

# Train Students to Study Independently

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## ABSTRACT

Independent study is a major ability of engineering students. In independent study training practice, we need to use different instructional strategies and responds to individual student needs and learning styles. The purpose of this paper is to demonstrate a four-step student independent study training mode we applied to teaching the Biomedical Engineering students in Dali University, China. We developed this teaching mode to fulfill the goals of the first years' undergraduates training and improve the students learning skills. The four-step teaching mode includes both in-class and out-of-class activities. The emphasis is on how to train students to get information from the reading materials, understand the concept, develop critical thinking and eventually become independent learner.

**Keywords:** independent study, engineering education, training mode

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## I. Introduction

In traditional class teaching, instructors rule the whole class and the students were forced to receive information given by the instructors. Therefore, the students do not have enough time to think independently. Obviously, this mode is not suitable for modern engineering students. As the development of the society, our engineering students must be able to participate and eventually to lead in aspects of conceiving, designing, implementing, and operating systems, products, processes, and projects. In to do so, engineering students must be able to study independently and think critically.

In teaching practice we have found that the first year college students are dependent to a great extend on teachers' instruction. They are lack of ability and strategies to study and think independently. This is because in China, the most important goal of students in high school is to prepare themselves for the national college entrance examination. The high school teachers have to focus on the instruction on how to teach students to pass

the sample tests. So, the students can only follow the schedules teachers have arranged. The students can understand the contents of the books only by keeping solving a lot of problems from the reference books the teachers assigned, instead of trying to read books detailed and learn the main idea of contents. And they do not have time to read the books they are really interested. They seldom have the opportunity to develop their own way of thinking. In this paper, we will introduce a teaching mode we used for the first college years engineering students to train them in acquiring the ability of studying independently and thinking critically.

## II. Teaching Mode

In order to fulfill our training goal in first years for undergraduate students, we developed a four-step teaching mode and applied to the course of Fundamental of physics.

### 1. Step One: Students Read Independently

Before giving the students the assignments, we have made a detailed training plan based on the content and the scientific research methods involved. We started with a hand-out to guide students on the time spending on the

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emphases and difficult parts, and the browsing part of the content. For example, we ask students to try to understand the main idea of the chapter, and do not spend too much time on the details. For formula or equation derivation, we ask students to follow the idea of the author, and look for the basic principles and theoretical basis.

Take the chapter “The Molecular Kinetic Theory of Gases” as an example. In this chapter, the emphasis contents are equation of state for ideal gases, the energy formula of ideal gases, and the laws of ideal gases. The difficult part is derivation of pressure formula. The rest of the contents in the chapter, including the molecular model of an ideal gas, the pressure formula of ideal gases, the Boltzmann energy distribution law, and the micro-structure of matter, are to be understood only. Under this guidance, we assigned four class hours for students to read this chapter. We ask them to spend three class hours to read emphasis parts, one class hour for comprehensive parts. In reality students had to spend more time on reading in their spare time in order to complete the assignment.

To help students read and understand the content, we give students about 10 questions per chapter. These questions are very general, and mainly focus on the emphasis contents. When students can answer these questions after they have read the chapter, it means they have understood the main ideas of the chapter.

While the students are reading the chapter, instructors walk around in the classroom, providing any assistance to the students. After class, instructors welcome students come to ask questions or discuss problems with teachers in their office time. And we found the students were very interested in doing so, because they started to see they have the ability to learn independently. In answering students' questions about reading the chapter, instructors can find out how the students approach the reading materials and point out the incorrect ways reading text book. In this case, the instructor can discuss with the students about the correct and efficient ways of reading. This does help students to develop their reading skills.

## 2. Step Two: Instructor Choose Student to Answer Questions

After the students have finished reading the chapter, instructors will use the 10 questions to check if the students understand the chapter. Then instructors will raise questions in depth and details for students to discuss further in class. By interacting with the students at this step instructors can see how the students understand the text. Since the questions were designed by instructors, the students can focus on the content of the text book, and read it in more detail.

To prepare the questions for students, we keep in mind that through questioning and answering, students can understand the main idea of the content. Therefore we study the chapter very carefully and design questions which cover the emphases and difficult content. For example, in chapter “The Molecular Kinetic Theory of Gases”, the content “Molecular Model of an Ideal Gas”, “The Equipartition of Energy”, “Distribution of Molecular Speeds” are the major parts we want students to grasp, we developed about 20 questions to discuss the main idea of the text. In this chapter, the scientific research method of idea mode is applied. So in the asking and answering processes, we always emphasize the research method appropriately.

