) work in the private sector, while smaller groups are employed in government jobs (12.4%) or own businesses (11.3%). Notably, 15.5% of respondents chose not to disclose their occupation. Regarding family size, most families have one or two children, accounting for 67% of the respondents. Families with three or more children constitute 33%, highlighting a substantial portion of larger families within the surveyed group.

Regarding educational engagement, half of the families have one child attending school or college (50.5%), with 32% having two children in education. A smaller percentage has three or more children attending educational institutions (17.5% combined). The age distribution of children shows that 56.7% are between 5 and 20 years old, indicating a significant number of families with children spanning a wide age range. Children aged

5–10 years and 5–15 years comprise 20.6% and 22.7% of the respondents, respectively. These insights suggest that RSE programs should be designed to accommodate families with varying numbers of children and broad age ranges while also considering the diverse occupational backgrounds of the parents.

3.3.2. Road Safety Knowledge

The questionnaire further reveals parents' preferences and practices regarding RSE for their children. About 64.9% of the parents prefer a mixed approach, utilizing both online and physical formats for RSE, while 30.9% favour physical-only education, and 4.1% opt for online-only education. When considering the location for RSE, 68% of parents prefer that their children receive instruction at home and school. This dual approach is significantly more favoured than exclusive education at school (27.8%) or home (4.1%). Regarding the timing, 51.5% of parents favour short, frequent sessions a couple of times per week, highlighting a preference for consistent and repetitive learning over longer, less frequent sessions.

Parents' engagement in discussing road safety with their children shows varied involvement levels. A considerable portion, 35.1%, sometimes engage in these discussions, while 24.7% do so often, and 16.5% always do. However, 19.6% of parents rarely discuss road safety, and 4.1% never do, indicating areas where increased parental involvement could be beneficial. Additionally, when explaining traffic signs, nearly half of the parents (46.4%) find the yield sign most challenging, followed by the pedestrian crossing sign (19.6%), stop sign (15.5%), and school zone sign (14.4%).

Finally, the survey reveals low participation in RSE programs for parents, with only 18.6% having attended such programs, while a significant 77.3% have not. Asking about their interest in attending RSE sessions shows that a majority, 54.6%, are definitely interested, while 23.7% may be interested. Additionally, 16.5% are not sure, and only 5.2% are probably not interested. The data highlight the importance of varied educational approaches and consistent parental involvement in enhancing children's road safety knowledge. Figure 5 represents the preferred modes and schedules for RSE.

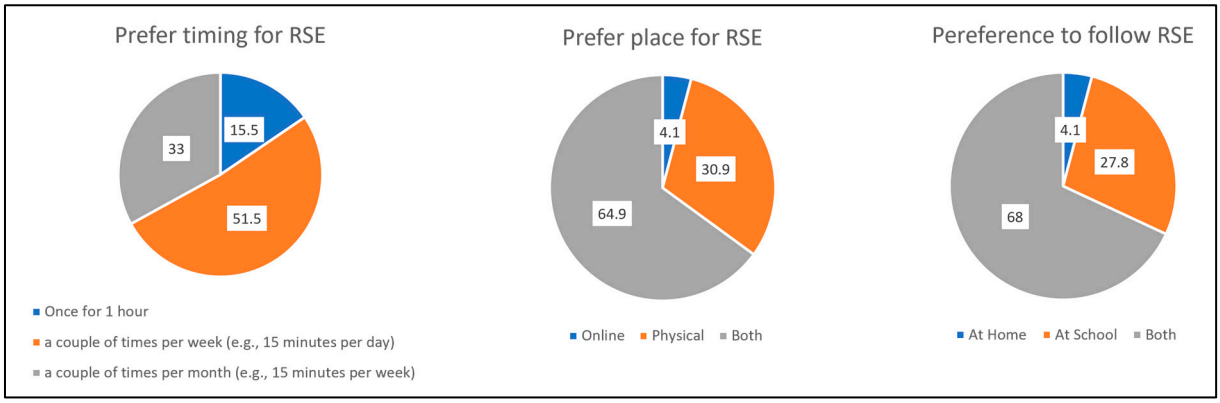

Figure 5. Preferences for timing, place and setting for RSE delivery.

3.3.3. Transportation Habits

The parents were further asked about their transportation habits, which provides insights into the primary modes of transportation used by children and their possession of driving licenses. Among the surveyed parents of children, a motorbike is the most prevalent mode of transportation, with 38.1% of their children using it regularly. Unspecified modes of transportation and walking are also significant, accounting for 29.9% and 19.6% of the children, respectively. Cycling is the least common method, with only 12.4% of the children opting for this mode.

Regarding driving licenses, a significant majority of the children (62.9%) do not possess a driving license, while 37.1% do have one. The data highlight reliance on motorbikes and other forms of transportation (car, van, etc.), possibly due to convenience or availability, reflecting broader transportation trends and the accessibility of different modes for children in the surveyed group.

