

THE TRAFFIC ENGINEERING FUNDAMENTAL KNOWLEDGE CURRICULUM EDUCATE TO CHILDREN FOR ROAD SAFETY

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Abstract

This research aims to examine the traffic road safety curriculum, which is the extraordinary curriculum for children in Thailand. This educates about traffic road safety to children based on traffic engineering knowledge. The entire content of the curriculum is based on case studies that depict both hazardous and safe situations. It covers all road users, including pedestrians, intersection rules, private vehicle users, and public transportation users. In this research, animations are used instead of actual crash recordings to minimize the negative impact of severity. As this curriculum is new and not a part of the standard curriculum for children in Thailand, ensuring an effective curriculum and learning processes is crucial. Therefore, assessing the curriculum from actual users is one of the approaches to check and maintain the effectiveness of the curriculum. Direct assessments, both formative and summative, are conducted to evaluate children's learning abilities regarding traffic safety before and after training. Statistical analysis of the data reveals that the fundamental knowledge of traffic safety in children increases by 20.28 percent after training. The study shows that students are more likely to change their behaviors towards increased safety, with an average change of 34.30 percent. When evaluating satisfaction with the traffic safety training activities, most participating students express a high level of satisfaction with the teaching materials and lesson contents. It is evident that the curriculum is highly effective in enhancing learning skills while providing an enjoyable and participatory experience. Ultimately, the ones who benefit from this curriculum are the teachers who implement it and the children who will come to learn and absorb the knowledge and practices related to safety. The hope is that this curriculum will help increase awareness of safety among children and have a positive impact on their road usage behavior, making it safer in the future.

Keywords: Case-Based Learning; Children; Road Safety; Traffic Engineering Fundamental Knowledge Curriculum

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Introduction

The problem statement presents a comprehensive analysis of road accident fatalities among children and adolescents, drawing on data provided by the manager of the Academic Center for Road Safety (Jinvong, 2021). The data, sourced from the Ministry of Public Health, Royal Thai Police, and Central Protection for Accident Victims (2013-2017), reveals the alarming number of children and adolescents aged 0-19 who have died in road accidents, particularly involving motorcycles. This section will also highlight the increasing number of deaths among 10-14 and 15-19-year-olds, underscoring the urgent need for safety education targeting these age groups.

With the application of Case-based Learning (CBL), learners are exposed to specific situations that reflect real-world scenarios, enabling them to analyze complex problems, make decisions, and develop critical thinking skills. Furthermore, the problem statement will provide an in-depth analysis of the current state of safety education in Thailand, identifying gaps and shortcomings in existing programs and initiatives.

This review focuses on the application of learning from case studies, known as Case-based Learning (CBL). There have been numerous research studies presenting methods for utilizing CBL in various fields. For example, in the United States, CBL has been applied in the medical field to assess the effectiveness of teaching healthcare in a new holistic approach to evaluate people's health in the present era (McLean, 2016). Additionally, research has been conducted in India, where CBL has been applied in pharmacy courses to teach students about the clinical and social aspects of patient care through real patient case studies, enhancing their learning experience (Okoro *et al.*, 2022). In China, CBL has been utilized to study the effects of case-based learning on the learning outcomes of undergraduate nursing students in health assessment skills. The findings indicate that CBL enhances learning performance, critical thinking, and self-confidence compared to traditional learning methods (Lall and Datta, 2021; Ma and Zhou, 2022). In the UK, CBL has been studied to strengthen sustainable learning within education by incorporating a wide range of case media and convenient analysis of multi-dimensional sustainable learning environments, overcoming the challenges of traditional case-based learning. The study findings indicate increased student engagement and sustainable skill development (Emblen-Perry, 2022). Furthermore, in Canada, the impact of a new laboratory format on student

