Cultivating Road User Safety Attitudes to Differing Levels of Vehicle Automation: An Online Collaborative Learning Approach

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Most safety education is designed for individual or whole group knowledge and skill acquisition and may not adequately cultivate preferred safety attitudes. The study addresses the design of online collaborative learning from two perspectives: (1) online community-based self- and peer reflection and (2) integration of online collaborative tools and technologies. To develop the three components of safety attitude (cognitive, affective, and behavioral), the proposed teaching approach drew on Community of Inquiry theory to support reflection and learner engagement. The Zoom video conferencing system (Zoom) and Miro were utilized for online collaborative learning, and short educational movies provided a more concrete sense of automated driving. For the 21 undergraduates who participated in the study, the learning outcomes indicate that the video material enhanced their overview of the system and functions of these innovative cars.

Keywords: safety education, safety attitude, online collaborative learning, automated car, s

Introduction

Background

Cars are currently assigned to one of six levels of automation, ranging from level 0 (no automation) to level 5 (full automation) (SAE J3016, 2021). At present, level 3 cars are generally the highest level sharing the road with other traffic. Most road users recognize the importance of safety education; among the available types of education and training, most are either lecture-based (where an instructor talks to multiple participants in a classroom) or involve self-paced e-learning. However, recent safety education initiatives have emphasized the interaction between instructor and participants. In particular, it is recognized that improving safety attitude requires self-reflection through social learning, and some researchers have tried to develop more effective, efficient, and attractive approaches based on collaborative learning (e.g., Koivisto & Mikkonen, 1997). The present study addresses the design of online collaborative learning from two perspectives: (1) online community-based self- and peer reflection and (2) integration of online collaborative tools and technologies.

Related Literature

Automated Car Usage and Education

Up to level 2 (partial automation), the driver remains largely responsible for driving. At level 3 or higher, the driver can do things other than driving when the car is operating in automated mode, with some restrictions (e.g., no sleeping or drinking). At level 3 (conditional automated driving), the driver must still be careful even in automated mode, and they must be ready to take over at the car's request. Automated cars may help to reduce deaths or injuries in traffic accidents and increase transport options for the elderly and disabled. Some of these vehicles are now in experimental use as public transportation in towns with declining populations or where bus drivers are difficult to recruit or retain. Level 2 cars are now becoming commonplace, and there are also some level 3 cars on the market. The driver's roles and responsibilities are different at levels 2 and 3. For example, level 3 requires the driver to return to intervene (RtI) when the automated function is no longer available. Cars of different levels now coexist on the road, with corresponding differences in vehicle behavior. For example, level 3 cars may reduce speed and stop or execute emergency maneuvers as a result of RtL. As Zhou et al. (2018) reported, the RtI response is shorter and smoother when the driver has some knowledge of the automated car, but knowledge and skill alone may not suffice for safe driving. Zhou et al. (2019) suggested that knowledge acquired from a short lecture may not be retained and is likely to be forgotten after some period of time. To enhance learning retention, then, there is a need for more effective education and learning interventions.

Safety Attitude

Hakatta et al. (2002) proposed a hierarchical model of driver behavior based on four layers adopted from Keskinen (1996): (1) vehicle maneuvering; (2) mastering traffic situations; (3) driving goals and context; and (4) life skills and goals. The highest layer (4) places cars and driving in the context of personal development and skills for self-control, including safety attitude, as critical factors in safe and secure transportation. Eagly and Chaiken (1993, p.1) defined attitudes as "tendencies to evaluate an entity with some degree of favour or disfavour, ordinarily expressed in cognitive, affective and behavioural responses." Attitudes are important predictors of behavior (Kraus, 1995), and individual differences in risk-taking extend beyond unsafe behaviors to general attitudes and behavioral tendencies (Haga, 1999), including pedestrians' attitudes and behaviors (Dinh et al., 2020).

