

Study and practice of flipped classroom in opto-electronic technology curriculum

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ABSTRACT

“Flipped Classroom” is one of the most popular teaching models, and has been applied in more and more curriculums. It is totally different from the traditional teaching model. In the “Flipped Classroom” model, the students should watch the teaching video after school, and in the classroom only the discussion is proceeded to improve the students’ comprehension. In this presentation, “Flipped Classroom” was studied and practiced in opto-electronic technology curriculum; its effect was analyzed by comparing it with the traditional teaching model.

Based on extensive and deep investigation, the phylogeny, the characters and the important processes of “Flipped Classroom” are studied. The differences between the “Flipped Classroom” and the traditional teaching model are demonstrated. Then “Flipped Classroom” was practiced in opto-electronic technology curriculum. In order to obtain high effectiveness, a lot of teaching resources were prepared, such as the high-quality teaching video, the animations and the virtual experiments, the questions that the students should finish before and discussed in the class, etc. At last, the teaching effect was evaluated through analyzing the result of the examination and the students’ surveys.

Keywords: Flipped Classroom, teaching model, opto-electronic technology, teaching video

1. INTRODUCTION

The “Flipped classroom” is a new teaching model and different from the traditional teaching model which is “lesson taught in class” and “homework done after class”. In the “Flipped classroom”, the students acquire the knowledge by watching the teaching videos before class and discuss the difficult and important contents in class. The contents that are flipped include the statuses of teaching and learning, the roles of the teacher and the students, the time and the space of study.

The “Flipped classroom” teaching model is the outcome of the deep amalgamation of the information technology and the classroom teaching. In 1993, Eric Mazur founded the computer-assistant teach, the teacher began to change from “lecturer” into “coach”^[1]. In 2000, Maureen J. Lage, the professor of university of Miami, published the paper “Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment”, this means the naissance of the idea of “Flipped Classroom”^[2]; In 2007, Jonathan Bergmann, the teacher of Colorado middle school, practice the “Flipped Classroom”^[3]. Since 2010, “Flipped Classroom” has been used in many fields, such as lawyer educating, doctor educating, teacher educating etc. Now, with the development of MOOCs(Massive Open Online Courses) and Microcourses, “Flipped classroom” has been a popular teaching model.

In our university, Opto-electronic Technology is a required course for the student whose major is opto-electronic engineer, optical information or optical engineering. It is so important that plenty of manpower, material resources and finance have been paid on it, and now it has been the excellent course of Hunan province. The course website has been built^[4], the teaching videos have been recorded, the animations and virtual experiments have been made. So we decided to practice the “Flipped Classroom” in this curriculum.

2. CONTENTS OF OPTO-ELECTRONIC TECHNOLOGY

Opto-electronic Technology is a major course. It is the base of many courses, such as Fiber Optics, Opto-electronic System, Opto-electronic Experiments, etc. Its main contents are the typical radiation source, the important photodetectors,

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the modulation of optical signal, the detect technology, and the typical photoelectric system. Table 1 gives the title of each chapter^[5] and figure 1 shows the relation among the knowledge points^[6].

Table 1. Contents of Opto-electronic Technology.

Contents of opto-electronic technology	
Chapter 1 Radiation source	Chapter 7 Photoelectric imaging device
Chapter 2 Introduction of opto-electronic detector	Chapter 8 Optical signal modulation
Chapter 3 Photoconductive detector	Chapter 9 Direct detector and coherent detector
Chapter 4 Photovoltaic detector	Chapter 10 Photoelectric detection circuit
Chapter 5 Photoelectron emission detector	Chapter 11 Typical photoelectric systems
Chapter 6 Thermal detector	

