ORIGINAL ARTICLE

EVALUATION OF EFFECTS OF DIFFERENT TYPES OF MACHINE'S TUTORIALS ON HANDS-ON LEARNING PERFORMANCES

Mohd Mustaqim HASHIM[1], Muhamad Fakhruddin NOOR ZAINAN[1], Mohd Raziff MAT HASSAN[2], Ammar ADNAN[3], Radin Zaid RADIN UMAR[4], Siby SAMUEL[5],Mohd Hanafi ANI[1], Malek HAMID[1,*]

[1]Department of Manufacturing and Materials Engineering, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[2]Faculty of Science & Technology Open University Malaysia, Kuala Lumpur, Malaysia
[3]SimplyErgo Consultancy, Kedah, Malaysia
[4]Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia
[5]Department of System Design Engineering, University of Waterloo, Ontario, N2L 3G1, Canada

[*] Corresponding Author: abdmalek@iium.edu.my

ABSTRACT

Tutorial is a medium instruction to transfer knowledge and one of its applications is to provide instruction on how to use appliances, devices, or systems. Currently, only a few studies have been done on which type of medium of instruction is better for engineering machinery. Thus, for this study, the aim is to obtain a suitable type of tutorial instructions for engineering machinery. In order to achieve it, the following objectives need to be met; (i) to evaluate the effects of different types of medium of instructions for machines - manual handbook and video tutorial - on hands-on learning performance in overall and; (ii) to evaluate the effects of medium of instructions for machines on hands-on learning performance based on - safety, equipment, procedure and housekeeping. Thirty-two participants ranging between 19-20 years of age were randomly assigned into two groups – Video tutorial and Manual handbook. The video tutorial groups were exposed to four video tutorials while the Manual handbook groups were given a manual handbook. Then, participants were evaluated by performing four hands-on tasks. From the finding, there was a significant different in the hands-on learning performance between the Video tutorial group (M=95.313, SD=7.739) and Manual handbook group (M=62.500, SD=15.138) conditions; t (30) = -7.720, p < 0.0001. For the criteria; in safety; video (M=100, SD=0) and handbook (M=81.25, SD=25) are significantly difference with t (15) = -3.00, p = 0.009. In procedure; video (M=87.500, SD=28.867) and handbook (M=25.000, SD=40.824) are significantly difference with t (30) = -5.000, p < 0.0001. In housekeeping; video (M=100.00, SD=0.00) and handbook (M=65.625, SD=47.324) are significantly different with t (15) = -2.905, p = 0.011. In equipment; video (M=93.750, SD=17.078) and handbook (M=78.125, SD=31.457) are marginally significant difference with t (23) = -1.746, p = 0.094. In conclusion, using video as a medium of instruction helps participant to perform better in hands-on task of the engineering machinery compared to manual handbook.

Keywords: *Machine's tutorial, Manual hand book, Video tutorial, Hands-on, Learning performance*

INTRODUCTION

Tutorial is a means of transferring knowledge and may be used as a part of learning process. It seeks to teach by example and provide enough information in completing a task. Thus, making it more interactive and specific than a book or a lecture (Qin, 2011). In this study, the focused is on the two-common medium of instructions, which are manual handbook and video tutorial. Manual handbook is a written reference material used by leaners as guidance in completing a certain designated task (Willis, 2007). It consists of step-by-step instructions that depends on well-written explanation also supported by photographs, schematic drawings and graphical illustrations. Manual handbook is more towards the conventional way of teaching and may be hard to understand and follow. On the other hand, video tutorials can be effective in supplying the user with general and thorough information, instructions and step-by-step process on a certain procedure (Ponzanelli et al., 2016). Currently, the popularity of video tutorials in the teaching worlds has been blooming and widely used for academic purposes, since making content on a video has become a lot easier (Jenkins et al., 2011; Lin, Zimmer & Lee, 2013; van der Meij, 2014).

