

Teaching Reform of Introduction to Nanomaterials Based on Flipping Classroom

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Abstract. In order to fit for scientific and technological progress consumption as well as embody the interactive teaching philosophy that can teach and learn from each other in the field of nanotechnology, this thesis' author absorbed advanced teaching ideas and elements of round table teaching and flipping classroom and changed teaching posture and style. In the teaching of introduction to nanomaterials, the author tried to carry out the flipping classroom teaching methods that "Anti teaching for learning, anti learning to teach", brought students to platform, let students talk about the latest nanotechnology knowledge they had consulted one by one, used vivid example to illustrate the strange properties of nanomaterials. Teaching practice showed that flipping classroom teaching method is an effective measure to arouse students' enthusiasm for learning, it not only changed hidebound model of teaching liked "lays down the law" of the teaching methods and made the classroom atmosphere more active, but also embodied the "nano-man effect", which students can give full play to each student's role in classroom like nanometer particles. In the teaching, the "top-down" method of "teaching" is adopted first, and then the "bottom-up" method of "learning" is combined. That is to say, first, teachers designed teaching contents and methods of derivation, divided the teaching content into many units and modules, and then guided students to search for the latest examples of these units. Finally, it led each student to make the collected pictures and videos into a beautiful PPT with the teachers' help, asked students to make speeches or shared in Blue MoYun class to read. This mode guided students to intensify the cognition of small-size effect, specific surface effect, macroscopic quantum tunneling effect, "dielectric limited domain", "Curie temperature", "red shift blue shift phenomenon", "Kulun blocking effect", "lotus effect", "house lizard effect" and a series of abnormal properties that Micro/nanometer Scaled brought by vivid visual effect, formed a whole understanding of a series of abnormal properties of nanomaterials. The using of flipping classroom improved teaching effect as well as promoted the further improvement and optimization of curriculum resources, then, sorted out videos and pictures by integrating resource. It formed a virtuous circle of teaching interaction.

1. Introduction

The "Flipping classroom" is a kind of subversive teaching method targeting at teaching structure and teaching procedure used by printing-technology-based traditional class, which will lead to a series of reform on role of teacher, curriculum model and management mode, etc. However, this doesn't mean that no teacher is required in flipping classroom. Instead, in flipping classroom, there will be more time for teachers and students to have interactions. Therefore, teachers will play a role guiding students how to learn but not a role delivering knowledge. Meanwhile, teachers will play the role designing teaching interactions but not a role leading the interactions. Teaching activities will be carried out via the dialogues and interactions between students and teachers, teachers shall adjust their words and performances according to students' questions. That is study is not a process that teachers just deliver the knowledge while students just listen to the teachers. The teaching in flipping classroom not only change the roles of teaching and learning but also expand the space and time for teaching and learning, which will greatly save the time to play videos. Actually, flipping classroom is really suitable for class requiring large amounts of videos. Nanomaterial introduction

is the right subjects requiring to be supported by play many videos.

2. Study Content and Problems Existing in Teaching

Nanotechnology is a kind of scientific technology that studies the movement rule and interaction of composition systems when they are in a space with a dimension of 0.1-100nm, as well as the technical problems encountered when nanotechnology is actually used in our daily life. Now, nanotechnology has been considered as one of the key techniques in 21st century. In order to know about the abnormal property of nanomaterial, it is necessary to have a systematic introduction on the four effects owned by nanomaterial --- small size effect, quantum effect, surface effect and macroscopic quantum tunneling effect [1]. The following are the contents to be taught: origin of nanomaterial, development history of nanotechnology, research category of nanotechnology, current study on nanotechnology, abnormal property of nanomaterial, development trend of nanotechnology, classification of nanomaterial, making method of nanomaterial, test method of nanomaterial, application of nanomaterial, etc [2].

In order to better introduce the essences of the four effects, cases shall be used. When introducing the cases, it is mandatory to introduce the methods used to make nanomaterial. When introducing the making method, it is necessary to introduce relevant equipment... Assumed that there is no video but only words can be used to do the explanation. As a result, what students can get is just a simple concept and theories which are hard to be understood. So it is easy for us to figure out the result what will the teaching be like. Contrarily, if videos and audios are used in the class, too much time will be cost for playing the videos and audios, which will shorten the class volume and output. In order to solve these problems, mosoteach can be turned for help. That is the videos and audios can be uploaded to the teaching system beforehand so that students can do a preview. Then in the class, students can have a round table discussion to solve the key problems. Actually, this is a teaching method combining the mosoteach and flipping classroom.

For the subject "Nanomaterial Introduction", it is a subject full of different contents and aspects, whose basic concepts are quite dull. So if there is no vivid and interesting example, it is difficult to get the students to fully understand. In order to improve the teaching effect, I have done a lot to attract the students, like updating the courseware, integrating teaching materials and resources, perfecting PPT etc. However, no matter how great the courseware is and no matter how vivid the photos are, the students are hard to be attracted.