learning experiences has been investigated and compared to the traditional laboratory format. The study presents the rationale for integrating engineering design with constructivist learning in the new laboratory format to ensure effective and impactful teaching for the new laboratory format, enabling deep experiential learning and a circuit of learning experiences (Zhang *et al.*, 2022; Clark *et al.*, 2023). Indeed, research on Case-based Learning (CBL) has demonstrated its applicability in various fields such as medicine (Malau-Aduli *et al.*, 2013; Nair *et al.*, 2013), education (Cen *et al.*, 2021; Kulak and Newton, 2014; 2015; Patterson, 2006; Sendur, 2012), and engineering (Alani, 2020; Chankong and Maneetien, 2018; Tiwari *et al.*, 2018). However, CBL has gained the most popularity and has been extensively utilized in medical education. Healthcare professionals often need to learn from real case studies, and overall trends show that applying CBL to the tested groups results in improved perception and positive outcomes in various aspects of learning. While there are some research studies related to CBL in engineering, there is currently a lack of research specifically focused on applying Case-based Learning in traffic engineering and safety. Therefore, this research represents a novel discovery that can be applied in the study of traffic engineering and safety curricula.

The course curriculum in Thailand is provided in three categories, which are nine fundamental subjects, three additional subjects, and three development activities. Those all subjects never mentioned about one of the living skills which is road user safety. Unlike the development countries that they contain the road user safety content based on traffic engineering in the elementary school. Moreover, to achieve a driver's license, they do not need to be certified by the driving school but need only pass the driving test, which means that there are possible misunderstanding behaviors. Therefore, this research aims to study the importance of safety education for school-aged children, with a special focus on the roles of families and schools in overall development. By utilizing Case-based Learning (CBL), students are actively engaged in immersive learning experiences, delving into real-life situations to integrate knowledge, explore different perspectives, and propose problem-solving strategies. This approach is crucial in preparing learners to face future challenges confidently and effectively. Middle childhood, which spans from the start of primary school to adolescence, serves as a crucial stage for learning and development. Given

the concerning rise in road accident fatalities among children and adolescents, there is an urgent need to create a comprehensive safety education curriculum that caters to the learning needs of this demographic. The active learning is suitable to educate for the short course training and the focus group (Bonner and Dorneich, 2021; Detlor *et al.*, 2012; Freeman *et al.*, 2014; Hartikainen *et al.*, 2019; Trivino-Cabrera *et al.*, 2021). Proving the case of safety and crash by animation, will be the best an example for student learning. The final goal is to contribute to the development and implementation of a comprehensive safety education curriculum, focusing on the unique learning abilities of children and the influences of family and school on their holistic development.

Research Methodology

This section is comprised of an overview of the study framework, which will explain the related analysis series as shown in Figure 1. The first is to perform a suitable curriculum for children's learning based on the case of road traffic situations. This will provide the situation that has happened in the actual for both safe situation and harmful situations to demonstrate via animation together with instructor explanation during the short training. The direct assessment and indirect assessment are collected to evaluate the learning ability and learner satisfactory.

Course design and Student assessment

Course design

The curriculum emphasizes the importance of instilling safe road user behaviors from childhood to promote safe practices throughout life. This curriculum, designed according to the structure in Figure 2, aims to enhance children's learning abilities to improve or develop safe traffic behaviors

while ensuring their satisfaction with the learning process. By utilizing Case-based Learning (CBL) in daily activities related to traffic engineering in children's lives, the core knowledge content consists of four main topics: pedestrian crossings, intersection rules, private vehicle users and public transportation users. These contents are integrated into learning through games such as Whisper game, Bingo game, and Simulation road game to sustain learners' interest over an extended period, inspiring them and fostering enthusiasm for the learning process. Furthermore, there is also student assessment to confirm learning abilities, safe traffic behaviors, and satisfaction with the curriculum, which are the main goals of this curriculum. All contents aim to raise the children's learner skills to enhance their road safety behaviors with the most importance that they obtain the appropriate understanding. The course plan is designed for a single day including in the morning and afternoon session as shown in Table 1. The morning session is planned for the animated media learning activity and some of assessments in a total 180 mins or 3 h. Then, the afternoon session is planned for once comprehensive on game-based learning activities and some of assessments in total 120 mins or 2 h.

The course contents that are based on the animated media are illustrated in Figure 3. The case scenarios are inserted with the fundamental traffic engineering that introduces the design to link the user idea with engineering design. This can help the users to understand the reason for the design to lead to agreeing with traffic safety regulations. For example, the crossing pedestrian is designed as a series of rectangular with the dominant color, which is white; this will make the driver clearly see and understand to provide awareness for the pedestrians. The location is usually provided at the intersections and needed accessibility places that guide the users to recognize. Then educate in the point of view of both pedestrians, which may become further drivers, on how to cross safety and how to raise awareness.