As the world is advancing into a new tech world, the use of video for tutorial purposes has outweigh the paper based. Several studies have been conducted to compare the effectiveness between paper-based tutorial (manual handbook) and video tutorial for learning purposes. Among them were; software training (van der Meij, 2014); Microsoft Words (Alexander, 2013); problem-based learning (Chan et al., 2010) and; comparing the four conditions (paper-based tutorial, video-based tutorial, paper and video-based tutorial and no instructions) for procedural knowledge (Payne, Chesworth & Hill, 1992).

In general, there are many advantages of using video tutorials in comparison to paper-based tutorial, such as, provide more superior and interactive way of teaching in terms of practical

skills (Donkor, 2010), congruency between a recorded demonstration and real task execution (Shippey et al., 2011) and provide a better understanding of a subject matter through stimulating the auditory and visual system (Leahy & Sweller, 2011). However, there are also a few advantages of paper-based, for instances the speed of processing information depends on the user-paced and it is equipped with structural overviews that enhance the accessibility of its content, in which it can be difficult to access in video (van der Meij, 2014; Alexander, 2013). For this paper, the focus is on the transfer of knowledge (theory application) from both medium into hands-on application. Hands-on knowledge is generally acquired by personally involve in applying the knowledge that has been learnt rather than just having the knowledge.

Although there are advantages of both methods in learning performance, in terms of learning engineering machinery, there is no specific information regarding the preferable methods to optimize the hands-on learning performance. Hence, it is essential to study the effect of these different types of tutorial instructions for the optimum hands-on learning performance.

The aim of this study is to obtain a suitable type of tutorial instructions for engineering machinery. So, in order to achieve it, the following objectives need to be met; (i) to evaluate the effects of different types of medium of instructions for machines - manual handbook and video tutorial - on hands-on learning performance in overall and; (ii) to evaluate the effects of medium of instructions for machines on hands-on learning performance based on - safety, equipment, procedure and housekeeping. housekeeping.

METHODS

Participants

Thirty-two participants ranging between 19-20 years of age were recruited for this study. They were undergraduate students from Faculty of Engineering at the International Islamic University Malaysia (IIUM). The population of interest were the engineering student in IIUM. This is to ensure that participants have basic knowledge on machining operations. Furthermore, the chosen participants were make sure that they have never taken the Workshop Technology course – to control the familiarity among participants. Ethnic background, first language and minority status were not taken into account in the study.

Apparatus & Stimuli

Machines: The machines that were used in the experiment are Lathe machine (Figure 1 below), Arc welding machine (Figure 2 below), Bench work (Figure 3 below) and CNC milling machine (Figure 4 below). All four machines were included in the Workshop Technology course.

