Formalization of Pre-Learning Instructional Method Based on Information Processing of Learner Driver

Yuta Kurihara[1], Motoki Shino[2], Wataru Miyazaki[3], Minori Kizaki[3], Katsuko T. Nakahira[4][a] and Muneo Kitajima[4][b]

[1]*Department of Human & Engineered Environmental Studies, The University of Tokyo, Kashiwanoha, Kashiwa, Chiba, Japan*

[2]*Department Mechanical Engineering, Tokyo Institute of Technology, Ookayama, Tokyo, Japan*

[3]*Minami Holdings Co., Ltd., Onojo, Fukuoka, Japan*

[4]*Department of Information & Management Systems Engineering, Nagaoka University of Technology, Nagaoka, Niigata, Japan*

Keywords: Driving Skill Acquisition, Driver Training, Formalization of Instructional Methods, Cognitive Processing.

Abstract: This study aims to formalize instructional methods for driving skill acquisition by examining learner drivers' information processing during instruction. To examine the effects of pre-learning on skill development, experiments were conducted to analyze how procedural knowledge provided before practice influences skill acquisition. The experiment focused on two tasks: lane changes, which require precise execution of procedures at moderate speeds, and S-curve navigation, which involves controlling a vehicle on narrow roads. The results indicate that, for tasks requiring procedural accuracy, such as lane changes, providing procedural steps as semantic knowledge before practice facilitated their conversion into procedural memory through verbal repetition and stationary practice. In contrast, for S-curve navigation, effective skill acquisition was achieved by managing vehicle speed through intermittent stops. This approach reduced working memory load and enabled learners to more effectively predict vehicle position and orientation. This study underscores the importance of tailoring pre-learning strategies to the specific demands of each task and contributes to the development of instructional designs that enhance the efficiency and effectiveness of driving education.

1 INTRODUCTION

Driving skills require the integration of perception, judgment, and motor operation, making effective education essential for cultivating safe drivers. In Japan, driving schools play a central role, with government-certified instructors providing personalized guidance based on standardized requirements (National Police Agency, 2022). At these schools, government-certified instructors provide personalized guidance to learner drivers, resulting in variations in instructional quality depending on the instructor's background.

Traditionally, skill education has relied on practitioners' intuition and experience. In recent years, efforts have been made to formalize experts' tacit knowledge, transforming it into explicit knowledge and integrating it into educational processes through digital transformation (DX). In sports, formalizing expert movements and enabling novices to observe and replicate these actions have been shown to significantly enhance skill acquisition (Nuruki et al., 2011). Similarly, in piano education, an approach where beginners compare videos of their own movements with those of experts has been formalized, demonstrating the effectiveness of e-learning materials based on this method (Nakahira et al., 2011).

DX-based approaches have been explored for driving skills. For instance, systems aiding steering timing during reverse parking have been shown to reduce errors (Duan et al., 2019). Additionally, methods targeting perception and decision-making have been developed to enhance learners' hazard recognition (Crundall et al., 2017).

Despite these advancements, the processes involved in acquiring driving operation skills remain underexplored, particularly regarding how learner drivers process instructional content and translate it

[a] https://orcid.org/0000-0001-9370-8443
[b] https://orcid.org/0000-0002-0310-2796

Kurihara, Y., Shino, M., Miyazaki, W., Kizaki, M., Nakahira, K. T. and Kitajima, M.
Formalization of Pre-Learning Instructional Method Based on Information Processing of Learner Driver.
DOI: 10.5220/0013389400003912

In *Proceedings of the 20th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2025) - Volume 1: GRAPP, HUCAPP and IVAPP*, pages 682-689
ISBN: 978-989-758-728-3; ISSN: 2184-4321

into actions. While previous studies have focused on specific operations, such as reverse parking, using technical approaches, instructional methods integrating real-time feedback and appropriate timing are yet to be fully clarified. Consequently, methods that consider novice drivers' cognitive processes remain underdeveloped, and essential insights for constructing effective instructional designs are still lacking.