3.3.4. Awareness and Concerns

A notable 67.1% of the parents surveyed consider themselves either "Very Aware" (32%) or "Somewhat Aware" (35.1%) of road safety measures. On the other hand, 22.7% of respondents are "Neutral", suggesting a significant portion of the community is indifferent or uncertain about their knowledge of road safety. Additionally, 10.3% of respondents consider themselves "Not very Aware", highlighting a gap in awareness that may need to be addressed through targeted educational campaigns.

The most significant concern of parents regarding their child's road safety, by a large margin, is "speeding vehicles", which is mentioned by 62.9% of the parents. Following this, "distracted drivers" is the second most pressing concern, mentioned by 15.5%. "Lack of pedestrian crossings" and "inadequate signage" are also notable concerns, with 11.3% and 9.3% of the respondents, respectively, indicating these as their primary worries. Figure 6 highlights the parent's concerns about their children's road safety.

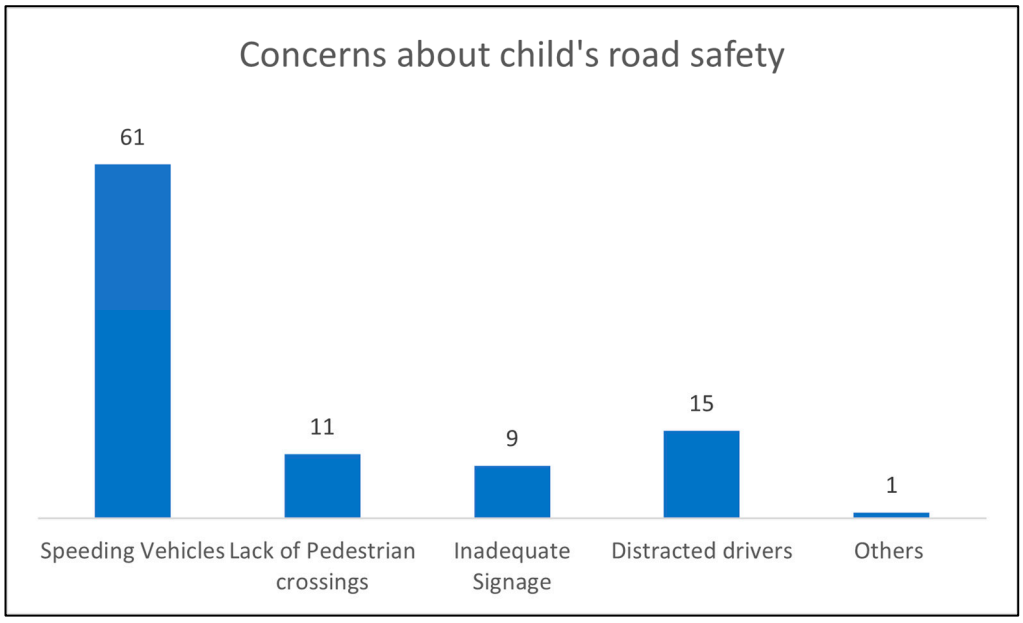

Figure 6. Parents concerned about their children's road safety.

3.3.5. School and Community Involvement

When asked about the school and community involvement of children's parents, around 49.5% of the parents believe that schools are not offering sufficient education on road safety. In comparison, only 32% think schools are doing an adequate job. Additionally, 18.6% of respondents are uncertain, indicating a need for better communication and transparency about the school road safety curriculum.

When it comes to community programs or initiatives, the data indicate a substantial gap. Only 27.8% of respondents acknowledge the existence of such programs, whereas 57.7% believe there are no community-level efforts to promote child road safety. Moreover, 14.4% of respondents are unsure about the presence of these programs, reflecting a possible lack of awareness or visibility of existing efforts. Figure 7 represents parents' perspectives regarding school and community involvement in RSE delivery.

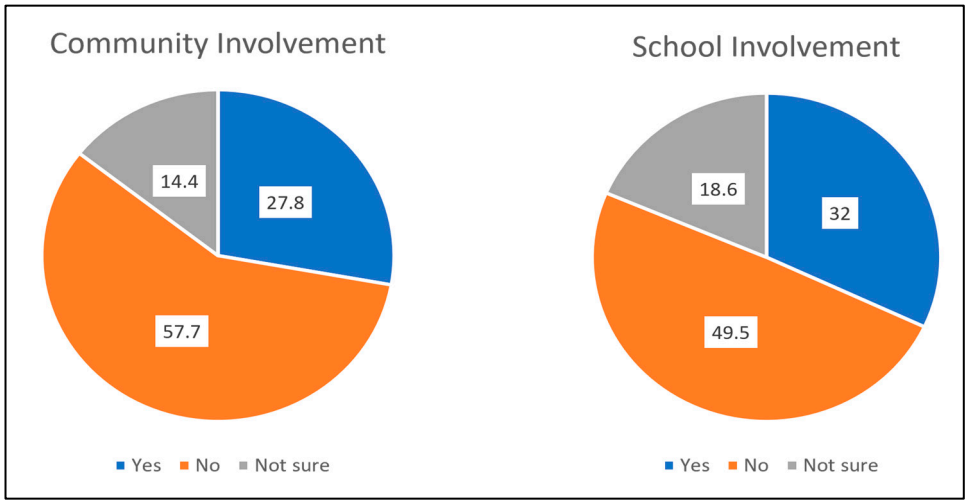

Figure 7. Parents' opinion on school and community involvement for RSE.

