

## **The application of flipped classroom in EDA experiment teaching**

**Danfeng Hu, Bo Qu, Xu Huang & Jingen Ni**

*School of Electronic and Information  
Soochow University, No.1 Shizi Street, Suzhou, Jiangsu, 215006, People's Republic of China  
Corresponding Author: hdf78@suda.edu.cn 86-0-18036824278*

ABSTRACT: EDA (Electronic Design Automation) is the hotspot of the development of electronic technology, the corresponding course gradually become an important application courses in the electronic engineering. The teaching strategy of this course is a very important part, whereas the traditional teaching mode has not been able to fully adapt to the application of flipped classroom. According to the characteristics of flipped classroom, teachers construct learning resources such as websites, videos and online tests. Students can learn the knowledge out of class. It puts more of the responsibility for learning on the shoulders of students. At the same time, through the development of micro experiment platform makes the students can begin the hands-on exercises at the very beginning to consolidate what they have learned. The experiment time it also increased, the students' participation is improved. The teaching effects also become better.

### INTRUCTION

In General, students' overall learning process is divided into two stages: the first is the phase of knowledge transfer; the second is the phase of knowledge absorption and digestion, which is also called internalization of knowledge [1]. The most common teaching process of engineering application courses such as electronic design automation (EDA), principle of microcomputer and DSP designing is that teachers teach the knowledge in classrooms first and then students internalize it outside classrooms at present. This process tends to cause several problems like communications

between teachers and students aren't enough, students' learning initiatives are inadequate and individual differentiated instruction can't be realized. So many colleges are trying to reform this pattern of teaching [2].

Flipped classroom is a form of blended learning in which students teach and switch roles with teachers. It is also called "upside down classroom": students learn content online by watching video lectures, usually at home, and what used to be homework is now done in class [3]. Teachers discuss questions with students and give them more personalized guidance and interaction, instead of lecturing. This concept was firstly proposed by Salman Khan in 2004. He began to record videos at the request of a younger cousin who felt that recorded lessons would let her skip parts she had mastered and replay parts that were troubling her. Salman Khan then made a lot of videos on mathematics and post them on the internet. All these videos were highly praised by students and teachers in other schools. Some teachers and schools changed their teaching style after watching Khan's videos. In the past ten years, the concept of flipped classroom has found followers not only in basic education, but also in higher education. This idea is to use educational resources recently popularized by technology, such as video classes or virtual environments of certain courses, so that students have contact with the content at home. Thus, time in the classroom is released, so that teachers and students make progress in learning either by doing exercises, answering questions, or by promoting debates.

The essence of the flipped classroom is that students internalize the knowledge in classroom with teachers' and classmates' helping, and acquire it out of classroom by themselves with videos, websites and other information technology. The students become the center of teaching process in this mode. They can control the learning curve and decide the best time to study by their own. By this way, it can remarkably improve learning efficiency of students. At the meanwhile, teachers become real organizers, mentors and facilitators [4]. They will go on only when students make clear each point. Teachers might lead in-class discussions or turn the classroom into a studio where students create, collaborate, and put into practice what they learned from the lectures they view outside class. As has been said, the

reform of EDA experiment teaching can be realized through flipped classroom.

#### TRADITIONAL EDA EXPERIMENT TEACHING

Students receive certain hours of theory lessons first in traditional EDA teaching mode. Then they begin to do some experiments in the laboratory. In the experiment classes, teachers give the instructions and demonstrate the procedure to all students. Each experiment in class receives a fixed amount of time. Students who do not master the material get no extra time.

For example, a SSD (seven-segment display) decoder design is a basic experiment in this course. The SSD is a form of electronic display device for displaying decimal numerals. It is an alternative to the more complex dot matrix displays. The seven elements of the display can be lit in different combinations to represent the Arabic numerals. Often the seven segments are arranged in an oblique (slanted) arrangement, which aids readability. In most applications, the seven segments are all nearly uniform shape and size (usually elongated hexagons, though trapezoids and rectangles can also be used), though in the case of adding machines, the vertical segments are longer and more oddly shaped at the ends in an effort to further enhance readability. They are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information. A SSD decoder structure is shown in Figure 1. The CLK is a input signal, g to a connect to DOUT[6..0] are output signals.

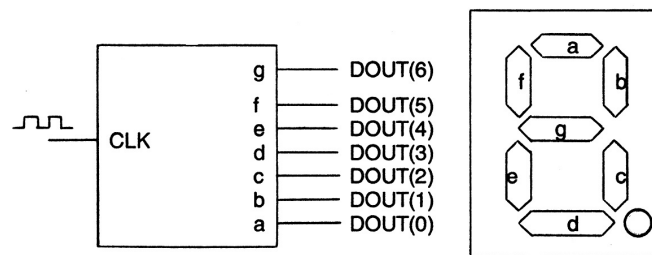


Figure 1: SSD decoder structure.

