Educational Videos Production and Questionnaire Survey for Automotive Repair Painting Engineers

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Automobile repair helps restore damaged car bodies to their original shapes and colors. As all body damage is different, repair engineers must be highly skilled in their craft. In this study, the features of automobile repair painting work by skilled engineers were digitized using three-dimensional motion analysis and film thickness meters, and YouTube videos for engineer training were produced using the numerical data. A questionnaire survey for automobile repair painting engineers who watched the YouTube videos was conducted to clarify the impression of the videos of the engineers in the position of teaching and those who were not in a position to teach. While most respondents found the videos helpful, less than half of respondents answered that problems with their regular painting job were solved.

Keywords: Automotive Repair, Painting, Tacit knowledge, Educational Videos, YouTube, Questionnaire Survey

Introduction

Current state of the automobile repair industry in Japan

Automobile repair is the work of restoring damaged car bodies to their original shape and color. As each damaged vehicle delivered to the repair shop is different, repair work changes according to the damage. The most difficult part of automobile repair is performing different work every time. As repair work is often done by hand, it takes about 10 years to become a full-fledged engineer specialized in repair work Car repairs are done in factories near the outdoors, where organic paint is sprayed with spray guns. Further, the compensation for repair depends heavily on the assessment of the auto insurance company, and it is difficult for skilled engineers to be fairly evaluated. Due to these factors, the number of young people working in the automobile repair industry is decreasing in Japan, and the generational transfer of techniques is becoming a major problem.

Previous research and objectives

In Japan, automobile repair work is learned at a vocational school or as part of on-the-job training (OJT). Few young people start working after studying at vocational schools. Many young people who work as car repair engineers today find jobs at car repair shops after graduating from high school and learn their skills there. Therefore, to continue working, it is important to learn repair skills in an automobile repair shop within a few years of employment. However, as auto repair engineers are not instructors, it becomes very difficult to teach tacit knowledge such as the knack of work. Inevitably, many operations still rely on being taught to "see and steal." To improve this kind of education in the factory, books have been published that introduce the essentials and the working methods of various skilled workers. In addition, many car repair videos have been uploaded on video sites in recent years, with the goal of helping young engineers.
In this study, we used measuring instruments to clarify individuals' implicit tacit knowledge. Among automobile repairs, sheet metal work and painting work require a lot of manual operation and are difficult to learn. The motion of engineers in painting work was measured by three-dimensional motion analysis equipment, gripping force meters, or eye trackers. From these data, the characteristic actions of only experienced engineers were extracted. In automobile painting, block painting (painting a whole part) of doors was taken as an object, and skilled engineers' characteristics were extracted (Ikemoto et al., 2016; Takai & Ikemoto, 2019). Furthermore, video teaching materials were produced using the extracted data, and the trends of the viewers were investigated (Ikemoto et al., 2017). The purpose of this study is to clarify what makes better video teaching materials for the transfer of technique. Based on the results of the viewer trend survey in the previous research (Ikemoto et al., 2017), the authors conducted an evaluation questionnaire for painting engineers on newly produced videos.

Research Design & Methods

Production of video content

The data used as the content of the teaching videos was the experimental data for block painting on car doors, which was clarified in the previous research (Ikemoto et al., 2016; Takai & Ikemoto, 2019). In this experiment, five experts with 20 or more years of experience and five non-experts with three or less years of experience were instructed to finish block painting with white paint within 30 minutes. Fig. 1 shows the experiment. The block painting is completed by gradually moving the spray gun up or down while moving it to the left and right to the edges of the door. To achieve a uniform finish, various factors are involved, such as the distance between the spray gun and the door, speed, angle, and travel distance.

The video was produced with an active auto repair paint expert, and production proceeded while the expert's opinions were given. The content produced in this study was set to be less than five minutes each because previous research showed that videos peaked at around five minutes in viewership, and because many young Japanese people are more familiar with short videos on social media.

