A Study of Students' Perceptions toward the Use of Gamification in Traffic Safety Education in Ho Chi Minh City, Vietnam

Hoai Nguyen PHAM[1]*, Ariane CUENEN[2], Tu Anh TRINH[3], Geert WETS[4], Davy JANSSENS[5]

[1,3] *Institute of Smart City and Management, University of Economics Ho Chi Minh City, Ho Chi Minh City, Vietnam*

[2,4,5] *Transportation Research Institute (IMOB), Hasselt University, Hasselt, Belgium*

*Corresponding Author: hoaipm@ueh.edu.vn

Abstract

High school students are overrepresented in traffic crashes compared to other subgroups of students in Vietnam. Traffic safety education can increase students' knowledge and skills, but it faces issues regarding psychological factors including engagement, motivation, and attitude. Gamification has great potential to tackle these issues. This research aimed to explore the effectiveness of traffic safety education, through a gamified platform, on students' knowledge and skills about traffic safety and their engagement, motivation, and attitude towards traffic safety education before and after following this platform. An online questionnaire conducted among 223 students in March of 2019 shows that the platform is not only advantageous to measure students' learning outcomes regarding traffic safety knowledge and skills, which are categorized based on their socio-demographic characteristics, but also generates engagement, motivation, and positive attitudes towards traffic safety education. In an effort to increase the effectiveness of traffic safety education, gamification is suggested as an innovative and effective teaching method for traffic safety education in Vietnam.

Keywords: attitude, engagement, gamification, motivation, traffic safety education

1. Introduction

Traffic crashes have been the primary cause of mortality for children and young adults up to the age of 19 (World Health Organization [WHO], 2015). According to Vu and Nguyen (2018), in Vietnam, traffic crashes in general have decreased over the years, but in the group of high school students, they have increased. More than 70% of traffic accidents involve high school students (aged between 16 and 18 years) who use bicycles, electric bicycles, mopeds, or even (illegally) motorbikes (Vu & Nguyen, 2018). The number of traffic accidents involving this group was eight to nine times higher than the mortality rate for the same group in developed countries like Belgium, Italy, and Greece, and it was roughly five times higher than the country's average death rate for all ages (Vu & Nguyen, 2018). Males were much more involved in crashes than females, 85.8% versus 14.2%, respectively (Vu & Nguyen, 2018). Wrong-lane running (23.6%), incorrect direction change (11.1%), speeding (8.9%), overtaking (6.7%), and risky road crossing (6.2%) were the five most risky driving behaviors among Vietnamese students (Vu & Nguyen, 2018).

A variety of preventive measures have been applied in the traffic safety sector, such as regulation and sanction (Alonso, Esteban, Montoro, & Useche, 2017; Zhang, Jing, Sun, Fang, & Feng, 2019), communication and media campaigns (Staton et al., 2016; Zatoński & Herbeć, 2016), and traffic safety education (Alonso, Esteban, Useche, & Colomer, 2018; Goniewicz, Goniewicz, Pawłowski, & Fiedor, 2016; Kitamura, Hayashi, & Yagi, 2018; Y. Y. Lee, Fang, Weng, & Ganapathy, 2018; Riaz, Cuenen, Dhondt, et al., 2019). Since students prefer "cool" things to safety (WHO, 2015), they are not always interested in traffic safety education when traditional teaching methods such as handbooks are used (Huizenga, Admiraal, Akkerman, & Dam, 2009; Li, 2015). In the age of information technology, online learning is effective in improving students' efficiencies compared to offline learning (Malas & Hamtini, 2016). However, one of the biggest challenges of online learning is how to engage and motivate students in their learning process (Malas & Hamtini, 2016). Gamification, defined as the use of game design elements in non-game contexts (Deterding, 2012), shows its great potential to motivate, engage, and capture students' imaginations and make their online learning more interesting (Dunwell et al., 2014; Riaz, Cuenen, Janssens, Brijs, & Wets, 2019).

In Vietnam, traffic safety education has been introduced as a non-mandatory subject in high schools for many years. However, little was known about students' motivation, positive attitude, and engagement towards traffic safety education. Moreover, the potential for gamification in traffic safety education is still uncovered in Vietnam. Considering this, the overall objective of the present study is to propose an innovative learning method for traffic safety education targeting Vietnamese high school students. To this end, the specific objectives are (1) to compare scores between familiar and unfamiliar traffic situations, between boys and girls, between participants who have been involved in crashes and their counterparts who have not been involved in crashes, and between participants who received a fine for violation of traffic rules and their counterparts who did not receive a fine for violation of traffic rules; and (2) to explore the effect of traffic safety education, through a gamified platform, on their engagement, motivation, and attitude.

