Prevention of Risky Motorcycle Driving Behaviors Using Gamification among Senior Secondary School Students in Bangkok: A Quasi-experimental Study

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Abstract: Motorcycles have the highest rate of vehicle collisions in Thailand, causing deaths, injuries, and disability—this quasi-experimental study aimed to test gamification's effectiveness in preventing risky motorcycle driving behaviors. The participants were senior secondary school students in Bangkok who used motorcycles daily to travel between home and school. Students in grade 11 and in two classrooms were randomly selected and assigned to experimental and control groups. Then, random sampling was used to select the participants who met the inclusion criteria in the experimental group (n = 37) receiving the behavioral risk prevention program using gamification for six weeks and the control group (n = 38) receiving a regular program from school. Questionnaires used for data collection were the Demographic and Motor Cycle Related Behavior and Experience Form, the Prevention Motivation Questionnaire, and the Intention of Driving Safety Questionnaire. Descriptive, and paired and independent t-tests were used to analyze the data.

The results revealed that the mean score of prevention motivation and the intention of driving safety in the experimental group after receiving the program were significantly higher than before receiving the intervention program and significantly higher than the control group. This study underscores the potential of using gamification to prevent adolescent motorcycle accidents. However, further research is necessary to evaluate the program's long-term effectiveness in different settings. Moreover, it highlights the importance of reinforcing training and licensing for motorcycle driving among adolescents.

Keywords: Gamification, Intention of driving safety, Prevention motivation, Prevention program, Risk behavior, Senior secondary school students

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Introduction

Accidents are a cause of death and disabilities worldwide, particularly in Thailand. The World Health Organization reports that Thailand has the highest road traffic death rate in Asia and the second-highest global fatality rate per 100,000 people.[1] The number of people killed in traffic accidents fell from second to ninth in the world, while Thailand's motorbike fatality rate remained the highest.[2] Motorcycles have the highest rate of vehicular collisions in Thailand,[3] with the Bangkok metropolitan area having the highest rate of accidents reported (36.96%).[1] Children and teenagers are the groups most commonly injured in

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auto accidents.[4] Data from 2020 to 2021 showed that 17.38% of deaths or severe injuries were caused by motorcycle use, with an average of 9,120 accidents occurring per year, and 15.82% of deaths or injuries were among the population aged 15-19 years old.[3]

Driver factors cause the majority of traffic accidents.[4-6] Safely riding a motorbike is a behavior that helps to avoid traffic accidents. These factors include riding according to traffic laws, wearing a helmet, not having more than one pillion passengers, not turning in front of other vehicles, and using turn or hand signals when changing lanes or directions. Furthermore, avoiding driving too close to a vehicle in front (tailgating), not using a smartphone on the bike, following the road traffic signals and signs, and not consuming alcohol are also behaviors that contribute to safe motorcycle riding.[7-12] A person's risk of an accident, injury, disability, or death increases with risky riding habits.[4,7] However, adolescence is the age at which physical growth is maximized, as well as changes in mood and attitude due to hormonal changes in the body. These developments bring about several behavioral dangers, including drinking alcohol, smoking, engaging in risky sexual behavior, and violence. They are also among the groups with the highest rate of injuries and deaths from traffic accidents.[7,13] As mentioned above, preventing motorcycle accidents among teenagers is a beneficial strategy to help decrease the rate of deaths and injuries in this group.[13]

Conceptual Framework and Review of Literature

The Protection Motivation Theory (PMT) developed by Rogers[14] was used as a conceptual framework for this study. The PMT is a widely used framework for understanding how individuals respond to potential threats. Individuals protect themselves by considering threat appraisal and coping appraisal.[14] Threat appraisal evaluates severity, and coping appraisal assesses response to the situation.[14] Threat appraisal includes 1) the perceived probability, the students' awareness that they are at risk of traffic accidents at any time, and 2) the perceived severity, that is, students' awareness that traffic accidents involving motorcycles can lead to injuries, disabilities, or fatalities if traffic rules are not followed. Coping appraisal consists of 1) the response efficacy, students' awareness of the benefits they will receive if they engage in safe motorcycle driving behavior and adherence to traffic regulations; 2) self-efficacy for preventing motorcycle traffic accidents, students' awareness that they can prevent or avoid traffic accidents. These four threat and coping appraisals guide interventions to prevent risky motorcycle driving behaviors among senior secondary school students.

Various intervention initiatives[15-23] have endeavored to mitigate risky behaviors among individuals aged 10-19 years by delivering educational materials focusing on aspects like using helmets, minimizing distractions when operating a vehicle, recognizing hazards on the road, and fostering a safer road setting. Instruction is frequently used in the programs designed to educate students on riding motorcycles safely, including media, lectures, video presentations[15-23] and commentary distributing motorcycle safety guides and maps of danger zones.[6] These findings indicate that individuals involved in these initiatives exhibited enhanced understanding, convictions, attitudes, intentions, and actions related to road safety. However, more is needed to increase interest and encourage learning.[2] To encourage adolescents to recognize risk factors in violent situations and to expect them to respond efficiently to protective behaviors and increase capacity to prevent motorbike accidents, the activities in the program should add more interest, participation, and fun.[2] Therefore, this study intended to test the behavioral risk prevention program by using gamification to motivate students to enhance their classroom behavior and increase participation in class activities.