In response to these challenges, this study aims to formalize instructional methods for driving skills by analyzing learner drivers' behaviors and instructor guidance, with a focus on cognitive processes during skill acquisition. To achieve this, the study examines the information processing underlying skill acquisition. Section 2 defines the targeted skills and outlines the assumed information processing framework to establish a theoretical basis. Section 3 describes the experiments to evaluate current instructional methods while section 4 analyzes the results to clarify the information processing required for skill acquisition.

2 THEORETICAL FRAMEWORK AND TARGET SETTING FOR SKILL ACQUISITION

This section establishes the theoretical framework for analyzing the skill acquisition process of learner drivers and introduces models to understand the fundamental information processing involved in skill learning. The specific skills targeted in this study are then identified, and key focus points for instructional methods are defined in this research.

2.1 Assumed Information Processing

Fitts' three-stage model (Fitts and Posner, 1967) provides the theoretical foundation for understanding skill learning. This model describes skill acquisition as progressing through three stages. The first, the cognitive stage, involves learners acquiring knowledge of the new skill and understanding the associated procedures. The second, the associative stage, focuses on enhancing the skill's efficiency and accuracy through repeated practice. Finally, the autonomous stage is achieved, where the skill becomes automatic, enabling learners to allocate attention to other tasks. Based on this model, instructional methods should align with learners' progress through these stages, emphasizing the appropriate timing and content of guidance.

Additionally, the Cognitive Model (Moreno and Mayer, 2007) is employed to analyze how learner drivers process information and acquire skills. As shown in Figure 1, external information enters working memory, activates related long-term memory, and is then processed and translated into motor actions. Conversely, processed information is integrated into long-term memory, which includes declarative memory (semantic memory for knowledge and language, and episodic memory for personal experiences) and non-declarative memory (procedural memory for skills and habits).

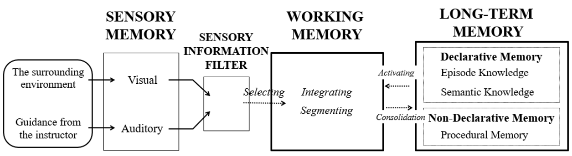


Figure 1: The cognitive model for skill acquisition (Moreno and Mayer, 2007).

Using these two models, this study investigates how instructors' guidance is integrated into learners' memory, forms procedural memory, and facilitates skill acquisition based on the timing of instruction.

2.2 Research Targets

To understand the information processing involved in learner drivers' acquisition of driving operation skills, this study defines the targeted skills. In Japanese driving schools, training is divided into two phases: the first focuses on skill acquisition within the driving school, while the second involves developing these skills on public roads. This study focuses on the first phase, emphasizing the acquisition of new skills. For learners who have already mastered basic operations, such as starting and cornering, instructional items can naturally be categorized into two main groups.

The first category consists of training items aimed at learning actions regulated by traffic rules. For instance, tasks such as lane changes and obstacle avoidance require learners to perform precise visual checks and execute vehicle operation procedures accurately and efficiently The second category involves tasks that develop learner's ability to estimate the vehicle's position relative to the road using visual information. As shown in Figure 2, these tasks enhance spatial awareness, helping learners navigate narrow roads

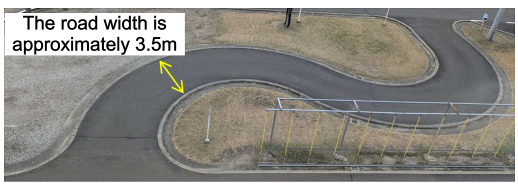


Figure 2: The S-curve used in driving training.

by determining appropriate paths and speeds. Examples include navigating S-curves and L-shaped crank courses. Based on these two categories, this study targets lane changes and S-curve navigation as representative tasks for actions regulated by traffic rules and tasks requiring spatial awareness.

