Original Article

# Comparison Video Based Learning Versus Live Demonstration of Dental Student Knowledge and Skills for Working Length Determination Using Electronic Apex Locator

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## Abstract

The objectives of this study were to compare the effectiveness of video based learning (Video) versus a live demonstration (Demo) on dental student knowledge and skills for working length determination with electronic apex locator and to evaluate their improvement after self-directed video based learning. Sixty-three dental students were randomly assigned to two teaching groups. In the classroom, the Demo group attended a live demonstration and the Video group watched a video about working length determination with electronic apex locator. The knowledge and skills were evaluated by using multiple choice questions and a practical test. After all the students had self-studied an online video for 6 weeks, the second practical test was performed. Satisfaction questionnaires were completed after each practical test. The Mann–Whitney U test and the Wilcoxon signed-ranks test were used to compare the scores between groups and within group, respectively. There were no significant differences in knowledge or practical scores between the Demo and Video groups. After self-directed learning, the Video group practical score significantly increased, however, no differences were found in the Demo group. The Demo group was significantly more satisfied with their learning method. In conclusion, video based learning enhanced the knowledge and skills of dental students for working length determination with electronic apex locator as well as a live demonstration had done. Self-directed video based learning subsequent to classroom video improved practical skills.

**Keywords:** Dental student, Live Demonstration, Self-directed learning, Video Based Learning

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## Introduction

Preclinical training in dental education is composed of basic sciences and laboratory practice. Live demonstrations are often used to teach clinical skills in laboratory classes because these provide better opportunities for students to learn directly from instructors, ask questions, and understand procedures compared with students who do not receive the Demonstration.[1] However the weakness of live demonstration is that it can be difficult to see what is being done,[2] thus, it should be performed using small groups. If teachers perform live demonstration many times, they may teach the content inaccurately and it is time consuming.[1] Dental students have limited studying time; therefore they should use more effective learning methods. It is imperative to investigate which teaching and learning methods result in more effective student learning.

Media technology has been introduced into dental education. Electronic media such as audio, video and web-based media are used to enhance traditional teaching methods. Previous studies found that video based learning (VBL) allowed students to see better, offered more consistent teaching, and used less teaching time compared with live demonstrations.[1-4] Due to a high quality internet network and electronic devices, students can study their lessons anytime, anywhere and as often as they want. Although VBL has many advantages, the outcome efficiencies of VBL from previous studies such as attitudes, knowledge, or practical skills varied. Some studies reported that VBL outcomes were better compared with traditional methods,[1,3] however, other studies found the VBL outcome was not different[2,4-7] or worse.[8]

Canal preparation length and obturation are critical factors a in root canal treatment outcome,[9] thus, working length determination is an important step in endodontic treatment. Currently, the electric apex locator (EAL), an electronic instrument used to determine the root canal length, is a commonly used instrument for measuring working length because of its high accuracy.[10] Therefore, dental students should have knowledge and skills about length determination with EAL.

Although there are many studies about the effectiveness of video teaching compared with traditional teaching methods in dental education,[1-5,7,8,11] there has been no reports evaluating their use in teaching how to determine the working length. The purposes of this study were to compare the effectiveness of video based learning versus live demonstration on dental student knowledge and skills for working length determination using an EAL and to assess the skill improvement of these students after self-directed video based learning.

## Materials and Methods

This study protocol was approved by the Human Ethics Committee of the Faculty of Dentistry Chulalongkorn University, Thailand (HREC-DCU 2017-050). The sixty-four fourth-year Chulalongkorn University dental students who attended the endodontic laboratory course provided informed consent. The students were randomly divided into two groups (n=32) according to grade point average (GPAX) and sex. One group was assigned to learn by live demonstration (Demo group) and the other group was assigned to learn using video (Video group). The study design is shown in Figure. 1.

The lesson in video consisted of 11 parts: 1) Working length determination methods, 2) EAL principles, 3) EAL components and assembly, 4) Tooth model components, 5) Armamentarium for working length determination, 6) Working length determination using EAL, 7) Causes of inaccurate EAL measurements, 8) EAL display interpretation, and 9) Clinical use of the EAL to determine the working length. The video content was revised and approved by experienced endodontic instructors before it was presented to students.

