Student Performances During and After Physics Instruction Using Interactive Lecture Demonstration

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ABSTRACT

Interactive Lecture Demonstration (ILD) is one of active learning strategies which was used to teach high-school level in the topic of magnetic force on a moving charged particle. The aim of this work is to study the student performances in learning and effectiveness of the ILD on this physics topic. There are three different sample groups; E1 and E2 were taught by ILD, and C1 by traditional teaching. After instructions, all students were investigated their conceptual understanding by using the conceptual physics surveys. The results show that students who studied by ILD had more conceptual understanding than those who studied in the traditional classroom. In addition, the analysis of students' prediction indicated that the effectiveness of ILD depends on students' background in physics.

Keywords: Interactive Lecture Demonstration (ILD), Magnetic force on a moving charged particle

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Introduction

The magnetic force on a moving charged particle is a basic physics topic that students learn in the domain of Electricity and Magnetism. This topic had been included to teach in high-school and undergraduate level. Maloney et al. (2001) developed the well-known conceptual survey which namely Conceptual Survey of Electricity and Magnetism (CSEM). The survey consists of the questions that probe student in the topic of magnetic force on a moving charged particle. The CSEM was used to investigate more than 5000 introductory physics students at different institutions in the United State. They found that students were confused in physics content and the traditional teaching could not improve students' conceptual understanding effectively.

Interactive Lecture Demonstration (ILD) is one of active learning strategy which was developed to increase more interaction between people in class. Sokoloff and Thornton (1997) started to apply the ILD in kinematics and dynamics. Their comparison of effectiveness between ILD and traditional teaching (where students listen to lecture, do homework and take exams) indicated that the use of ILD had more effectiveness to enhance students' understanding greater than traditional teaching.

In this study, the ILD was applied to teach grade-12 students at Thabo School in the topic of magnetic force on a moving charged particle and compare effectiveness between ILD and traditional teaching. Moreover, the performances of students who had different background in physics was studied during ILD instruction.

Objective of the study

To study the student performances in learning and effectiveness of teaching with Interactive Lecture Demonstration (ILD) in the topic of magnetic force on a moving charged particle.

Materials and Methods

Sample group

The sample groups were grade-12 students who enrolled in the physics course at Thabo School, Nongkhai province. Two classes were designed as experimental groups (E1 and E2) and were taught by researcher. Another class was set as a control group (C1) and was taught by high-school teacher. The details of sample groups in this study are shown in Table 1.

Table 1 Sample group information

Group	Teaching Method	Number of student
E1	ILD	33
E2	ILD	40
C1	Traditional Teaching	39

The background in physics of students were assessed by comparing their midterm exam score and high-school teacher interview. E1 group had similar background in physics to C1 and both groups had better background in physics than E2.

ILD procedures

In ILD class, the students were given lecture of magnetic force on a moving charged particle by using guided worksheet. They were also explained the operation of demonstration set as the Cathode-ray tube set (Figure 1). The set is a common physics apparatus available in many high-schools.

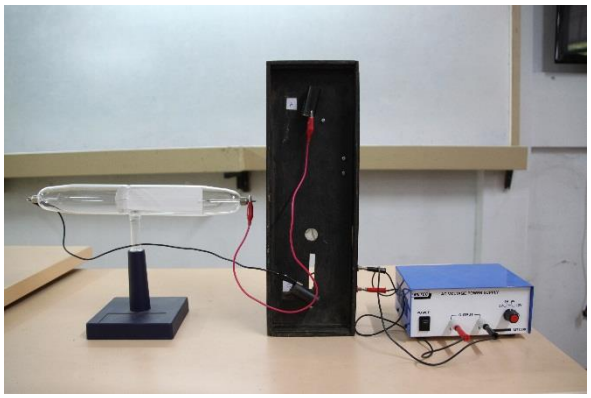

Figure 1 The Cathode-ray tube set

After the lecture step, the instructor led students to the ILD process which consists of 4 activities that students were asked to predict the result in different situations. To illustrate the 8 step of ILD process, the demonstration set 3 (D3) was presented as an example.