3.3.6. Personal Experiences

The data indicate that 46.4% of respondents have personally experienced an incident related to road safety. This is a significant portion, suggesting that nearly half of the community members have direct encounters with road safety issues. Regarding accompanying their children to school, a substantial portion (35.1%) of parents always did so, reflecting a high level of concern and proactive involvement in ensuring their child's safety. Around 23.7% of the parents accompany their children occasionally. In addition, a small portion of parents choose rarely (10.3%) and never (2.1%) to accompany their children.

3.3.7. Relation Between Parental Discussions on Road Safety and Parental Confidence in Child's Understanding

There is a statistically significant between parents discussing road safety with their children and their confidence in their child's understanding of road safety ($r = 0.32$, $p = 0.001$). Additionally, parents who report having these discussions tend to have higher confidence in their child's road safety knowledge, or conversely, parents with higher confidence are more likely to report having had these discussions. Also, while the relationship is statistically significant, the moderate strength of the correlation suggests that other factors likely play a role in parents' confidence in their child's road safety understanding

3.3.8. Relation Between the Number of Children on Parental Confidence in Children's Road Safety Knowledge

There is a statistically significant relationship between the number of children and parental confidence in their child's road safety understanding; the relationship is weak ($r = 0.20$, $p = 0.045$). This suggests that having more children is associated with slightly higher confidence in children's road safety knowledge, but the effect is negligible. Other factors likely play a more significant role in determining a parent's confidence in their child's understanding of road safety.

3.4. Parents Interview Data

Around 51 codes were generated from the collected data using NVIVO 14 software and then categorized into five themes. The themes are Barriers to Participation and Cycling, Community and Stakeholder Involvement, Educational Content and Methods, Engagement and Communication and Safety and Infrastructure. There were four participants (three females and one male) who participated in an interview about RSE programs and

their acceptability. The table, including key themes, codes and quotes, can be seen in Appendix B.

3.4.1. Barriers to Participation and Cycling

This theme encompasses various factors that hinder people, particularly children and families, from cycling and participating in road safety programs. The barriers identified include cultural attitudes, economic constraints, safety concerns, and lack of awareness. One significant barrier is the economic aspect, as highlighted by this quote:

> *"Good quality bikes and properly fitted helmets can be expensive, which might be a barrier for some families."*

This suggests that the initial equipment cost can prevent some families from participating in cycling activities.

Cultural factors also play a role, as evidenced by the statement

"*there is no cycling culture.*"

This indicates a lack of societal norms or practices that encourage cycling as a regular activity. Safety concerns are another significant barrier, particularly related to traffic conditions. As one participant noted,

> *"cycling might seem risky due to traffic or lack of safe cycling paths."*

This perception of danger can significantly discourage people from cycling, especially in areas with heavy traffic or inadequate infrastructure.

3.4.2. Community and Stakeholder Involvement

This theme highlights the importance of engaging various community members and stakeholders in promoting road safety and cycling. It emphasizes collaboration between different groups and the role of schools and communities in these efforts. This quote underscores the importance of community meetings:

> "*Hold regular meetings where parents can discuss road safety concerns and ideas for improvement in the neighborhood.*"

This suggests that creating forums for open dialogue can lead to community-driven solutions. Interactive community initiatives are also valued, as shown by this statement:

> "*interactive initiatives like safety workshops at local parks or safety demonstrations with local authorities would be valuable.*"

This indicates a preference for hands-on, engaging activities that involve the community directly. The crucial role of educational institutions is emphasized in this quote:

> "*Schools and communities play crucial roles in our child's road safety education.*"

This highlights the need for a collaborative approach between schools and the broader community in educating children about road safety.

3.4.3. Educational Content and Methods

This theme highlights the importance of engaging various community members and stakeholders in promoting road safety and cycling. It emphasizes collaboration between different groups and the role of schools and communities in these efforts. The importance of community meetings is underscored by this quote:

> "*Hold regular meetings where parents can discuss road safety concerns and ideas for improvement in the neighborhood.*"

This suggests that creating forums for open dialogue can lead to community-driven solutions. Interactive community initiatives are also valued, as shown by this statement:

> "*interactive initiatives like safety workshops at local parks or safety demonstrations with local authorities would be valuable.*"

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> "*Schools and communities play crucial roles in our child's road safety education.*"

This highlights the need for a collaborative approach between schools and the broader community to educate children about road safety.

3.4.4. Engagement and Communication

This theme addresses the methods and importance of maintaining open lines of communication between all parties involved in road safety education, including students, parents, and schools. The importance of positive reinforcement is highlighted in this quote:

> "*Acknowledge schools and communities doing a great job with road safety education. This will inspire others!*"

This suggests that recognizing and celebrating successful efforts can motivate broader participation. The role of city authorities in promoting cycling culture is also addressed:

> "*City authorities could help by promoting cycling culture through different incentives and initiatives and improving the bicycling infrastructure.*"

This indicates that engagement and communication should extend beyond schools to include local government and urban planning.