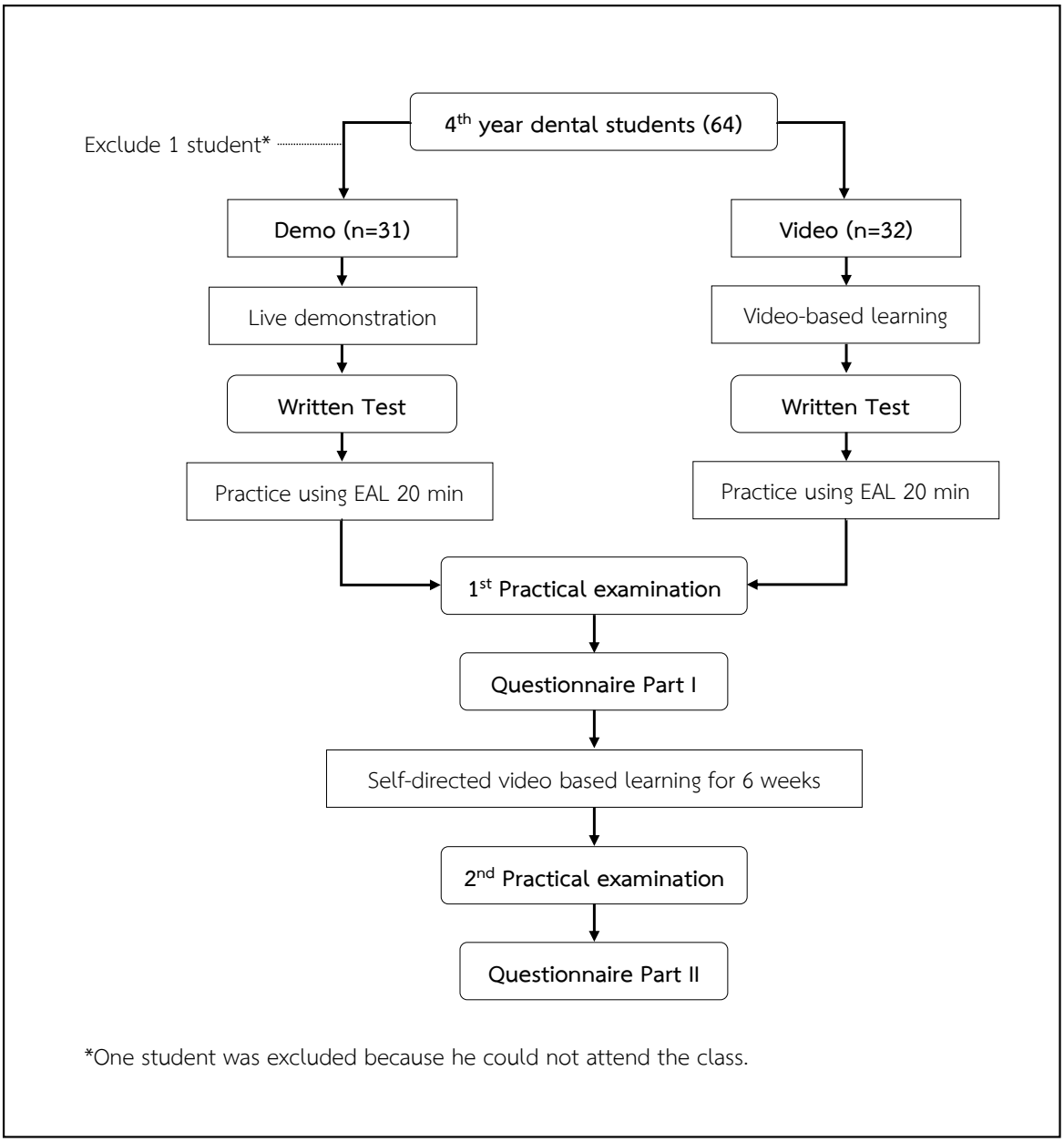


***Figure 1*** *Study design and sample size*.

In the classroom, the Demo group students were divided into subgroups (n=8). Each subgroup was taught using a live demonstration by the same experienced instructor for 20 minutes. The lesson content was similar to that in the video. The students in the video group watched the video in the lecture room. Students were not allowed to ask any questions during their learning session.

After the assigned teaching session, the students' knowledge was immediately evaluated using a written test consisting of 15 multiple choice questions. The students then practiced working length determination using EALs in upper molar models for 20 min. Due to the limited number of EALs and time, 4 students from the same group practiced together.

The practical skill was evaluated by observation of each student performance of working length determination using EALs in mesiobuccal root canal of upper molar models. A skill performance checklist (score 1 point/step) was used to assess each student's skills (as shown in supplementary). Two examiners, endodontic postgraduate students, were blinded to the student's group and were trained to correctly use the checklist. Inter-rater reliability and intra-rater reliability calculated by Cohen's Kappa coefficient showed almost-perfect reliability (K values = 0.948 for Inter-rater reliability and 0.843 and 0.843 for intra-rater reliability). The students were randomly assigned to an examiner who evaluated each student's skill performance (1st practical test).