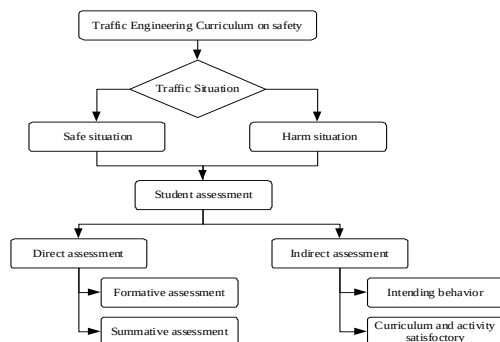


Figure 1. Research Framework

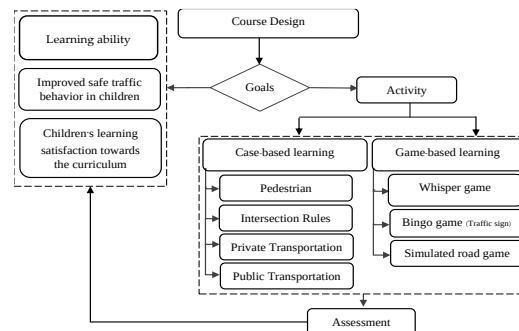


Figure 2. Course design outline

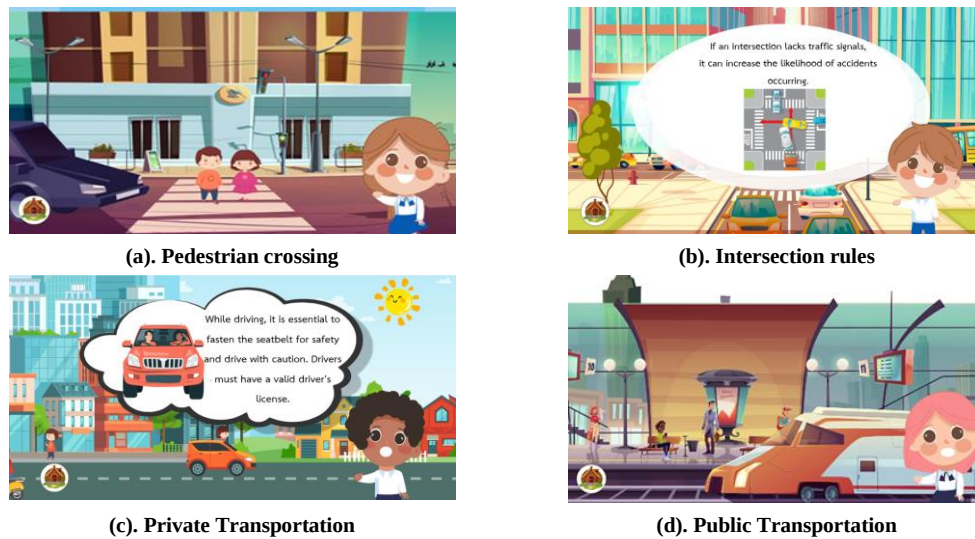


Figure 3. The example case case-based animated media

Table 1. Course activity planning

List	Details	Time (mins)
Morning session		
Introduction	Activity	15
Pre-test	Summative assessment	20
Pre-Questionnaire Safe Traffic Behavior	Indirect assessment	10
Pedestrian	Activity	10
Pedestrian Test	Formative assessment	10
Intersection Rules	Activity	10
Intersection Rules Test	Formative assessment	10
Break session	Activity	15
Private Transportation	Activity	10
Private Transportation Test	Formative assessment	10
Public Transportation	Activity	10
Public Transportation Test	Formative assessment	10
Conclusion and Discussion	Activity	20
Post-test	Summative assessment	20
Lunch Break session	Activity	60
Afternoon session		
Whisper game	Activity	20
Whisper game Reward session	Activity	10
Bingo game	Activity	20
Bingo game Reward session	Activity	10
Simulated road game	Activity	20
Simulated road game Reward session	Activity	10
Post-Questionnaire Safe Traffic Behavior	Indirect assessment	10
Satisfaction towards the curriculum	Indirect assessment	10
Closed session	Activity	10

This will make the pedestrian to understand and accept for traffic safety regulations under the reasonable reasons. The teaching duration is relatively planned on elementary school operation time due to the course can be suitably applied for further. The instructors provide the time for all tests equal or more with the learning activity due to the differences in learning abilities between the ages of 10-12 years, and the young students are not fluently reading in sentences.