2.3 Targeted Learning Based on Current Instructional Methods

Based on survey, current instructional methods for lane changes and S-curve navigation are structured into three stages: pre-learning (before practice), practice, and feedback (after practice).

During pre-learning, instructors explain the procedures using training manuals. For lane changes, they outline the required steps, while for S-curve navigation, they emphasize maintaining low speed before detailing the navigation process. Learners then practice on the actual course and receive feedback afterward. When aligned with the information processing model in Figure 1, pre-learning guidance primarily helps learners store procedural steps as semantic memory in long-term memory. During practice, learners use this memory to perform driving operations, converting the knowledge into procedural memory and acquiring skills. Feedback allows learners to reflect on experiences stored as episodic memory, enhancing their understanding.

Among these instructional phases, pre-learning is considered the most influential for practice and feedback. Therefore, this study focuses on pre-learning, specifically examining and comparing the practice behaviors of learners who successfully acquired skills with those who did not after pre-learning. This analysis aims to identify the information processing required for skill acquisition after learners memorize new skills during the pre-learning phase. Based on these insights, the study seeks to formalize instructional methods grounded in learners' information processing, as outlined in Section 1, specifically within the context of pre-learning.

3 PRE-LEARNING EXPERIMENT

This section presents an experiment designed to formalize effective instructional methods by evaluating the impact of pre-learning procedural information on skill acquisition. Learners studied pre-learning materials based on instructors' guidance, and their procedural accuracy was measured during subsequent practice to evaluate the effectiveness of skill acquisition. The participants were 10 learner drivers evaluated as having acquired basic driving skills after completing training.

3.1 Evaluation

To evaluate skill acquisition, a sensor-equipped instructional vehicle was used to measure driving performance, including speed, steering angle, and self-position estimation (Figure 3). Since visual behavior is a key indicator of driving performance (Land and Lee, 1994), a gaze tracking device (Tobii Pro Glasses 2) was also employed to record learners' visual behavior. The recorded data were logged as time-series fixation targets, as shown in Figure 5.

For lane changes, the evaluation metric focused on the accuracy of following the instructed procedures. Skill acquisition was considered successful if learners executed the procedures correctly before the third practice attempt. For S-curve navigation, the evaluation criteria included the avoidance of wheel drop-offs, along with the accuracy of vehicle operation and visual behavior. A "wheel drop-off" was defined as a situation where a tire completely falls off the edge of the road or where more than half of the tire width extends beyond the road curb. To rule out random success, skill acquisition was deemed successful if learners completed both the second and third attempts without wheel drop-offs.

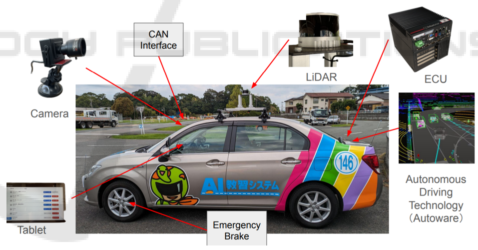
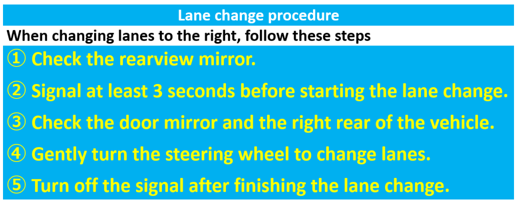


Figure 3: The vehicle used for driving instruction (Handa et al., 2023).

