How Visual Information Affects Motivation in the Context of a Simulator Driving Test Failure

Alicia Bernsland[1], Birgitta Thorslund[2]

Linköping University, Department of Computer and Information Science,
Linköping, Sweden[1,2]

Abstract

Young drivers are overrepresented in crash statistics, often due to underdeveloped risk awareness and limited driving experience. Simulator-based training and testing tools, particularly those incorporating hazard perception and prediction, are increasingly being explored as supplements to traditional licensing methods. A Swedish initiative has introduced a simulator-based screening test aligned with the Goals for Driver Education (GDE) framework, with the potential to become a formal part of driver assessment. As implementation progresses, the design of feedback, especially following test failure, becomes critical for maintaining learner motivation and supporting reflective learning.

This study investigated how different levels of visual feedback after a failed driving test influence young drivers' motivation to learn. A total of 60 licensed drivers (aged 18–28) were randomly assigned to one of three interactive website prototypes that presented the same failed test result with varying degrees of detail and interactivity. Prototype A provided minimal feedback, Prototype B added a full-drive video and Prototype C included detailed video clips, reference demonstrations, and linked exercises. A mixed-methods approach was used, combining Likert-scale responses and open-ended survey questions, supported by optional follow-up interviews.

Quantitative analysis revealed that participants exposed to the highest level of feedback reported significantly greater motivation to learn and higher perceived sufficiency of feedback. Thematic analysis of qualitative responses highlighted the motivational value of clear visual structure, actionable information, and emotionally supportive features such as encouragement and progress tracking. Participants especially appreciated the ability to see their specific mistakes alongside examples of correct behavior.

These findings suggest that rich, interactive feedback can mitigate the demotivating effects of test failure by promoting self-awareness, reflection, and constructive emotional responses. Design features that support clarity, interactivity, and personalization are particularly effective in sustaining motivation. The study offers practical insights for the development of learner-centered feedback systems in simulator-based driver training and contributes to the broader understanding of how failure-related feedback can be optimized in high-stakes learning environments.

Keywords: *Driver Education, Traffic Safety, Feedback*

1. Introduction

Young drivers are widely considered a high-risk group [1-3], partly due to limited knowledge and risk awareness e.g. [4-5]. To address this, various approaches have been developed to supplement on-road driver training and improve risk awareness. For example, hazard perception and hazard prediction tests are commonly used in several countries to train and assess driver risk perception e.g. [6-7]. Driving simulators, widely accepted as effective training tools e.g. [8-9], have been proposed for certain elements of driver training and testing, with potential for better detection of risky driving behavior [10].

A recent Swedish initiative has introduced a simulator-based screening test that may become a required component of driver education [10]. Designed in collaboration with national transport agencies and traffic educators, the test including both hazard perception and hazard prediction is structured around the Goals for Driver Education (GDE) framework [11], particularly targeting the second level to complement on-road assessments. Evaluation by instructors and examiners confirmed that the test addresses all levels of the GDE model, supporting its value as an addition to existing licensing procedures [12]. Moving toward implementation, designing understandable and fair feedback for driver students who fail the test, is a critical next step to ensure motivation.

Errors and failures are inherent parts of the learning process, particularly in complex, real-world tasks such as driving. While failures represent undesired outcomes, errors refer to the behaviors or decisions that may lead to those outcomes [13-14]. Both are closely tied to emotional responses, which can significantly influence how individuals react to and learn from these experiences [15-17].

Research shows that failure often threatens a person's sense of self, leading to emotional defensiveness, reduced motivation, and disengagement from learning opportunities [16]. Feedback is a cornerstone of effective learning, offering individuals the opportunity to recognize their errors and adjust future behavior [18-19]. For feedback to be useful, it must be clear, timely, and grounded in observable actions rather than judgments about the learner's character [20]. Constructive feedback not only informs but also supports reflection and deeper understanding, especially when it fosters dialogue and shared goals between the feedback provider and recipient.

As driving simulators are being considered for integration into the Swedish driving test, there is a growing need to develop effective feedback systems that accompany test results. In particular, feedback following test failures must be designed to support learning and sustain motivation. This study examines how drivers experience different forms of visual feedback following a driving test failure, and how these experiences influence their motivation to learn and improve.