3.4.5. Safety and Infrastructure

This final theme focuses on the physical environment and the need for improvements to support safe cycling and transport. The need for comprehensive improvements is highlighted in this quote:

> "*Improvements could include better training for teachers, more engaging materials, and active involvement of traffic police in educational activities.*"

This suggests that enhancing safety involves not just physical infrastructure, but also improving the quality and engagement of educational efforts. The link between infrastructure and safety perception is emphasized here:

> *"improvements in road infrastructure and awareness campaigns could enhance safety."*

This indicates that physical improvements to roads and cycling paths and increased public awareness are key factors in improving overall safety for cyclists and pedestrians.

Overall, the study shows that to improve RSE and get more people cycling, we need to teach better, get the community involved, and improve roads and bike paths. It suggests that conducting all these things together is the best way to make fundamental changes.

4. Discussion

This study aimed to explore the acceptability of road safety education (RSE) among parents and teachers in Pakistan. This study's results show similarities and differences when compared to other research. Our results align with studies conducted in other developing countries, such as the research conducted in Thailand [44,45], which reported a lack of specialised training for teachers in RSE, mirroring findings in Pakistan. Similarly, Kamran et al. [46] emphasized that accomplishing an inclusive school community requires

establishing an inclusive culture supported by collaboration among teachers, parents, and stakeholders. Additionally, more than half of the parents indicate a lack of community involvement in RSE, which resembles a study conducted in Spain [47], which also reveals the lack of community involvement in RSE contributes to risky behaviour for children going to school and suggests a need for strengthening action at the community level.

Moreover, the use of technology in RSE varies across studies. For instance, while only one-fifth of Pakistani teachers reported extensive use of technology in RSE, studies like Hulme et al. (2021) [48] in the USA emphasized the successful integration of technology in enhancing children's learning about safety. Additionally, the lack of specialized training among Pakistani teachers aligns with the findings from Saadati et al. (2021) [49] in Iran, where inadequate training methods contribute to RSE programs' low efficiency. On the other hand, the high awareness of RSE among parents in Pakistan differs from the study conducted in Spain [50], where parents' awareness of road safety measures is relatively low. These similarities and differences highlight the diverse challenges and successes across different contexts, emphasizing the need for tailored approaches to implement RSE worldwide effectively.

The results highlight the need to address regional disparities when implementing RSE in Pakistan. With better infrastructure facilities and access to the technological world, an urban sector may have better access to e-learning applications and the organized incorporation of RSE into the school curriculum. However, these options may prove difficult for rural communities with limited resources and infrastructure requiring community-based approaches like workshops and demonstrations. Addressing these regional disparities through tailored strategies ensures that RSE programs are inclusive and effective. For example, rural initiatives could include local leaders and culturally relevant materials, while urban-based projects might focus on advanced technology integration to engage students. These region-specific measures highlight the importance of equitable access to RSE for children across Pakistan.

These findings underscore the novel contributions of this study, particularly its identification of context-specific barriers to RSE implementation and its emphasis on mixed-methods approaches to understanding stakeholder perspectives. Tailoring RSE strategies to regional conditions aligns with global recommendations for improving road safety and ensures that diverse socio-economic contexts are considered when implementing these programs.

4.1. Teachers Data

The results from the questionnaire present significant insights into the current status of RSE in Pakistani schools and teachers' perspectives regarding its implementation. While RSE is considered essential, its integration into the school curriculum is inconsistent across different education levels. Not even half of the surveyed teachers reported having a dedicated RSE program in their curriculum, with high schools showing the highest implementation rate. This finding highlights a significant gap in RSE implementation, particularly in secondary and primary schools, suggesting a need for a more standardised approach across all education levels in Pakistan. Previous studies have highlighted that a standardized approach to RSE leads to more effective learning outcomes [51,52]. This integration would also ensure consistent and comprehensive coverage of road safety topics, providing children with the knowledge and skills to navigate traffic environments safely.

An alarming finding is that just one-third of teachers indicated they had received professional development or training for teaching road safety effectively. This lack of specialised training could potentially impact the quality and effectiveness of RSE delivery. Moreover, the data show no significant correlation between years of teaching experience

or grade level and the likelihood of receiving RSE training, indicating a systemic gap in teacher preparation for this critical subject [46].

Teachers reported using various methods to deliver RSE, with practical demonstrations and classroom lectures being the most prevalent, believing children learn best through hands-on experiences and real-world applications. The use of technology in RSE varies widely, with only one-fifth of teachers reporting extensive use. This suggests an opportunity to enhance RSE through increased technology integration and interactive teaching methods, potentially increasing student engagement and learning outcomes [53–55].

The survey revealed that only one-third of teachers had conducted workshops or informational sessions for parents on reinforcing road safety at home. Regular parent–teacher meetings were identified as the primary channel for communicating road safety feedback to parents. These findings underscore the need for increased efforts to engage parents and the broader community in RSE initiatives [56].