The term gamification describes gameplay elements and strategies in contexts that are not gaming-related to arouse curiosity and promote engagement from all parties.[24-26] Gamification brings gaming concepts into other non-gaming situations to create interest and encourage participation. The primary motivational strategy of gameplay is to reward players who complete missions. The prizes consist of points, achievement badges, and levels; competition is an essential component of gamification techniques. The gamification technique does not have to be actual gameplay but rather an application of the game's motivational techniques to achieve the objectives through various activities.[24,25]

Adolescents between 10 and 19 years old are growing out of childhood and preparing to enter adulthood. It is a time when numerous changes occur simultaneously; it is a time of fast growth and mental, emotional, and physical development. Each adolescent behaves differently, and distinct ages will also exhibit different behaviors. They like competition and being accepted by their peers, family, society, and surroundings.[27] The gamification strategy helps motivate students, particularly teenagers, to participate in studies, class activities, and group work regarding competition and rewards mentioned above. Therefore, this study applied the concept of gamification to draw the adolescents' attention, as the target group, to join each week of the program.

Aims and Hypothesis

This study aimed to test gamification's effectiveness in preventing risky motorcycle driving behaviors among senior secondary school students in Bangkok. The hypothesis was that the experimental group's prevention motivation and intention of driving safety scores would be significantly higher than before receiving the program, and higher than the control group measured six weeks after the program.

Methods

Design: A quasi-experimental study was used. This report followed the TREND statement in improving the reporting quality of nonrandomized behavioral and public health intervention evaluations.[28]

Sample and Setting: The program G*power (Version 3.1.9.4) was used to determine the sample size, and the effect size = 0.679 was employed.[29] This computation independent t-test (two-tailed test), set = 0.05, and power of the test = 0.80 were the statistics utilized in the computation. The sample size was 72 participants, 36 participants per group. According to a previous study, the sample group lost about 10-15% of its members during the trial.[30] Hence, the sample was raised to 3-4 participants. The total number for both groups was 75, with 37 participants for the experimental group and 38 for the control group.

Purposive sampling was used to select one school for this study from those under the Office of the Secondary Educational Service Area in Bangkok, which reported the highest rate of accidents (36.96%).[1] The inclusion criteria were: 1) male and female students enrolled in grades 10 - 12 at an educational institution, 2) able to communicate in Thai, and 3) students who rode daily to and from school on a motorcycle. The selected school had ten classrooms for each grade (10-12); random sampling was used to select one grade, which was grade 11, and then two classrooms in grade 11 were randomly selected and randomly assigned to the experimental (classroom A setting) or control (classroom B setting). There were 48 students in classroom A (experiment setting), 40 meeting the inclusion criteria, and 37 were randomly selected to be included in the experimental group. There were 50 students in classroom B (control setting), with 42 students meeting the inclusion criteria and 38 randomly selected to be in the control group.

Ethical Considerations: This study was approved by the IRB, Faculty of Medicine Ramathibodi Hospital

(COA. MURA 2022/597), Bangkok. The participants received advice that they could withdraw from the program at any time, that their study rights would be protected, and that they and their parents signed a consent form before the study started.

Research Instruments: The instruments in this study comprise those used to obtain the data and the intervention program. Data collection instruments included the Demographic and Motorcycle-related Behavior and Experience Form, the Prevention Motivation Questionnaire, and the Intention of Driving Safety Questionnaire.

The Demographic and Motorcycle-related Behavior and Experience Form: The primary investigator (PI) developed this form from a literature review. It includes age, gender, motorcycle traffic accident history, motorcycle ownership, driver's license, frequency of helmet use, motorbike maintenance or inspection, driving history, and any previous exposure to information about accidents and motorbike accident prevention.