The first questionnaire (Questionnaire I) was administered to the students immediately after the first practical test. The questionnaire consisted of closed-ended questions scored on a 5-point Likert scale from very much (5) to very little (1) concerning their opinion and satisfaction with their assigned teaching method and open-ended questions for teaching suggestions.

After the first practical test, the students were assigned to self-study the video lesson via Facebook for six weeks. Then, the students' skill performance was re-evaluated (second practical test) and they completed a second questionnaire (Questionnaire II). The second questionnaire collected learning satisfaction data, comments about the video quality, and self-directed learning data such as electronic devices, number of video views, and learning accessibility.

The data were not normally distributed when they were analyzed by Kolmogorov-Smirnov test. The Wilcoxon Matched Pairs Signed-Ranks test was used to compare the first and second practical test scores within group. The Mann-Whitney U test was used to analyze the test scores and the questionnaire results between groups. The level of significance was 0.05.

## Results

Sixty-three dental students participated in this study. No significant differences of sex or GPAX were found between the groups (Table 1). The Demo group written test scores ranged from 9–14 and the mean score was 11.97±1.19. The Video group written test scores ranged from 8–14 and the mean score was 11.69±1.83. No significant difference was found between the groups ($P$=0.482).

The practical test scores of the two groups were similar on the first and second test (Table 2). However, in the Video group, the second practical score was significantly higher compared with the first practical score, while those of the Demo group were not different.

All students completely answered the questionnaires after both practical tests. The results from Questionnaire I (Table 3) showed the Demo group reported significantly higher satisfaction compared with the Video group. Moreover, The Demo group felt that they had received more knowledge and that the amount of information was adequate for performing working length determination using an EAL. The Questionnaire II results (Table 4) showed that there were no significant differences between teaching method groups in any aspect evaluated. Before the second practical test, most students watched the video one time (47.6 %) and two times (39.7 %) and 61.9 % of the students viewed it on the day of the test.

*Table 1* *Student sex and GPAX distribution*

| | Group | | *P* - value |
|---|---|---|---|
| | Demo (n = 31) | Video (n = 32) | |
| **Number of students** | | | |
| Male | 9 | 10 | 1.000 |
| Female | 22 | 22 | |
| **GPAX (mean±SD)** | 3.45±0.22 | 3.43±0.25 | 0.696 |

*Table 2* *The comparison of practical scores between groups and within each group*

| Practical test | Group | | | | *P*-value (Between group) |
|---|---|---|---|---|---|
| | Demo (n=31) | | Video (n=32) | | |
| | Pass | Mean score | Pass | Mean score | |
| **First** | 19 | 11.48±0.72 | 16 | 11.38±0.79 | 0.481 |
| **Second** | 20 | 11.58±0.62 | 25 | 11.72±0.52 | 0.35 |
| ***P*- value (within group)** | | 0.439 | | 0.029* | |

**Indicates a significant difference (P<0.05). Pass is the number of students that correctly performed all steps.*

*Table 3* *Percentage of questionnaire answers after the first practical test*

| Question | Group | Percentage of answers (%) | | | | | *P*-value |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| How much knowledge did you get from the assigned teaching method? | Demo | 25.8 | 67.7 | 6.5 | - | - | 0.029* |
| | Video | 15.6 | 53.1 | 31.3 | - | - | |
| Was the knowledge adequate for working length determination using the Root ZX? | Demo | 12.9 | 74.2 | 12.9 | - | - | 0.005* |
| | Video | 6.3 | 46.9 | 40.6 | 6.3 | - | |
| How confident were you to perform the practical test correctly? | Demo | 12.9 | 61.3 | 19.4 | 6.5 | - | 0.426 |
| | Video | 15.6 | 43.8 | 31.3 | 9.4 | - | |
| Did Practicing with the Root ZX before test help you understanding its use | Demo | 38.7 | 51.6 | 9.7 | | - | 0.870 |
| | Video | 34.4 | 59.4 | 3.1 | 3.1 | - | |
| How much were you satisfied with the assigned teaching method? | Demo | 22.6 | 64.5 | 12.9 | - | - | 0.001* |
| | Video | 9.4 | 34.4 | 53.1 | 3.1 | - | |