I. The instructor turns on the Cathode-ray tube set with giving the magnetic field that is pointing into page and asks students to predict the electron trajectory when the magnitude of the magnetic field is increased by individually.

II. Students get the ILD worksheet (Figure 2) to record their individual prediction.

III. Students discuss their predictions with peers in small group.

IV. Students are asked to predict the result again. They answer their new prediction on the ILD worksheet but still keeping the old prediction.

V. The students hand in their prediction part. The instructor reflects some students' answers to the class.

VI. The instructor presents the real result of the demonstration set.

VII. Students observe the real result and compare with their prediction.

VIII. The instructor leads the whole class to discuss about the result of the demonstration set and students record the result on the result part of ILD worksheet.

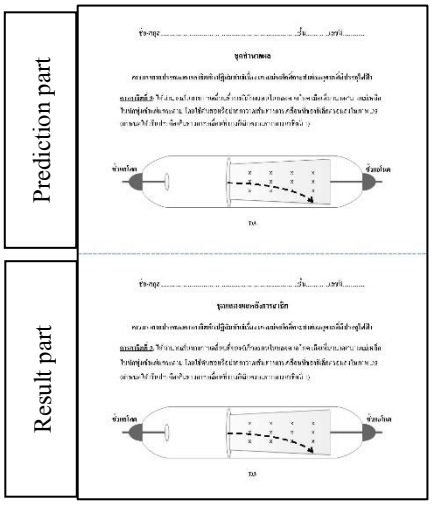

Figure 2 ILD worksheet of demonstration set 3

Student conceptual understanding assessment

After the instruction, all sample groups were investigated their conceptual understanding by the Magnetic Force on a Moving Charged Particle Test. The test has two parts, the first part consists of four multiple choice questions and the second part consists of two open-ended questions. The first three questions were taken from Conceptual Survey on Electricity and Magnetism (CSEM) and the last three questions were newly constructed by the authors and were verified by Physics experts. Table 2 summarizes the topic of each question in the Magnetic Force on a Moving Charge Particle Test.

Table 2 Conceptual areas of each question in the Magnetic Force on a Moving Charged Particle Test.

Question	Topic
1	Charged at rest in a uniform magnetic field
2, 5.1, 5.2	Direction of a uniform magnetic field
3	Magnitude of magnetic force
4	Direction of magnetic force on a moving charged particle

The effectiveness of teaching methods will be analyzed statistically from students' responses to the Magnetic Force on a Moving Charged Particle Test by using mean score.

Results

The mean score of the students' responses on the Magnetic Force on a Moving Charged Particle Test is shown in Table 3. The E1 students got the highest mean score of 3.9 from the full score of 7, followed by E2 with mean score of 1.6. The lowest mean score of 0.9 belonged to C1. The mean scores of all groups were significantly different.

Table 3 Mean score of each sample group

Group	Mean score	Standard Error
E1	3.9	0.3
E2	1.6	0.2
C1	0.9	0.2

In addition to the mean scores of students in each group, the students' responses on the test in each question are shown in Figure 3.