Online Collaborative Learning

The Community of Inquiry (CoI) framework (Garrison, 2011) is frequently applied to the design of online collaborative learning. The CoI framework comprises three components: teaching presence, social presence, and cognitive presence. It is important to ensure that these three presences are balanced (Goda, in print) and appropriately integrated in education and learning experiences. Fiock (2020) described an instructional approach to increase learner engagement and interaction quality based on Sorensen and Baylen's (2009) seven principles of good practice and CoI. Increased learner engagement enhances the learning experience (Parrish, Wilson, & Dunlap, 2011), which is the ultimate goal of CoI-based learning (Garrison, 2011). Fiock summarized good practices and collaborative tools for effective online collaboration.

Research Design and Methods

Design of Online Collaborative Learning Intervention

Self- and peer-reflection are known to be effective methods for cultivating attitudes (Koivisto & Mikkonen, 1997). In Gagné's Taxonomy of Learning, attitude is categorized as an affective domain (Gagné et al., 1992). According to Gagné (1984), attitude is unlikely to be influenced by a lecture-based approach, and vicarious reinforcement based on observation and reflection on human models may be more effective. Attitudes are also known to be difficult to measure, and self-report questionnaires are often used. In shaping desired attitudes, it is important first to support knowledge acquisition about the relevant facts and their impacts. In the present case, the workshop was designed to impart knowledge about automated cars and the coexistence of different levels. For the purposes of motivation and subject knowledge acquisition, instructional videos (Arame et al., 2022) were used, along with a movie exploring the effects of external communication from an automated car on pedestrians' behavior (Arame et al., 2021). The video material helped participants to gain a more concrete sense of the functions and impacts of these vehicles.

In accordance with study restrictions, the workshop was delivered entirely online and lasted for 90 minutes. The collaborative work was carefully designed to take account of the three presences described in the CoI framework. The online seminar was implemented using the Zoom video conferencing system and Miro, a tool for online collaboration. The design specified when and how these ICT tools were to be integrated into online learning (see Table 1). Participants were required to complete a prequestionnaire and pretest before the workshop began.

During the workshop, participants were required to connect using Zoom. The main Zoom room was used for the whole-class lecture and discussion, and the breakout rooms were used for small group discussions. Miro frames were preset for learning activities (see Figure 1), and participants used the frames one by one with accompanying instruction. As an opening activity set for the whole class, participants were instructed to share their experiences of accidents or near misses as drivers and road users. This activity served to activate existing knowledge and increased attention and social presence in CoI mode.

Table 1

Design of Workshop for Safety Attitudes: Activities and ICT Tools/Learning Materials

Time (min.)	Activity	Description	ICT Tools and Learning Materials	
	Prequestionnaire and pretest	Complete prequestionnaire and pretest	Online forms (prequestionnaire and pretest)	
5	Opening	Briefly introduce self to group; share traffic safety experience.	ZOOM (Main room & break rooms)/ ppt file	
10	[Lecture] Overview of self-driving cars; implications for society when different levels of self-driving cars coexist.	Learn about self-driving cars! Summary of self-driving cars. How does society look when different levels of self-driving cars coexist? What are the three components of attitude?		・Opening video with cases for initial attention (2 min.) ・ Video: Self-driving car (5 min.) ・Video: Outward communication (2 min.)
15	[Discussion 1(D1)] As a traffic user (pedestrian, etc.)	What attitudes should we adopt to ensure traffic safety where different levels of autonomous vehicles coexist? As a traffic user, organize these attitudes in terms of knowledge, emotions, and actions.		Miro
10	[Lecture] Review of D1 deliverables	Review outcomes on Miro.		
10	[Lecture] Coexistence of self-driving cars at different levels	Confirm Miro activities. Thinking about safe attitudes as a driver		・Opening video with story for increasing motivation (2 min.)
15	[Discussion 2 (D2)] As a driver	Where autonomous vehicles of different levels coexist, what attitudes should we adopt to ensure safe traffic use? As a driver, organize these attitudes in terms of knowledge, emotions, and actions.		Miro
10	[Lecture] Let's check the other groups' results on Miro	Look at other groups' outputs and review your own group's output. Place a red-blue sticker on another team's board on Miro to indicate consent/disagreement. Think about how you can contribute to safe, secure, and smooth transportation.		Miro
10	[Lecture] Review of D2 deliverables	Review outcomes on Miro.		
10	[Lecture] Example of scale for safe driving	Let's look at an example of a scale for safe driving! Let's think about a safe attitude in terms of the scale items.		
5	Wrap-up and postquestionnaire	Interval for reflection on the seminar.	Online forms: postquestionnaire and posttest	
	Postquestionnaire and posttest			