Student assessment

There are both direct assessment and indirect assessments that are examined. The direct

assessment mainly examines the student's learning ability; however, the indirect assessment asks for the intended behavior and the satisfactory relevance to course material and instructors.

Direct assessment: The assessments are received based on a paper examination, which has been designed according to the media content and instructor's explanation. The formative assessments are designed as paired questions, as shown in Figure 4, which actually can also be tested on the course media, but this study uses a paper base due to the lack of electronic devices. The pair question is rather informal, and it feels relaxed to answer, which is

suitable to do on formative assessment with children. The level of difficulty and duration to reply are pre-observed with the sample group of the same age students. There are five questions for each content that aim to quickly summarize the core contents. Then, the summative assessment is designed as a multiple-choice question with 20 questions covering all four contents, five questions for each content.

Indirect assessment: There are two indirect assessments that are evaluated: the intended improvement of behavior and learning satisfaction. There are ten questions about the intended behaviors are asked by the assumption situation to compare whether students have a trend to change their behavior after perceiving the road traffic safety knowledge. Then, the satisfaction learnings are asked to know student opinions about the course contents, teaching method, media, and game activities.

Results and Discussion

Pre-Training and Post-Training Score

The overall understanding of learning among the 417 participants is as follows: The pre-training average score was 13.041 (SD=3.428), with a range of scores from 4 to 20, and the post-training average score was 15.686 (SD=2.590), with a range of scores from 7 to 20. The average score before the training and the average score after the training showed an increase of 20.28%. The distribution of all populations is investigated to confirm normal distribution by using Skewness and Kurtosis

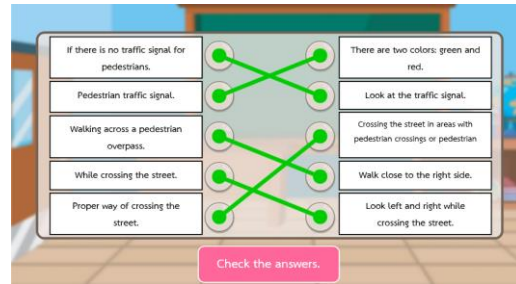


Figure 4. The example of formative assessment

statistics, as shown in Table 2. The distribution pattern needs to know correctly using the statistical method test. The results show that all of the population is distributed as normal (Kurtosis score < 8.0 and Skewness < 3.0) (Debenham, 1989). Therefore, a Paired-samples t-test can be used for inferential statistics.

The paired-samples t-test was conducted to examine whether the post-training scores showed a significant increase compared to the pre-training scores. This could provide evidence of the beneficial impact of the training on students' learning in the traffic and safety course, as shown in Table 3. The obtained result indicated a mean difference between the pre-training and post-training scores of 0.10546, which was statistically significant at the 0.05 level, representing an increase of 20.28%.

Questionnaire on Safe Traffic Behavior in Children

Analysis of intending safe traffic behavior in children before receiving basic traffic safety training found that children tend to neglect and not prioritize behaviors that pro-mote traffic safety. The study on

Table 2. The results overall for analysis of descriptive statistics

	Descriptive Statistics						
	N	Min.	Max.	Mean	Std.	Skewness	Kurtosis
Pre - Training	417	4	20	13.041	3.428	-0.559	-0.144
Post - Training	417	7	20	15.686	2.590	-0.645	0.112

Table 3. The Paired-samples t-test between Pre-Training and Post-Training Score

Paired Samples Statistics								
		Mean	N	Std. Deviation	Std. Error Mean			
Pair 1	Pre - Training	13.041	417	3.428	0.168			
	Post - Training	15.686	417	2.590	0.127			
Paired Samples Correlations								
			N	Correlation	Sig.			
Pair 1	Pre-Training and Post-Training		417	0.778	0.000			
Paired Samples Test								
		Mean	Std. Deviation	95% Confidence Interval of the Difference		t	df	Sig.
Pair 1	Pre-Training vs Post-Training	-2.64508	2.15364	Lower	Upper	-25.080	416	0.000
				-2.852	-2.437			