**indicates a significant difference between groups (P<0.05).*

*Table 4* *Percentage of questionnaire answers after the second practical test.*

| Question about self-directed VDO based learning | Group | Percentage of answers (%) | | | | | *P*-value |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| How much knowledge did you get from this learning? | Demo | 12.9 | 71.0 | 16.1 | - | - | 1.000 |
| | Video | 15.6 | 65.6 | 18.8 | - | - | |
| How much did this learning improve your skills? | Demo | 6.5 | 51.6 | 38.7 | 3.2 | - | 0.284 |
| | Video | 6.3 | 65.6 | 28.1 | - | - | |
| How satisfied were you with this learning? | Demo | 9.7 | 48.4 | 38.7 | 3.2 | - | 0.842 |
| | Video | 3.1 | 56.3 | 37.5 | 3.1 | - | |

## Discussion

This study was conducted to assess video based learning compared with live demonstration and to evaluate the improvement after self-directed video based learning via online electronic devices. The students in both groups had similar characteristics regarding sex and GPAX and had not used EALs prior to this study. In the present study, learning outcomes were measured in terms of knowledge and skills in working length determination using an EAL. A written test and practical tests were used to evaluate knowledge and skills, respectively. The written test questions were designed to be consistent with the laboratory working length determination lesson. To prevent "test leakage", the students of each group were taught in separate rooms and the written test was taken immediately after assigned learning. The practical tests assessed student's skills based on 12-item skill performance checklist for accurate determination. Beforehand, the written test and performance checklist were evaluated and adjusted by endodontic instructors. The questionnaires were presented to instructors and students who did not participate in this study to check question understanding and adjusted before they were used.

The written test results of the Demo and Video groups were not significantly different. This finding was similar to that of Fayaz *et al.*[11], who found no significant written score difference between videotape learning and live demonstration for teaching complete denture fabrication. In contrast, Ramlogan *et al.*[8] found that students in the live lecture group performed better on a clinical periodontology written test compared with those in the video lecture group. The lesson difficulty might have influenced the results of the studies. In the clinical class, the students might benefit more from live teaching, because they would have an opportunity have a discussion with a teacher while in length determination lesson which was an easy lesson it might not be necessary to ask questions during the lesson. However, because the amount of time spent teaching both groups in our study was specified, the students were not allowed to ask any questions. This aspect might have decreased the effectiveness of the live demonstration in the present study.

There was no significant skill difference between the Demo group and the Video group for working length determination using EALs. These findings are similar to those of Alqahtani *et al.*[2], which a procedural video was as effective as a live demonstration for teaching how to fabricate an orthodontic Adam's Clasp. Although Fayaz *et al.*[11] found that videotapes were more efficient compared with a live demonstration in some easy steps of complete denture fabrication, however difficult steps require high precision. So, students in the live demonstration group performed significantly better compared with those in the videotape group. From the first practical test, Demo group incorrectly did step "inserting the file into the root canal" more than the Video group. Demo students might not see the action of file movement because this step was not clearly seen when the teacher taught. However, there was a close-up view in the video, so students could see the action of the file more clearly. The step that the Video group did worse than the Demon group was "Move the file forward until the meter read APEX". The video students might not clearly understand why the file must be moved until APEX. Therefore, the difficulty of the lesson content may affect the learning outcomes However, the number of students that did something wrong from both groups were not different in the second practical test.

Although the differences in written and practical scores between the Demo and Video groups were not significant, the Demo group had higher mean scores on both tests compared with the Video group. These results conformed to the results from Questionnaire I. The comments of the Video group indicated that they found that the video was not interesting, moved through the information too rapidly, and omitted small details. In addition, the students watched the video on a projector screen unsupervised, thus, some students might not have continuously concentrated on the video. In contrast

the live demonstration, small group learning, likely caused the students to pay more attention and concentrate. Our study results were consistent with previous studies which found that students prefer live lectures rather than video lectures because students lacked the motivation to watch the video when there was no direct supervision.[12,13]

Interestingly, although the students in the video group were less satisfied that they received adequate knowledge for doing the practice test than those in the Demo group, the feelings about correctly performing the practice test in both groups were not different. In addition, most students (approximately 90 %) felt that practicing with an EAL before the test helped them have a better understand of its use. This result suggested that although video learning did not provide enough knowledge, self-practice with a model and EALs before the test increased the knowledge and skills of the student. Moreover, because of the limited number of EALs and time, four students had to practice using an EAL together, thus cooperative learning occurred. Cooperative learning has some advantages over individual learning, such as a stress-free learning environment, increased lesson interest, and increased student understanding.[14,15] Therefore, in the present study, cooperative learning might have improved student's knowledge before the test.