## 3. Step Three: Students Asking and Answering Questions to Each Other

In this stage, we ask students raise questions based on the main content, and have their peer students answer them, and the students who raise questions must judge if the answer is right or not. In the classroom, students are very active. In order to come up with an excellent question and find the right answer, they must read beyond the text so they spend much time to read reference materials. For example, one student ever found a question: In the space high above the atmospheric layer, the temperature of the sun's radiation is 3000K. What will happen if a person was put in this situation nakedly? We found there were 8 students gave different answers respectively. But

none of them got the right answer. This is a very good question. It covers the statistic concept of temperature and the Boltzmann distribution law. The instructor asked the student who put out the question to explain the right answer, and discuss with the students about the reason why they answered incorrectly.

Furthermore, the instructors at this stage play the role of facilitator. He/she provides assistance only when there are conflicts or debating. Students are the major player and they control their learning process.

#### 4. Step Four: Summary

After students read text book, answer instructors' questions and asking and answering mutually, we come to the last step: summary. We choose students randomly and ask them to present an assigned section of the content. At this point we have gone over the content more than two times, and the students understand the content thoroughly through the discussions in different stages, most of them can give a brief summary of the reading material. After the students' presentation, the instructor will summarize the chapter again and point out the students' wrong idea or incorrect understanding when they represent in class. Then the instructor demonstrates the strategies in text book reading and study. This again does help student improve their skills to study independently.

### III. Results and Discussion

In teaching Fundamental Physics, we choose eight chapters for the first-year students in the first semester. In order for the students to have a smooth transition from high school study, we lecture the first three chapters. Although instructors lecture the whole chapter, we mainly concentrate on how to get the main point across, how to analyze a problem based on what we have learnt. In class, instructors raise questions for the students to discuss among themselves. Even though we ask students to pre-read and take brief notes in class, then review the lessons, unfortunately, our students still keep their study habits from high school. To better understand the first year students, we made a study habits survey on 55 students of

**Table 1 Questions and survey results on students study habits**

1. Do you do pre-reading as the instructor required?		
A. Yes, I always do	B. Sometimes I do	C. Never
3 students(5%)	14 students(25%)	38 students (69%)
2. Do you take notes in class?		
A. Yes, I do.	B. Sometime.	C. No, I don't.
15 students(27%)	20 students(36%)	20 students(36%)
3. Do you like to participate in class discussion?		
A. Yes, I do.	B. Occasionally.	C. Don't like to.
16 students(29%)	29 students(53%)	10 students(18%)

2010 Biomedical Engineering major before we started to apply our Four-step teaching model. The survey questions and results are shown in Table 1.

From Table 1 we find that the students still keep the study habits from high school even though we have tried to change them in first three chapter's teaching. In question No. 1, only 30% students do or sometime do pre-reading. In high school, students don't need to do pre-reading, and they learn new stuff only in class, then do a lot of exercise (solving assigned problems from teachers and the reference materials). They are familiar with the problem types and the way to solve the problems. But they don't know why they have to do so, and their basic knowledge of the subjects are very poor. In college, we don't have time for students to do so many exercises and our teaching pace is very fast. So, if the students don't do pre-reading, they will have trouble to follow the instructor's lecture. Therefore, one of the great challenges for us to implement our Four-step teaching model is that we have to find a way to teach the students on how to do pre-reading. For question No. 2, still 36% students don't take notes in class. According to our conversations with some of students after class, we learnt that a great deal of students don't know how to take notes in class. Especially when teachers use a presentation (PPT) in class, quite a few students try to copy everything on the screen and they miss the instruction. For question No. 3, only 16% students like to participate in class discussion. The students who don't like to join in class discussion are afraid to make mistakes in front of the public. They are lacking confidence.

Prior to the application of this four-step teaching method, we also found our students are lacking motivation to

study the fundamental of physics. Most of the students are relying on instructors' lecture. They only focus on the ideas and content the instructors refer to. They do not want to think or to discuss any further. Only few students can finish the reference material we assigned to them. The students are just forced to follow the schedule of our teaching.

After we have applied this four-step teaching mode, our students are much more active in the study. They are given an opportunity to take control of their learning process. In order to participate in class they have to read more reference materials and scientific journals, and spent time working with each other before classes. At the end of the semester, we made two surveys in the same class. One survey is about the pre-reading and class discussion, the results are shown in Table 2.