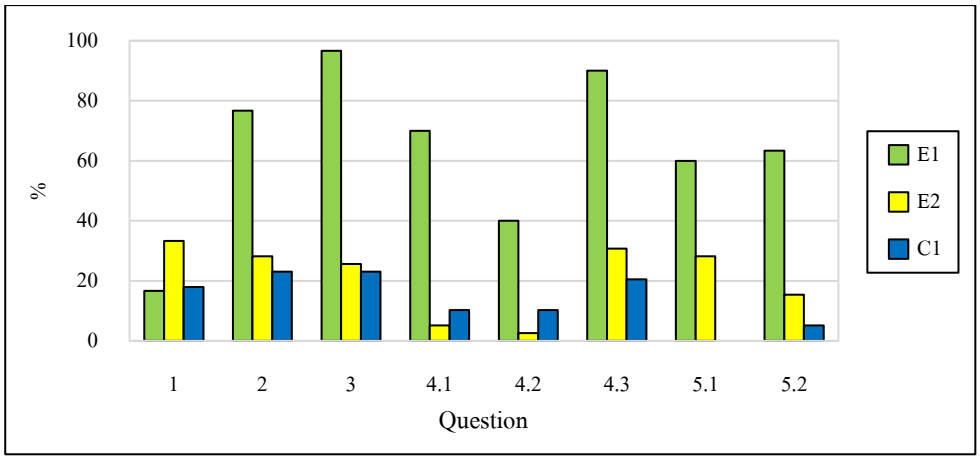

Figure 3 Percentage of students answered correctly in each question

The students in E1 had the highest percentage in all question except question 1 that asks students about the charged is placed in uniform magnetic field. None of student in C1 could answer correctly in question 5.1.

To understand the difference in the effectiveness between two ILD groups; E1 and E2, the prediction part of students were analyzed to see the changes in their predictions. Figure 4 shows an example of student's prediction in demonstration set 3.

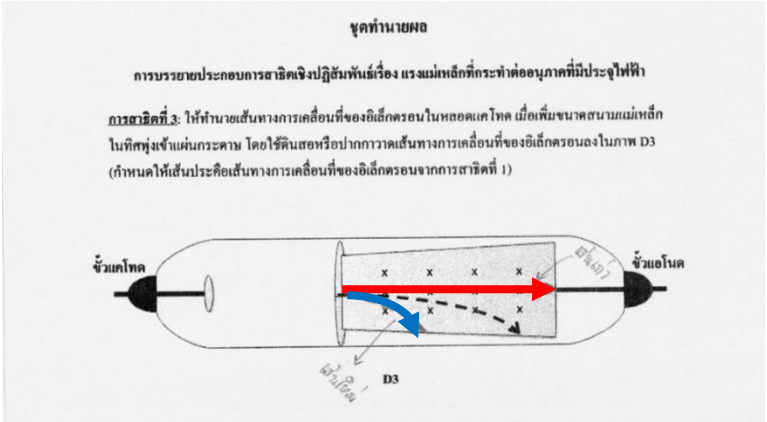

Figure 4 An example of student's prediction sheet in D3

The individual prediction of this student is the straight line which is incorrect answer (red arrow). After discussion, the student changed the answer to that curve part which is the correct one (blue arrow). The prediction before and after discussion of this student was grouped into FT type. The students' response on prediction part of ILD worksheet were categorized into 5 groups as shown in Table 4.

Table 4 Description of students' response categories

Type	Description
TT	Student predicted the correct answer and did not change the prediction after discussion with peers.
FT	Student predicted the incorrect answer and changed the prediction to correct answer after discussion with peers.
TF	Student predicted the correct answer and changed the prediction to incorrect answer after discussion with peers.
Ff	Student predicted the incorrect answer and changed the prediction to another incorrect answer after discussion with peers.
FF	Student predicted the incorrect answer and did not change the prediction after discussion with peers.

The percentage of E1 and E2 students' responses in each demonstration set are presented in Figure 5 and Figure 6 respectively.