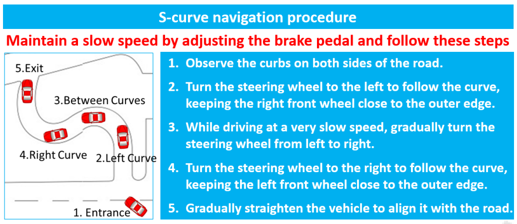
3.2 Procedure

In this experiment, learner drivers first drove around the outer loop of the training course to become familiar with driving. Next, for lane changes, participants studied the pre-learning materials shown in Figure 4 for 5 minutes and then took a written memory test on the procedure. Those who did not achieve a perfect score repeated this study and test process until they accurately reproduced the procedure in writing, confirming that participants had memorized the procedure. They then drove the lane change course three times as practice. After completing the lane change experiment, the same procedure was applied to the

S-curve course. If a wheel drop-off occurred during practice, the vehicle's automatic braking system (Figure 3) was activated, and the experimenter intervened to help the participant return to the course.



(a) Pre-learning material for lane change



(b) Pre-learning material for S-course

Figure 4: Pre-learning materials.

3.3 Experimental Results

3.3.1 Lane Change

Among the 10 participants, one was excluded because they had already received prior instruction on lane changes. Among the remaining 9 participants, only one (Participant A) successfully performed the procedure accurately by the third attempt. For the remaining participants, omissions or order errors persisted through the third attempt. In particular, during the third attempt, all 8 participants skipped the right-rear check (Step 3), 2 omitted the side mirror check (Step 3), and 1 performed steps 1 to 3 out of order.

Changes in procedural accuracy across practice attempts were analyzed to observe patterns in participants' performance. Participant A showed progressive improvement, initially omitting steps 1 and 3 but completing all steps by the third attempt. Among the other 8 participants, 2 exhibited gradual improvement, while 3 showed no change, and 3 experienced a decline, failing to execute previously completed steps.

In summary, only Participant A achieved full procedural accuracy by the third attempt, whereas the majority (6 participants) showed no improvement or declined in performance despite repeated practice.

3.3.2 S-Curve Navigation

Among the 10 participants, 3 successfully acquired the skill, while 7 did not. Figure 5 shows the relationship between visual behavior and vehicle speed for one participant who acquired the skill. The horizontal axis represents the time from S-curve entry to exit. The left vertical axis indicates gaze targets, with each rectangular bar showing the object being fixated on and the duration of fixation. The colors of the rectangles correspond to steps 1–5 in Figure 4. The right vertical axis displays vehicle speed as a gray line.

Based on the graph, the participant's speed intermittently dropped to zero during the first attempt. In terms of visual behavior, the participant primarily focused on the curbs on both sides at the entrance of the S-curve and on the right curb during the left turn, consistent with the pre-learning material. In contrast, during the second and third attempts, the participant maintained a continuous speed while keeping their gaze consistently on the same targets. The other two participants who successfully acquired the skill displayed similar patterns of behavior.

In contrast, examples of participants who failed to acquire the skill are provided. Three participants who did not intermittently stop during the first attempt all experienced wheel drop-offs in subsequent attempts. Additionally, four participants who initially reduced their speed intermittently still experienced wheel drop-offs. Figure 6 compares the driving operations of one such participant with those of the participant shown in Figure 5. Figure 6 illustrates the first 50 seconds of S-curve navigation, with the left vertical axis representing speed and the right vertical axis representing the steering angle, where negative values indicate right turns and positive values indicate left turns. The left graph shows data from a participant who failed to acquire the skill and experienced wheel drop-offs, while the right graph represents the first attempt of a participant who successfully acquired the skill. By comparing these graphs, as highlighted by circles in the figure, participants who successfully acquired the skill made gradual adjustments to the steering angle, while those who failed made abrupt and rapid steering movements.

In summary, the differences between successful and unsuccessful participants can be attributed to two key factors: effective speed management, particularly the ability to execute intermittent stops, and gradual steering adjustments.