The traditional way to teach this experiment is that teachers introduce the basic principle, explain the VHDL (Very-High-Speed Integrated Circuit Hardware Description Language) programs, demonstrate the compile, synthesis, fit, simulate and download process. A reference program is given in Table 1.

Students who have gotten fully prepared can accomplish this exam quickly. They follow the teachers' instructions and get the right result very soon. These students have abilities to do more complex experiments. As the teachers have to take care of all the students, so there isn't enough time available to discuss them. On the other side, students who are not familiar with the experiments may not have sufficient time to accomplish them.

The other deficiency is the experiment kits students used are bulky and have limited functions. As a consequence of this, students have to acquire knowledge only in classroom. Their creativity is not fully developed.

Table 1: Reference program about SSD decoder.

```
LIBRARY IEEE;
USE IEEE.STD_LOGIC_1164.ALL;
USE IEEE.STD_LOGIC_UNSIGNED.ALL;
ENTITY decled IS
PORT ( clk : IN STD_LOGIC;
DOUT:OUT STD_LOGIC_VECTOR(6 DOWNTO 0) );
END DECLED;
ARCHITECTURE behav OF decled IS
SIGNAL cnt4b : STD_LOGIC_VECTOR(3 DOWNTO 0);
BEGIN
PROCESS(clk)
BEGIN
IF clk'EVENT AND clk = '1' THEN
cnt4b <= cnt4b + 1;
END IF;
END PROCESS;
PROCESS(cnt4b)
BEGIN
CASE cnt4b IS
WHEN "0000" => DOUT <= "0111111";
WHEN "0001" => DOUT <= "0000110";
...
WHEN "1111" => DOUT <= "1110001";
WHEN OTHERS => DOUT <= "0000000";
END CASE;
END PROCESS;
END behav;
```

For example, an experiment is to design an elevator controller using VHDL tool and implement it in FPGA. The elevator controller is a device used to control a lift motion and to indicate the direction of motion, and the present floor level, etc. The device control the lift motion by means of accepting the floor level as input and generate control signals as output. The structure of this design is shown in Figure 2.

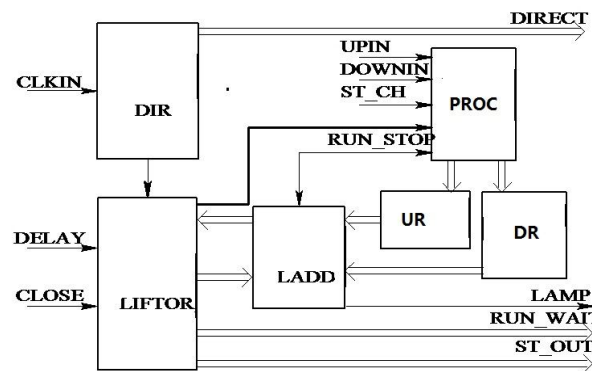


Figure 2: Elevator controller structure.

It needs a lot of resources in this examination, such as keys, LEDs, SSDs, etc. The experiment kits currently used are not easy to be expanded. It's necessary to develop a "micro-experiment platform" in flipped classroom teaching mode.

#### EDA EXPERIMENT TEACHING IN FLIPPED CLASSROOM MODE

In order to apply flipped classroom mode in EDA experiment teaching, the following conditions need to be meet. First of all, teachers and students can communicate with each other conveniently out of class. Today's Internet is a powerful way to communicate, including email, instant messaging and chat room services [5]. The social network apps on cell phone are also commonly used tools to discuss problems. The second is learning resources such as micro videos, quiz on each part and extending materials [6]. Students might watch micro videos of five to seven minutes each. The micro videos need to be concise and contain the appropriate contents; otherwise students would be easily distracted. Online quizzes or activities can be interspersed to test what students have learned. Immediate quiz feedback and the ability to rerun lecture segments may help clarify points of confusion. A video clip is shown in Figure 3.



Figure 3: A video clip

For example, an automatic bell system is designed in the EDA experiment class. System structure is shown in Figure 4.

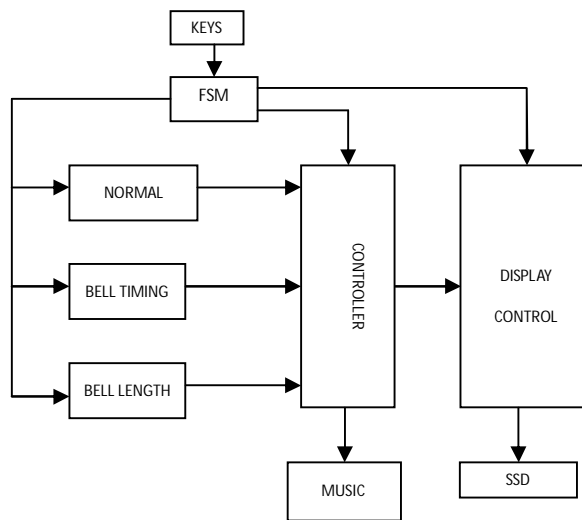


Figure 4: Automatic bell system structure.