*Significant at the 0.05 level

traffic safety behavior in children concluded that after attending the traffic and safety training course, there was an observed improvement of 34.30% in their behavior. Specifically, before the training, an average of 17.88% of children wore a helmet while riding a bicycle, but after the training, the percentage increased to 77.45%. This indicates a positive change in behavior, amounting to 59.57%. Regarding the behavior of tailgating on motorcycles, before the training, an average of 15.60% of children engaged in this behavior, while after the training, the percentage decreased to 50.90%. This represents an improvement of 35.30%. In terms of wearing seat belts in cars, before the training, 24.31% of children consistently wore seat belts, but after the training, the percentage increased to 79.69%. This shows a positive change in behavior, amounting to 55.38%. Furthermore, before the training, an average of 61.20% of

children followed traffic signs while on the road, and after the training, the percentage increased to 83.90%. This indicates an improvement of 22.70% in behavior. Concerning crossing the road using pedestrian crossings or footbridges, before the training, 38.28% of children engaged in this behavior, while after the training, the percentage increased to 83.66%. This represents an improvement of 45.38%. Concerning crossing the road using pedestrian crossings or footbridges before the training, 38.28% of children engaged in this behavior, while after the training, the percentage increased to 83.66%. This represents an improvement of 45.38%. In terms of boarding school buses or public buses, before the training, 30.67% of children consistently boarded these vehicles, and after the training, the percentage increased to 69.74%. This indicates an improvement of 39.07% in behavior. Before the training, 42.98%

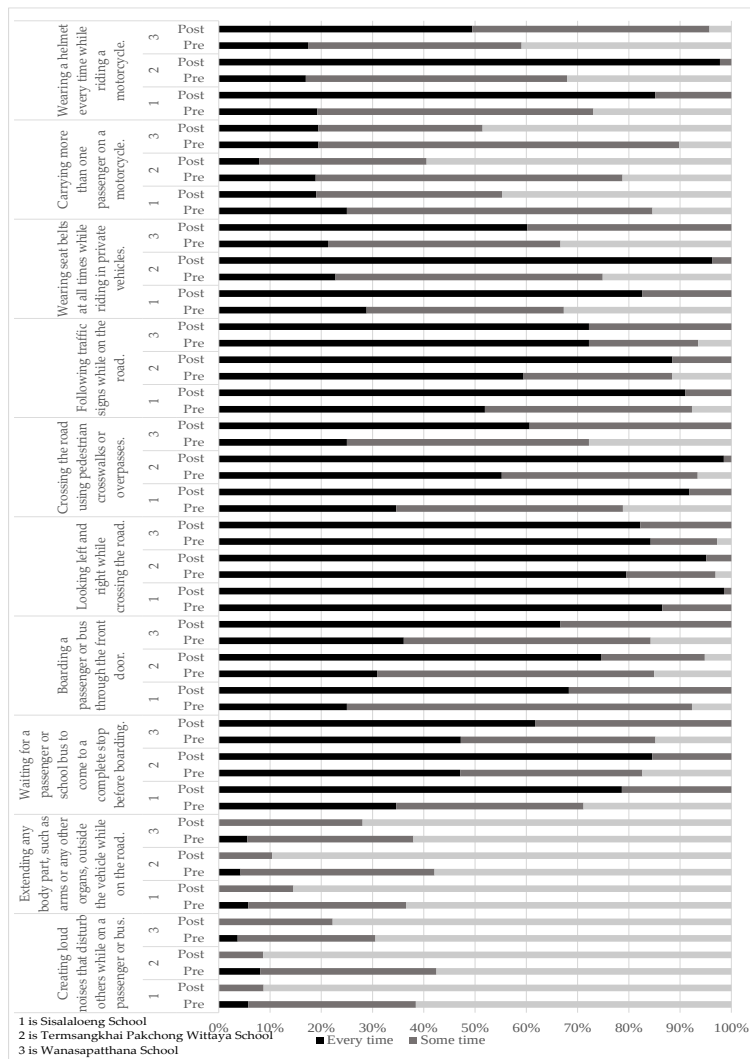


Figure 5. Safe Traffic Behaviors

of children consistently waited for school buses or designated buses, and after the training, the percentage increased to 74.97%. This represents an improvement of 31.99% in behavior. Concerning extending arms or body parts outside the vehicle while on the road, before the training, 61.14% of children engaged in this behavior, while after the training, the percentage increased to 82.31%. This represents an improvement of 21.17%. Finally, before the training, 62.84% of children exhibited the behavior of making loud noises that disturb others while on school buses or public buses, and after the training, the percentage decreased to 86.76%. This indicates an improvement of 23.92% in behavior shown in Figure 5.