Teachers expressed a largely negative perception of current RSE programs, with more than half of them finding it ineffective or highly ineffective. This dissatisfaction suggests a critical need for program improvement. Furthermore, data also revealed that teachers suggested that the curriculum should cover various topics such as pedestrian safety, bicycle safety, understanding traffic signals, and the dangers of distracted walking or cycling. This recommendation aligns with the existing literature that addresses critical safety topics, such as pedestrian behaviour, traffic signal compliance, and risk awareness, to mitigate accidents and promote safer mobility habits [19,57].

The interview data further elaborate on the themes identified, providing deeper insights into teachers' thoughts and experiences regarding RSE. Teachers highlighted the necessity of integrating RSE into various subjects within the school curriculum. They suggested that subjects like mathematics and science could incorporate road safety topics, such as calculating stopping distances and understanding the physics of collisions. This multidisciplinary approach would reinforce road safety across different contexts, making it more integral to children's education.

Furthermore, participants stressed that road safety practices should be demonstrated at home and in the community, calling for more community-based initiatives, such as local workshops and campaigns, to complement the school's efforts. This would create a supportive environment where children could practice safe behaviours regularly. Teachers expressed a need for continuous training, expert involvement, and government support to enhance their skills and knowledge in RSE. This aligns with the findings of the questionnaire, which show low professional development rates in RSE and suggests a clear area for improvement. They called for more comprehensive and well-structured RSE programs to be regularly updated to reflect current road safety challenges and practices.

4.2. Parents Data

The data from the parent's questionnaires reveal critical insights into parents' perspectives on RSE for their children. The demographic data show a diverse sample, with around half of parents employed in private sector jobs. This suggests that these families may experience different scheduling challenges and limitations in participating in RSE. More than two-thirds of the parents have one or two children, with a notable portion having three or more, indicating a need for educational programs catering to smaller and larger families. This diverse demographic emphasizes the need for adaptable and accessible RSE programs [58].

Most parents, almost 65%, preferred a mixed approach to RSE, combining online and physical formats, reflecting an understanding that a mixed methodology can enhance learning outcomes through varied engagement methods. Also, most parents preferred their

children to receive RSE at home and school, highlighting the importance of a comprehensive approach that integrates educational efforts across different environments. Moreover, the timing of educational sessions was also significant, with half of parents favouring short, frequent sessions multiple times per week. This preference suggests that parents believe in the effectiveness of regular, bite-sized learning to reinforce road safety principles continuously. However, low parental involvement further underscores the need for targeted educational support for parents. Studies have shown that parental participation is a critical component of effective RSE initiatives, where enhanced collaboration between schools, parents, and communities results in better child safety [23].

The low participation rate in RSE programs contrasts sharply with the high interest in attending such programs, suggesting a gap between available resources and parental awareness or accessibility. This inconsistency highlights an opportunity for community and educational institutions to enhance outreach and facilitate more accessible RSE initiatives. Also, the transportation habits of children reveal a reliance on motorbikes and unspecified modes of transportation, with a substantial portion walking. This pattern underscores the importance of RSE tailored to the most common modes of transport children use. Additionally, the low rate of possession of driver's licenses suggests that many children might be using these transportation methods without formal training, which RSE programs could address. This aligns with studies emphasizing the importance of tailored RSE programs to provide foundational knowledge and improve safe behaviours among children in low-resource settings [18,19].

Parents' awareness of road safety measures is relatively high, with more than two-thirds considering themselves very or somewhat aware. However, significant concerns persist, particularly regarding speeding vehicles. These concerns highlight areas where RSE could focus on behavioural and infrastructural improvements to enhance safety perceptions and realities for children.

Regarding school and community involvement, the data indicate a perception of inadequate RSE in schools and a lack of community programs. This finding suggests a need for increased efforts and resources to strengthen both school-based and community-wide road safety initiatives. Nearly half of the respondents have experienced road safety incidents, emphasizing the pressing need for effective RSE and measures.

Several key themes emerged regarding interview data that provide deeper context to the questionnaire findings. It provides a deep understanding of the barriers and facilitators to RSE from parents' perspectives. One prominent barrier is the influence of cultural norms and economic constraints, which can significantly limit children's participation in road safety programs. Parents expressed concerns about cycling safety, with many citing the lack of dedicated cycling lanes and inadequate traffic law enforcement as significant restrictions. This point is well reported in the literature, as cycling infrastructure increases cyclist safety [59–61]. At the same time, its absence discourages cycling [62] and enhances the perceived risks associated with other forms of road transportation. These barriers suggest that effective RSE must address not only knowledge gaps but also societal perceptions and infrastructural challenges. Research underscores the necessity of addressing these dimensions through integrated approaches that combine educational content, community involvement, and infrastructural improvements to improve road safety [21].

Despite these barriers, parents highlighted the importance of effective educational content and the role of community and stakeholder involvement in enhancing RSE. This multi-stakeholder approach could address the low participation rates in parent-focused programs observed in the questionnaire data. Interviewees emphasized the impact of in-person education conducted in structured environments, such as schools or community centres, where interactive and engaging methods can be employed. The suggestion for

comprehensive content covering various aspects of road safety aligns with the identified challenges in explaining certain traffic signs. There is a clear preference for online platforms that complement hands-on activities, ensuring that children receive comprehensive and practical road safety training.