2. Aim and Research Questions

The aim of this study was to address this underexplored context by investigating how information about an unexpectedly failed driving test can be visually presented to encourage continued learning and improvement. The following research questions were formulated for the context of failure:
RQ1: How are different levels of visual feedback experienced?
RQ2: What features of visual feedback promote motivation to learn?

3. Method

This survey-based study used a between-group design within a convergent mixed-methods framework. Quantitative data were collected via Likert-scale self-assessments, and qualitative insights were gathered through open-ended questions. Follow-up interviews were optional for further exploration.

3.1 Participants

A total of 60 participants, aged between 18 and 28 years, were recruited for this study using convenience sampling. Of these, 48% (n = 29) were men and 52% (n = 31) were women. All participants had held a driver's license for between 1 and 10 years. A recruitment letter was distributed to provide a brief overview of the study and its purpose. Participants were also informed of their right to withdraw from the study at any time without providing a reason.

3.2. Material

Three interactive website prototypes were created in Figma, each presenting a failed driving test with varying levels of information and interactivity. Prototype A (minimal feedback) included a list of the driver's violations and a general summary of areas for improvement, with no interactive elements. Prototype B added a full-length video recording of the drive to the elements in Prototype. Prototype C included all features from the previous prototypes, plus video clips of specific violations, reference videos demonstrating correct driving behavior, and interactive buttons linking to exercises related to each violation (see Appendix 1).

Recordings of complete simulator drives, specific traffic violations, and screenshots were generated to create the visual material for the prototypes. The simulator setup included a PC, three curved monitors offering a 120° field of view, a car seat, steering wheel, and pedals, all using the Logitech G920 model. This setup represented a simplified driving experience. The simulator software was developed by Skillster, a company specializing in vehicle training simulators (Skillster.se).

The survey began with demographic questions, followed by items evaluating the feedback in the prototypes, inspired by Tomita [21]. At first, there was an open-ended question: (1) *Describe your first impression of the feedback regarding its appearance.* This was followed by a series of Likert-scale questions, rated on a scale from 1 (strongly disagree) to 5 (strongly agree): (2) *Based on having just completed the driving test, how likely are you to agree with the statement: The visual design of the feedback helps motivate me to learn? (3) Based on having just completed the driving test, how likely are you to agree with the statement: The visual feedback is sufficient for me to feel motivated?* Participants could elaborate on questions (2) and (3) in open text fields.

3.2 Procedure

As the study was survey-based, materials were distributed via email and social media and completed on a computer. Before beginning, participants received written information about the study and their rights. They were then presented with a brief narrative designed to place them in context: imagining they had just completed the screening phase of the driving test and were about to view their results and feedback. After providing demographic information and consent for data storage, participants were shown a website containing visual feedback about a failed driving test. Once they had explored the site, they returned to the survey to answer the questions. The feedback website remained accessible throughout the survey. To ensure even distribution across conditions, participants were randomly assigned to one of the three prototype versions via a redirect link.

3.3 Analysis

Quantitative data from the Likert-scale responses were analyzed using one-way ANOVAs to compare the effects of each feedback prototype (*Low, Medium, High*) on *Perceived motivation to learn* and *Perceived sufficiency of feedback for motivation*. Responses to open-ended questions were analyzed using thematic analysis (Howitt, 2019). Emerging themes were used to support and contextualize the quantitative findings.

4. Results

The first research question, which explored participants' experiences with varying levels of visual feedback, was investigated through statistical analysis using SPSS. The second research question, focused on identifying visual feedback features that promote motivation to learn, was examined using thematic analysis.

4.1 Statistical Analysis

A statistically significant difference in *Perceived motivation to learn* was found between feedback groups, $F(2, 57) = 5.77$, $p = .005$, $\eta^2 = .17$. Bonferroni post hoc comparisons revealed that participants who received a high level of feedback reported significantly higher motivation scores than those in both the medium and low feedback groups. Refer to Table 1 for group means and Figures 1–2 for mean plots.

Table1. Means and Standard deviations (SD) for each group.