Two group discussions encouraged participants to think about safe behaviors from the dual perspectives of driver and traffic user. To support self- and peer- reflection, the three components of attitude were introduced, and participants were instructed to organize their near-miss experiences in terms of these three components. To make the process easier for participants who were unfamiliar with automated cars, video footage of the cars and the 3D environment were presented during the lectures along with the research results. As well as posting their own group's comments in Miro, participants were asked to check and evaluate other groups' posts in order to engage with a range of views and opinions related to safety attitudes.

Once the group discussions had finished, some of the scale items s related to unsafe behavior were introduced to stimulate further views on safety. Preliminary assessment of the procedure in the form of expert reviews and small group assessment was conducted two weeks before the workshop to implement any necessary revisions.

Participants

For the purposes of this study, 21 sophomore and senior undergraduate business majors were recruited as participants.

Data Collection

The study questionnaire included one item about holding a driver's license, nine items (SA1 to SA9 in Table 2) about general safety attitudes (Oya & Haga, 2016), and three open-ended questions about the merits and demerits of automated cars and opinions about the workshop. The safety-related items from Oya and Haga were general and did not refer specifically to driving. In the exercises asking participants to consider road safety from the perspectives of drivers and road users, the cognitive test used 20 multiple-choice questions to assess their knowledge of automated cars, based on the content of the instructional videos shown during the workshop. The questionnaire and test were administered as Google forms before and after the workshop.

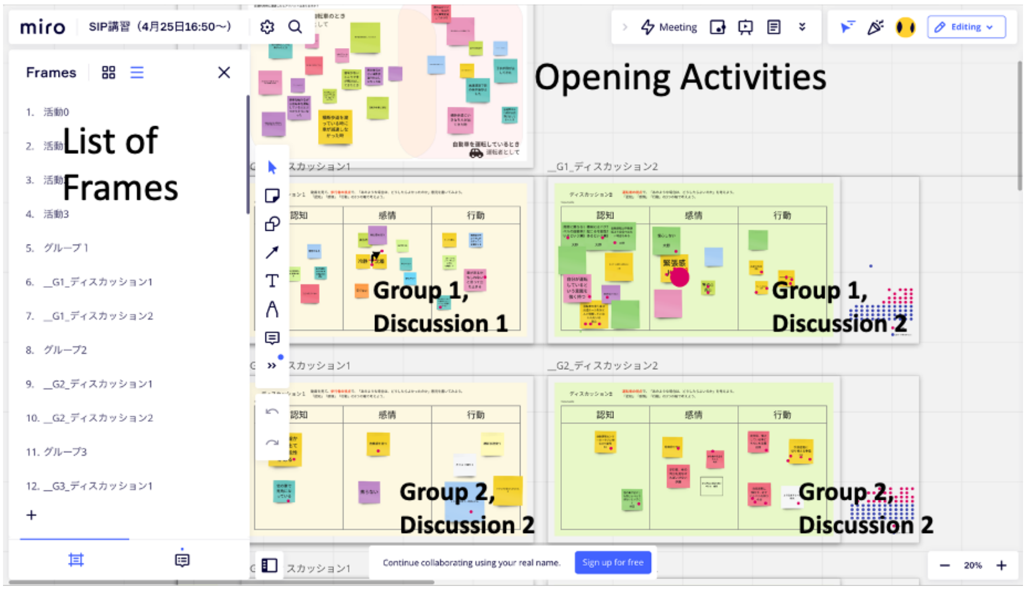

Figure 1 Screenshot: Using Miro for collaborative learning.

Results

Of the 21 participants recruited for the workshop, only 17 completed all of the questionnaires and tests, and these were included in the analysis. Table 2 summarizes the results of paired t-testing of safety attitude items. The results were statistically significant for the test ($t(16)=3.755$, p = 0.002) and for SA4 ("When doing something, I reflect on accidents and problems that occurred in the past" ($t(16)$= 2.729, p = 0.015) and tended toward significance for SA3 ("Before I start anything, I check the set procedures and safety precautions") ($t(16)$= 1.768, p = 0.096) and for SA8 ("If safety cannot be confirmed, I stop what I am doing") ($t(16)$= -1.807, p = 0.09).