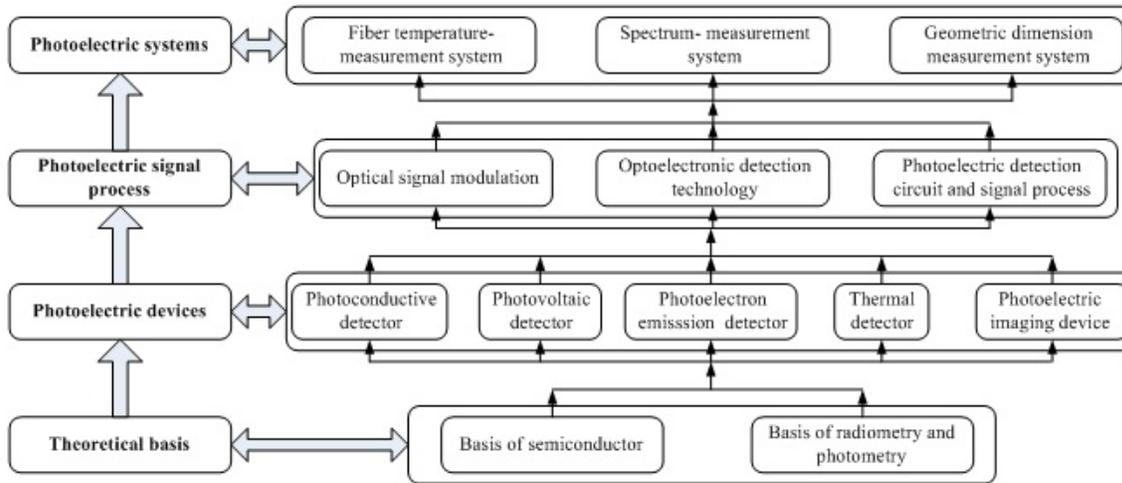


Figure 1. Relations of contents of the Opto-electronic Technology.

3. TEACHING VIDEOS

Teaching videos are very important for “Flipped Classroom”. The fact that the students have watched the teaching video effectively before the class is the basis of the discussion in the class. In order to meet the different needs of the different students, three series of teaching videos of Opto-electronic Technology have been recorded. Table 2 shows the record types and the teachers. Studio record and screen video record are very compact and each video is shorter than 15 minutes. Classroom teaching records were transcribed when the teacher was giving lessons in the classroom, each video is about 45 minutes. Figure 2 gives the screenshots of studio record, which recorded by Shi Jianhua.

Table 2. Teaching videos of Opto-electronic Technology.

Number	Record Type	Teacher
1	Studio Record	Shi Jianhua
2	Classroom Teaching Record	Jiang Wenjie, Shi Jianhua, Yang Lijia, etc.
3	Screencast Video Record	Shi Jianhua

4. FLASH ANIMATIONS AND VIRTUAL EXPERIMENTS

In order to help the students to understand the important and difficult knowledge points, twelve flash animations and eight virtual experiments have been made. Table 3 gives the title and the knowledge points of each animation. Figure 3 gives the screenshot of each animation. From these animations, the students can understand the structure, the principle,

the characters and the applications of each important device deeply. Table 4 gives the title and the knowledge points of each virtual experiment, and figure 4 gives the screenshot of each virtual experiment. From these virtual experiments, the students may know the working process of the important systems clearly.

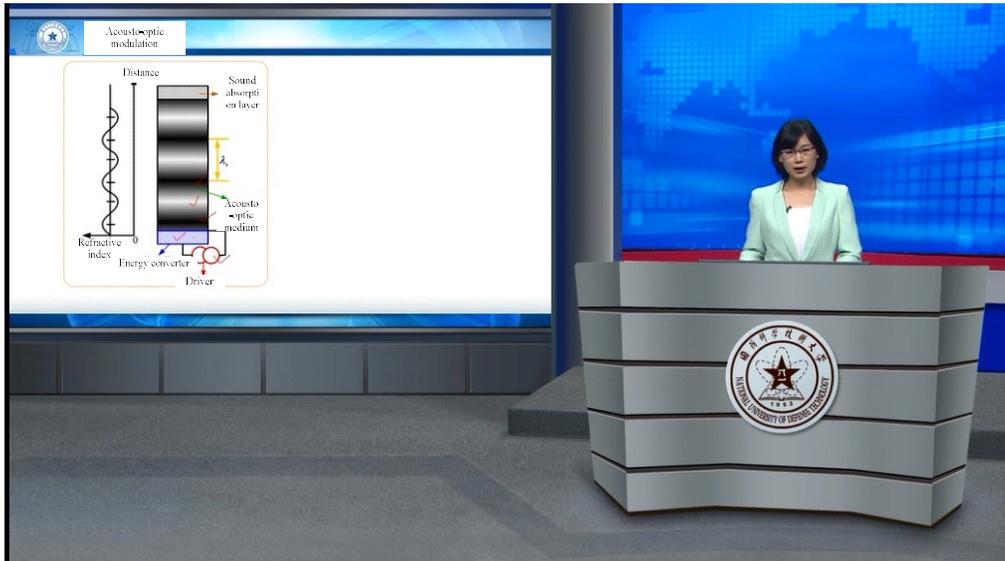


Figure 2. Screenshots of studio recorded by Shi Jianhua.