Data used for the content were selected from a) Standing position, b) Axillary and elbow angle, c) Spray gun angle, d) Spray gun trajectory, e) Spray gun running speed, f) Spray gun gripping force, g) Film thickness of after painting, h) Video of an expert painting, and i) Video of a non-expert painting. Based on these data, eight videos shown in Table 1 were produced. Due to the strong relationship between the data of e) Spray gun running speed and f) Spray gun gripping force, the fifth video is called "Spray gun speed." As for the data of the sixth video, g) Film thickness of after painting is used, but the film thickness was measured to check whether the paint was uniformly applied to the whole door panel, so the title was "Finished."

The videos were produced using Microsoft's PowerPoint presentation software and a free video-editing software called Aviutl. Fig. 2 shows a scene from the video created using PowerPoint and Aviutl. For ease of listening, the narration was read aloud using Ondokusan (COMOMO Co., Ltd.), a Japanese voice reading software. This video only uses voice narration and does not use illustrations or computer graphics. The resulting videos were published on YouTube (https://www.youtube.com/channel/UCzIkH4HKDOshmsg4yY5NkFQ).

Figure 1

Experimental photo

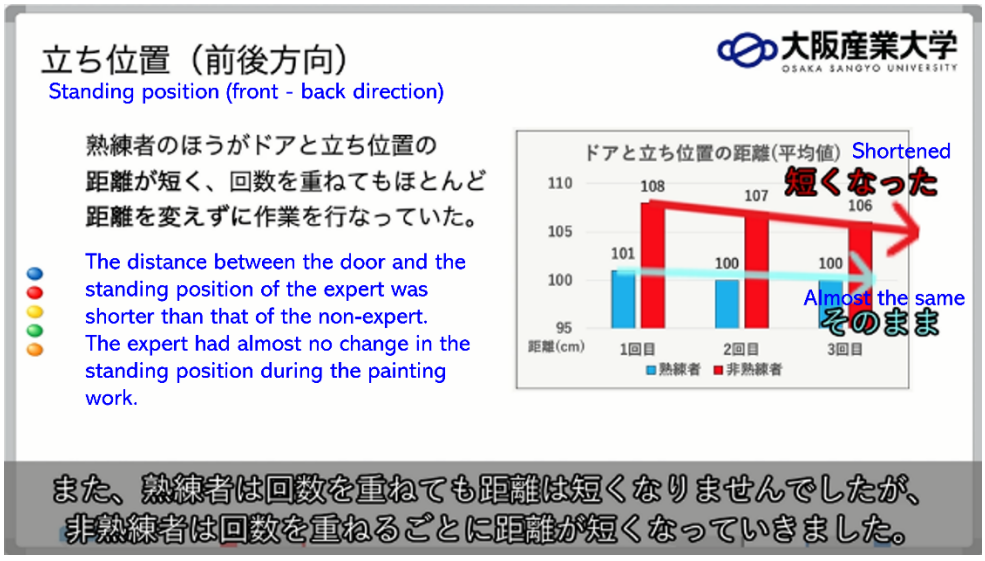
Table 1

Contents of the created videos

Video number	Contents
1	Standing position
2	Arm movement
3	Spray gun angle
4	Spray gun trajectory
5	Spray gun speed
6	Finished
7	Work of an expert
8	Work of a non-expert

Figure 2

Scene from the first video



Evaluation of videos

The questionnaire was created using a Google form and used to evaluate the videos. This questionnaire was conducted on the condition that the respondents were involved in automobile repair painting and that they could answer the questionnaire after viewing all the videos. Therefore, automobile repair shops that had cooperated with this research in the past were asked to answer the questionnaire. This experiment was approved by the ethics review of Osaka Sangyo University. The purpose of the questionnaire was explained in writing to the participants, and informed consent was obtained.

The questionnaire items are shown in Table 2. This questionnaire used a bifurcated structure so that the respondents could be asked different questions afterwards depending on whether they were “in a position to teach” or “not in a position to teach.”