Parents also recommended increased collaboration between schools, local authorities, and community organizations to create a supportive ecosystem for RSE. Infrastructure improvements, such as the development of safer cycling lanes and stricter traffic law enforcement, were identified as critical measures to substitute a safer environment for children, thereby encouraging greater participation in road safety activities. These insights underscore the need for a multifaceted approach that addresses educational and infrastructural components to improve road safety for children in Pakistan.

4.3. Limitations and Recommendations

The research has a few limitations. First, the sample size in both quantitative (63 teachers and 97 parents) and qualitative (5 teachers and 4 parents) terms and the pilot nature of the study limit the generalizability of the findings to the broader population of Pakistan. However, this was an exploratory evaluation, and various feasibility studies have been published with equivalent or smaller group sizes [25,41,63]. Moreover, the current study was aimed to target participants from diverse regions. Still, it was unclear how well it represents the entire population, mainly rural areas, which may face different road safety challenges. However, future research should endeavour to sample a significantly more extensive and regionally representative sample. Participants from diverse geographical locations and other socio-economic characteristics should be recruited to obtain more generalizable results in studying the RSE dynamics in Pakistan.

Furthermore, using sampling techniques such as stratified sampling could also mean that the estimate has a balanced representation of demographic and regional subgroups. Moreover, the data relied on a self-reported questionnaire, which can be biased as participants might overrate their knowledge or involvement in RSE. Lastly, the study was conducted primarily in English, which might have excluded the participants who are comfortable with local languages, skewing the results. Hence, future research is recommended.

Some recommendations have been made for the study related to parents' and teachers' perspectives about accepting RSE. Firstly, a comprehensive curriculum should be integrated across all educational levels, from primary to high school, and consistent and age-appropriate content delivery should be ensured. Secondly, mandatory professional development programs related to RSE should be implemented to equip teachers with the necessary skills and knowledge to deliver the content effectively. Thirdly, to enhance the children's engagement and learning, interactive technology and digital resources should be increased. Fourthly, community-based RSE programs, including local authorities and school parents, should be developed and implemented to create a supportive ecosystem for RSE. Fifthly, targeted measures should be adopted based on regional disparities. With better infrastructure and technology access, urban areas can utilize digital tools, gamified platforms, and formal curricular integration. In contrast, rural areas may benefit more from low-cost, community-led initiatives such as workshops, practical demonstrations, and localized teaching materials in native languages. These region-specific approaches will ensure equitable access to RSE across diverse contexts in Pakistan.

Sixthly, there should be a regular evaluation of RSE programs and the content with time and methods based on emerging trends and stakeholder feedback, as their engagement is essential for inclusive policymaking [64]. Seventhly, RSE programs should be culturally relevant and address the specific local challenges and norms related to road safety issues in Pakistan. Finally, future research should explore children's perspectives regarding the

acceptability of road safety education in Pakistan. Understanding their existing road safety knowledge, preferred learning methods, and engagement levels could significantly enhance the design and implementation of RSE programs. Co-designing RSE materials with children could further enhance program acceptance and effectiveness, ensuring that interventions are engaging and developmentally appropriate.

Future studies exploring the qualitative aspects of these methods and the perspectives of teachers and parents would provide a more comprehensive understanding of how feedback is delivered and received within the educational system.

5. Conclusions

This study explored the perspectives of parents and teachers regarding the acceptability of road safety education (RSE) programs in Pakistan. The findings reveal challenges and opportunities for improving children's traffic safety awareness and behaviours. Moreover, the research highlights a significant gap in implementing RSE across different educational levels in Pakistan, with not even half of the teachers reporting RSE in their curriculum. This inconsistency, combined with the lack of specialised training for most surveyed teachers, indicates a need for a more standardised and comprehensive approach to RSE. In addition, parents and teachers express dissatisfaction about the effectiveness of the current RSE, which needs an urgency for program improvement and positive change if appropriately addressed. The study also revealed the potential barriers to implementing the RSE, including cultural norms, social norms and infrastructure deficiencies. Therefore, these challenges emphasize the need for a multidimensional approach that targets not only educational perspectives but also societal perception and physical infrastructure improvement. Lastly, although there are many challenges in implementing the RSE effectively, the study reveals a strong interest of both parents and teachers regarding effective RSE. Therefore, by addressing the significant gaps and leveraging the willingness of stakeholders to engage, there is a prominent chance to enhance RSE and ultimately improve the road safety knowledge of children in Pakistan. Future research should focus on developing and testing interventions that address the specific needs and challenges identified in this study.

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Informed Consent Statement: Informed consent was obtained from all the participants involved in the study.

Data Availability Statement: The raw data supporting the conclusion can be obtained from the corresponding author upon request.

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Appendix A

Table A1. Key Themes, Codes and Quotes from Teachers related to RSE.