Videos about this experiment include several aspects. Firstly, the EDA software is introduced. This video shows how to use QUARTUS II. The work flow is recorded by specific software. One of these flows is shown in Figure 5. After watching this, the quiz is establishing a project.

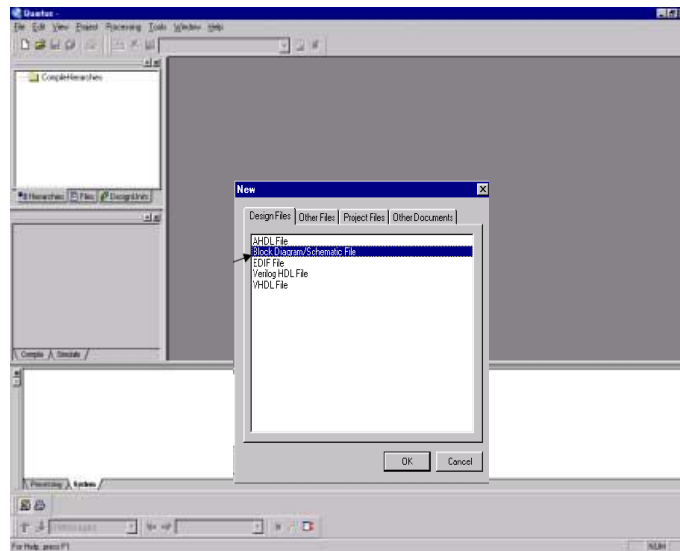


Figure 5: EDA software introduction.

Secondly, the system structure is analyzed in the video. Students can watch, rewind and fast-forward as needed. The quiz of this part is uploading design proposals.

Thirdly, reference codes of one module are demonstrated. The codes of frequency divider are given below. Students can program their own codes according to these. A reference program is given in Table 2.

When students accomplish all these process out of class, they can discuss problems with teachers instead of just listening. Teachers have plenty time to communicate with students instead of teaching basic knowledge on the class.

A micro experiment platform is also designed in flipped classroom teaching mode. The structure of it is shown in Figure 6. It is portable and easy to add new functions. Students can use it to realize their designs when they have watched the videos.



Table 2: Reference program about frequency divider.

```

LIBRARY IEEE;
USE IEEE.STD_LOGIC_1164.ALL;
ENTITY FREQDIVID IS
PORT
(
clock50M: IN STD_LOGIC;
clkout1K: OUT STD_LOGIC
);
END FREQDIVID;
ARCHITECTURE behav OF FREQDIVID IS
CONSTANT N: INTEGER:=24999;
SIGNAL counter: INTEGER RANGE 0 TO N;
SIGNAL clk: STD_LOGIC;
BEGIN
PROCESS(clock50M)
BEGIN
IF clock50M'event and clock50M='1' THEN
IF counter=N THEN
counter<=0;
clk<=NOT clk;
ELSE
counter<=counter+1;
END IF;
END IF;
END PROCESS;
clkout1K<=clk;
END:

```

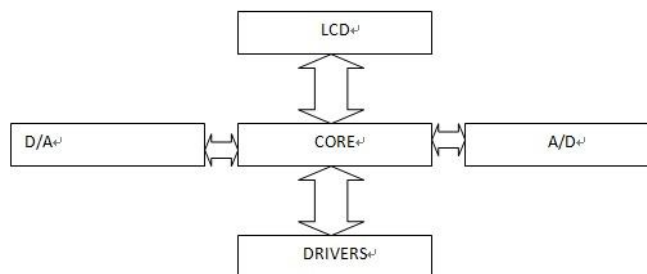


Figure 6: Micro experiment platform.

## RESULTS

We began to apply the flipped classroom in EDA experiment teaching from the autumn semester 2013-2014. So far about 300 students had learned in this mode. After each round of teaching process, we let students accomplish the survey about this teaching method and grade this course anonymously. The comparison of average result between traditional method and flipped classroom method is shown in Table 1.

Table 1. The comparison of average result between traditional method and flipped classroom method

Contents of the survey	Traditional method	Flipped classroom method
Time spent out of class in each experiment	0.6 h	3.2h
Willing to learn the corresponding following courses	69%	92%
Sure for learning something useful in electronics designing	47%	87%
Overall grade about this course	80.4	91.6

The percentage of accomplishing system comprehensive experiments is also promoted from 73% to 96% after applying the flipped classroom method. Two groups of these students win the second prize in the national electronics designing competition based on the works they completed in this course.

## CONCLUSION

The application of flipped classroom in EDA experiment teaching changes students' attitudes toward learning. The flipped classroom constitutes a role change for teachers and students. It puts more of the responsibility for learning on the shoulders of students while giving them greater impetus. With the construction of the learning resources, the effect of this method will be better.

## ACKNOWLEDGEMENTS

This work was supported by High Educational Reform and Research Funds of SOOCHOW University 2013, No. 5731504813 and National Experimental Teaching Demonstration Center of Computer and Information Technology in Soochow University.

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