4 DISCUSSION

The experimental results reveal that memorizing procedures through pre-learning materials and practicing based solely on that memorization may sometimes be insufficient for learner drivers to fully acquire skills. However, some learners successfully acquired skills

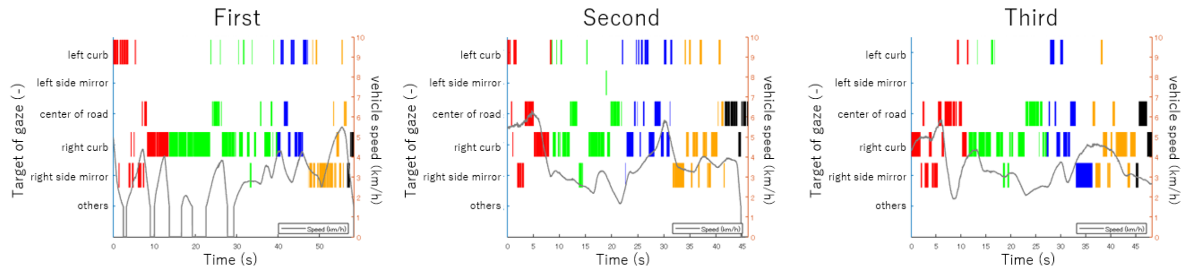


Figure 5: Visual behavior and vehicle speed during S-curve navigation.

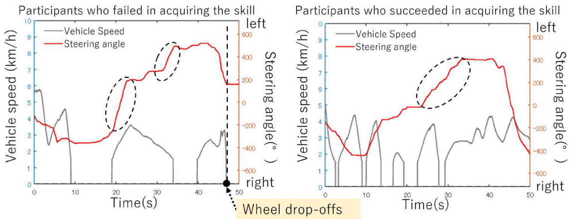


Figure 6: Comparison of steering operations.

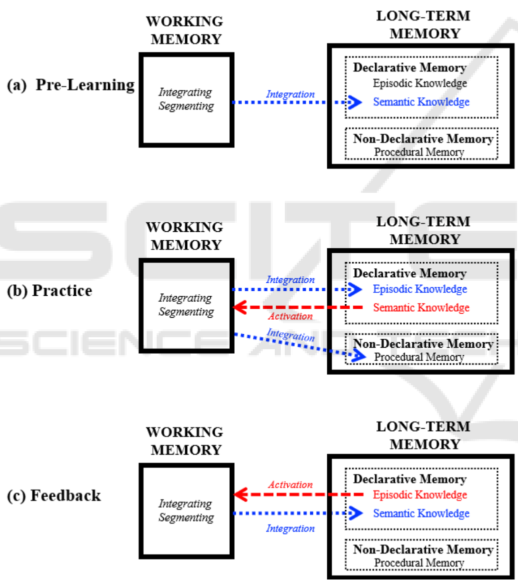


Figure 7: Information processing based on timing.

despite identical memorization tasks, suggesting that differences in information processing during the practice phase influenced these outcomes.

This study organizes the instructional content provided by experienced instructors during practice and feedback sessions for each skill. By analyzing this content, the study clarifies the information processing required of learner drivers and examines how these factors contribute to skill acquisition. Finally, the study formalizes pre-learning instructional methods based on the observed confirmation and operational behaviors of learners, as well as the guidance provided by experienced instructors.

4.1 Analysis of Instructional Content

This section examines instructional content during pre-learning, practice, and feedback, using the information processing model described in Section 2.3. The analysis relies on the framework shown in Figure 1, which illustrates how information is processed after entering working memory through sensory filters. The figure shows how procedural information, acquired as Semantic Knowledge during pre-learning, is gradually transformed into Procedural Memory through practice and feedback. This transformation forms the foundation for analyzing the role of instructional methods in skill acquisition.

Instructional content was collected from instructors' verbal guidance, gestures, and recorded driving behavior data. Additionally, learners' behavior was measured using the training vehicle (Figure 3) and the gaze tracking device (Tobii Pro Glasses 2) described in Section 3.1, as instructional content may change depending on learners' driving behavior.