2. Literature Review

2.1 Psychological Factors Enhancing the Effectiveness of Traffic Safety Education

2.1.1 Attitude. Although traffic knowledge and skills play important roles in improving students' behavior in traffic, they are not considered strong predictors of actual behaviour (Thomson, Tolmie, Foot, & McLaren, 1996; Zeedyk, Wallace, Carcary, Jones, & Larter, 2001). The degree to which a person has a positive or negative opinion of the activity, however, may be defined as attitude, which is seen to be a stronger predictor of behavior (Ajzen, 1991). According to McCartt, Mayhew, Braitman, Ferguson, and Simpson (2009), there are two dimensions of attitude: affective attitude and instrumental attitude. Affective attitude refers to how one feels about the behavior, while instrumental attitude is associated with one's thoughts, beliefs, and factual knowledge about the behavior. For instance, affective attitude describes whether a person is interested in the behavior or not, but instrumental attitude describes whether a person thinks the behavior will benefit them (Lowe, Eves, & Carroll, 2002).

Attitude is a strong predictor of actual behaviour (Fishbein & Ajzen, 2011), especially for children and young people (Alonso, Esteban, Useche, & Manso, 2016). Boys are more likely than females to have unfavorable views regarding traffic rules (Kelley-Baker & Romano, 2010). The attitude of the driver, which transforms information into action, is one of the key elements determining driving behavior (Jafarpour & Rahimi-Movaghar, 2014).

2.1.2 Engagement. Education is dealing with the issues of students' engagement (Malas & Hamtini, 2016) and motivation (J. J. Lee & Hammer, 2011). When it comes to engagement, it refers to "willingness, need, desire, and compulsion to participate in and be successful in the learning process promoting higher level thinking for enduring understanding" (Bomia et al., 1997). Engagement is also characterized by vigor, dedication, and absorption (Schaufeli, Salanova, González-Romá, & Bakker, 2002). Vigor is a term used to describe a strong amount of mental fortitude and energy. A strong sense of commitment to the task at hand is a sign of dedication. The state of being happily absorbed in one's task is known as absorption (Akanni, 2019; Bakker, 2011). The three dimensions of engagement could be considered to have separate constraints while also being closely associated with each other (Tuominen-Soini & Salmela-Aro, 2014).

Engagement could foster student performance by enriching their learning experience. Students that are actively immersed in their studies experience joy as they complete their tasks (Bomia et al., 1997. Engagement could be related to learning outcomes because a lower level of engagement among students was correlated with a very small amount of knowledge (Alvarez, 2002. Paying sufficient attention to engagement helps educators and policymakers design effective teaching and learning methods in order to advance the curriculum (Bovill & Bulley, 2011). A pedagogy linking students' learning experiences and their real-life experience could gain authentic student engagement (Zyngier, 2007).

2.1.3 Motivation. Motivation is "the ability to drive and change behaviour" (Xu, 2011). To be motivated is to feel compelled to take action (Ryan & Deci, 2000). In the Self-Determination Theory (Deci & Ryan, 2013), motivation is explained in two ways, including extrinsic motivation and intrinsic motivation. They are differentiated by the reasons and goals that cause an action (Ryan & Deci, 2000). Extrinsic motivation refers to unintentional behaviors that are motivated by outside pressures and factors. When someone is motivated by their own intrinsic desires rather than a potential reward, they have a higher propensity to participate in an activity. For instance, a student who is genuinely driven by a subject is inspired to study because it is entertaining or challenging rather than because of pressure or encouragement from professors or family.

Compared to extrinsically motivated students, students who engaged in an intrinsically motivated activity felt more active (Bomia et al., 1997) and confident about their abilities to learn new materials; they were also more likely to accomplish duties as instructed and to retain information for a long period of time (Dev, 1997). Nonetheless, for students who were not enthused and passionate about their learning activities, extrinsic motivation was still an excellent place to start (Serin, 2018). In the long run, intrinsic motivation should be given much attention by students by suggesting self-selected learning activities (Lowman, 1990) and innovating teaching contents (Serin, 2018).

It was well acknowledged that one of the key elements driving engagement was motivation. (Haywood et al., 2009; Reeve, 2012; Walker, Greene, & Mansell, 2006). When students were more motivated to learn, they were more likely to be engaged (K.-J. Kim & Frick, 2011). As a result, they showed better academic performance and learning outcomes (Lin, Hung, & Chen, 2019; Pintrich, 2003). Especially for students aged sixteen and over, lack of motivation was considered a personal barrier preventing them from engaging in learning activities (Haywood et al., 2009). In traffic safety education, online learning in the form of gamification (S. Kim, Song, Lockee, & Burton, 2018; Riaz, Cuenen, Janssens, et al., 2019) and games has been applied to enhance students' motivation and engagement (Dunwell et al., 2014).

2.2 Potentials of Gamification to Foster Psychological Factors in Traffic Safety Education

Gamification is the application of game design elements in situations other than games (Deterding, 2012; Kapp, 2013; Simões, Redondo, & Vilas, 2013). Kapp (2013) divided gamification into two categories: content gamification and structural gamification. Content gamification is the use of game elements like story elements or challenges to make the educational content more game-like without turning it into a game, as opposed to structural gamification, which refers to the use of game elements like points, badges, levels, and leaderboards without any changes to the educational contents. Simões et al. (2013) claimed that adding gaming aspects to educational programs raised student engagement. Gamification has the ability to greatly enhance student motivation, engagement, and inventiveness while also making learning more enjoyable (J. J. Lee & Hammer, 2011). Poondej and Lerdpornkulrat (2016) showed that students who experienced gamified courses expressed a greater interest in attending the course compared to students attending regular courses. When compared to offline learning, gamified online learning activities produced higher levels of engagement.