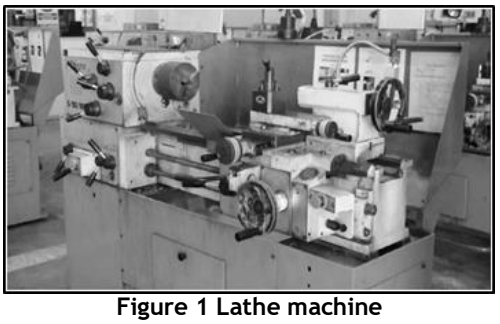

Figure 1 Lathe machine

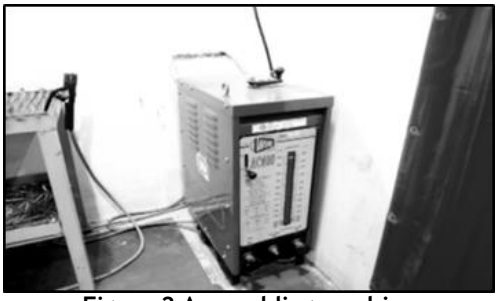

Figure 2 Arc welding machine

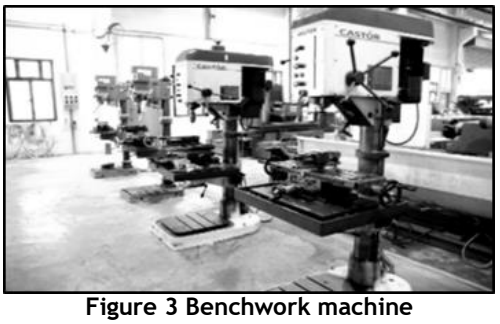

Figure 3 Benchwork machine

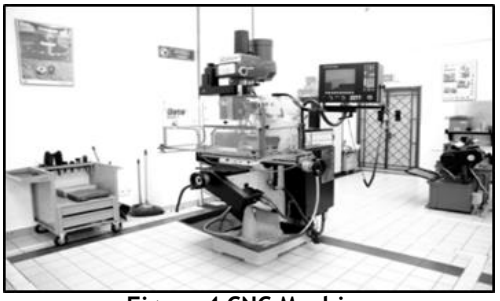

Figure 4 CNC Machine

Medium of Instructions: There are two medium of instructions – manual handbook and video tutorial – were used in the experiment. The manual handbook provides information and manual instructions on how to operate all four machines for the purpose of this experiment. While for the video tutorial, the instructions were developed in a video tutorial form by the researcher. Four criteria - safety precautions, equipment, experimental procedure and housekeeping - were considered during the preparation of video tutorial. In safety precautions, all the safety aspects and procedures to be practiced in the experiment were addressed. For example, on and off switch for spindle rotation must be correctly activated

for user safety (Figure 5 below). For the equipment used in the experiment, all the tools used were familiarized. For instance, in bench work experiment, Vernier caliper, L-block and threading tools were introduced. In the procedure, a step-by-step process in explaining the machine operation was introduced. Lastly, for housekeeping, proper procedures to clean up the workspace after the experiment were shown.

In explaining the video tutorial, a laptop - Lenovo Z40 - was used. The same laptop was used throughout the experiment to maintain the quality of the video tutorials. In addition, an earphone – Apple earpods – was used to minimize the surrounding noise and maintain the audio quality of the video.

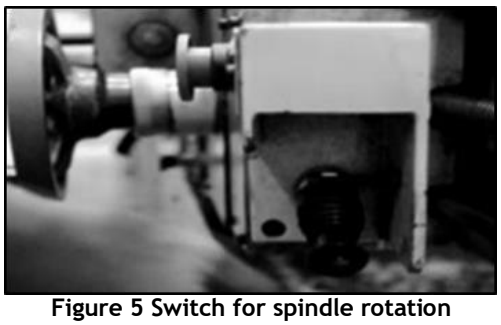

Figure 5 Switch for spindle rotation

Assessment Test: A set of assessment form consisting four parts – one part for each machine - was designed. In each part, contain four tests - safety, equipment, procedure, and housekeeping. Three students from the Ergonomics Laboratory have been asked to serve as pilot participants for the test. This was done to ensure the instructions was clearly understood by the participant.

Administrative Forms: In this study, four types of administrative form - (i) informed consent form (ii) participant form (iii) assessment form and (iv) payment voucher - were used.

For informed consent form, it was used to obtain participant's approval before the experiment started. The participant form was used to record the demographic data of the participant – age, gender and nationality. Next, the assessment form was used to record the data of each participant after the assessment was done. Lastly, the payment voucher form was used to record the detail regarding the payment made to the participants.

Experimental Design

In general, the experiment was conducted on Monday, Tuesday, Wednesday, and Thursday only. Weekends and Friday were excluded in the experiment. This is to avoid any potential factoring effect on the participant performance (i.e. Participant's lifestyle may be different. Thus, a different performance may be shown). The experiment was conducted between 2:00 p.m. to 5:00 p.m. to ensure that the level of comprehension among the participant was similar.

The machine and medium was randomly assigned to each participant based on their time of arrival. The manual handbooks and tutorial videos were labelled as A, B, C, and D for Lathe machine, Arc welding, Bench work, and CNC milling respectively. The participants were label M for man and F for female. Each machine has eight participants that consist of four participants (two males and two females) for the Manual handbook group and the other four participants (two males and two females) for the Video tutorial group. The arrangement of the randomly assigned group is shown in Table 1 below.