Themes	Codes	Description	Quotes
Challenges and Support Needs	Access to Up-to-Date Resources, Accessibility and Flexibility, Challenge of Consistent Engagement, Changing Attitudes and Motivations, Collaboration Among Teachers, Lack of Encouragement for Training Programs, Prioritizing Road Safety, Teacher Responsibility	Teachers face obstacles such as resource access, engagement consistency, and motivational shifts, requiring support for collaboration and prioritization.	*"Ensuring consistent reinforcement at home and overcoming parents' busy schedules."* *"...ensuring consistent engagement, as parents' busy schedules can make it difficult for them to participate regularly."* *"Online sessions can be recorded and shared for those who cannot attend live, ensuring wider reach and flexibility."* *"I have not followed any professional and teacher training program regarding traffic safety. The main reason is the society and school does not encourage it even there is not appropriate initiative from governments side as well."* *"a significant challenge is ensuring consistent engagement, as parents' busy schedules can make it difficult for them to participate regularly."*
Curriculum Integration and Content	Benefits of Integration, Combination of Theoretical and Practical Knowledge, Comprehensive Training Content, Curriculum Integration, Curriculum Integration of Road Safety Education, Essential Topics for Road Safety, Examples of Integration, Existing Training Program, Integration with Other Subjects	Effective road safety education requires integrating theoretical and practical knowledge within the curriculum, highlighting essential topics.	*"Math: Calculating safe stopping distances, reaction times."* *"In science classes, we can discuss the physics behind vehicle collisions and the importance of seat belts."* *"Curriculum approaches to road safety education for young children have often favoured the use of games, rhymes, songs, photos and worksheets"* *"Makes learning more engaging and relatable to real-world experiences."* *"Reinforces road safety concepts from multiple angles."* *"The content will cover essential topics such as understanding traffic signals, pedestrian safety, the importance of wearing helmets and seat belts, and the dangers of distracted driving."*
Parental and Community Involvement	Crucial Role of Parents, Flexible Options for Parental Engagement, Importance of Traffic Safety Initiatives, Mandatory Participation Recommendation, Parent–Child Interaction on Road Safety	Engaging parents and the community is vital, with flexible and mandatory participation to reinforce road safety education at home.	*"Parents should model safe behavior, discuss road safety rules, and practice them with children."* *"Parents play a crucial role in reinforcing road safety education at home."* *"...can teach in a friendly way when they see someone breaking the traffic rules or sign and tell them that it can be very dangerous."* *"I would recommend making participation mandatory, as traffic safety is a critical issue."* *"Offering flexible options, such as evening sessions or online resources, can help mitigate this issue."*

Table A1. *Cont.*

Themes	Codes	Description	Quotes
Program Design and Structure	Interactive Digital Content and Simulation Tools, Interactive Elements, Interactive Workshops for Parents and Children, Modeling Safe Behaviours, Multi-Sensory Learning Approaches, Practicing Safety Habits, Preference for Physical Meetings, Reinforcing the Message, Subconscious Learning, Successful Strategies, Use of Media for Road Safety Education	Successful programs utilize interactive, multi-sensory, and media-rich content to model and reinforce safe behaviours through digital and physical interactions.	*"Interactive activities at home (board games, role-playing safe crossings)."* *"...students will internalize and practice safe behaviors consistently."* *"...show them cartoon or even animated movies or short clips that promotes the culture of traffic safety."* *"One successful strategy I have observed is involving parents in interactive workshops where they can learn alongside their children."* *Encouraging children to practice what they learn at school in real-life situations helps reinforce their understanding and makes safety habits second nature."* *"Resources such as interactive digital content, real-life case studies, and simulation tools can make lessons more engaging and impactful."*
Teaching Method and Engagement Strategies	Activity-Based Learning, Behaviour Correction Through Curriculum, Collaborative Learning Environment, Encouraged Participation, Guest Speakers for Real-World Insights, Hands-On Demonstrations and Community Building, Hybrid Format, Hybrid Model of Delivery, Preferred Delivery Method, Relevance and Engagement	Engaging teaching methods include activity-based learning, collaborative environments, guest speakers, and a mix of hands-on and hybrid delivery formats.	*"...involving parents in interactive workshops where they can learn alongside their children."* *"...encourage their children through activity-based learning. Like making traffic lights charts, about Zebra crossing and play cards"* *"Hybrid (Physical at school with option for online attendance)."* *In-person sessions can provide hands-on demonstrations and foster a sense of community among parents, making the learning experience more impactful."* *"Preferably a combination of physical and online sessions (recordings available for future reference)."* *"The program was offered in a hybrid format, with initial theoretical lessons conducted online and practical workshops held physically."*
Training and Professional Development	Content for Professional Training Programs, Content of Seminars, Continuous Professional Development, Desired Training Duration, Duration of Sessions, Duration of Workshops, Extended Duration for In-Depth Coverage, Government-Sponsored Programs, Importance of Workshops for Road Safety Education, Incentives for Teachers, Knowledge and Skills Development, Need for Expert Involvement, Need for Professional Training for Teachers, Professional Development Time	Professional development for teachers should include continuous training, expert involvement, and government support to enhance skills and knowledge in road safety.	*"Provide funding for guest speakers, educational materials, and field trips."* *"...up-to-date resources and ongoing professional development is crucial."* *"Road safety education is considered essential to teach children to interact with traffic safely."* *"The school can also give some kind of incentives to its teacher who follow these kinds of courses...for example financial or an extra leave or covering the expenses of the training.* *"Offering continuous professional development opportunities throughout the year would also keep teachers updated on the latest traffic safety protocols and teaching methodologies."* *"Gaining knowledge and understanding of rules and situations"* *"Developing and improving skills through training and experience"* *"Schools and educational institutions can support teachers by providing dedicated time for professional development on road safety"*

Appendix B

Table A2. Key Themes, Codes and Quotes from Parents related to RSE.