Lieberoth (2015) discovered that presenting an activity as a game may be just as successful as incorporating game features. Also, according to this study, the use of aesthetic game design components may help motivate players. Hanus and Fox (2015) demonstrated that delivering prizes in the form of coins and badges and fostering competitiveness and social comparison with a leaderboard caused declining motivation. The study also showed the detrimental impacts of rewards on intrinsic motivation. Mekler, Brühlmann, Tuch, and Opwis (2017)'s research on the relationship between the two aspects of motivation showed that while individual game components like points, levels, and leaderboards were extrinsic motivators and greatly impacted performance, they had no effect on intrinsic motivation. Also, this study discovered that incentives increased extrinsic drive while decreasing intrinsic motivation. It is essential to take into account the kind of user incentive that is needed in order to effectively design for a "game" experience. When applied alone, levels or badges were extrinsic motivators, but when they were attached to a profile or character, they could be viewed by other users and were a part of their identity. Users may feel a sense of accomplishment from badges presented as part of a character's identification, and when social standing is based on them, it may inspire them to keep playing (Simões et al., 2013).

3. Methodology and Data

3.1 Participants

A total of 302 students joined the research (44.4% boys, mean age = 16, standard deviation = 0.53). However, only 223 respondents (47.1% boys, mean age = 16, standard deviation = 0.56) finished all modules of the gamified e-learning platform. Hence, the drop-off value was 26.16%.

Seventy percent of children commuted alone to school. None of the respondents possessed a driver's license at the time the questionnaire was being completed. Nonetheless, as shown in Table 1, 34.5% of respondents commuted to school alone on a motorbike (>50 cc) despite not being of legal age to do so. A moped (<50 cc) was utilized by 14.8% of students, followed by bicycles (11.7%), electric bicycles (4.5%), and walking (4.5%). 30% of those surveyed either used the bus or rode pillion in their parents' cars to go to and from school. The percentage of responders who have been in accidents on the road is about 42%. In addition to this, there were 2.69% of pedestrians, 2.69% of electric cyclists, 3.59% of cyclists, 8.52% of moped drivers, 10.76% of motorcyclists, and 13.90% of pillion passengers on their parents' motorbikes. In contrast to the 18% of guys who were involved in accidents, 24% of girls had similar experiences. Nonetheless, pillion passengers in road crashes were mostly female (10.76%), followed by moped drivers (6.28%) and electric bikers (3.59%). Boys were involved in collisions in the majority of forms of transportation as passengers or drivers, including moped drivers (4.93%), motorcyclists (4.48%), cyclists (3.59%), and pillion passengers (3.14%).

Table 1. Socio-demographic information of respondents

Variable	Level	Frequency	Percentage
Gender	Boy	105	47.1%
	Girl	118	52.6%
Driving license for motorcycle	Yes	0	0
	No	223	100%
Accident involvement	Yes	94	42%
	No	129	58%
Traffic fines	Yes	10	4.5%
	No	213	95.5%
Transport mode	Motorcycle (illegally)	77	34.5%
	Bicycle	26	11.7%
	Moped	33	14.8%
	E-bicycle	10	4.5%
	Walking	10	4.5%
	Others	67	30%

Infractions including driving without a license, turning without signaling, not wearing a helmet, running red lights, and veering into the wrong lane resulted in fines for 3.15% of motorcycle riders. For moped riders and electric bikers, this proportion was cut to 0.90% and 0.45%, respectively.

3.2 Developing the gamified platform for Vietnam students

A gamified platform is described as a set of web-based tools that integrate game mechanics and components to enable the development, distribution, organization, communication, and assessment of material (Malas & Hamtini, 2016). An interactive platform that was created in Dutch by the Transportation Research Institute (IMOB) at Hasselt University was modified for use in Vietnam (Figure 1). By employing engaging questions about traffic conditions in students' home towns and other places, this platform (initially designed with cyclists between the ages of 9 and 13) is intended to increase traffic awareness. This is one of the gamified online platforms that used relevant video from the target audience's perspectives, namely from their own location, covering a variety of traffic safety education topics (knowledge and skills like situation awareness, risk detection, and risk management).

Modules were created from these components. Knowledge of traffic law was the focus of the first module. Situation awareness was taken into consideration in the second module. The third and fourth modules focused on how children perceive risks through risk identification and the appropriate reaction to risks (risk management). Quizzes from the earlier modules were picked at random for the final module. When students completed each module's questions, the answers were given to them along with brief explanations. Each module has two submodules, with the exception of the first and last ones. The second module featured questions about the nearby city that the students had never visited, whereas the first module had questions about the city where the students were residing.

A camera placed on a bicycle captured traffic events from the riders' perspectives in order to gather footage for the platform. The platform featured game components including points from 0 to 100, levels from 0 to 10, and badges including white, bronze, silver, and gold. The platform's construction is shown in Figure 2.