The Prevention Motivation Questionnaire (PMQ) was developed by Nuboon,[20] and was used in this study with permission. The PMQ examines the role of health education in reducing the risk of motorbike accidents among students 19–20 years old. It comprises 42 items with four subscales: 1) the Perceived Probability of Traffic Accidents from the Motorcycles (11 items), which is a hazard assessment regarding the likelihood that motorcycle traffic accidents would occur (e.g., "Driving a motorcycle in the rain increases the likelihood of accidents."), 2) the Perceived Severity of Traffic Accidents from Motorcycles (7 items) (e.g., "Accidents from motorcycle riding can lead to disabilities or fatalities."), 3) the Efficacy of the Response for Preventing Motorcycle Traffic Accidents (14 items), which measures expectations for the effectiveness of reacting to safe motorcycle conduct, (e.g., "Not drinking alcohol or getting intoxicated before riding a motorcycle can help reduce the rate of accidents."), and 4) the Self-efficacy for Preventing Motorcycle Traffic Accidents (10 items) for assessing expectations for defensive riding on motorcycles (e.g., "You can drive a motorcycle strictly adhering to traffic rules, even when traffic is heavy."). Participants select a response from the 5-point Likert scale ranging from 1 = strongly oppose to 5 = strongly agree, and the total score ranges from 42 to 210, with a higher score reflecting higher prevention motivation. The content validity of the questionnaires was reviewed by three nursing faculty experts in health promotion and health care in children and adolescents. The CVI was 0.97. Cronbach's Alpha coefficient of the four subscales in the pretest, with 15 students enrolled in grades 10–12, was between 0.83–0.91. In the actual study, Cronbach's alpha coefficients for subscales were 0.85–0.94, and Cronbach's alpha reliability for the total scale was 0.84.

The Intention of Driving Safety Questionnaire was also developed by Nuboon[20] and used in this study with permission. This questionnaire surveys the intention to drive motorcycles safely and comprises 15 items. Participants answer from five choices: always, often, sometimes, ever, and never intend to practice and the total score ranges from 15 to 75, with a higher score indicating a higher intention of driving safely. An item example is, "You intend to drive a motorcycle by strictly following traffic rules." The same experts who reviewed the Prevention Motivation Questionnaire and pretest with the same group reviewed the content validity of the questionnaires. The CVI was 0.97. Cronbach's alpha coefficient in the pretest was 0.85, and in the actual study was 0.88.

The Behavioral Risk Prevention Program Using Gamification (BRPP-G)

The BRPP-G was a 6-week group-based program developed by the PI based on the Protection Motivation Theory by Rogers[14] and a literature review. In addition, the gamification principles have been integrated into the program by applying the basic principles of the game to the activity in each session. The same group of three experts who validated the content of the instruments for data collection reviewed the congruence between the program concepts and activities. Also, the program was tested with the same group of 15 children in a data collection instrument

pretest before implementation. The BRPP-G is called "Gun Knock Game" and is composed of 6 sessions: 1) "Game Start, 2) "Open Sign Game," 3) "Crumple and Throw Game," 4) "Learn from the Model," 5) "Brainstorming, Testing Guidelines," and 6) "Game Over." The program was delivered in a group with six participants each, once a week for six weeks. The program details in each session, the time spent, the objectives, and the activities in each session are displayed in **Appendix Table A1.**

The regular school program was the club's health education session, which was taught on Friday afternoons, covering various topics such as sex education, smoking, substance abuse, and knowledge of wearing helmets.

Data Collection: This study was conducted from December 2022 to February 2023. The class teacher informed the students about the program, and if they wanted to participate, they would sign their names and add their phone numbers. The PI met prospective participants to clarify the study's details, including the study's objectives. Students interested in participating in the research would sign up with the class leader within five days of receiving the research project statement. The PI met prospective participants and explained the informed consent process. The PI also called their guardians to ask permission; both the guardian and prospective participants signed their names, and the consent was returned to the PI on the first day of the program. The PI made introductions and developed contacts to learn more about the control group. Then, before the experiment, the PI defined the research objectives, and data were gathered (pre-test). Regarding the study's design, the data collection started with the control group within the first six weeks and collected the data (post-test). The experimental group then started (pre-test), and the PI proceeded with the intervention by using one classroom in the school and collecting all the data in the second six weeks (post-test).

Data Analysis: Data were analyzed using IBM SPSS Statistics for Windows version 28.0.[31] The level of significance was 0.05 (95% CI). The demographic and motorcycle-related behavior and experience were compared between the groups using the t-test, the Chi-square test, and Fisher's exact test. The data of two variables: 1) prevention motivation (the perceived probability of traffic accidents from motorcycles, the perceived severity of traffic accidents from motorcycles, the efficacy of the response for preventing motorcycle traffic accidents, the self-efficacy for preventing motorcycle traffic accidents), and 2) the intention of driving safety, had a normal distribution; therefore the paired t-test was used to compare data within the groups and the independent t-test was used to compare data between the groups.

Results

The average age of the experimental group was 16.81 years old, whereas the control group was 16.21 years old. The majority of participants in both groups were male and had 1-3 years of experience in motorcycle riding, did not own a motorcycle, and did not have a driver's license. Since 2022, most of both groups have not had a motorbike accident. Both groups sometimes wore helmets and had motorcycle inspections or maintenance. Almost all participants in both groups received information about accidents, and most received news about accident prevention, which was not a significant difference ($p > 0.05$). The demographic detail is shown in **Table 1.**

Table 1. Comparison of the demographic and motorcycle-related behavior and experience

Demographic data	Experimental group (n = 37)				Control group (n = 38)				Chi-square	p-value
	n	%	Mean	SD	n	%	Mean	SD		
Age (years)			16.81	0.57			16.21	0.47	1.464[a]	0.230
Gender										
Male	21	56.75			28	73.68			1.683	0.195[b]
Female	16	43.25			10	26.32				

Note. [a] = t-test, [b] = Chi-square test, [c] = Fisher's exact test

Table 1. Comparison of the demographic and motorcycle-related behavior and experience (Cont.)