Responses to the open-ended questions about automated cars listed their merits, including reduction of human error, accident rate, and fatigue due to extended driving. In relation to the workshop, positive opinions were expressed about the video materials, instructional flow, and the workshop theme.

Discussion

In designing a workshop to cultivate safety attitudes in the context of automated cars, the CoI framework was deployed to design online collaborative learning activities and ICT use. The approach proved effective in increasing cognitive and social presence in the opening activity and ensuring the smooth transition of attention to the workshop theme. The results were satisfactory at levels 1 and 2 of Kirkpatrick's evaluation model (Kirkpatrick, 1998); participants expressed positive opinions in the post questionnaire, and posttest scores increased significantly. In relation to safety attitude, before and after comparisons confirmed an increase in reflection on past cases (SA4). This outcome was expected, as three collaborative activities (including the opening activity) required participants to recall past experiences of accidents or near misses. Results for SA3 (checking safety procedures and precautions) were statistically significant, and SA8 ("If safety cannot be confirmed, I stop what I am doing") also showed a significant tendency, with a negative t value. This result is difficult to interpret, but it suggests that participants felt they should not start something before checking safety, and the negative result for SA8 therefore seems reasonable. The other SA items proved more difficult to influence in the short term, which may help to explain why further significant differences were not observed.

Conclusion

Attitude change takes time, and there is a need for ongoing observation after the workshop to evaluate its impact. Safety education should target everyone from children to the elderly, as well as foreign visitors to cultivate preferred safe attitudes to automated cars for road safety, security, and smoothness. Future studies should encompass a wider range of participants over longer periods of time.

Table 2

Results of paired t-test (2-tailed) for test and safety attitudes (N = 17)

Paired Item (Post - Pre)	Paired Differences					*t*	df	Sig. (2-tailed)
	M	*S.D.*	*S.E.M*	95% Confidence Interval				
				Lower	Upper			
Posttest Total Score - Pretest Total Score	2.294	2.519	0.611	0.999	3.589	3.755	16	0.002
SA1*. Be sure to follow safety rules and established procedures.	-0.059	0.243	0.059	-0.184	0.066	-1	16	0.332
SA2_R. Sometimes I don't follow safety rules or routines when I am confident that it's okay.	0.118	0.993	0.241	-0.393	0.628	0.489	16	0.632
SA3. Before I start anything, I check the set procedures and safety precautions.	0.294	0.686	0.166	-0.059	0.647	1.768	16	0.096
SA4. When doing something, I reflect on accidents and problems that occurred in the past.	0.529	0.8	0.194	0.118	0.941	2.729	16	0.015
SA5_R. Even if I take some risks, I complete tasks in time according to the work schedule.	-0.059	0.966	0.234	-0.556	0.438	-0.251	16	0.805
SA6. To prevent human error, I have some concrete methods.	0.235	0.664	0.161	-0.106	0.577	1.461	16	0.163
SA7. If I am uncertain about what I am doing, I make sure to adopt a safe approach.	0.176	0.529	0.128	-0.095	0.448	1.376	16	0.188
SA8. If safety cannot be confirmed, I stop what I am doing.	-0.412	0.939	0.228	-0.895	0.071	-1.807	16	0.09
SA9_R. As far as possible, I do not want to participate in safety education, training, and seminars.	0.059	0.659	0.16	-0.28	0.397	0.368	16	0.718

Note. *SA: safety attitude; R: reverse item.