The gamified platform was adapted to the local conditions of Ho Chi Minh City (HCMC) and Bien Hoa City (BHC). While BHC is HCMC's neighbor, HCMC is the students' home city. However, this Vietnamese platform version focused on older students, ages 16 to 18, who utilize bikes, electric cycles, and mopeds.
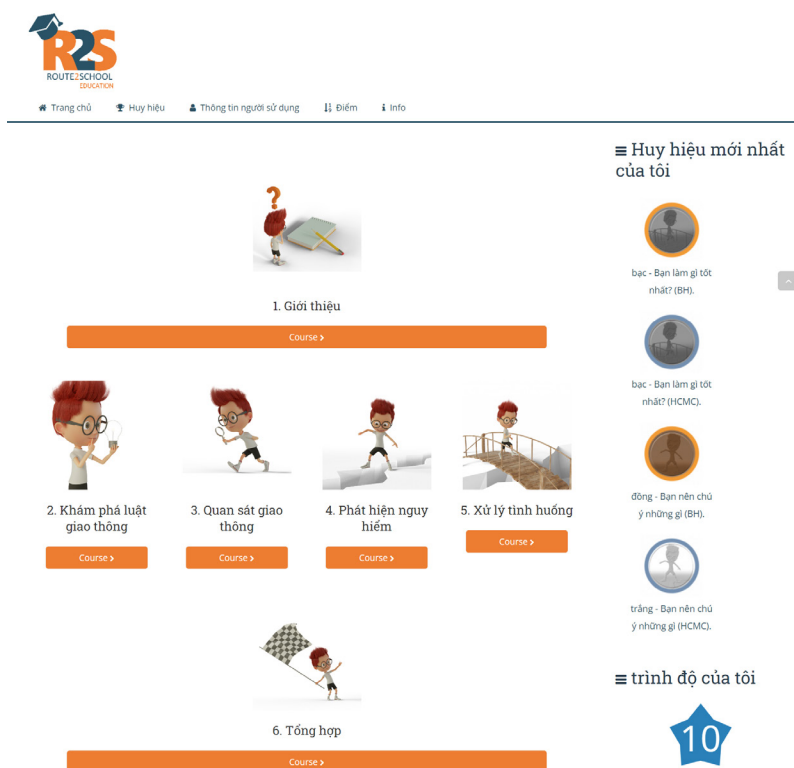

Figure 1 A gamified platform for Vietnamese students

The original platform's structure is carried over to the adapted one (6 modules. Due to the importance of traffic knowledge and skills for youths who ride on roads (such as situation awareness, danger identification, and risk management), they are still maintained. Quizzes of knowledge and abilities based on the Vietnam Traffic Law and the five key concerns with driving (poor lane changing, bad direction changing, speeding, overtaking, and dangerous road crossing. From the viewpoint of the target group, footage was gathered. Based on the responses, automated feedback was produced. The customized platform preserved game features like points (0–100%, stages (10 levels, and badges (white, bronze, silver, and gold.

With the exception of the introduction and the last module (BHC, each of the remaining modules is broken down into subsections regarding HCMC and BCH. The final module, which students learned about in the other modules, has 20 questions, with each submodule having 10 questions. Prior to conducting the research, the platform underwent a pilot test with five students to determine its viability.

3.3 Development of the online questionnaires

Two online surveys were created to investigate high school students' opinions on the motivation, engagement, and attitude aspects of traffic safety instruction before (pre-questionnaire) and after (post-questionnaire) using the platform. Each questionnaire consisted of four sections: (1 questions about social-demographic characteristics including gender, transport modes, motorcycle driving license, involvement of traffic crashes, and traffic fines; (2 a 9-item motivation scale, including intrinsic motivation (5 items) and extrinsic motivation (4 items), was adapted from the Academic Motivation Scale (Vallerand et al., 1992); (3) a 6-item attitude, including affective and instrumental dimensions (3 items per dimension), is developed by (Ajzen, 1991); (4) a 14-item engagement
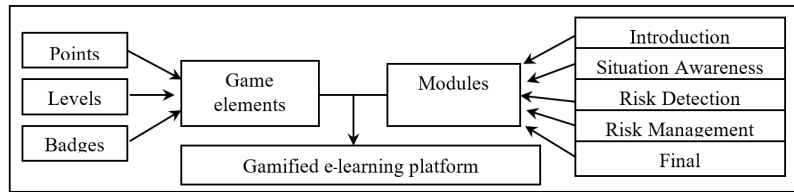
scale, including subscales of vigor (4 items), dedication, and absorption (5 items per dimension), is adapted from the Measurement Scale of Engagement (Schaufeli et al., 2002); and (5) evaluation of effectiveness of traffic safety education (9 items). Only the post-questionnaire contained Section 5. A 7-point Likert-type scale with a range of 1 (strongly disagree) to 7 (strongly agree) served as the anchor for each scale's items, which were then translated into Vietnamese. Higher scores represent higher engagement, motivation, and attitude. The questionnaires went through several piloting stages, where they were discussed with school authorities and tested on a pilot sample of five students.