	Feedback Group	***Mean***	***SD***	***N***
Motivation to learn	Low	3.40	0.50	20
	Medium	3.55	1.32	20
	High	4.30	0.66	20
Sufficiency of feedback for motivation	Low	3.40	0.60	20
	Medium	3.15	0.88	20
	High	3.85	0.89	20

Similarly, there was a statistically significant difference between feedback groups for *Perceived sufficiency of feedback for motivation*, $F(2, 57) = 3.60$, $p = .034$, $\eta^2 = .11$. Post hoc tests showed that participants in the high feedback group rated the feedback as significantly more sufficient for motivation compared to those in the medium feedback group.

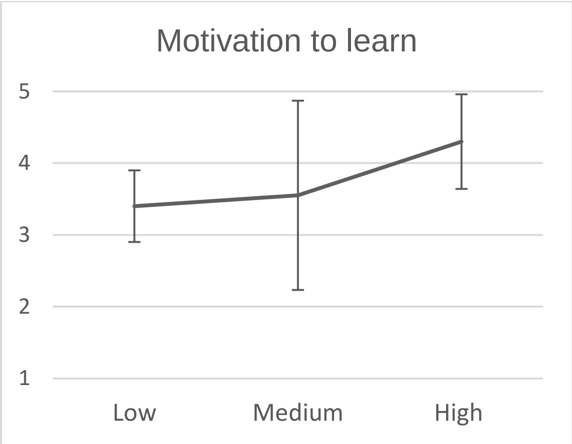

Figure 1. Means plot of Motivation to learn.

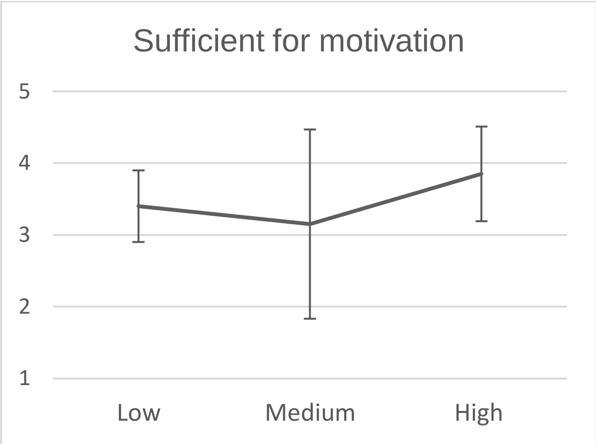

Figure 2. Means plot of Sufficiency of feedback for motivation**.**

4.2 Thematic Analysis

Participants generally appreciated the clarity of the feedback in prototype A, particularly in distinguishing between passed and failed subtasks. Color coding (e.g., red and green) and the summary box highlighting areas for improvement were cited as motivational. One participant compared the color-coded progress to the experience of playing a game, enhancing engagement. However, opinions were split on whether the feedback was sufficient for motivation. Some requested more detailed information, such as clickable subtasks, timestamps, and video explanations.

For prototype B, feedback was again described as clear, with terms like “relevant,” “pedagogical,” and “easy to navigate” frequently used. The design was perceived as professional, but some felt the full-drive video was too long and lacked specificity. Participants valued the subtask list and summary box but desired more actionable guidance (e.g., strategies rather than general advice). Suggestions included adding timestamps and showing required points to pass. As with Prototype A, responses were mixed regarding motivational sufficiency.

Participants praised the clarity and structure of the feedback in prototype C, which was seen as informative without being overwhelming. Many appreciated the instructional videos and the option to explore deeper insights. Motivating aspects included the visual summary of completed vs. failed subtasks and the ability to see correct driving behavior. However, some wanted written explanations to complement the videos, improve recall, and provide more concrete advice on skill improvement.

Participants offered several ideas to enhance motivation and usability, such as: A progress graph across multiple attempts, Encouraging phrases (e.g., “Great job!”) to soften failure feedback, Voice feedback (virtual or from an instructor) to increase credibility, Clarification or removal of fuel consumption statistics, A share button to save feedback for future reference, and Improved visual design (e.g., higher contrast, larger text).

5. Discussion

The aim of this study was to investigate how information about an unexpectedly failed driving test can be visually presented to encourage continued learning and improvement. In this section, the results are discussed for each research question respectively, followed by a methods discussion of strengths, limitations, and future work.