4.2 Lane Change

4.2.1 Analysis of Lane Change Instruction

The instructional methods of experienced instructors for lane changes were analyzed, focusing on their effectiveness. Based on Figure 7, the following instructional practices were identified: First, during the pre-learning phase, the instructors taught the procedures described in Figure 4. During the practice phase, regardless of the learner, experienced instructors provided concise verbal cues, such as ”rearview mirror” and ”signal”, which represented each step at the appropriate timing. Finally, during the feedback phase, instructors pointed out learners' mistakes, reviewed the procedures verbally with them, and guided them to rehearse and execute the procedures in a stationary vehicle.

The impact of this instructional content on skill acquisition is analyzed based on Figure 7. First, during the pre-learning phase, learners retained procedural information as semantic knowledge. During the practice phase, this was activated through visual and auditory inputs from the road environment and instructor cues, resulting in motor outputs. Therefore, semantic knowledge must be easy to activate and applicable during practice. To evaluate this condition, the procedural instruction was assessed using Cognitive Load Theory (Sweller, 1988), which categorizes cognitive demands into intrinsic load (task complexity), extraneous load (unnecessary elements in the learning environment), and germane load (elements that facilitate learning). According to this theory, by excluding additional information—such as explanations of why certain actions are necessary—and focusing solely on procedural execution, learners can concentrate on the steps themselves, reducing task complexity and minimizing intrinsic load. This approach ensures that the provided semantic knowledge meets the condition of being easy to activate and directly applicable to motor outputs during practice.

During the practice phase, providing only keywords representing each step likely served, as shown in Figure 7(b), to trigger learners' procedural memory through external stimuli. This approach is considered effective for tasks like lane changes, where precise actions must be performed within a short time, as it facilitates the rapid transformation of activated memory into motor outputs. Furthermore, since the capacity of Working Memory is limited, supporting the activation of already provided information without introducing new elements likely plays a role in reducing extraneous load.

Finally, regarding feedback, verbalizing procedural steps has been shown to generally enhance the accuracy and speed of subsequent motor actions (Guadagnoli et al., 1992). Additionally, repeating the steps in a stationary state allows learners to review them in a low cognitive load environment, facilitating their transformation into procedural memory in advance. Therefore, by ensuring that learners accurately recognize their mistakes and rehearse the steps in a stationary vehicle, it is believed that they retain verbalized semantic knowledge that is easily converted into procedural memory, alongside procedural memory developed in a stationary state. This preparation aids in performing high-speed lane changes in subsequent practice.

In summary, pre-learning instruction provided learners with semantic knowledge that could be effectively transformed into procedural memory. During practice and feedback, the instruction focused on aiding this transformation, facilitating skill acquisition.

4.2.2 Formalizing Instructional Content Based on Learner Drivers' Behavior

Based on the previous section and as described in Section 3.3.1, this discussion examines the factors that led to omissions in procedural execution during practice, despite learners retaining information about the procedures. Lane changes require quick execution of steps at vehicle speeds of 10–20 km/h, and in this experiment, the lack of support for activating semantic knowledge during practice likely resulted in delayed activation. In contrast, feedback involving verbalization of the steps and repetition in a stationary vehicle likely facilitated the transformation into procedural memory. These findings suggest that for skills requiring procedural execution at higher speeds, retaining procedures as semantic knowledge alone is insufficient; verbalized guidance and repetition in a stationary environment are effective.

Additionally, the low number of participants who improved procedural accuracy with increased practice is discussed. Unlike tasks such as avoiding wheel-drops in an S-curve, lane changes lack easily recognizable error indicators, and participants may have mistakenly believed they executed the steps correctly without adjusting their behavior. This limitation, due to the lack of feedback, highlights the necessity of providing feedback for procedural improvement.

4.3 S-Curve Navigation

4.3.1 Analysis of S-Curve Navigation Instruction

Similar to the lane change instruction, the instructional content for S-curve navigation is summarized as follows: During the pre-learning phase, as shown in Figure 4, instructors emphasized the importance of low-speed control using the brakes before teaching the specific steps for navigating the S-curve.