Table 2

Questionnaire Items

Question No.	Question content / Choices							
Q1	How many years of experience do you have in automobile repair block painting?							
	Less than a year	1–2 years	3–4 years	5–9 years	10–19 years	20–29 years	30+ years	Other car repair painting work
Q2	Are you in a position to teach block painting to others?							
	In a position to teach				Not in a position to teach			
Q3-1	By watching this video, have you solved the problem in your usual painting work?							
	Solved				Did not solve			
Q4	If you answered "solved" in the above question, what did you solve?							
	Free description							
Q5	Does this video seem useful when teaching others?				Is this video useful for self-study of painting work?			
	Useful	Somewhat useful		Neither	Somewhat useless		Useless	
Q6	Which video helped you the most?							
	1	2	3	4	5	6	7	8

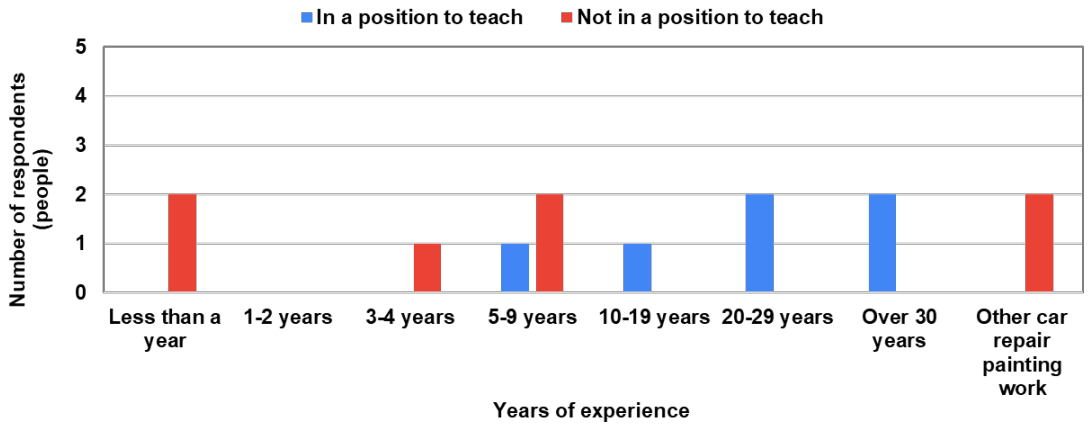
Results

Respondent attributes

For the moving image evaluation questionnaire, 13 people responded. Of the respondents, six were in teaching positions and seven were engineers not in teaching positions. Fig. 3 shows the respondents' painting experience. Respondents who were in a teaching position had more than five years of painting work experience. Respondents who were not in a teaching position had less than nine years of painting work experience. Two of the respondents who were not in a teaching position were engaged in automobile repair work other than painting. Respondents who selected five to nine years of work experience were in both teaching and non-teaching positions.

Figure 3

Career of respondents

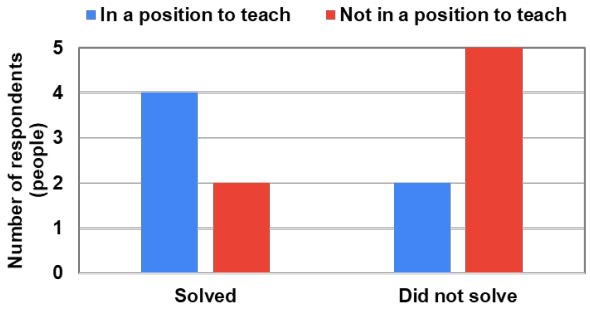


Answers to whether the problem was solved

Fig. 4 shows responses to the question "By watching the video, have you solved the problem of usual painting work?" Many of the respondents who answered that they had solved the problem were in a teaching position. Many of the respondents who answered that it was not solved were not in a teaching position. All the people who responded to the open-ended question of what was solved were in a teaching position. They described their responses as follows: "I knew how to teach"; "All items necessary for uniform spraying were analyzed and the work was explained"; "Spray gun control to stabilize film thickness."

Figure 4

Answers to "By watching the video, have you solved the problem of usual painting work?"