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References

Arame, M., Handa, J., Goda, Y., Toda, M., Matsuba, R., & Daimon T. (2021). Verification of affordance effect of HMI in the VR environment. *Education and New Developments* 2021. https://doi.org/10.36315/2021end063

Arame, M., Handa, J., Goda, Y., Toda, M., Itoh, M., & Kitazaki, S. (2022). Using narrative-based video on gaining safety driving: Focusing on career resilience and learning style in automated driving level 3. In X. S. Yang, S. Sherratt, N. Dey, & A. Joshi (Eds.), *Proceedings of Sixth International Congress on Information and Communication Technology. Lecture Notes in Networks and Systems, vol 216*. Springer. https://doi.org/10.1007/978-981-16-1781-2_68

Dinh, D., Vũ, N. H., McIlroy, R. C., Plant, K. A., & Stanton, N. A. (2020). Effect of attitudes towards traffic safety and risk perceptions on pedestrian behaviours in Vietnam. *IATSS Research, 44*(3), 238–247.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Harcourt Brace Jovanovich College Publishers.

Fiock, H. S. (2020). Designing a community of inquiry in online courses. *International Review of Research in Open and Distributed Learning, 21*(1), 134–152.

Gagné, R. (1984). Learning outcomes and their effects: Useful categories of human performance. *American Psychologist, 39*(4), 377-385.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design. Harcourt Brace Jovanovich.

Garrison, D. R. (2011). E-learning in the 21st century: A framework for research and practice (2nd ed.). Routledge.

Goda, Y. (in press). 5. Design and facilitation to balance social, teaching, and cognitive presence. In M. Cleveland-Innes, S. Stenbom, & D. R. Garrison, *The design of digital learning environments: Online and blended applications of the Community of Inquiry*. Routledge.

Haga, S. (1999). 不安全行動のメカニズム [Factors behind unsafe acts]. 信学技報, SSS99-12 (1999-7), https://www2.rikkyo.ac.jp/web/haga/papers.html [Japanese]

Hakatta, M., Keskinen, E., Gregersen, N. P., Glad, A., & Hernetkoski K. (2002). From control of the vehicle to personal self-control; broadening the perspectives to driver education. *Transportation Research Part F: Traffic Psychology and Behaviour, 5*(3), 201–215.

Keskinen, E. (1996). Why do young drivers have more accidents? Junge Fahrer Und Fahrerinnen. Referate der Esten Interdiziplin€aren Fachkonferenz 12–14 Dezember 1994 in Koln. Berichte der Bundesanstalt fur Strassenwesen. Mensch und Sicherheit, Heft M 52 (in English).

Kirkpatrick, D. L. (1998). *Evaluating training programs*. Berrett-Koehler Publishers.

Koivisto, I., & Mikkonen, V. (1997). Mirroring method. A traffic safety campaign without authoritative "right answers." *Reports from Liikenneturva* 42/1997.

Kraus, S. J. (1995). Attitudes and the prediction of behavior: A meta-analysis of the empirical literature. *Personality and Social Psychology Bulletin, 21*(1), 58–75. doi:10.1177/0146167295211007

Oya, H., & Haga, S. (2017). 公正な職場は仕事の誇りと安全行動意思を高めるか：職業的自尊心ー安全行動意思モデルと組織的公正，情緒的組織コミットメント. [Does organizational justice guide occupational pride and intention to safety actions?: Occupational pride - intention to implement safety actions model with organizational justice and affective commitment to the organization]. *Japanese Association of Industrial/Organizational Psychology Journal, 2017*(1), 19–35 [Japanese]

Parrish, P. E., Wilson, B. G., & Dunlap, J. C. (2011). Learning experience as transaction: A framework for instructional design. *Educational Technology, 51*(2), 15–22. http://www.jstor.org/stable/44429912

Sorensen, C. K., & Baylen, D. M. (2009). Learning online: Adapting the seven principles of good practice to a web-based instructional environment. In A. Orellana, T. L. Hudgins, & M. Samonson (Eds.), *The perfect online course: Best practices for designing and teaching* (pp. 69–86). Information Age Publishing.

Zhou, H., Itoh, M., & Kitazaki, S. (2018). How does knowledge about system limitations contribute to interventions into partial automation among elderly drivers? *Proceedings of The 2018 IEEE international Conference on Systems, Man, and Cybernetics* (SMC2018). Miyazaki, Japan.

Zhou, H., Itoh, M., & Kitazaki, S. (2019). Long-term effect of experiencing system malfunction on driver take-over control in conditional driving automation. *Proceedings of The 2019 IEEE international Conference on Systems, Man, and Cybernetics* (SMC2019). Bari, Italy.