Satisfaction towards the child safety training program

For the evaluation of satisfaction towards the traffic road safety for children training program, it was categorized into three sections: 1. Educational media, 2. Training Content, and 3. Educational Development Games. There were a total of 14 factors, as shown in Table 3. The evaluation criteria consisted of three levels based on the Likert scale (Alani, 2020), which are: 1. Very Satisfied,

ranging from 2.34 to 3.00, 2. Moderately Satisfied, ranging from 1.67 to 2.33, and 3. Dissatisfied, ranging from 1.00 to 1.66 (Nakraikhin and Klinmakphon, 2018). Based on the study's findings from 417 participants, it was found that the overall satisfaction towards the child safety training program was at a high level, with a mean score of 2.46 and a standard deviation of 0.42, as shown in Table 4.

When considering the category of educational media as a factor, it was found that the participants were very satisfied with all factors, including: 1. The teaching media (mean=2.47, SD=0.60), 2. The teaching media containing new and useful learning content (mean=2.55, SD=0.60), 3. The teaching media being easy to understand (mean=2.45, SD=0.61), 4. The teaching media being presented clearly (mean=2.46, SD=0.60), 5. The teaching media having clear and easily understandable audio (mean=2.45, SD=0.64), 6. The teaching media having clear and easy-to-read font style, size, and color (mean=2.45, SD=0.60). For the category of training content, participants were very satisfied with all factors, including: 7. Knowledge about crossing the road (mean=2.58, SD=0.58), 8. Knowledge about driving at

Table 4. Satisfaction towards the traffic road safety for the children training program

Item	Sisalaloeng School		Wanasaphatthana School		Termsangkhai pakchongwittaya School		Total		Result
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1. Educational media									
1. The teaching media	2.46	0.61	2.35	0.64	2.58	0.56	2.47	0.60	Very satisfied
2. The teaching media contains new and useful learning content.	2.52	0.64	2.54	0.56	2.58	0.63	2.55	0.60	
3. The teaching media is easy to understand	2.38	0.60	2.42	0.65	2.50	0.59	2.45	0.61	Very satisfied
4. The teaching media presents clear	2.50	0.64	2.41	0.57	2.49	0.62	2.46	0.60	Very satisfied
5. The teaching media have clear and easily understandable audio.	2.50	0.67	2.37	0.62	2.49	0.63	2.45	0.64	Very satisfied
6. The teaching media has clear and easy-to-read font style, size, and color.	2.48	0.64	2.43	0.55	2.46	0.62	2.45	0.60	Very satisfied
2. Training content									
7. Knowledge about crossing the road.	2.58	0.64	2.50	0.59	2.64	0.55	2.58	0.58	Very satisfied
8. Knowledge about driving at intersections.	2.44	0.70	2.52	0.54	2.58	0.62	2.53	0.60	Very satisfied
9. Knowledge about personal transportation.	2.37	0.74	2.36	0.61	2.42	0.72	2.39	0.68	Very satisfied
10. Knowledge about public transportation	2.44	0.67	2.39	0.55	2.45	0.59	2.43	0.59	Very satisfied
3. Educational development games									
11. Educational development games.	2.65	0.56	2.48	0.57	2.65	0.56	2.59	0.57	Very satisfied
12. Whisper game	2.38	0.66	2.46	0.62	2.40	0.69	2.42	0.66	Very satisfied
13. Bingo game (Traffic Sign)	2.25	0.76	2.39	0.60	2.29	0.71	2.32	0.68	Moderately satisfied
14. Simulated road game.	2.42	0.72	2.38	0.61	2.45	0.66	2.42	0.65	Very satisfied
Total							2.46	0.42	Very satisfied

intersections (mean=2.53, SD=0.60), 9. Knowledge about personal transportation (mean=2.39, SD=0.68) and 10. Knowledge about public transportation (mean=2.43, SD=0.59). For the category of educational development games, participants were most satisfied with the following factors: 11. Educational development games (mean=2.59, SD=0.57), 12. Whisper game (mean=2.42, SD=0.66), 14. Simulated Road game (mean=2.42, SD=0.65). However, in factor 13) the Bingo game (Traffic Sign) received a moderately satisfied rating (mean=2.32, SD=0.68).