Table 3. Flash animations of Opto-electronic Technology.

Number	Title	Knowledge points
1	The automatic exposure of camera	The principle and characters of photo resistance
2	Laser semi-active guidance system	The principle, characters and work process of laser semi-active guidance system
3	Four-quadrant detector	Principles of four-quadrant detector and the photodetector
4	Photomultiplier	The structure and principle of photomultiplier
5	Transfer of charge packet in CCD	The transfer of the signal in CCD
6	Transfer of voltage to frequency	The working process of voltage-frequency convertor
7	Measuring technique of moire fringe	The generation of moire fringe, length measurement by moire fringe
8	Frequency modulation of light intensity	Frequency control of alternating light intensity
9	Roundness measurement of spindle's surface	Amplitude modulation of light intensity
10	The principle of temperature measurement by distributed fiber	Temperature effect of Raman scattering
11	The system of temperature measurement by distributed fiber	The construction and the working process of temperature measurement by distributed fiber
12	Modulation by reticle	The construction and the principle of reticle

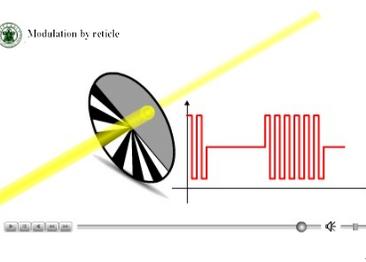
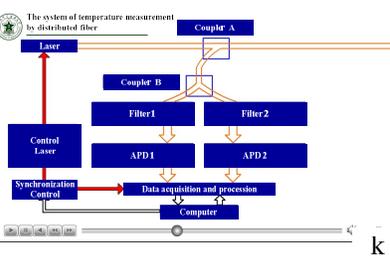
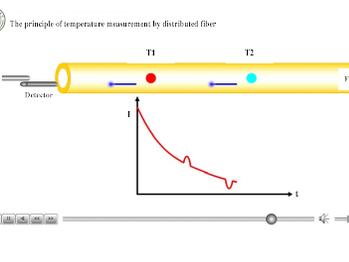
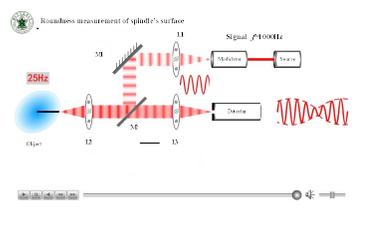
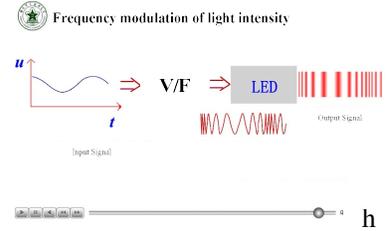
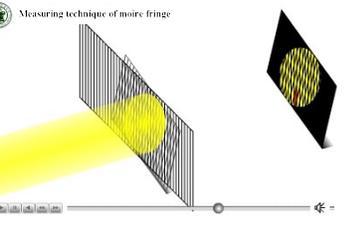
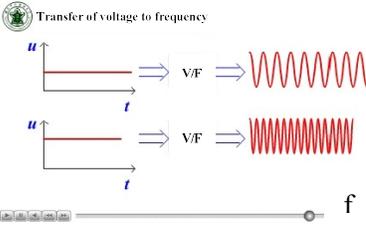
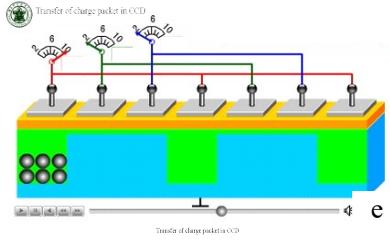
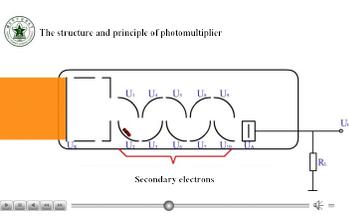
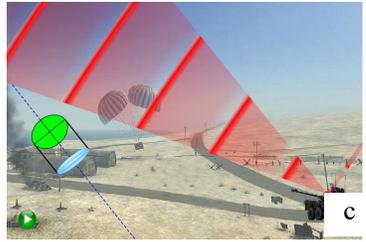
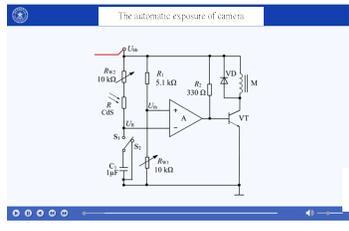


