

## A Research of Digital Integrated Circuit Design Curriculum's Bilingual Education Based on Methodology of SIOP

## Gong Chen<sup>\*</sup>, Weiwei Ling, Li Li and Yue Shi

Chengdu University of Information Technology, No.24 Block 1, Xuefu Road, Chengdu, China

\*Corresponding author. Email: chg@cuit.edu.cn

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**Abstract.** Teaching mythology of Sheltered Instruction Observation Protocol (SIOP) is developed by United States for non-native English teaching. It is a high quality teaching methodology. SIOP also provides a perfect teaching paradigm for college teachers. This paper introduces basic concepts and essential characteristics for SIOP. The necessity and feasibility of the bilingual education reform in Digital Integrated Circuit Design curriculum are discussed. The detail of applying SIOP in Digital Integrated Circuit Design curriculum's bilingual education is also demonstrated, such as course preparation, establishing of background knowledge, providing comprehensibility input.

### 1. Background

Since 2001, the Ministry of Education in China has explicitly asked universities to carry out bilingual education actively. Henceforth, bilingual education has become the focus of the reform of higher Education. In 2015, the State Council has proposed a three-step project of the strategic objectives in building world-class university and disciplines. The project envisages China having a number of universities and key majors as world-class by 2020, with the number of world-class universities and disciplines in China entering the top tier in the world by mid-21st century. Moreover, the college students need to develop comprehensive quality and international view. [1] Therefore, bilingual education in universities should be improved to match above requirements. Bilingual education will be a true reflection of university internationally, fully adopt Chinese ethos, provide an outstanding academic education, focus on sector-leading pastoral care and introduce a wealth of co-curricular activities to broaden the horizons of all college students.

Digital Integrated Circuit theory is the core curriculum of Science and Engineering of Microelectronic. The basic concepts of Digital Integrated Circuit Design are constructed of MOS model and digital stand cell electrical characteristic, furthermore, Digital Integrated Circuit Design need be curriculum practiced from a design perspective. Hence, this has the properties of abstract and complexity. Up to now, few universities in China offer bilingual education in Digital Integrated Circuit Design. Totally four model of bilingual education are used 1) English education approach (English textbook, fully English teaching); 2) Chinese English mix education approach (English textbook, both Chinese and English teaching); 3) Half English education approach (English textbook, fully Chinese teaching); 4) Traditional education approach (Chinese textbook with English professional vocabulary, fully Chinese teaching). Because English education approach require both teachers and students with high level of English language proficiency, most of college bilingual education are belong to type of model 2)3)4). In this situation, many of bilingual education in Digital Integrated Circuit Design are prone to two pitfalls: 1<sup>st</sup>, an obvious phenomenon is the language barrier, especially in the beginning of bilingual education, which results in Chinese students keeping silent in the classroom, and lagging seriously behind in learning progress. 2<sup>nd</sup>, college students are hard to understand the English textbook. Therefore, teachers need to explain one concept many times. As a result, college major course might easily turns into an English minor course. Through college students practice their English skills during these procedure, the lack of relevant professional knowledge would probably affect their employment.

Based on above analysis, how to improve the teaching effect on the bilingual education of Digital Integrated Circuit Design becomes the theme topic. In detail, teaching effect could be explained as helping students to construct disciplinary framework, understanding basic principle of transistors and process, mastering common Digital circuit design simulation and synthesis method. All in all this paper focus on creating a good English learning environment, getting rid of student's anxiety, and enhancing student's competitiveness.

### 2. Introduction of SIOP

SIOP could also called sheltered instruction approach. Consisting of three steps and eight links, SIOP has become a mainstream English as a Second Language (ESL) teaching methods in the English speaking countries in the 21<sup>st</sup> century. SIOP pays attention to the integration of time and form in ESL, emphasizes the combination of its basic tasks and advanced tasks, and advocates a dynamic balance between teacher's support and student's autonomy. [2] SIOP must not be viewed as simply a set of additional or replacement instructional techniques that teachers implement in their classroom. Indeed, SIOP draws from and complements methods and strategies advocated for both second language and mainstream classrooms.

SIOP includes totally eight links, they are preparation, building background, comprehensible input, strategies, interaction, lesson delivery and practice, respectively. [3] College teachers could choose any combination of SIOP links depend on the discipline background and teaching content.

# **3.** The Application of SIOP in Digital Integrated Circuit Design Curriculum's Bilingual Education

Digital Integrated Circuit Design Curriculum pay attention to theoretical analysis and engineering application. Based on its discipline characteristic, we re-combine and merit SIOP eight links into seven portions as shown if Fig.1. They are preparation, building background, comprehensible input, strategies, interaction and experiment, the last one is review and evaluation.