Answers on videos' usefulness

Fig. 5 shows the answer to "Is this video useful?" Those who were in a teaching position were asked "Does this video seem useful when teaching others?" and those who were not in a teaching position were asked "Is this video useful for the self-study of painting work?" One person in both the teaching position and the non-teaching position answered "Neither." All other respondents answered with "useful" or "somewhat useful." Those who were in a teaching position all answered "useful" except for one who answered "neither."

Fig. 6 shows the answers to the most useful video. As for those who were in a teaching position, two people each selected the third and eighth videos, and one person each selected the fourth and seventh videos. For those who were not in a teaching position, three people selected the fourth video, two people selected the seventh video, and one person selected the first video and the third video.

Figure 5

Answer when asked "Is this video useful?"

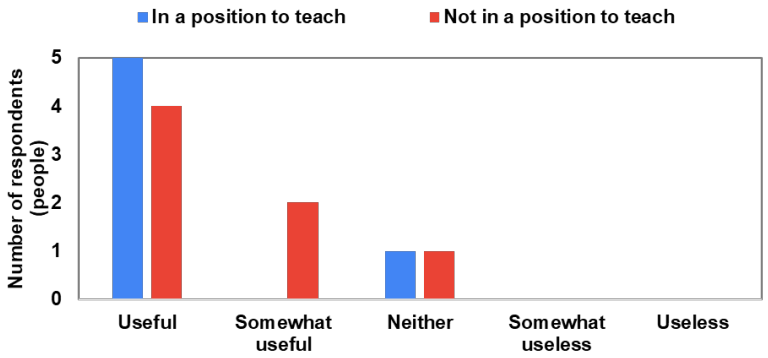
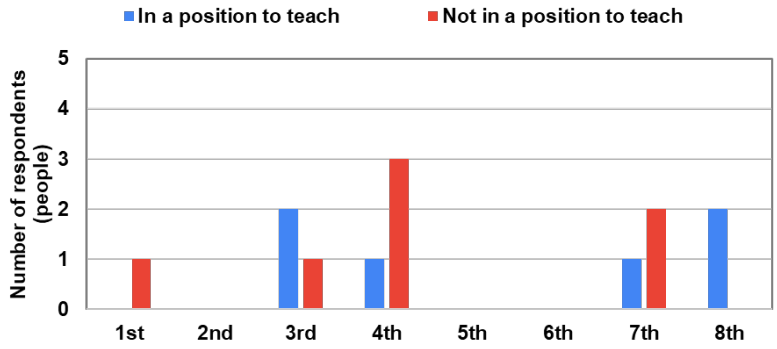


Figure 6

Answer when asked "Which video helped you most?"



Discussion

Previous experiments have shown that it takes about 10 years to go from engineer to expert. When asked whether they were in a teaching position, the answers were divided into those who were in a teaching position and those who were not, depending on whether they had taught for five to nine years or less. From this, it can be inferred that it is useful to recruit skilled workers with more than 10 years of work experience and unskilled workers with less than three years of work experience. The videos were useful to many respondents, but fewer than half had their issues resolved. In responses for the eighth video, which was the most useful and explained "work of a non-expert," it proved useful only for people who were in a teaching position. It became clear that the focus of the work was different for people who were in a teaching position and people who were not in a teaching position. Based on these findings, it was inferred that it would be necessary to produce videos with the input of not just one expert but several experts and non-experts to create teaching materials that satisfy more engineers. Not all of the research is available in these videos, so a few experts and non-experts could come together to create new videos that solve some of the problems engineers have with their regular work.

Conclusion

For the purpose of clarifying the ideal way of which training material is better for the technology succession of automobile repair painting, the video which included the features of the expert obtained in the experiment was produced, and the evaluation questionnaire to the painting engineer who watched the video was carried out. While most respondents found the videos helpful, less than half of respondents answered that problems with their regular painting job were solved. Based on these findings, it was inferred that it would be necessary to produce videos with the input of not just one expert but several experts and non-experts to create teaching materials that satisfy more engineers.

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