Demographic data	Experimental group (n = 37)				Control group (n = 38)				Chi-square	p-value
	n	%	Mean	SD	n	%	Mean	SD		
Motorcycle riding experience (years)										
1-3	25	67.56			23	60.53			0.888	0.705[c]
4-5	8	21.62			8	21.05				
Over 5	3	10.82			7	18.42				
Motorcycle ownership										
No	26	70.27			32	84.21			1.359	0.244[b]
Yes	11	29.73			6	15.79				
Driving license										
Have	28	75.68			33	86.84			0.892	0.345[b]
Don't have	9	24.32			5	13.16				
Wearing a helmet										
Sometimes	11	29.73			14	36.84			0.671	0.756[b]
Never	7	18.92			8	21.05				
Every time	19	51.35			16	42.11				
Motorcycle inspection or maintenance										
Ever	8	21.62			15	39.47			2.033	0.154[b]
Never	29	78.38			23	60.53				
Motorbike accidents since 2022										
Never	20	50.05			29	76.32			6.774	0.071[c]
Ever (times)										
1	13	35.14			7	18.42				
2 or more	4	14.81			2	5.26				
Receiving information about accidents										
Ever	0	0			2	5.26			0.487	0.485[c]
Never	37	100			36	94.74				
Receiving news about the prevention of motorcycle accidents										
Ever	1	2.70			4	10.53			0.801	0.371[c]
Never	36	97.28			34	89.47				

Note. [a] = t-test, [b] = Chi-square test, [c] = Fisher's exact test

The mean score of prevention motivation respectively (perceived probability of traffic accidents from motorcycles, the perceived severity of traffic accidents from motorcycles, the efficacy of the response for preventing motorcycle traffic accidents, and the self-efficacy for preventing motorcycle traffic accidents) in the experimental group after receiving the program, were significantly higher than those at baseline and higher than the control group ($p < 0.05$) (see **Tables 2 and 3**).

Table 2. Comparisons of prevention motivation and intention of driving safety in the experimental group between baseline and after intervention

Variables	Baseline		Post-test		Paired t-test	p-value
	Mean	SD	Mean	SD		
Prevention motivation	182.75	16.28	186.91	21.83	-1.226	< 0.001
Over all						
Perceived probability	46.79	4.97	48.51	6.23	-4.992	< 0.001
Received severity	30.04	4.11	30.76	3.85	-2.172	0.036
Responses efficacy	62.03	6.57	63.15	7.46	-3.309	0.002
Self-efficacy	43.89	4.89	44.49	5.97	-3.059	0.004
Intention of driving safety	57.99	7.40	64.60	8.49	-5.646	< 0.001

Table 3. Comparisons of prevention motivation and intention of driving safety between groups after intervention

Variables	Control group (n = 38)		Experimental group (n = 37)		Independent t-test	p-value
	Mean	SD	Mean	SD		
Prevention motivation	179.32	16.75	196.95	11.20	13.28	< 0.001
Overall						
Perceived probability	46.05	6.05	51.84	3.21	16.99	< 0.001
Received severity	29.46	5.06	32.19	2.60	6.61	0.012
Responses efficacy	60.49	6.77	66.11	4.34	11.53	0.001
Self-efficacy	43.32	5.12	46.81	3.56	12.26	0.001
Intention to drive safely	57.03	8.06	69.95	4.95	4.96	0.029

Discussion

Using the Protection Motivation Theory and gamification involvement framework, the behavioral risk prevention program effectively motivated accident prevention and increased the intention of driving safety among senior secondary school students. This program provided the participants with knowledge of motorcycle accidents, raised their awareness of the risks, including the severity of motorcycle accidents, and the expectation of the effectiveness of the response,[22] such as driving lower than the speed limit, getting a license permit, and following the traffic rules. The program also enabled the participants to develop self-confidence and the intention to drive safely. In addition, applying the gamification principle to the program made it interesting and encouraged participation. Games could encourage students to participate in the activities by making them fun and exciting and creating a healthy competition, incentivizing them to collect points each week.