3.4 Data collection and analysis

To recruit students, the principal researcher visited several high schools in HCMC and had meetings with the schools' principals to explain the research's objectives in March of 2019. One principal allowed the study to be conducted, and publicly announced the study to students, and asked them for voluntarism. Students were recruited randomly based on their availability. Before the study, the students' written informed consent was acquired. During the pre-questionnaire, they answered the online questionnaire (without Section 5). They then continued with the gamified platform's education on road safety. In each module, they started answering questions in the submodule about HCMC, then continued to the submodule about BHC. During the post-questionnaire, students who finished the platform answered the online questionnaire, including the part about the evaluation of the platform (i.e., Section 5).

The research was conducted in the computer room at their school in three days (two hours per student, 30 students at one time due to limitations on the number of computers), under the supervision of the principal researcher and two teachers of the school. The principal researcher undertook an internal training process to efficiently manage and become familiar with the steps of data collection.

Regarding analysis of the platform, descriptive statistics were conducted to explore the scores among modules and submodules, between genders, between groups involving traffic crashes and uninvolving traffic crashes, and between groups (1) including students who violated traffic rules and got traffic fines in the past and (2) including students who violated traffic rules in the past but did not get traffic fines for it. For each group, one-way analysis of variance (ANOVA) was used to identify differences. Regarding the analysis of the online questionnaires, descriptive statistics were conducted to explore the engagement, motivation, and attitude towards traffic safety education with a gamified e-learning platform as an intervention. Principal component analyses were used to test the validity of this scale at both the pre-questionnaire and post-questionnaire. During the pre-questionnaire, the overall Kaiser-Meyer-Olkin (KMO) was used to establish the suitability of the data for factor analysis. Cronbach's alpha was used to test the reliability of the measurement scales. The data was processed using Statistical Package for the Social Sciences (SPSS) (IBM Statistics 22).

4. Results

4.1 Results from the platform

The mean scores for modules and submodules are displayed in Table 2. Greater mean scores indicated knowledge, situation awareness, danger identification, and risk management at higher levels. The mean scores for the various modules varied significantly (F(1,221) =4.192, p<0.05). In comparison to the knowledge, situation awareness, and risk detection modules, the scores in the risk management module were considerably higher (p<0.001). The submodule on risk management in BHC had the highest mean score out of all the submodules. Submodules about BHC had higher mean scores overall (79.31).

Table 3 shows the score difference between boys and girls in modules. The mean scores for boys and girls did not significantly differ from one another (F(1,221) = 1.35, p = 0.236).

Table 2. Mean scores and standard deviations (SD) by modules and submodules

Module	City	Mean (SD)
Knowledge	HCMC	57.94 (19.10)
	BHC	68.94 (20.07)
	Total	63.48 (8.87)
Situation awareness	HCMC	39.45 (24.87)
	BHC	48.92 (28.90)
	Total	44.03 (11.92)
Risk detection	HCMC	73.05 (16.94)
	BHC	79.04(13.64)
	Total	76.11 (8.91)
Risk management	HCMC	77.94 (21.14)
	BHC	79.31 (19.5)
	Total	78.49 (5.47)

Table 3. Mean score by gender

Module	Gender	Mean (SD)
Knowledge	Boy	62.68 (9.38)
	Girl	63.05 (8.42)
	Total	62.87 (8.87)
Situation awareness	Boy	43.50 (10.53)
	Girl	44.75 (13.05)
	Total	44.16 (11.92)
Risk detection	Boy	76.64 (8.49)
	Girl	75.40 (9.28)
	Total	75.98 (8.91)
Risk management	Boy	79.07 (4.24)
	Girl	78.22 (6.35)
	Total	78.62 (5.46)

The score difference between students who experienced traffic crashes and those who have not experienced traffic crashes is shown in Table 4. Regarding the mean module scores, these two groups' variances were substantial, F(1,221) =4.17, p<0.05. When compared to students who had not been in any crashes, the scores of students who had been involved in accidents rose dramatically.

Table 5 shows the score difference between two groups: group (1), which includes students who violated traffic rules and got traffic fines, and group (2), which includes students who violated traffic rules but did not get traffic fines. The mean scores of group (1) differed significantly from group (2), F(1,221) =5.28, p<0.05. The grades of the studen ts in group (1) were much higher than the grades of group (2).

Table 6 displays descriptive information from the platform evaluation. On this scale, there were ten statements. The statement "I found the platform interesting" gained the highest mean (4.69 out of 7). Around 72% of students thought this platform was intriguing. Only 7.63% of students said they disagreed with this. The statement "I found the questions in HCMC easier than BHC" has the lowest mean (2.34 out of 7) recorded. In general, this statement was endorsed by 62% of students.

Almost 60.09% of students preferred the levels that were included on the platform. When questioned about the badges, the same percentage was discovered. A total of 64.13% of students reported that "it was simple to access the platform" when it came to platform access. Almost 59% of students said they strongly agreed with recommending the platform to others.

Over 52% of students thought the questions were challenging, and nearly 48% said the final module was challenging. Almost 71% of students said that they did not spend an excessive amount of time using the platform to study.