Discussion

According to the diversity of students' learning experiences vary due to the current teaching methods, and learning solely from textbooks may not effectively meet the diverse learning abilities of students. This can be a hindrance to learning in the classroom, prompting teachers to seek better teaching approaches that foster greater student involvement, ultimately influencing their ability to apply knowledge in their daily lives. This study utilizes Case-Based Learning (CBL) as an applied approach, using real-world case studies in various branches of engineering through safety and traffic engineering curricula. After employing statistical hypothesis testing, such as paired t-test, to assess the suitability of the statistical test, a paired t-test example is used to compare learning outcomes between pre-training and post-training assessments, which correlates with students' ability to succeed in the curriculum (Kaddoura, 2011; Tayem, 2013; Vora and Shah, 2015; Ali *et al.*, 2018; Ariyarit *et al.*, 2023; Wang *et al.*, 2023; Wu *et al.*, 2023). Moreover, from a satisfactory perspective, students tend to exhibit a tendency to modify their traffic behavior and enhance safety practices in a positive direction.

Therefore, it is crucial to consider teaching strategies that incorporate real-world case studies, including Case-Based Learning (CBL), along with active learning strategies, for implementation in the classroom. Furthermore, the study found that overall, the road safety training program received very satisfaction from the participants. This was observed in the following aspects: 1. Media for teaching and learning, which involved the use of clear and easily understandable motion graphics to convey knowledge. This approach received very satisfied in all factors and was consistent with studies that indicated positive attitudes and satisfaction among learners when knowledge was conveyed through motion graphics, as it stimulates active participation in learning and elicits positive emotional responses from learners (Khalid *et al.*, 2010; Donkor, 2011; Yakovleva and Goltsova,

2016; Choe *et al.*, 2019; Hapsari and Hanif, 2019; Ardaningsih and Adnyayanti, 2022; Liando *et al.*, 2022), 2. Content in the training, which covered road users including pedestrians, private vehicle users, and public transportation users. This category received very satisfaction from the participants in all factors. 3. Educational development games, which involved the transfer of road safety knowledge through game activities that were suitable for the participants. When considering satisfaction factors, all games received great satisfaction except for the Bingo Game, which received moderate satisfaction. This was because the Bingo Game was a knowledge-testing game involving various types of road signs in Thailand and internationally, which made it more challenging to understand and required more time to play. As a result, participants might not have been as interested as they should have been. However, when considering the overall picture of the educational development games, it received a very satisfaction from the participants, which aligned with the literature review of 670 articles that concluded that the use of augmented reality and gamification in education, supported by suitable technology, improved learning processes, changed behaviors, positive attitudes, and positive emotions, leading to learner satisfaction with the curriculum (Renaud and Suissa, 1989; Struck and Teasdale, 2008; Lampropoulos *et al.*, 2022).

From the results, it is clear that this curriculum is highly effective in enhancing road safety learning skills. Simultaneously, it provides a fun and engaging experience for children. Based on the aforementioned importance, it can be confirmed that the Thai education system should incorporate road safety content into its curriculum. The lesson plans from this study can be adapted to fit the context of Thai educational curriculum for children, aiming to increase their awareness of road safety and promote safe road usage behaviors. This aligns with previous studies indicating that addressing road safety issues cannot be expedited, but early intervention yields long-term benefits efficiently (Di Pietro and Malaysia, 2009).

Limitations and further research

This study lies in its focus on primary school students as the sample group for disseminating the traffic road safety curriculum. However, to ensure that road safety behaviors become ingrained or become integral parts of children's culture and practices, it is advisable to initiate the dissemination of road safety education with children from primary school through secondary school. This comprehensive approach would enable children to

understand traffic situations, leading them to develop correct and safe traffic behaviors in accordance with traffic regulations.

Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Suranaree University of Technology (COA No.41/2565, 16 June 2022).

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