Previous studies support our finding in that the intervention that applied Rogers' idea of motivation could increase self-care management behaviors among people with asthma,[32] build a positive attitude, and enable to practice prevention to avoid accidents in the workplace,[33,34] inspire students to learn about preventing accidents, raising awareness of the seriousness of motorcycle-related traffic accidents and being mindful of the possibility of motorbike accidents on the road.[20,22] Also, an intervention study that applied the self-efficacy theory and Hiyari Hatto (near miss) risk map described a situation where you observed or considered an almost-happening event, reported the incident, and your feelings could raise adolescents' motorcycling literacy.[6] Our findings are also consistent with a study[21] that used the Protection Motivation Theory and the health literacy concept to increase the score of motorcycling avoidance behaviors in the experimental group. In addition, our findings support a previous study[22] that applied the Promotion Motivation Theory in a driving

safety program for motorcycle accident prevention among university students. This program used various strategies such as teaching, using media, analyzing risk mapping in accident-prone areas, and conducting discussions, demonstrations, and practice sessions. The result of this program[22] showed effectively increased knowledge, perceived susceptibility, perceived severity, response efficiency, intention, and practice for motorcycle accident prevention.

Also, our findings are consistent with previous studies[25,26] that used gamification concepts in educational settings. Gamification fostered participatory learning, as participating in competitive games is enjoyable, grabbing students' attention[25,26] and aiding in developing their computational thinking skills. Another study blended an educational approach that used gamification to help elementary school students develop problem-solving and mathematics-real-world connections skills.[24]

Limitations

There were some limitations in this study. First, the generalization of our findings might be limited because the study was conducted in only one setting in Bangkok. Second, a quasi-experimental study, which divided the group by classroom, was employed; thus, the threat to internal validity could not be avoided.

Conclusions and Implications for Nursing Practice

The study helped encourage the participants to prevent motorcycle accidents and increased their intention to ride a motorcycle safely. School nurses can apply this program to motivate students to prevent motorcycle accidents. Nevertheless, a long-term assessment of the intention of students to drive safely is needed to adjust the program to more sustainable results. The adjusted programs should add more collaboration from various sectors, such as teachers, police officers, parents, and the community. The program should include driver training or a driving simulator.[35,36] Each school should require students to have a driver's license and a helmet.

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References

1. World Health Organization (WHO). Global status report on road safety 2018 [Internet]. 2018 June 17 [cited 2024 July 22]. Available from: https://www.who.int/publications/i/item/9789241565684
2. Srisakul S. The effects of health protective motivation for helmet wearing behavior among higher secondary school students, Si Racha district, Chon Buri province [master's thesis]. [Chon Buri]: Burapha University; 2015. Available from: https://digital_collect.lib.buu.ac.th/dcms/files/51924183.pdf (in Thai).
3. Injury data collaboration center, Division of Injury Prevention. Situation of death from road accidents in Thailand [Internet]. 2020 [cited 2024 July 22]. Available from: https://dip.ddc.moph.go.th/ (in Thai).
4. Sonthikul S. Motorcycle related injuries in children in the South-East Asia region [Internet]. Bangkok: Thai Health Promotion Foundation. 2016 Sept [cited 2024 July 22]. Available from: https://trsl.thairoads.org/FileUpLoad/1625/170208001625.pdf (in Thai).
5. Luktong L. Development of prevention systems of road traffic accidents by district health board mechanisms, Song Dao District, Sakon Nakhon Province. J Res Health Inno Dev [Internet]. 2024 Jan 8 [cited 2024 Apr 1];5(1):105-16. Available from: https://he01.tci-thaijo.org/index.php/jrhi/article/view/268211 (in Thai).
6. Chimchaiyaphum T, Sota J. The effectiveness of a motorcycle accident prevention program by applying self-efficacy theory and a HiyariHatto risk map among secondary school students in Phrathatnongsammuen school, Bankaeng Sub-district, Phukieo District, Chaiyaphum Province. Off Dis Prev Contr 9th Nakhon Ratchasima J. 2016;22(3):33-44. Available from: https://he02.tci-thaijo.org/index.php/ODPC9/article/view/189110 (in Thai).