Table 1 Arrangement of the randomly assigned group

Group	A	B	C	D
Manual handbook	M1	M3	M5	M7
	M9	M11	M13	M15
	F1	F3	F5	F7
	F9	F11	F13	F15
Video tutorial	M2	M4	M6	M8
	M10	M12	M14	M16
	F2	F4	F6	F8
	F10	F12	F14	F16

In explanation, as can be seen in Table 1 above, for each group - Manual handbook and Video tutorial, the first participant of both genders was assigned to the manual handbook group, then the second participant to the video tutorial group, so on and so forth. This is to ensure that if the target total participants cannot be obtained, the experiment can always be stopped while maintaining the balance of the distribution of participant into the two groups is followed. The same concept applies to the distribution of participant among the machines.

Procedure

The procedure of the experiment was classified into two phases – (i) manual or video tutorial session and (ii) assessment session.

Manual or Video Tutorial Session: Before the experiment was started, participant was given a consent form to be read, in order to have a better understanding regarding the experiment that will be conducted. After participants finished reading the form, he or she can provide their consent in participating for the experiment. Then, participant was asked to sign the form.

Next, participant was asked to complete the participant form, and all the data obtained is recorded in a file and kept in the locked cabinet in the laboratory for future use.
After that, participant was pseudo-randomly assigned into either Manual handbook group or the Video tutorial group. The advantage of this is participants were distributed evenly between the two groups at any given time.

Lastly, participant was briefed on the purpose of the experiment in general, and the procedure during the experiment conducted. Participant was informed that he or she will have to read the manual handbook or watch video tutorials on a laptop (video tutoring session) and he or she will be assessed (assessment session) to complete the experiment. For the manual handbook group, participant was placed in a quiet room and was informed that he or she will have to read the manual handbooks. For the video tutorial group, participant was informed that he or she will be watching video tutorials and was equipped with a headphone. In addition, they were informed not touch any keys on the laptop during the video tutoring session – i.e. a participant should only watch the videos without controlling the video stream. Time allocated for both groups was twenty minutes to finish the session. The allocation of the time is based on the duration of the video tutorials.

Assessment Session: During the video session, participant was asked to watch the assigned video tutorial (based on the group and machine type assigned) for 15 minutes.

Assessment Session: After the first session was completed, participant was tested by answering the assessment form that needed to be completed in ten minutes. This completed the second phase of the experiment. The allocated time for both session was thirty minutes.

Upon completing the session, participant was asked to filled out a payment voucher and was paid RM 6 for completing the experiment.

Variables and Hypotheses
Dependent Variable 1: The percentage of score on the assessment (overall). The assessment consists of four hands-on tasks, one task for each criterion – safety, equipment, procedure, and housekeeping. For each criterion, participant score either 0, 0.5 or 1. Participant was scored 1 if he or she performed the hands-on task correctly, 0.5 if partially correct and 0 if performed incorrectly. The maximum score is 4 points – 1 point for each criterion – and the minimum score is 0.

Hypothesis 1: the Video tutorial group will have higher percentage of score than the Manual handbook group, as the instruction of the machining operation will be better with video tutorial. This is because, video tutorial is fast and effective, able to show the process (Guy & Lowness, 2012), increase motivation in problem solving, able to learn the problem qualitatively (Singh & Bartolo, 2005) and reduce learning time (Stiller, Petzold & Zinbauer, 2011).
Dependent Variable 2: The mean score of the assessment (by criteria). For method on scoring the assessment – refer to Dependent Variable 1 above.

Hypothesis 2: The Video tutorial group will score higher in the assessment for each criteria compared to Manual handbook group. The reason for the hypothesis is the same as Hypothesis 1 above.

RESULTS & DISCUSSION

The raw data of the experiment was recorded in Microsoft Excel 2013. Then it was transferred into SPSS software version 21 to be analyzed. By using SPSS, the average scores for the overall performance of the participants as well as average scores based on criteria - safety, equipment, procedure and housekeeping - was analyzed. In addition, independent t-test was performed in order to analyze the significant value in comparing the means between the two groups in the study – Manual Handbook and Video Tutorial.