5.1 Experience of Different Levels of Visual Feedback

The quantitative findings indicate that higher levels of visual feedback, particularly those incorporating interactive features, are associated with increased motivation to learn. These results are especially relevant given the high-risk status of young drivers [1-3] and the possible integration of simulator-based testing into driver education programs in Sweden [10]. As the introduction highlights, addressing limited risk awareness among novice drivers is a key objective of modern training approaches. Feedback that allows learners to actively engage with test outcomes, such as reviewing specific violations or exploring corrective actions, may help mitigate the demotivating effects of test failure. This aligns with previous research emphasizing the importance of clear, behavior-focused feedback in promoting constructive emotional responses and learning engagement [16,20]. Within the GDE framework, these findings support the idea that interactive feedback can play a critical role in helping learners develop meaningful insights into their driving behavior.

5.2 Features of Visual Feedback Promoting Motivation to Learn

Thematic analysis of open-ended responses further highlights the features of visual feedback that support motivation, especially after failure. Participants emphasized the value of clear visual distinctions (e.g., color coding), structured summaries, and especially interactive elements such as timestamps, video clips of errors, and demonstrations of correct behavior. These features were described as enhancing clarity, emotional engagement, and understanding, which are factors that are particularly important for young drivers learning to interpret and respond to risk. The emphasis on actionable, personalized content aligns with the need for feedback that fosters reflection and supports the GDE framework's goal of self-awareness and risk evaluation [11]. Suggestions for additional motivational features, such as progress tracking, encouraging messages, and voice feedback, reflect a broader need for emotionally supportive design in simulator-based assessments. This is consistent with research on learning from failure, which highlights the importance of feedback environments that balance honesty with encouragement [15,17].

5.3 Method Discussion

While the study offers valuable insights into how different types of visual feedback influence motivation, several methodological limitations should be noted. First, the relatively small sample size limits the generalizability of the findings and may reduce statistical power. Future studies should aim to include a larger and more diverse participant group to strengthen the robustness of the results. Second, the use of self-reported ratings introduces potential bias, as participants' motivation levels may be influenced by social desirability or limited self-awareness. Incorporating behavioral measures, such as engagement with follow-up exercises or performance in subsequent tests, could provide a more objective assessment of motivation and learning. Despite these limitations, a key strength of the study is its mixed-methods approach, which allowed for both statistical analysis and deeper qualitative insight. Future work should explore how feedback features influence long-term learning outcomes and investigate the role of emotional responses in real-time interactions with simulator feedback.

6. Conclusions

Higher levels of interactive visual feedback were found to significantly enhance learner motivation, suggesting that detailed, engaging formats are more effective than basic summaries in supporting learning after failure. Participants identified clarity, interactivity, and emotional support as key motivational features of feedback, highlighting the importance of feedback design that is both informative and learner-centered. This study contributes to the growing body of research on simulator-based driver training by providing empirical evidence on how feedback design influences motivation, offering concrete design principles to guide the development of future learning tools within licensing systems.

REFERENCES

[1] Banz, B. C., Fell, J. C., & Vaca, F. E. (2019). Complexities of young driver injury and fatal motor vehicle crashes. *Yale Journal of Biology and Medicine, 92*(4), 725–731.
[2] Elvik, R. (2010). Why some road safety problems are more difficult to solve than others. *Accident Analysis and Prevention, 42*(4), 1089–1096. https://doi.org/10.1016/j.aap.2009.12.020
[3] Walshe, E. A., McIntosh, C. W., Romer, D., & Winston, F. K. (2017). Executive function capacities, negative driving behavior and crashes in young drivers. *International Journal of Environmental Research and Public Health, 14*(11), 1314. https://doi.org/10.3390/ijerph14111314