Table 4. Mean score by traffic accidents

Module	Traffic accident	Mean (SD)
Knowledge	No	56.65 (5.62)
	Yes	67.33 (8.05)
	Total	62.87 (8.87)
Situation awareness	No	39.36 (6.26)
	Yes	47.59 (12.93)
	Total	44.16 (11.92)
Risk detection	No	74.60 (5.49)
	Yes	76.98 (10.62)
	Total	75.98 (8.91)
Risk management	No	77.74 (4.86)
	Yes	79.25 (5.80)
	Total	78.62 (5.46)

Table 5. Mean score by traffic fine

Module	Traffic fine	Mean (SD)
Knowledge	Yes	73.93 (6.77)
	No	60.53 (7.37)
	Total	62.87 (8.87)
Situation awareness	Yes	48.75 (13.99)
	No	43.18 (11.23)
	Total	44.16 (11.92)
Risk detection	Yes	79.45 (10.03)
	No	75.25 (8.51)
	Total	75.98 (8.91)
Risk management	Yes	80.42 (5.93)
	No	78.23 (5.3)
	Total	(5.46)

Table 6. Evaluation of the platform

No.	Item	Mean	SD
1.	I found the platform interesting.	4.69	1.52
2.	I liked the levels.	3.34	1.53
3.	I liked the badges.	3.50	1.60
4.	I found the questions in HCMC easier than BHC.	2.34	1.58
5.	It was easy for me to access the platform.	3.43	1.61
6.	I would recommend the platform to others.	4.09	1.52
7.	I found the questions on the platform difficult.	3.07	1.59
8.	I found the 'finale' difficult.	3.05	1.78
9.	The time investment was too large.	2.18	1.60

4.2 Results from the online questionnaire

The validity of this measure was examined using principal component analysis both before and after the questionnaire. Pre-questionnaire results showed that Bartlett's test of sphericity was statistically significant for p < 0.05 [χ2 (139) = 610.67], with an overall Kaiser-Meyer-Olkin (KMO) of 0.85. A total of 67% of the variation was explained. For the post-questionnaire, Bartlett's test of sphericity was statistically significant for p < 0.05 [χ2 (406) = 785.35], with an overall KMO of 0.94, and the total explained variance was 61%, for which the factor structure replicated the one before the intervention. The Cronbach's alpha reliability of the engagement, motivation, and attitude scales was 0.95, 0.95, and 0.92, respectively.

Table 7 presents descriptive statistics of engagement, motivation, and attitude. The lower the mean score, the more engagement, motivation, and attitude students had. During the pre-questionnaire, the means tended to the side of disagreement. In contrast, the means were more on the positive side during the post-questionnaire. This indicated that students were more engaged, motivated, and had a positive attitude after learning on the gamified e-learning platform.

Table 7. Descriptive statistics of measurement scale

Measurement scale		Pre-questionnaire		Post-questionnaire	
		Mean	SD	Mean	SD
Attitude	Affective attitude	2.65	1.49	4.04	2.12
	Instrumental attitude	2.21	1.57	5.33	1.85
	Total	2.43	1.52	4.69	1.98
Motivation	Intrinsic motivation	2.99	1.64	4.91	1.85
	Extrinsic motivation	3.05	1.77	4.84	1.97
	Total	3.02	1.71	4.88	1.89
Engagement	Vigor	2.97	1.79	5.14	1.83
	Dedication	3.15	1.50	5.08	1.66
	Absorption	2.81	1.56	4.53	1.85
	Total	2.98	1.62	4.91	1.78

5. Discussion

Regarding participants, a total of 302 students signed up for the platform, but only 223 of them completed it, representing a drop-off rate of 26.16%. All study disciplines have reported cases of questionnaire dropout, and there is a correlation between this rate, the need for online reminders, and the proportion of infrequent internet users who are more deliberate in their online behavior (Rübsamen, Akmatov, Castell, Karch, & Mikolajczyk, 2017). Also, the current study was carried out when students were getting ready for their exams in the second semester of the school year. Although traffic safety education is not mandatory in Vietnamese high schools, several students thought it would be more beneficial to spend their time reviewing other subjects' lectures rather than completing the program.

Regarding participants' mode of transport use, the results showed that high percentages of traffic crashes among Vietnamese students were found in groups of moped drivers and motorcyclists (Le et al., 2023). According to the Vietnam Traffic Law, adolescents are not allowed to obtain a driving license before the age of 18. However, from the age of 15, it is allowed to drive mopeds (small motorcycles with a cylinder capacity under 50 cm³) without a driving license. Although they did not own a motorbike driving license, most of the students used motorbike illegally by themselves. This implied that the underestimation of traffic laws existed not only among students but also among their parents since motorbike use among students gets permission from their parents. Beside that, a group of students faced traffic crashes when being pillion passengers on their parents' motorbikes, indicating reckless driving could be found among parents. Therefore, education and training on traffic safety should be conducted for parents (Alonso, Useche, Valle, Esteban, & Gene-Morales, 2021).

Besides that, schools should put their efforts into educating students to obey traffic laws, especially when using mopeds to go to school.