In Table 2, the results of question No. 1 indicate that 42% students can do pre-reading effectively, and 17% students have a good habit in collaborative study. 15% students still have not learnt how to pre-read. In question No. 2, we found not all the students do pre-reading as we recommended (we recommended the method as shown in C: Read the emphasis parts in detail and briefly read the rest.) It is easy to understand that our students do need time to make the transition from high school learning

**Table 2** Survey results on pre-reading

1. When you encounter a problem while you pre-read, what will you do?	
A: Stop pre-reading.	8 students (15%)
B: Ask other students.	17 students (31%)
C: Try all the best to solve it.	7 students (13%)
D: Mark it down and keep going on.	23 students (42%)
2. What do you prefer in pre-reading?	
A: Read the chapter all through.	19 students (35%)
B: Try to do the corresponding exercises while pre-reading.	19 students (35%)
C: Review the learnt part, then pre-read the new content.	5 students (9%)
D: Read the emphasis parts in detail and briefly read the rest.	12 students (22%)
3. In class discussion, you	
A: like to raise questions	15 students (27%)
B: like to answer questions	28 students (51%)
C: just like to be a bystander	12 students (22%)

to college learning. Question No. 3 indicates that most of our student still are not confident in class discussion, and it is much more difficult to raise questions for students because they have to understand the problems thoroughly first.

Another survey we have made is about how the students like the Four-step teaching method. Some of the survey results are shown in Table 3.

The survey results of question No. 1 in Table 3 indicate that most of the students applaud our reformation. But 15% students still prefer the traditional teaching method. They felt comfortable in the traditional way because they don't need to think about too much in the study (we learnt this based on the notes students wrote down at the last item of the survey), For question No. 2, the results show that about 85% students feel it is hard or very hard to participate in class discussion. This is as we expected. For first year college students, they just started to get used to college learning, therefore most of the students still lack of confidence in their ability to analyze and think.

The results of question No.3 shows that close to 60% students reported an improvement in oral presentation. This is consistent with the results in Table 2 question

**Table 3** Four-step teaching method survey

1. Which teaching method do you prefer?		
A. Traditional method	B. Four-step method	
8 students (15%)	47 students (85%)	
2. Do you think it is hard to participate in class discussion?		
A. very hard	B. hard	C. not hard
26 students(47%)	20 students(36%)	8 students (15%)
3. Did you have an improvement in oral presentation?		
A. Yes, I do.	B. little bit.	C. No, I don't.
32 students(58%)	12 students(22%)	10 students(18%)
4. Do you collaborate with your classmates in your study?		
A. Yes, I always do.	B. Occasionally.	C. Don't like to.
30 students(56%)	18 students(33%)	6 students(11%)
5. Where did you spend more time?		
A. reading text book	B. discussion in class	C. summary
33 students(61%)	16 students(30%)	5 students(9%)
6. Do you think the four-step method challenges you more?		
A. Yes, it does.		B. No, I don't think so.
43 students (80%)		11 students (20%)

No.3, C.

In Table 3 we found that there still is a proportion of students who did not get good result in our training practice. In question "Where did you spend more time?", there are 58% students paid more attention on text book reading. This indicates that those students have not found the efficient method of reading. It is understandable that this happened at the very beginning of the students' independent learning. We can expect that after two years' training, our students will learn effective way of reading and pay more attention to thinking, problem solving, discussion and researching.

The survey results of question No. 6 show that 80% students agree that the Four-step teaching method challenges them more than the traditional teaching method.

#### IV. Conclusion

The purpose of independent study is to provide an alternative learning environment for students. This training program uses different instructional strategies and responds to individual student needs and learning styles.

The four-step teaching mode consists of three main parts. The first part is to guide and help students read the text book efficiently. The second part is to create an environment for class discussion. Regardless of the questions constructed by the instructor or by the students the teacher must have the ability to organize and provide directions to the class. The instructor will still have to assist in solving the problems and explain the right or wrong answers made by students in class discussion. This is the most difficult and important part in this training mode. It requires extensive preparation on the part of the instructor. The third part is summary of the chapter. It takes students to a deeper understanding of the basic theory, principle, and concepts. Obtaining ability of independent study is very important to modern engineering student. However, as we learnt from our experiences, it is a hard job to train first year engineering students in China because the educational model in elementary and secondary schools does not emphasize students' ability development. In education practice, we found our four-

step training method benefit engineering students in their learning process. On the other hand, we also see the challenges to implement the training mode, such as higher standard of teacher's ability to organize and direct the class discussion and it is time consuming. We are going to follow up and do more research on these students in their following years, and to perfect the engineering student independent study training mode.

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