Figure 3. Screenshot of the flash animations: (a) the automatic exposure of camera. (b) Laser semi-active guidance system. (c) Four-quadrant detector. (d) Photomultiplier. (e) Transfer of charge packet in CCD. (f) Transfer of voltage to frequency. (g) Measuring technique of moire fringe. (h) Frequency modulation of light intensity. (i) Roundness measurement of spindle's surface. (j) The principle of temperature measurement by distributed fiber. (k) The system of temperature measurement by distributed fiber. (l) Modulation by reticle.

Table 4. Virtual experiments of Opto-electronic Technology.

Number	Title	Knowledge points
1	Amplitude-modulation wave	The waveform and the modulation depth of amplitude-modulation wave
2	Frequency spectrum amplitude-modulation wave	The frequency characters of amplitude-modulation wave
3	Frequency-modulation wave	The waveform and the modulation depth of frequency-modulation wave
4	The beat frequency of coherent detection	The principle of coherent detection
5	Frequency spectrum of impulse	Frequency spectrum characters of impulse
6	Modulation and demodulation of frequency-modulation of light intensity	Modulation and demodulation of frequency-modulation of light intensity
7	Laser scout, alarm and disturb	The key technologies of laser scout, alarm and disturb
8	The detection of dim light by phase locked amplifier	The detection technology of dim light, the principle of phase locked amplifier