The main objective of the study is to examine an innovative teaching method for Vietnamese high school students to enhance their traffic insights. In this regard, two specific objectives were identified, including (1) to compare scores between familiar and unfamiliar traffic situations, between boys and girls, between participants who have been involved in crashes and their counterparts who have not been involved in crashes, and between participants who received a fine for violation of traffic rules and their counterparts who did not receive a fine for violation of traffic rules; and (2) to explore the effect of traffic safety education, through a gamified platform, on their engagement, motivation, and attitude. While the specific objective (1) could be found from the results of the platform, the specific objective (2) was achieved from the results of the online questionnaire.

Regarding the results from the gamified platform, significant differences in scores were found among modules and submodules. In particular, the module of risk management witnessed the highest mean score because students experienced this module most after the modules of knowledge, situation awareness, and risk detection. On the platform, they could learn from their mistakes and gain knowledge and skills from module to module. Regarding mean scores in submodules, despite the fact that all students reside in HCMC, submodules regarding BHC had better scores. The cause was that students initially encountered the HCMC submodules before moving on to the BHC submodules. They received explanations after responding to each question at HCMC, and they also learned from their errors. Therefore, although students probably were more familiar with HCMC, they achieved better results in submodules about BHC. According to DaCoTA (2012), the fourth stage of development, known as the formal operational level, is for students who are 12 years old and older. They can recognize, evaluate, and avoid hazards at this stage, and they have the capacity for abstract thought. They can thus comprehend complicated driving laws and put them into effect even in unfamiliar conditions. They may benefit from this since it is crucial for a child's growth not just to be exposed to their own surroundings but also to distant areas like neighboring municipalities. (Spencer & Woolley, 2000). Knowing about the traffic insights in HCMC and BHC enabled them to travel more safely.

Other results from the gamified platform showed significant differences in scores between students involve in traffic crashes and students not involve in traffic crashes. Accordingly, the scores for students who were involved in traffic crashes were higher than for their counterparts who were not involved in traffic crashes. Inexperienced road users tend to be involved in a higher number of road accidents compared to their experienced counterparts (McCartt et al., 2009). After road accidents, they may gain traffic insights from their mistakes on the road. However, knowledge does not directly transfer to behaviours (Zeedyk et al., 2001). Moreover, traffic safety knowledge acquisition through real-life experience should not be encouraged because human lives may be seriously damaged, ruining efforts to enhance traffic safety, especially for students who are the next labor generation in countries.

Another result that shows a significant difference in scores was found between group (1), which includes students who violated traffic rules and got traffic fines, and group (2), which includes students who violated traffic rules but did not get traffic fines. Higher scores were found in group (1), indicating that traffic fines are considered a form of enforcement that governments have used to keep their residents from traffic violations (Elvik, 2016). Besides, Alonso et al. (2017) found that traffic fines have an educational function from the perspective of traffic offenders. In this sense, getting fines from the police could improve traffic insights for the offenders from an educational point of view. However, results showed that only a minority of Vietnamese high school students got traffic fines due to their traffic violations. This means only a small number of students could be educated and gain traffic insights through traffic fines. Moreover, students' lives may be damaged during the stage of traffic violations prior to the occurrence of traffic fines.

When it comes to gender, boys and girls did not have significantly different mean scores across modules or submodules (Riaz, Cuenen, Janssens, et al., 2019). Riaz, Cuenen, Janssens, et al. (2019) indicated that there was no difference in gender among familiar and unfamiliar traffic situations. For a specific behaviour such as crossing streets, gender was also not considered a significant factor in achieving different results regarding behaviours among children (Albert & Dolgin, 2010).

The platform received positive evaluations from students. They found that questions, especially in the final module, were not too difficult because these questions were selected randomly from the other modules. The majority of students disagreed that HCMC questions were simpler than BHC ones, although all of them live in HCMC and probably have never been to BHC. Children in residential cities encountered more hazardous traffic conditions in their surroundings, yet it was difficult for them to put their knowledge to use in those circumstances (Spencer & Woolley, 2000). Students also admitted that the platform was user-friendly and time-consuming when learning on it. Students found the platform interesting because of its levels and badges. Although levels were a popular and widely used gamification concept, they served just as a reward for task completion and may not have increased learning capabilities (Goehle, 2013). The use of badges as a visible indicator of goal accomplishment was acknowledged (Werbach, 2014). The use of badges proved beneficial for keeping students motivated and involving them in their learning. Students were motivated to strive toward goals by earning badges. Using badges in the classroom encouraged students to study harder. (Santos, Almeida, Pedro, Aresta, & Koch-Grunberg, 2013).