Themes	Codes	Description	Quotes
Barriers to Participation and Cycling	Cultural attitudes, Economic Barriers to Cycling, Fear of Traffic Conditions, Lack of awareness and time constraints, Lack of Cycling Culture, Limited Awareness of Program Importance, Low Parent Participation, Practical Barriers to Cycling, Safety concerns, Traffic risks for cyclists	Factors such as cultural norms, economic constraints, safety concerns, and limited awareness that hinder cycling participation.	"*social norms and perceptions about cycling being unsafe or inconvenient play a role*" "*The primary reasons children don't cycle to school include safety concerns due to heavy traffic.*" "*Parental participation in road safety programs is low due to factors like lack of awareness, time constraints*" *Good quality bikes and properly fitted helmets can be expensive, which might be a barrier for some families.*" "*there is no cycling culture*" *cycling might seem risky due to traffic or lack of safe cycling paths*"
Community and Stakeholder Involvement	Collaboration Between Stakeholders, Committees and social media, Community Meetings for Road Safety, Community Support for Road Safety, Community workshops and campaigns, Community-Level Initiatives, Organizing events, Role of Schools and Communities, Safe school zones and community involvement, Schools' integration and activities	Engagement and cooperation between various stakeholders, including schools and communities, to promote road safety.	"*increased collaboration between schools, local authorities, and parents.*" "*Communities can support this by creating safer walking and cycling routes and organizing local initiatives to promote road safety*" "*Initiatives could include organizing road safety fairs*" "*Hold regular meetings where parents can discuss road safety concerns and ideas for improvement in the neighborhood.*" "*interactive initiatives like safety workshops at local parks or safety demonstrations with local authorities would be valuable*" "*Schools and communities play crucial roles in our child's road safety education*"
Educational Content and Methods	Awareness Campaigns and workshops, Combination of Education Methods, Content of Road Safety Education, Incorporating Safety Lessons in Curriculum, In-person education, Practical demonstrations, Practical sessions inclusion, Practical Training for Real-Life Situations, School-Based Practical Exercises, Standardized Education, Structured Learning Environments, Topics to cover in education	Diverse educational strategies and practical training to effectively teach road safety in structured environments.	"*. . . understanding traffic signals, pedestrian safety, cycling safety, and the importance of wearing helmets and seat belts*" "*In-person education at school tends to have the most significant impact due to structured learning environments, peer interactions, and immediate feedback from teachers*" "*a combination of road safety education at home, reinforced at daycare or preschool, and supported by online resources would have the most significant impact*" *Schools should have road safety lessons with practical exercises, maybe even inviting traffic police to talk to the children.*" "*cover topics such as understanding traffic signals, pedestrian safety, cycling safety, and the importance of wearing helmets and seat belts*"

Table A2. *Cont.*

Themes	Codes	Description	Quotes
Engagement and Communication	Communication among school and parents, Digital Platforms for Engagement, Engaging Techniques, Frequency and duration of engagement, Importance of early education, Importance of Road Safety Education, Interactive Activities and Simulations, Keeping Parents Informed, Parent–Child Interactive Activities, Perception of benefits, Promoting Cycling Culture, Recognition of Good Practices, Regular Discussions on Road Safety, Social norms and perceptions	Methods and techniques to enhance engagement and communication among students, parents, and schools regarding road safety.	*"Use online platforms to share resources, safety tips, and updates on road safety initiatives, encouraging parents to participate and share their experiences."* *"Include interactive activities like role-playing scenarios, quizzes, and games during workshops that involve both parents and children"* *"Engaging children for at least one hour per week over several months would be effective"* *Acknowledge schools and communities doing a great job with road safety education. This will inspire others!"* *City authorities could help by promoting cycling culture through different incentives and initiatives and improving the bicycling infrastructure"*
Safety and Infrastructure	Improvements needed, Infrastructure improvements, Infrastructure issues, Perceived Safety of Other Transport	The need for infrastructure enhancements and addressing safety issues to create a safer environment for cycling and transport.	*"lack of cycling lanes, and insufficient traffic law enforcement"* *"creating safe cycling paths"* *"the convenience and perceived safety of driving or taking the bus or car often outweigh the benefits of cycling"* *"Improvements could include better training for teachers, more engaging materials, and active involvement of traffic police in educational activities"* *"improvements in road infrastructure and awareness campaigns could enhance safety"*

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