7. Chivanon N. Accidents in children: situation and prevention. JFONUBUU. 2016;24(3):1-12. Available from: https://he02.tci-thaijo.org/index.php/Nubuu/article/view/74896 (in Thai).
8. Li Z, Huang Z, Wang J. Association of illegal motorcyclist behaviors and injury severity in urban motorcycle crashes. Sustainability. 2022;14(21):13923. doi: 10.3390/su142113923.
9. Abdulwahid SN, Mahmoud MA, Ibrahim N, Zaidan BB, Ameen HA. Modeling motorcyclists' aggressive driving behavior using computational and statistical analysis of real-time driving data to improve road safety and reduce accidents. Int J Environ Res Public Health. 2022;19(13):7704. doi: 10.3390/ijerph19137704.
10. Andrade Í, Pitteri J. Profile and behavior of motorcyclists in traffic in the region of Jardim Aureny I, II, III, IV and Taquaralto de Palmas-TO. Rev Ceres [Internet]. 2022 Oct [cited 2024 July 24];14(1):178-96. Available from: http://ojs.unirg.edu.br/index.php/1/article/view/3674
11. Rusli R, Oviedo-Trespalacios O, Salam SAA. Risky riding behaviours among motorcyclists in Malaysia: a roadside survey, Transp Res Part F Traffic Psychol Behav. 2020;74:446-57. doi: 10.1016/j.trf.2020.08.031.
12. Ali SZNBM; Razelan ISBM. Exploration of risky riding behaviour among young motorcyclist. IOP Conf Ser Mater Sci Eng. 2021;1092(1):012074. doi:10.1088/1757-899X/ 1092/1/012074.
13. Chiangkhong A, Surakarn A, Kleebbua C. Pounglek W. A profiles of motorcycle accident mortality and risk behavior in Thai children. IJG [Internet]. 2024 Apr 26 [cited 2024 Jul 13];20(3):54-63. Available from: https://journals.sfu.ca/ijg/index.php/journal/article/view/3133
14. Rogers RW. Cognitive and physiological processes in fear appeals and attitude change: a revised theory of protection motivation. In: Cacioppo J, Petty R, editors. Social psychophysiology. Guilford Press; 1983. pp. 153-77.
15. Brockamp T, Koenen P, Caspers M, Bouillon B, Köhler M, Schmucker U; Working Group of Injury Prevention of the German Trauma Society (DGU). The influence of an injury prevention program on young road users: a German experience. Eur J Trauma Emerg Surg. 2019;45(3):423-9. doi: 10.1007/s00068-017-0872-9.
16. Zainafree I, Hadisaputro S, Suwandono A, Widjanarko B. The road safety education program for adolescents using social media, proving increasing knowledge, beliefs, attitudes, intentions and behavior. Safety. 2022;8(1):12. doi: 10.3390/safety8010012.
17. Chapman R, Buckley L, Sheehan M. Developing safer passengers through a school-based injury prevention program. Saf Sci. 2012;50(9):1857-61. doi: 10.1016/j.ssci.2012.05.001.
18. Sharwood LN, Martiniuk A, Sarrami Foroushani P, Seggie J, Wilson S, Hsu J, Burns B, Logan DB. Intentions and willingness to engage in risky driving behaviour among high school adolescents: evaluating the bstreetsmart road safety programme. Inj Prev. 2023;29(1):1-7. doi: 10.1136/ip-2022-044571.
19. Box E, Dorn L. A cluster randomised controlled trial (cRCT) evaluation of a pre-driver education intervention using the Theory of Planned Behaviour. Transp Res F: Traffic Psychol Behav. 2023;94:379-97. doi: 10.1016/j.trf.2023.03.001.
20. Nuboon K, Banchonhattakit P. Effects of health education program of motorcycle accident prevention among students in Rajamangala University of Technology Isan Nakhonratchasima. Res Dev Health Syst J. 2015;8(2):1-9. Available from: https://trsl.thairoads.org/FileUpLoad/1652/170206001652.pdf (in Thai).
21. Surakarn A, Chiangkhong A, Pounglek W, Kleebbua C. Effectiveness of motorcycling avoidance behaviors promoting program among adolescence under 15 years old. Kuakarun J Nurs. 2022;29(1):145-59. Available from: https://he01.tci-thaijo.org/index.php/kcn/article/view/254833/173349 (in Thai).
22. Phupuewkaew W, Thongkam W, Tippayanet N. Effects of driving safety program of motorcycle accident prevention among students in Rajabhat Mahasarakham University. Off Dis Prev Contr 9th Nakhon Ratchasima J. 2018;24(1):76-85. Available from: https://he02.tci- thaijo.org/index.php/ODPC9 /article/view/188819 (in Thai).
23. Sitti S, Narin R, Tuanrat W. Effectiveness of a motivation enhancement program on practices to prevent motorcycle accident injuries in middle high school students, Chiang Mai province. Lanna Public Health J. 2022;18(2):1-15. Available from: https://he02.tci-thaijo.org/index.php/LPHJ/article/view/258522/177580 (in Thai).