The Effect of Machine's Manual Handbook and Video Tutorial on Hands-on Learning Performance (in Overall)
The graph in Figure 6 below illustrates the percentage scores of both Manual handbook and Video tutorial groups in overall.

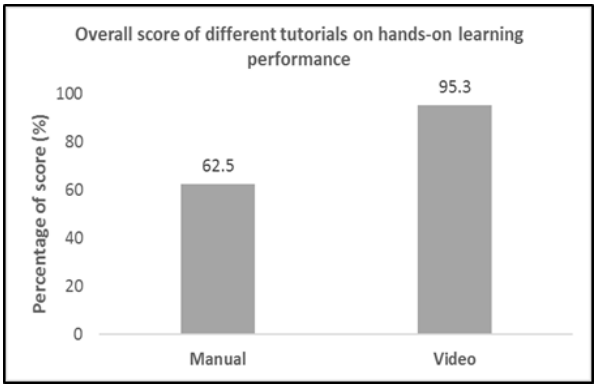

Figure 6 Overall score of different tutorials on learning performance

In overall, by comparing the total scores of both groups, the percentage of Video tutorial group is higher than the Manual handbook group. On average, Video tutorial group scored 95.3%, while Manual handbook group only 62.5%. The percentage different is 32.8%. Next, the data was further analyzed by using SPSS to compute the mean of the hands-on learning performance

of the two group and Independent sample t-test was performed. The output of the model given that, in overall, there was a significant different in the scores for Video tutorial group (M=95.313, SD=7.739) and Manual handbook group (M=62.500, SD=15.138) conditions; t (30) = -7.720, p < 0.0001. This result suggests that different types of machine's medium of instruction does influence hands-on learning performance. Specifically, the result suggests that when a Video tutorial was used as the medium of instruction, the hands-on learning performance increases.

Based on Figure 6 above, video tutorial always has higher percentage score than manual handbook. This is because participant was able to understand the information better when watching video, as detail of the experiment was very clear and more interactive. This is parallel with the previous study of English teaching, where digital video is found to increase student motivation and enhanced learning performance (Kearney, Jones & Roberts, 2012). In addition, video tutorial is also known; to be fast and effective, show the process clearly (Guy & Lowness, 2012), increase motivation in problem solving and enable learners to learn the problem qualitatively (Singh & Bartolo, 2005). Moreover, using video tutorial as the medium of instruction also could reduce the learning time (Stiller, Petzold & Zinbauer, 2011).

The Effect of Machine's Manual Handbook and Video Tutorial on Four criteria of the tutorial content - safety, equipment, procedure and housekeeping

The bar graph in Figure 7 below depicts the percentage of score between Manual handbook and video tutorial groups in terms of safety, procedure, equipment and housekeeping.

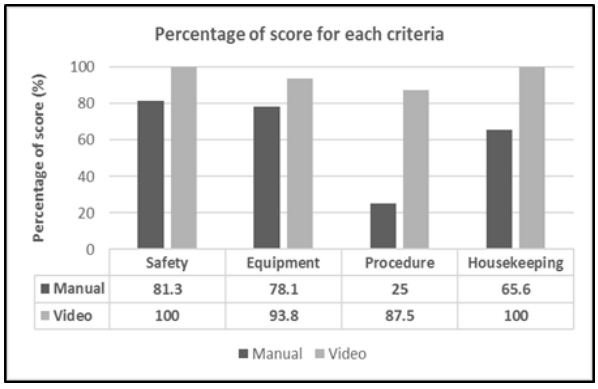

Figure 7 Percentage score of different tutorials on learning performance based on criteria

Percentage of scores of the assessment test (by criteria): On average, the percentage of score in all the criteria for Video tutorial group is better than the Manual handbook group. In safety and housekeeping aspect, Video tutorial group performed excellent on the hands-on learning performance with a full score (100%) compared to Manual handbook which score 81.3% and 65.6% respectively. Next, in equipment aspect, Video tutorial group score 93.8% while for the Manual handbook group 78.1%. Lastly, comparing both groups based on the procedure shows that Video tutorial group has higher score (87.5%) than Manual handbook group, with only a quarter of the percentage of the full score (25%). Comparing between the percentages of the two means by criteria – safety, equipment, procedure and housekeeping - the differences are 19.7%, 15.7%, 62.5%, and 34.4%. It was observed that there are differences among the percentages within the different criteria evaluated.