During the practice phase, instruction varied based on learner performance. For learners driving at excessive speed, instructors focused solely on speed control using the brakes. For those maintaining an appropriate speed, instructors provided additional guidance, such as encouraging them to look further ahead along the curve to guide their visual behavior. For learners who started steering too early in left curves, instructors avoided direct intervention, instead prompting them to consider whether the front-right wheel was aligned with the outer edge of the curve, helping them recognize their steering errors.

In the feedback phase, instructors emphasized the importance of speed control for learners who drove too fast, explaining that excessive speed limited their ability to predict vehicle positioning. They also guided learners on how to increase awareness of vehicle position and orientation. For example, they explained that even if the right curb was no longer visible, the front-right wheel remained aligned under the driver's feet, allowing for further adjustments. Instructors also taught learners to predict vehicle movements based on steering inputs, encouraging them to set the steering angle, observe the vehicle's response, and make adjustments as needed.

The impact of this instructional content is analyzed using the information processing model in Figure 7. Procedural guidance is comparable to that provided for lane changes. The effect of speed management during course navigation is also analyzed. In S-curve navigation, in addition to activating Semantic Knowledge, it is necessary to predict vehicle position and orientation based on visual information from the road environment and to execute precise maneuvers accordingly. Practicing at low speeds not only allows sufficient time for activating procedural memory but also allocates more Working Memory capacity to vehicle control based on visual inputs, as illustrated in Figure 7(b). As a result, even though S-curve navigation involves additional tasks, such as predicting vehicle position and orientation compared to lane changes, cognitive load can be effectively reduced. The emphasis on strict speed management during practice serves the same purpose.

As shown in Figure 7(c), feedback focused on guiding learners to adjust their visual and operational behaviors based on their practice memories retained as Episodic Knowledge. For example, learners who experienced wheel drop-offs in left curves were instructed on the necessity of predicting vehicle position and orientation using visual inputs, as well as methods to correct their steering. This approach fosters self-feedback, which is essential in the associative stage of skill acquisition (Fitts and Posner, 1967). By helping learners understand the relationship between visual inputs, vehicle control, and the outcomes of their actions based on Episodic Knowledge, the retention of driving skills can be effectively promoted.

In summary, the pre-learning phase emphasized speed management to free up Working Memory capacity, enabling learners to focus on predicting vehicle position and orientation. During practice and feedback, learners were guided to understand the relationship between visual information and vehicle control based on the outcomes of their actions.

4.4 Formalizing Instructional Content Based on Learner Drivers' Behavior

The differences between participants who successfully acquired the skills and those who did not are analyzed, focusing on two key points: intermittent stopping, and fine steering adjustments. This discussion particularly emphasizes intermittent stopping related to speed management, which was a primary focus of instructor guidance.

Based on the instructors' guidance, this behavior was effective for skill acquisition in two main ways during subsequent practice sessions. First, intermittent stopping allowed participants to focus on key visual targets and allocate more working memory capacity to processing visual information, such as predicting vehicle position and orientation within the S-curve. After resuming movement, participants could concentrate on vehicle control based on their prior predictions, which improved their overall performance.

Second, as illustrated in Figure 7(c), intermittent stopping enabled participants to verify whether their predicted vehicle position and orientation matched the actual vehicle behavior during short-distance movements. This process facilitated more accurate execution of steering corrections, as emphasized in the instructional content.

4.5 Formalization of Instructional Methods in Pre-Learning

Based on the identified information processing characteristics of learner drivers, pre-learning instructional methods are summarized in Table 1. For lane changes, memorizing the steps in a verbalized format and practicing them in a stationary vehicle facilitates their transformation into procedural memory, making it easier to convert the information into procedural memory. For S-curve navigation, both procedural and speed management information are retained as Semantic Knowledge, with intermittent stopping used to optimize working memory for predicting vehicle position and orientation, as well as executing corresponding maneuvers.