24. Phitthayasenee M, Sittiwong T, Phumpuang K. Blended learning model using gamification base to promote computational thinking skills of student's teachers. Lampang Rajabhat Univ J. 2020;9(2):172-83. Available from: https://so04.tci-thaijo.org/index.php/JLPRU/article/view/247860/168280 (in Thai).
25. Ngimkhuntod S, Rampai N, Diteeyont W. Development of game application on Thai subject in topic of spelling and reading with blended learning activity to enhance reading skill of grade 1 students. RMUTI J Hum Soc Sci. 2021;8(2):31-45. Available from: https://so05.tci-thaijo.org/index.php/RMUTI_SS/article/view/252931 (in Thai).
26. Jongmuenwai1 B, Kongsrima K, Prachai S, Jabjone S, Suikraduang A. Gamification for learning. PJ Journal. 2018;4(2):34-43. Available from: https://ph02.tci-thaijo.org/index.php/project-journal/article/view/184468/129912 (in Thai).
27. Department of Mental Health, Ministry of Public Health. What parents should know when their children enter an age of change [Internet]. 2018 Dec 24 [cited 2024 Apr 20]. Available from: https://dmh.go.th/news-dmh/view.asp?id=28427 (in Thai).
28. Des Jarlais DC, Lyles C, Crepaz N; TREND Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. Am J Public Health. 2004;94(3):361-6. doi: 10.2105/ajph.94.3.361.
29. Sanitlou N, Satphet W, Naphaarak Y. Sample size calculation using G*Power program. J Suvarnabhumi Tech. 2019;5(1):496-507. Available from: https://so04.tci-thaijo.org/index.php/svittj/article/view/181958/136948 (in Thai).
30. Chirawatkul A. Statistics in research: appropriate selection. Bangkok: Wittayapat; 2015.
31. International Business Machines Corporation. IBM® SPSS® Statistics 26.0 for Windows. Armonk (NY): IBM Corp; 2019.
32. Tareram J, Ua-kit N. The effect of motivation promoting program on self-management behavior in asthmatic adult patients. J Nurs Health Care. 2018;36(3):221-32. Available from: https://he01.tci-thaijo.org/index.php/jnat-ned/article/view/151851/110914 (in Thai).
33. Jiamjai C, Boonchuaythanasit K, Kainakha P. Effectiveness of health education program for health literacy development by cooperative learning to promote safe motorcycling behavior of Mathayomsuksa students, Benchamatheputit Phetchaburi school, Phetchaburi. Kasetsart Educ Rev. 2016;31:205-17. Available from: https://so04.tci-thaijo. org/index.php/eduku/article/view/78159/62645 (in Thai).
34. Sridet R, Phimphanchaiyaboon L, Meesomsak N. Road traffic accident: motivation for motorcycle accident prevention in adolescents and youth. JNSU. 2021;22(43):127-36. Available from: https://he01.tci-thaijo.org/index.php/nursingsiamjournal/article/view/250900/171791 (in Thai).
35. Holt MF, Testerman GM. Trauma surgeon-led and funded injury prevention program decreases admission for motorcycle crash injuries. Am Surg. 2022;88(4):740-5. doi: 10.1177/00031348211050837.
36. Schmidt J, Drattell J, Hashida K, Lynall R, Gore R, Devos H. Examination of simulated driving performance throughout concussion recovery. Arch Phys Med Rehabil. 2024;105(4):e191. doi: 10.1016/j.apmr.2024.02.655.

Appendix

Table A1. The BRPP-G is called "Gun Knock Game" comprising six sessions

Week/Time schedule	Objective	Activities
Week 1 Preparation and **Session 1**, "Start game" 1 hour 30 minutes	- Help the participants understand how activities are structured - Establish a positive rapport with and become familiar with research team - Encourage participation in activities	- All students sign up for the event. - Set up a group exercise focused on developing relationships, familiarizing, and eradicating behaviors (6 groups of students, each with 5-7 students) - Members of the group collaborate to give the group a name - Go over activity goals and guidelines for participation and playing of games
Week 2 **Session 2: "Accident Knowledge"** 2 hours	- Educate research participants about the likelihood of motorcycle traffic accidents and their perceived probability of traffic accidents	- Sign up to attend the event, and each student will be awarded one point every week by the research team by stamping. - The study team created six nameplates using the "Disc open game" game, which included: Disc 1: Accident =Meaning, Disc 2: Accident Types, Disc 3: Accident Causes, Disc 4: Preventing Accidents, Disc 5: Result in Loss, and Disc 6: Examples of Dangerous Actions for Motorcycle. - Members of the group send one representative to choose a placard randomly. - Instruct each group to spend 10-15 minutes discussing information on the placard they are holding - The research team creates a competition or contest in which the group representative presents in class for no more than 10 minutes. - Winning team scores three points, followed by the second-place team two points and third-place team one point - Using the study team's stamps, one can get points. - To conclude the week's activities, researchers provide an overview of this activity's content.
Week 3 The third session, "**Interesting law**" 2 hours	- Increase participants' the received severity of traffic accidents from motorcycles	- Signing up to attend the event - Each student will be awarded 1 point every week. - Introduce them to the game through an activity called "The Game of Crumpling and Tossing" - Group members receive five photos each, two of which showed inappropriate driving behavior and traffic violations. - Opening one door at a time at random - Participants listen to signals from the research team to open each photo. - If any group randomly finds photos that demonstrate inappropriate and illegal driving behavior, the team crumples the picture and throws it into a basket on the opposite side of room.

Table A1. The BRPP-G is called "Gun Knock Game" comprising six sessions (Cont.)