With respect to the results from the online questionnaire, the effect of traffic safety education through a gamified e-learning platform on their engagement, motivation, and attitude was found. During the pre-questionnaire, students were asked to indicate how they experienced their traffic safety education in terms of motivation (intrinsic and extrinsic motivations), attitude (affective and instrumental attitudes), and engagement (vigor, dedication, and absorption). Low levels of motivation, engagement, and attitude were found among students. Regarding motivation, the results highlighted that students had extrinsic motivation during the pre-questionnaire. They somewhat disagreed on the presence of intrinsic motivation. Based on the questionnaire, respondents admitted that they were extrinsically motivated toward traffic safety education because they would like to demonstrate themselves to be intelligent people who could succeed in traffic safety education. However, they did not experience pleasure and satisfaction when discovering new things or broadening knowledge in traffic safety education (Williams, Preusser, & Ledingham, 2009).

When it came to attitude, the results showed that both affective and instrumental attitudes were negative among students, indicating that they were not only uninterested in traffic safety education (Green et al., 2008; Li, 2015), but they also thought this topic was unbeneficial for them (Williams et al., 2009).

With respect to engagement, the results implied that students were from neutral to somewhat disagreed about the presence of vigor, dedication and absorption in traffic safety education. The results showed that students did not feel bursting with energy, enthusiastic or mentally toward traffic safety education. They did not find traffic safety education full of meaning and purpose. It was easy for them to detach themselves from their learning. In this regard, students in the midst of their academic careers generally lacked engagement (Fredricks, Parr, Amemiya, Wang, & Brauer, 2019; Saeed & Zyngier, 2012).

Results from the post-questionnaire revealed that students were more enthused about their studies and were brimming with enthusiasm. Regarding engagement, students were strong and vivacious, robust, passionate, or pleased when using the platform. They were also happy with what they had learned. As a result, individuals might keep studying on the platform for a long time. Even when things did not go well, they persisted. When they were studying, they ignored everything else around them. This study was connected to earlier research (Ibanez, Di-Serio, & Delgado-Kloos, 2014). Points and other game components served as indicators of success or accomplishment (Zichermann & Cunningham, 2011); levels were used to reward players for finishing tasks (Goehle, 2013), and the use of badges as a visual indicator of the accomplishment of objectives Students used the platform to learn in order to win incentives or to display their accomplishments.

The gamified platform had an influence on both internal and external motivation. Students who were asked about intrinsic motivation agreed that it came from a desire to learn and find new things. Students increased their knowledge and gain experience completing challenging academic tasks while becoming completely engrossed in the platform's content. They were driven by an extrinsic desire to have fulfilling lives in the future. They wanted to prove they were intelligent individuals. They believed that academic success was crucial and that they were capable of achieving it. The platform's gaming features, such as points, levels, and badges, provided both intrinsic and extrinsic incentives. This outcome was consistent

with research on the impact of game mechanics like points, levels, and badges on learners' motivation (Mekler et al., 2017; Thom, Millen, & DiMicco, 2012). Students should thus be more intrinsically driven than extrinsically motivated, as they were motivated to finish the assignment in order to receive external rewards (Lepper, Greene, & Nisbett, 1973). Extrinsic incentives might eventually lessen students' intrinsic motivation if they are used (Werbach, 2014). As a result, the platform does not include extrinsic rewards. Moreover, only intrinsic motivation increased creativity and learning results, which in turn increased students' efforts (Mekler et al., 2017). Intrinsically driven students were more engaged, which led to higher information retention (Ryan & Deci, 2000). Extrinsic and intrinsic motivation, though, have to be taken into account in tandem because they both enhance performance (Cerasoli, Nicklin, & Ford, 2014).

Students' perceptions about traffic safety education via the gamified platform were positive and fascinating. The results were consistent with prior research showing that the majority of students have favorable sentiments about gamification (Burkey, Anastasio, & Suresh, 2013).

6. Limitation and Future Research

The research was conducted at only one high school. In Vietnam, there are several high schools where students may have varying degrees of knowledge and skills about road safety. Students from different high schools should be recruited to gain a better understanding of their traffic insights. In addition, there is only a few hours and no time break between modules for students to do questionnaires and experience platforms, which may lead to better results because it would not be too difficult for them to remember the knowledge and skills that they were taught in a day. The time period for research should be longer so that retention of knowledge and skills can be measured more precisely.

Another drawback is that the study was conducted without a control group. It is important that the control group be integrated into future studies. Nonetheless, this research gained the first insights about the possibilities of a gamified platform in Vietnam. The application of gamification in traffic safety education should be examined in other schools and cities in Vietnam to strengthen its significant role in enhancing traffic safety. Then, the platform could be transformed for other developing countries by maintaining the structure of the original platform but adapting to local issues in traffic safety.

The platform should be more developed and tested in order to increase traffic insights among students in developing countries in the long run.

7. Conclusion

A lack of knowledge and skills exists among high school students in Vietnam. The application of gamification in traffic safety education could measure students' traffic insights effectively and enhance their psychological factors, including engagement, motivation, and attitudes. The gamified platform is a typical example of transforming traditional teaching methods from European countries to developing countries by maintaining the structure of the original platform and adapting to local issues in traffic safety. In the long run, this promising method should be more tested and developed in order to increase traffic insights among students in Vietnam and other developing countries. Gamification in traffic safety education could provide students with traffic insights and positive psychological factors in their learning. It should be used in combination with other preventive measures, such as sanctions, to contribute to long-term improvements in traffic safety among high school students.

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