Then I finally knew that "teaching" is not the only thing that can determine the teaching effect. That is, "learning" shall be paid attention to as well. If "learning" is ignored and traditional mode "teacher keeps teaching and students just keep listening to the teacher", teaching effect will not be good. First, in traditional class, students will be tired and bored; second, "one-way output" does not have any interactions and students do not have opportunities to think by themselves, so the traditional class is just like "sleep song" for students. Under this background, it is really necessary to well connect "teaching" and "learning" and make their relationship closer.

3. Flipping-Classroom-Based Reform Attempt of Nanomaterial Introduction

The teaching reform on nanomaterial shall strictly follow the principle "strengthen the practice, emphasize application, enhance quality and cultivate ability", focusing on theoretical teaching and rare cases by using modern educational techniques, teaching materials and online educational resources. Besides, teaching reform shall concentrate on the students and try to improve the learning. Anyway, the reform shall be targeted and carried out step by step, trying to get it well matched with modern teaching.

If so, it is mandatory to use the advanced educational concept advocated by flipping classroom --- mutual learning and mutual teaching; meanwhile, it is necessary to learn from the advanced teaching method used by mosoteach, trying to set up an open teaching platform, by which a close relationship between students and teachers can be formed. By such a platform, the students will not only the subject to be taught but also a main force to support the teaching reform. Then students

will play an active role in class and research studies, which is going to push forward the nanometer teaching and its research.

3.1 Enrich base station, get students as the learning subject

Just like what is mentioned above, education is not a work to set up a base station for teaching but also a work to get students as the learning subject. The network of teaching and learning shall be with 4G broadband. Otherwise, the teaching and learning will be independent from each other and they cannot reach the same target. Therefore, being as a teacher, the first thing is to enrich his or her own educational base station and enrich his or her own teaching resource system. That is what the teachers have shall be available for students' learning. Second, teachers shall enrich their own teaching resources and keep the pace with the development of nanotechnology. For example, teachers shall get all new nanotechnologies into the teaching. Actually, if we want to have the teaching and learning well integrated with each other, both teachers and students shall be involved in. By combining the newest research status and the hottest topic being talked about, student shall be pushed forward to look for the suitable cases. Then the newest cases can be used for the teaching and make teaching more interesting. Such an interactive teaching fully reflects the spirits held by "nanometer people" in these days. The establishment of mosoteach makes such a teaching-learning system come true.

3.2 Well design teaching interactions and encourage students to learn

In teaching, the design of instructional interaction has been well managed. Cases used for leading-in were quite topic-concentrated and interesting, such as the cases which break through people's understanding on nanometer were listed out. For example, on the blackboard, it is said that: true gold does not fear fire, ceramics are not fragile, metals are no longer shiny, and non-metal begins to shine. When these words were written on the blackboard, students were easily attracted and they doubted that: why? Is that true? At this time, don't show them the photos and videos you have obtained in a hurry; instead, ask the students to look for such examples by themselves online. Later, students found out that in the world of nanometer, gold turns to black, nanometer platinum turns to platinum black and other interesting pictures. Students handed up and wanted to show what they have found.

The design was much better than the situation that teachers only present the animation and photos they have got. By getting students involved into the interactions, what students thought about can be known about; meanwhile, students could have a feeling of achievement by looking for pictures. Additionally, the animations and photos found by students could be shared with others by posting them on Wechat, or students could go onto the platform to make a brief introduction. By sharing, the interaction between teaching and learning will be much better. By the exchange and speeches among students, all students can visually see that ceramics which are fragile will have a good toughness after getting into the status of nanometer and we can have non-broken ceramics; nanometer silver can be melted by boiled water (at a temperature of 100°C); gold can be melted at a temperature of 330°C (a temperature for fried bread sticks)... In nanometer world, there are so many abnormal things happening.

After watching the abnormalities, introduce a concept and fact to the students that nanometer is a length unit standing for a rather small size -- $1\text{nm} = 10^{-9}\text{m}$. The most fundamental reason for a substance to have a change is that: a small size effect happens. So how small will it be and why there is a small size effect? Do not answer these questions at once. Instead, ask the students to look for the answers by themselves. Some students said that 1/10000 of an hair, some students said that as small as red blood cell some said... For small size effect, some said that the volume became large because the size was too small; some said that the volume did not change but the exposed superficial area was huge; some said that the volume did not enlarge but seemed to be larger, which just look like tofu, the more it was cut, the more the superficial area would be; or even some said that volume was larger because it was just like a bucket of wheat, there would be two buckets of flour after being grand. In the class, students were so active to answer the questions and show their own opinions. Actually, what students answered were all covered in my teaching plan. However,

the effect was totally different if students were asked to answer the questions. When answering the questions, students had a feeling of achievement and honor. Students were greatly encouraged to join the class and the atmosphere was rather good.