5 CONCLUSION

This study aimed to formalize instructional methods in driving education by focusing on the information processing characteristics of learner drivers. Specifically, the effects of pre-learning instruction on skill

Table 1: Formalization of pre-learning instructional methods.

Category	Objective	Reason
Lane Change	Memorize procedural information in a verbal format and practice in a stationary state.	To allocate sufficient working memory for converting actions into motor outputs.
S-Curve Navigation	Memorize low-speed control with intermittent stops.	To allocate working memory for predicting vehicle position and orientation, and for associated operations.

acquisition were experimentally evaluated, and the instructional content was analyzed based on instructors' guidance. As a result, the instructional methods were formalized as follows: For tasks like lane changes, which require the accurate execution of procedures at a consistent speed, procedural steps are retained in a verbalized format and practiced in a stationary vehicle, facilitating their transformation into procedural memory. For tasks such as S-curve navigation, which involve vehicle control on narrow roads, procedural information must be accompanied by speed management strategies - specifically intermittent stopping - to allocate working memory during practice and encourage the prediction of vehicle position and orientation.

In summary, this study focused on the information processing characteristics of learner drivers and successfully formalized instructional methods for pre-learning by evaluating its impact on skill acquisition. However, this study was limited to pre-learning and did not address the formalization of instructional methods for practice and feedback phases. Additionally, the analysis was restricted to lane changes and S-curve navigation, leaving the generalizability to other tasks unverified. Future work will focus on formalizing instructional methods for practice and feedback phases and integrating them into a comprehensive instructional design, followed by evaluating its effectiveness.

ACKNOWLEDGEMENTS

We would like to express our gratitude to Minami-Fukuoka Driving School for providing their facilities as the experimental site for this study.

REFERENCES

Crundall, D., Howard, A., and Young, A. (2017). Perceptual training to increase drivers' ability to spot motorcycles at t-junctions. *Transportation Research Part F: Traffic Psychology and Behaviour*, 48:1–12.

Duan, G.-J., Yan, X., and Ma, H. (2019). An intelligent driver training system based on real cars. *Sensors*, 19(3).

Fitts, P. M. and Posner, M. I. (1967). *Human Performance*. Brooks/Cole, Belmont, CA.

Guadagnoli, M. A., Kohl, R. M., and Lee, T. D. (1992). The contribution of verbalization to action: A multiple memory systems analysis. *Journal of Motor Behavior*, 24(1):86–91.

Handa, K., Muraki, T., Miyazaki, W., Ishihara, K., Egami, Y., and Matsuki, Y. (2023). Development of remote driving instruction system based on autonomous driving technology. *Proceedings of the JSAE Annual Congress (Web)*, 2023(Autumn):Paper No. 256 (Web Only).

Land, M. F. and Lee, D. N. (1994). Where we look when we steer. *Nature*, 369(6483):742–744.

Moreno, R. and Mayer, R. (2007). Interactive multimodal learning environments. *Educ Psychol Rev*, 19:309–326.

Nakahira, K. T., Fukami, Y., and Akahane, M. (2011). Verification of the effectiveness of blended learning in teaching performance skills for simultaneous singing and piano playing. In Riaz, Z., editor, *Biometric Systems*, chapter 11. IntechOpen, Rijeka.

National Police Agency (2022). Standard of instruction at designated driving dchools. https://www.npa.go.jp/laws/notification/koutuu/ \allowbreak{}menkyo/menkyo20220307_18.pdf. Accessed: 2024-12-17, In Japanese.

Nuruki, A., Shimozono, T., Kawabata, T., Yamada, M., Yunokuchi, K., and Maruyama, A. (2011). A study on feature of eye tracking in difference of skill level during observational learning of movement. *IEEJ Transactions on Electronics, Information and Systems*, 131(1):182–189. Accessed: 2024-12-17, In Japanese.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2):257–285.