Generally, based on all the criteria compared, the finding shows significant different for safety, procedure and housekeeping criteria. For the equipment criteria, the model given that the different is marginally significant. In safety criteria, Video tutorial group (M=100, SD=0) and Manual handbook group (M=81.25, SD=25) are significantly difference with t (15) = -3.00, p = 0.009. In procedure criteria, Video tutorial group (M=87.500, SD=28.867) and Manual handbook group (M=25.000, SD=40.824) are significantly difference with t (30) = -5.000, p < 0.0001. In housekeeping criteria, Video tutorial group (M=100.00, SD=0.00) and Manual handbook group (M=65.625, SD=47.324) are significantly different with t (15) = -2.905, p = 0.011. In equipment criteria, Video tutorial group (M=93.750, SD=17.078) and Manual handbook group (M=78.125, SD=31.457) are marginally significant difference with t (23) = -1.746, p = 0.094. These results suggest that, for all criteria, different type of medium of instruction - Manual handbook and Video tutorial - does affect hands-on learning performance. Specifically, the results suggest that when video tutorial was used as the medium of instruction, the hands-on learning performance produce a better outcome.

Looking at the differences among the percentages of each criterion, there is a huge different between the score of video tutorial and manual handbook in procedure with 62.5%. The reason is, throughout the content of the tutorial of those machines, procedure has the most complex information to be understood and involved many steps that need to be followed. By giving instructions through the video, it provides a better learning experience to the participant since, it can show the process clearly (Guy & Lowness, 2012). Besides that, video tutorial could reduce the learning time (Stiller, Petzold & Zinbauer, 2011), participant would need more time in order to remember all the procedure if they learn it through manual handbook. Moreover, video tutorial provides a mimicking effect in which it is easier for people to follow the content (van der Meij, 2014; Palmiter & Elkerton, 1993).

On the other hand, the different of the equipment criteria shows the lowest differences of 15.6% with marginally significant. One element that could be pointed out in here is that, equipment is the simplest information to be learnt throughout the content of the tutorial. For this criterion, the learning process would not be much different because in both methods - video tutorial and manual handbook - participant only need to see the picture of the equipment. Even though the equipment part is easy, video tutorial still outperforms manual handbook, perhaps because participants who were exposed with manual handbook may focus more on other criteria in comparison to the equipment criteria.

CONCLUSION

To conclude, using video as a medium of instruction helps participant to perform better in hands-on task of the engineering machinery compared to manual handbook. Overall, there was a significant different in the hands-on learning performance between the Video tutorial group (M=95.313, SD=7.739) and Manual handbook group (M=62.500, SD=15.138) conditions; $t(30) = -7.720$, $p < 0.0001$. For the criteria - safety, procedure, equipment and housekeeping – all the criteria show significant different, while equipment criteria show a marginally significant different. In safety; Video tutorial group (M=100, SD=0) and Manual handbook group (M=81.25, SD=25) are significantly difference with $t(15) = -3.00$, $p = 0.009$. In procedure; Video tutorial group (M=87.500, SD=28.867) and Manual handbook group (M=25.000, SD=40.824) are significantly difference with $t(30) = -5.000$, $p < 0.0001$. In housekeeping; Video tutorial group (M=100.00, SD=0.00) and Manual handbook group (M=65.625, SD=47.324) are significantly different with $t(15) = -2.905$, $p = 0.011$. Lastly, in equipment; Video tutorial group (M=93.750, SD=17.078) and Manual handbook group (M=78.125, SD=31.457) are marginally significant difference with $t(23) = -1.746$, $p = 0.094$.

The result from this project provides additional information regarding which medium of instruction is better for hands-on learning performance when it comes to learning engineering machinery. The finding shows that, using video tutorial increase the hands-on performance when learning engineering machinery. In addition, the finding from this study also could lead to other similar research studies in deeper approaches.

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