Figure 1. Students are presenting their own opinions

3.3 Group work is good for after-class discussion

In order to better integrate the resources found by students, group work could be done. Each group should have a discussion on what they had learned in the class. Then according to the discussion, the group should make a unit module. After that, someone who was going to make a presentation on their achievements in the group should be asked to make a speech. By PPT, all students would easily know that nanometer was just a length unit. For example, if a nanometer particle was put on a football, it's just like that a football was put on the earth. So nanometer was not so amazing. The amazing thing was that nanometer would make things suffer abnormal changes [3].

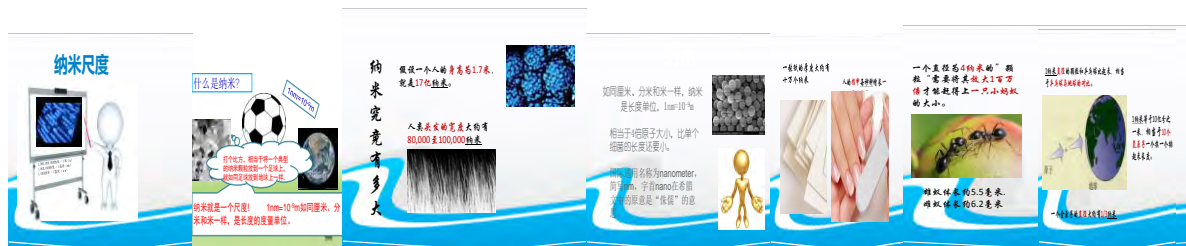


Figure 2. nanometer concept and metaphors found by students

3.4 Focus on easily-understood metaphors, easily explain the difficult concepts and definitions

Teaching is a kind of art. However, teaching platform is not a stage and there is no rehearsal. Instead, teaching is a live show. Actually, the teachers will play a role just as the announcer working in CCTV, although their targets are different but their responsibilities are totally the same. Unlike other traditional subjects, the subject “nanometer” is a subject getting popular much later. For subject “nanometer”, it is necessary to combine with the newest research status and lead students to the most advanced technology. Meanwhile, it is necessary to blend basic theories with applications, by which students will not only know about the theories but also explain the actual phenomena by nanometer theories. What's more, students will be able to do innovations by using nanotechnology, trying to make the teaching more efficient and targeted. Especially that research projects shall be used by the teaching to help with the teaching; students shall be led to use the knowledge that they have learned and get themselves better involved into the research innovation. Then the teaching will provide guidance for students to deal with their research innovations. Anyway, the teaching shall focus on the promotion and application of nanotechnology, trying to enhance students' research ability.

According to the try that mosoteach combines with flipping classroom, we can know that although the subject “Nanomaterial Introduction” covers a lot, the teaching can still be highly efficient if a mode where the relationship between teaching and learning is rather close can be formed. If such an “interactive teaching mode” is formed, teaching effect will be enhanced and curriculum resources will be perfected gradually. In this way, teaching resources for the subject “nanomaterial introduction” will be richer and richer. This reflects the inheritance and continuation of teaching and learning [4].



Figure 3. Unit module made by students and the open reply

By combining mosoteach and flipping classroom, it is known that once they are combined, all positive factors can be used and students can make full use of the “nanometer people effect” once they are “nanometer people”. If so, students will become the main force to push forward the teaching reform and nanometer will become a study system which is open and successive. In the future, the study system will be continuously improved and enriched. By flipping classroom, students’ learning was more efficient and they would have independent learning and exploration after class.

4. Conclusion

Based on what is mentioned above, the subject “Nanomaterial Introduction” is an important basic course. After one year’s experiment in combining flipping classroom with mosoteach, it is concluded that:

(1) Design a teach-learning system focusing on students and an auxiliary system for mosoteach mobile platform, which is an efficient measure to enlarge the teaching capacity and enhance information output;

(2) Students are asked to look for the newest research status, which will not only encourage students but also enlarge the reform team; meanwhile, teaching reform is greatly enriched. Teaching materials are well combined with each other, by which generality and specialty are highly integrated. In this way, the teaching can keep the pace with the world and it is really practical.

(3) In the future, the design and method for teaching shall be continuously updated, and the new development of curriculum shall be emphasized. Set up teaching documents and curriculum database that are suitable for the subject “Nanomaterial Introduction” and cloud class, which shall be used in practice. When they are being practiced, keep perfecting and completing. Then finally, curriculum proposal which is suitable for mobile information-based teaching that can be used by the “Nanomaterial” in terms of its cloud teaching materials and cloud class.

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