Week/Time schedule	Objective	Activities
		- Each group spends 10 minutes summarizing key points and sending a group representative to present to the class. - To summarize the contents of this activity
Week 4 The fourth session, **"Role model"** 1 hour 30 minutes	- Raise participants' efficacy of the response and self-efficacy to prevent motorcycle traffic accidents	- Signs up to attend the event and awarded 1 point every week - Imports a "Learn from the Model" exercise that features a victim of a motorcycle accident - Has a chance to speak with the victim and ask questions or share suggestions - Each group has to speak in front of the class in the form of a simulation of an accident caused by improper use of a motorcycle. - Simulates presentation in front of class in the form of a contest - Select the group that presents the most comprehensive, interesting, and creative content - Using the study team's stamps, one can get points. - Summarize the contents of this activity
Week 5 The fifth session, **"Process"** 1 hour 30 minutes	- Increase participants' confidence in their efficacy of responses and self-efficacy to prevent motorcycle traffic accidents	- Signs up for the event and will be awarded 1 point every week - "Brainstorming about the Solution" exercise is introduced. - Each group is given a flip sheet to use. - Each group spends 15 minutes summarizing prevention guidelines. -The presenter addressed the class. - Using the study team's stamps, one can get points. - Contents of this activity are summarized.
Week 6 The sixth session, **"Game Over"** 1 hour 30 minutes	- Evaluate the perceived probability and received severity of traffic accidents from motorcycles, the efficacy of response and self-efficacy for preventing motorcycle traffic accidents, and intention of driving safety	- Sign up to attend the event - Accrued points are collected by the research team. - Prizes are provided to participants in the event. - Everyone evaluates the challenges together. - The research team employed the same set of questionnaires.

การป้องกันพฤติกรรมเสี่ยงจากการขับขี่รถจักรยานยนต์โดยใช้เกมมิฟิเคชันในนักเรียนชั้นมัธยมศึกษาตอนปลาย โรงเรียนในเขตกรุงเทพมหานคร: การวิจัยแบบกึ่งทดลอง

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บทคัดย่อ: รถจักรยานยนต์เป็นพาหนะที่มีอัตราการเกิดอุบัติเหตุสูงสุดในประเทศไทย อุบัติเหตุดังกล่าวทำให้มีผู้เสียชีวิต บาดเจ็บ และความพิการ การวิจัยกึ่งทดลอง มีวัตถุประสงค์เพื่อศึกษาการป้องกันพฤติกรรมเสี่ยงจากการขับขี่รถจักรยานยนต์โดยใช้เกมมิฟิเคชัน (การนำเอาแนวคิดและกลไกในการออกแบบเกมมาใช้ในกิจกรรมที่ไม่ใช่เกมและประยุกต์ใช้ในการออกแบบกิจกรรมการเรียนรู้) กลุ่มตัวอย่างคือ นักเรียนชั้นมัธยมศึกษาตอนปลายในโรงเรียนแห่งหนึ่ง เขตกรุงเทพมหานครที่ใช้รถจักรยานยนต์ในการเดินทางระหว่างบ้านและโรงเรียนเป็นประจำทุกวัน โดยใช้การสุ่มตัวอย่างในการคัดผู้เข้าร่วมวิจัยซึ่งแบ่งออกเป็นสองกลุ่ม กลุ่มทดลอง (37 คน) ซึ่งกลุ่มทดลองได้รับโปรแกรมป้องกันพฤติกรรมเสี่ยงโดยใช้เกมมิฟิเคชันโดยมีระยะเวลาดำเนินการ 6 สัปดาห์และกลุ่มควบคุม (38 คน) ซึ่งได้เข้าร่วมกิจกรรมตามปกติของทางโรงเรียน แบบสอบถามในการเก็บรวบรวมข้อมูลประกอบด้วยข้อมูลทั่วไป พฤติกรรมและประสบการณ์ในการขับขี่ แบบสอบถามแรงจูงใจในการป้องกันและแบบสอบถามความตั้งใจในการขับขี่ที่ปลอดภัย วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา paired t-test และ indendent t-test

ผลการวิจัย พบว่า คะแนนเฉลี่ยตัวแปรแรงจูงใจในการป้องกันและความตั้งใจในการขับขี่ที่ปลอดภัยในกลุ่มทดลองหลังจากได้รับโปรแกรมสูงกว่าก่อนเข้าร่วมโปรแกรมอย่างมีนัยสำคัญทางสถิติและสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ โปรแกรมดังกล่าวสามารถใช้เป็นแนวทางในลดอัตราการเกิดอุบัติเหตุในกลุ่มวัยรุ่นในโรงเรียนอื่น ๆ และควรมีการศึกษาติดตามประสิทธิผลของโปรแกรมในระยะยาว

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คำสำคัญ: เกมมิฟิเคชัน ความตั้งใจในการขับขี่ที่ปลอดภัย แรงจูงใจในการป้องกัน โปรแกรมป้องกันพฤติกรรมเสี่ยง นักเรียนชั้นมัธยมศึกษาตอนปลาย

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