### **3.1 Preparation**

There are two tasks in the link of preparation. 1) To learn about students' current English proficiency; 2) To adapt traditional Digital Integrated Circuit Design course and design classroom activities based on the students' current English proficiency. Because of the condition, teachers are hard to learn the students' overall English level before the lecture. Therefore, teachers can set some simple English problems in the introduction chapter, such as "why is designing digital ICs different today than it was before?" or "what are CMOS devices and manufacturing technology today?" And in the first class, most of students should introduce themselves and answer one question with English in two or three minutes. Then teachers could adapt course content and design classroom activities according to above investigation.



### **3.2 Building Background**



Fig. 1.Education organizational framework of Digital Integrated Circuit Design under SIOP model.

The task of building background is to establish and distinguish old and new knowledge, and emphasize the new during teaching. For instance, the content of transistor structure and behavior model has been taught in Microelectronic Devices and Principles. However, in Digital Integrated Circuit Design, these old knowledge are deeply used to analysis stand cells of digital combine logic circuit. Therefore, before class, student should review different current equations versus to transistors in different region. Then they could easily understand the procedure about using current equations to deduce new knowledge of "switching threshold", "noise margin" etc. Meanwhile, anxiety to learning of new knowledge is decreased.

### **3.3** Comprehensible Input

Teachers should clearly clarify the target and outline in the beginning of a class. And teachers' expression should close to the students' current English proficiency. One difficulty feature of Digital Integrated Circuit Design is that there are many derivation and design from function requirement to schematic topology. To solve this problem, the comprehensible input could be divided into three steps. 1<sup>st</sup> step, to deliver clear design sequence and rules to students in class. 2<sup>nd</sup> step, to prepare related exercises to consolidate the procedure of derivation. 3<sup>rd</sup> step, to verify the derivation through measurement results. After these three teaching steps, theoretical of derivation and design from function requirement to schematic topology is consolidated.

### **3.4 Strategies**

Students are encouraged to adopt Scaffolding Instruction, e.g. GIST, Graphic Organizers, Rehearsal Strategies and Comprehensive Strategies. There are many useful communication and learning styles, for example, to create specialized Digital Integrated Circuit Design curriculum website, to use communication software like QQ or WeChat. Teachers should always interact and communicate with students. They can upload teaching materials, teaching videos and research papers in the curriculum website. In addition, they can answer students' question at any time and any place through communication software.

### **3.5 Guided Interaction**

SIOP encourages students to participate the activities in class. In guided interaction, the teacher promotes a learning environment where students maximize their ability to interact with each other through student discussions, conversations, meaning negotiation, collaboration, and feedback. The teacher creates opportunities for students to use multiple strategies such as co-design, student interaction, and flexible groupings to enhance learning of Digital Integrated Circuit Design. The teacher also promotes mutual respect and confidence building among students. Unlike teacher



dominated instruction, the role of the teacher in guided interaction is that of a facilitator who coordinates the learning peocess and makes learning fun, coordinates the learning process and makes learning fun, interesting, and stimulating for students. [4] For example, students are multi-grouped to design different complementary CMOS circuit. Let each group to draw up one function equation. Then teacher choose two groups as a pair, they exchange the theme and go on designing complementary CMOS circuit according to each other's function equation. At last, they judge each other's design in class. As a result, both students' analytical abilities and language expression abilities have been improved.

#### **3.6 Experiment**

Digital Integrated Circuit Design's knowledge structure changes quickly over time. The experiment's content should meet the state-of-the-art industry requirement. This feature makes Digital Integrated Circuit Design different from other curriculums. The experiment's content should considered to update in every four or five years. At present, we keep the traditional experiment of inverter performance simulation by using EDA tool (Cadence). And we have added new experiment's content about Design Compiler / IC Compiler (Synopsys) synthesis with timing and power constraints. In the next step, we consider to add Verdi and VCS Formal into the experiment. The contemporary experiment of Digital Integrated Circuit Design increase college students' employment.

#### **3.7 Review and Evaluation**

SIOP require teachers to review as many as possible, in addition, teachers should evaluate students' learning progress and learning effect in time. Teachers might evaluate students' actually learning in Digital Integrated Circuit Design with the following two aspects. 1) To try diversification of checking contents. The checking contents in Digital Integrated Circuit Design could be diversified. In-class exercise, group discussion, experiment performance and experiment reports etc., all above options can used to evaluate students' practical ability. The sum of the evaluation results can used to consist of students' usual performance. 2) To try diversification of evaluation methods. Except the learning progress of specialized knowledge, the English expression ability, analytical ability, communicate ability and cooperative ability could be also include in the evaluation methods.

#### 4. Summary

With the target of creating world-class universities and disciplines, bilingual education draws increasing attention from the society. The difficulty for implementation of bilingual education in Digital Integrated Circuit Design is that this discipline requires to achieve both course objectives and language objectives. SIOP supplies methodologies about course preparation, language design and optimization of teaching methods etc. for curriculum reform in Digital Integrated Circuit Design. During this procedure of curriculum reform, we should take national requirement and industry needs into consideration. SIOP improves bilingual teaching educational quality of Digital Integrated Circuit Design. As a result, international competitiveness of college students can be improved sharply.

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