[4] Fisher, D. L., Pollatsek, A. P., & Pradhan, A. (2006). Can novice drivers be trained to scan for information that will reduce their likelihood of a crash? *Injury Prevention, 12*(Suppl. 1), i25–i29. https://doi.org/10.1136/ip.2006.012021
[5] McKnight, A. J., & McKnight, A. S. (2003). Young novice drivers: Careless or clueless? *Accident Analysis and Prevention, 35*(6), 921–925. https://doi.org/10.1016/S0001-4575(02)00100-8
[6] Crundall, D., Van Loon, E., Baguley, T., & Kroll, V. (2021). A novel driving assessment combining hazard perception, hazard prediction and theory questions. *Accident Analysis & Prevention, 149*, 105847. https://doi.org/10.1016/j.aap.2020.105847
[7] Ventsislavova, P., Crundall, D., Baguley, T., Castro, C., Gugliotta, A., Garcia-Fernandez, P., Zhang, W., Ba, Y., & Li, Q. (2019). A comparison of hazard perception and hazard prediction tests across China, Spain and the UK. *Accident Analysis & Prevention, 122*, 268–286. https://doi.org/10.1016/j.aap.2018.10.010
[8] Bates, L., Rodwell, D., & Matthews, S. (2019). Young driver enforcement within graduated driver licensing systems: A scoping review. *Crime Prevention and Community Safety, 21*(2), 116–135.
[9] Casutt, G., Theill, N., Martin, M., Keller, M., & Jäncke, L. (2014). The Drive-Wise Project: Driving simulator training increases real driving performance in healthy older drivers. *Frontiers in Aging Neuroscience, 6*, 85. https://doi.org/10.3389/fnagi.2014.00085
[10] Thorslund, B., Thellman, S., Nyberg, V., & Selander, H. (2024a). Simulator-based driving test prescreening as a complement to driver testing – Toward safer and more risk-aware drivers. *Accident Analysis and Prevention, 194*, 107335. http://doi:10.1016/j.aap.2023.107335
[11] Hatakka, 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. https://doi.org/10.1016/S1369-8478(02)00018-9
[12] Thorslund, B., Thellman, S., & Selander, H. (2024b). An evaluation of driver education goal fulfillment in a simulator-based driver screening test. *Proceedings of the 19th SweCog Conference, October 10–11, Stockholm, Sweden*, 155–160.
[13] Zhao, B., & Olivera, F. (2006). Error reporting in organizations. *Academy of Management Review, 31*(4), 1012–1030. https://doi.org/10.5465/amr.2006.22528167
[14] Dahlin, K., Roulet, T., & Chuang, Y. T. (2018). Opportunity, motivation and ability to learn from failures and errors: Review, synthesis, and the way forward. *The Academy of Management Annals, 12*(1), 252–277. https://doi.org/10.5465/annals.2016.0049
[15] Zhao, B. (2011). Learning from errors: The role of context, emotion, and personality. *Journal of Organizational Behavior, 32*(3), 435–463. https://doi.org/10.1002/job.696
[16] Eskreis-Winkler, L., & Fishbach, A. (2019). Not learning from failure—The greatest failure of all. *Psychological Science, 30*(12), 1733–1744. https://doi.org/10.1177/0956797619881133
[17] Taylor, S. E. (1991). Asymmetrical effects of positive and negative events: The mobilization-minimization hypothesis. *Psychological Bulletin, 110*(1), 67–85. https://doi.org/10.1037/0033-2909.110.1.67
[18] Bhattarai, M. D. (2007). ABCDEFG IS – The principle of constructive feedback. *Journal of the Nepal Medical Association, 46*(167), 151–156. https://doi.org/10.31729/jnma.293
[19] Hesketh, E. A., & Laidlaw, J. M. (2009). Developing the teaching instinct – 1: Feedback. *Medical Teacher, 24*(3), 245–248. https://doi.org/10.1080/014215902201409911
[20] Jug, R., Liang, X., & Bean, S. M. (2018). Giving and receiving effective feedback: A review article and how-to guide. *Archives of Pathology & Laboratory Medicine, 143*(2), 244–250. https://doi.org/10.5858/arpa.2018-0058-ra
[21] Tomita, K. (2017). Does the visual appeal of instructional media affect learners' motivation toward learning? *TechTrends, 62*, 103–112. https://doi.org/10.1007/s11528-017-0213-1

Appendix 1 Prototype C with the highest level of feedback

Figure 3. First screen of Prototype C with the highest level of feedback. Like Prototype A, it displays a list of violations and a summary of improvement areas. Unlike A, it includes the button “Watch your driving and do exercises.” In Prototype B, this button appears as “Watch your driving” only, without links to exercises.

Figure 4. Second screen of Prototype C with the highest level of feedback. Like Prototype B, it includes a full-length drive video. In addition, it features clips of specific violations, reference videos of correct behavior, and interactive buttons linking to related exercises. Prototype A does not include this screen.