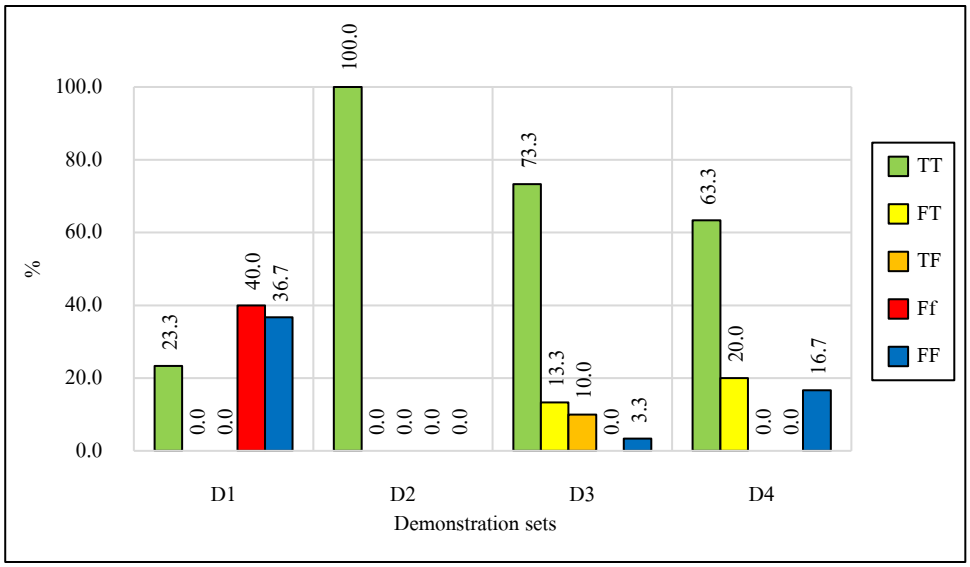

Figure 5 Percentage of students' prediction in each type of E1

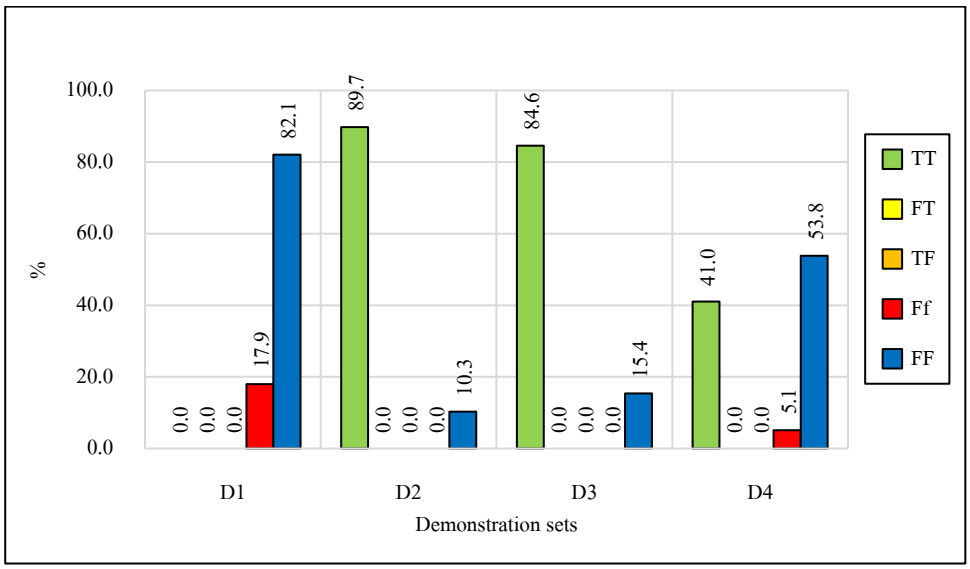

Figure 6 Percentage students' prediction in each type of E2

Discussion

The results in Table 3 indicated that the mean score of ILD classes were significantly better than that of the traditional class. Although the student in E2 got the higher mean score than C1 but the mean score of E2 was much lower from the mean score of E1 which studied with the same teaching method (ILD). However, the score of E1 students' response on Question 1 was lower than E2. There was no concrete evidence to explain what the cause of this result but the overview of this question was very low as same as Maloney found. The possible reason was that students in experimental group did not observe this situation or similar situations in the demonstration where the magnetic field did not affect the motion of charged particle.

The performances of students' responses on ILD worksheets in both E1 and E2 presented the possible factor that related to their differently mean scores. The percentage of predictions in TT of E1 were higher than that of E2. The appearance of FT type (13.3% in D3 and 20.0% in D4) of E1 students indicated that the discussion step in ILD process caused students changed their incorrect to correct prediction which was desirable in ILD method. However, none of students in E2 could change the prediction from incorrect to correct one and the percentage of students who still kept the same incorrect prediction (FF) were higher than E1 in all demonstration sets.

The possible reason that could discuss the high percentage of FF in E2 class is that there were no students with good understanding in each subgroup to lead the members discussed for correct understanding and result. Most students still agreed with their own individual prediction.

Conclusions

Interactive Lecture Demonstration (ILD) has effectiveness to enhance high-school student conceptual understanding in the topic of magnetic force on a moving charged particle greater than traditional teaching and the effectiveness of ILD depends on students' background in physics.

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