After self-directed video based learning, there was no significant difference between the Demo group and Video group practical test results. However, the number of students passing the second practical test increased by 9 students in the Video group, while the Demo group number increased by one student. These results indicated that self-directed video based learning improved student skills in the Video group but had little effect on the Demo group students. It might be that the students in the Video group felt that they did not perform well on the first test, thus, they might have concentrated more when self-studying video before the second practical test, resulting in a significant improvement of the practical score. Conversely, most students in the Demo group felt that a live demonstration provided adequate knowledge for the practical test (shown in Table 3). All students did not know the first test results. It was possible that they were confident that they did the first practical test correctly (shown in Table 3) so they might not have paid attention to the study video before the second test. In addition, the questionnaire results indicated that the Video group had more students who felt that the self-learning video helped them improve their skills compared with the Demo group. It might mean that video learning would be highly effective if the students had enough time to study and could view the video as often as they wanted. Self-directed video based learning helped students to review the whole lesson in which some parts might not be easy to understand by only watching the video one time. During the six-week self-directed video based learning, the student might get some knowledge about working length determination from Endodontic lecture which is the co-requisite subject. However, in this lecture, there were few details about EAL and no details about how to use EAL so it might affect practical skills slightly.

Video content and quality could affect self-directed learning outcomes. In our study, the results from Questionnaire II showed our video had good quality (shown in the supplementary). In addition, video accessibility, suitable equipment, and free time for learning influenced the learning outcome of students.[16,17] Most students (90 %) were satisfied that the video was available online through a private Facebook group and they had enough free time, the proper electronic devices, and a good internet connection for self-directed learning (as shown in the supplementary). This implied that there were no technical obstacles for self-directed video based learning in this study. In addition, the number of times the video was viewed and the last time the video was viewed were not related to second practical scores. This was consistent with a previous study that found that the amount of times the video was watched did not affect surgical hand wash test scores.[18]

Future studies should evaluate the outcome of these methods when the students practice working length determination in the clinic. In addition, the video should increase exercises and attractiveness to motivate student learning. It would be interesting to compare the effectiveness of self-directed video learning, classroom learning and other learning methods for other dental lessons.

## Conclusion

Video based learning enhanced the knowledge and skills of dental students for working length determination with EAL as well as live Demonstration did. Self-directed video based learning improved practical skills after students viewed the video in the classroom, but it did not affect students who had been given a live demonstration.

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## Supplement

**Supplement 1**

***Skill performance checklist for practical test (1 point per step)***

| No. | Important performance steps | √ or X |
|---|---|---|
| 1 | Determine the tooth length from the original radiograph | |
| 2 | Choose the proper file size | |
| 3 | Adjust the rubber stopper based on the radiographic tooth length | |
| 4 | Insert the file into the root canal with correct action | |
| 5 | Hook the lip clip part at the wire on the tooth model | |
| 6 | Clip the file holder part on the file. | |
| 7 | Move the file forward until the meter read 'APEX' | |
| 8 | Move the file outward until meter read '0.5' bar | |
| 9 | Adjust the rubber stopper to touch the proper reference point | |
| 10 | Remove file holder part from the file | |
| 11 | Remove the file from the root canal carefully | |
| 12 | Measure the file's length as the provisional working length | |

**Supplement 2**

***Percentage of questionnaire answers after the 2nd practical test about the VDO quality and VDO accessibility of students.***

| Question about self-directed VDO based learning | Group | Percentage of answers (%) | | | | | *P*-value |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| To what level did the video have clear illustrations and was easy to understand? | Demo | 19.4 | 67.7 | 12.9 | - | - | 0.375 |
| | Video | 12.5 | 68.8 | 18.8 | - | - | |
| To what level did the video have clear sound and was easy to understand? | Demo | 25.8 | 51.6 | 22.6 | - | - | 0.631 |
| | Video | 18.8 | 59.4 | 15.6 | 6.3 | - | |
| To what extent was the video sharing via the Facebook private group suitable? | Demo | 45.2 | 48.4 | 6.5 | - | - | 0.176 |
| | Video | 25.0 | 71.9 | 3.1 | - | - | |
| Did you have suitable electronic devices for accessing and watching the video? | Demo | 67.7 | 29.0 | 3.2 | - | - | 0.680 |
| | Video | 62.5 | 34.4 | 3.1 | - | - | |
| Was internet signal strong enough for online video viewing? | Demo | 54.8 | 35.5 | 9.7 | - | - | 0.747 |
| | Video | 50.0 | 40.6 | 9.4 | - | - | |
| How much free time did you have for self-directed video based learning? | Demo | 19.4 | 35.5 | 29.0 | 16.1 | - | 0.236 |
| | Video | 25.0 | 43.8 | 25.0 | 6.3 | - | |