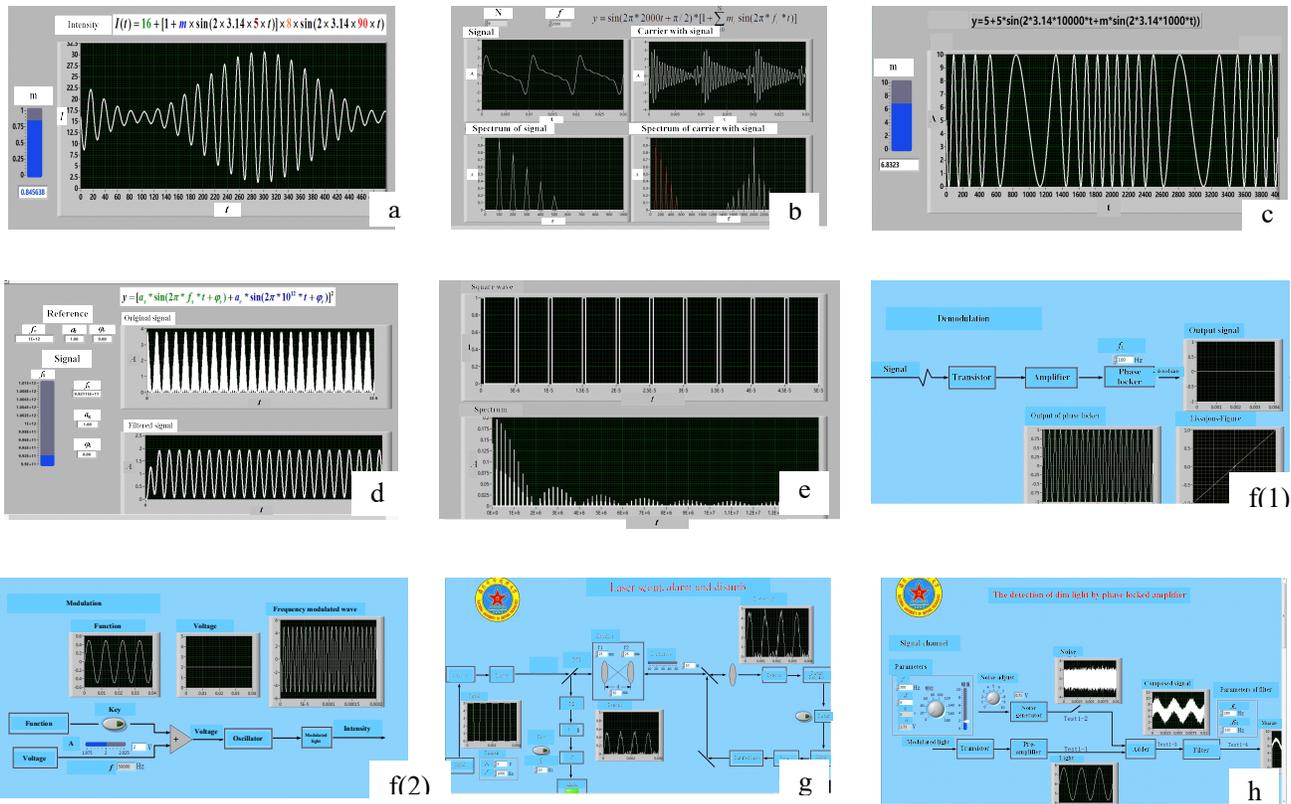


Figure 4. Screenshot of the virtual experiments: (a) Amplitude-modulation wave. (b) Frequency spectrum amplitude-modulation wave. (c) Frequency-modulation wave. (d) The beat frequency of coherent detection. (e) Frequency spectrum of impulse. (f) Modulation and demodulation of frequency-modulation of light intensity. (g) Laser scout, alarm and disturb. (h) The detection of dim light by phase locked amplifier.

5. CHAPTERS SELECTION

In order to compare the “Flipped Classroom” and the traditional teaching model, only the chapter 2 “Introduction of opto-electronic detector” and chapter 4 “Photovoltaic detector” are selected to promote “Flipped Classroom”. Other chapters are still taught by the traditional teaching model.

6. QUESTIONS BEFORE CLASS

In order to supervise the students to watch the teaching video, some basic questions are put forward and the students should answer these questions before the class. Table 5 gives the questions before class for chapter 2 and chapter 4.

Table 5. Questions before class for chapter 2 and chapter 4.

Number	Chapter 2	Chapter 4
1	What is the classification of photo detector?	Please describe the V-I curve of a PN joint with a light illuminating.
2	What is the classification of photo detector?	Please give the current of the photocell when the circuit is short.
3	What is the effect of the photovoltaic?	Please give the output voltage of the photocell when the circuit is open.
4	What is the effect of the photoelectron emission?	Please give the principle of phototransistor.
5	What is the effect of optothermal?	Please give the structure of PIN PD.
6	What is the definition of quantum efficiency?	Why the voltage and the temperature should be stable when an APD is used?
7	What is the meaning of the detector's responsibility?	Compared with the common PD, why the response time of APD is shorter?
8	How many kinds of noise in a detector?	Why can a Si-PD not be used to detect a light whose wavelength is more than 1.1 μm ?

7. DISCUSSION IN THE CLASSROOM

In order to improve the students' comprehension, strengthen the students to use the knowledge to solve the practical matter, some difficult problems are discussed in the classroom. Table 6 gives the questions that are discussed in classroom for chapter 2 and chapter 4.

8. TEACHING EFFECTIVENESS

In order to know the teaching effectiveness of the “Flipped Classroom”, a questionnaire was prepared and the students must finish the questionnaire before final examination. The result shows that about 80 percent students watched the teaching video before class, most students can understand the 75~90% content of the teaching. About 60% students like the traditional teaching model and about 40% students like the “Flipped Classroom” teaching model.

The scores of examinations are also analyzed. The result shows that the scoring averages of traditional teaching model and the “Flipped Classroom” were little difference.

Table 6. Questions discussed in the classroom for chapter 2 and chapter 4.

Number	Chapter 2	Chapter 4
1	Please describe the difference between the photo detector and the photo electronic detector?	Why the photovoltaic can't work in the first quadrant?
2	Which kind of photo detectors is fit for detecting the object moving with high speed?	The response time of the photodiode is much shorter than the photocell, why?
3	Why the photoconductive detector should made by the material with high resistance and worked at the low temperature?	Why the photocell is made by many detached board?
4	For photoconductive detector, photovoltaic detector and photoelectrons emission detector that made by the same material, whose cutoff wavelength is longest?	How can we use the photocell to detect the color of an object?
5	How can we increase the quantum of a photodetector?	Please design a an amplify circuit for photodiode.
6	Why the electric current of a photo detector changes with the light wavelength?	Please describe the difference between the common photodiode, the PIN PD and APD.
7	How can we reduce the noise of the detector?	How can a four-quadrant detector be used to determine the direction of an object?
8	Please design an experiment set to measure the spectrum responsibility of a detector?	

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