A New Teaching Design and Trying to Improve the Quality of Experiment Teaching of Life Science

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Abstract. In the teaching of life science, to set up a practical protocol of teaching design was aid to improving effect of education and consequently improved the education quality of life science. The present paper suggested a new teaching design of experiment of life science, including five links: Guidance of the experiment, experiment designing and process scanning, showing and summarizing the results, writing the experiment report or research report, evaluating and feedback the relevant information. The paper especially emphasized details included knowing the importance of the experiment, orthogonal test, dividing the class to several groups and division of labour, writing the experiment report or research report in standard.

Introduction

To culture the undergraduates’ ability of experimental operation was not only the basic links of culturing the major techniques, but also the important method to arise their ability of comprehending the basic theories and concepts. Life science was one experimental research field, so the culturing ability of experimental operation of major (included Biology, Biotechnology and Bioengineering) was pretty important. Therefore, many university or college did the best to offer more experimental course within comprehensive techniques. We absolutely approved this cultural outline, in the meantime, we thought that how to arise the effect of each class of experiment or every course of experiment was the key and important tasks for the teacher or guide of the experiment, and that also was the important link of superintending for the educational manager, in the condition of normally executing of the present experimental courses. “Experiments of Biochemistry” was the basic experimental course for majors of Life science, so we took it as one example to introduce the teaching research and teaching reformation. Many years ago, some teacher began doing lots of trials of teaching reformation for the attempt to arise the quality in this course’s teaching[1-10], and the author also did trials in teaching process of courses “Experiments of Bioseparation” and “Comprehensive Experiments of Biotechnology”. So based the investigation examples from references and ours experience, we suggested a new teaching design of experiment of life science for improving the education quality of experimental course of life science. We hope that it could be polished much better and more practical with the researcher and expert in this field.

The Present Condition of Teaching Research and Teaching Reformation of Course “Experiments of Biochemistry”

Major headings should be typeset in boldface with the first letter of important words capitalized. In the basic groups of course of field of life science and relevant field, i.e. Forestry, Agriculture, Medical science, Biomedical, Pharmacology, theoretical course “Biochemistry” and “Experiments of Biochemistry” held key position in the construction of majoring. There were many papers on the topic of teaching research and teaching reformation about the two courses, so the trend of teaching research and teaching reformation about the two courses stood for the native trends of teaching research and
teaching reformation about the theoretical course and experimental courses. The following was a summary about the teaching research and teaching reformation of “Experiment of Biochemistry” in recent years.

At present, to carry out the designative and exploring experiment was one of the main ways of teaching research and teaching reformation. Based the students having basic operation techniques and according to the present condition of laboratory in school, the teacher directed the students to check reference and set up a protocol for probing a topic, consequently the designative and exploring experiment was carried out. The resemble teaching way was an open way of teaching. Though this way of teaching reformation was aid to train the researching skill, in our opinion, the supervision was very important to avoid the biting the air [1, 4,5,8-10]. Another way of teaching reformation was similar to the reversion class. The students introduced the contents of experiments followed by querying by classmate and evaluating by teacher. This was a very useful method for arising the effect of preparing the lesson and teaching [4, 7]. To strengthen the summary, to give the experiment report in the way of research report, to emphasize the interaction between the experimental phenomenons and theory, to train the ability of organization, expression and coping with any contingency were the high-point of teaching reformation in recent years and consequently got the desirable teaching effect [2, 3,5]. It was appreciate to show the results with ppt in link of summary. In link of evaluating the mark for students, Shu Le-xin, et al. [2], Zhang yong-min, et al. [6], Xu Wen-jun, et al. [7] took some beneficial research according to each conditions of their schools. In one word, giving the marks of experimental course was different from that of theoretical courses. To study the way of evaluating marks of students taking part in experimental course might be afraid of another trobulesome problem. Only relying the experiment reports, it was a little sole; taking the experiment again, it should take much more time. Writer of present paper thought that it should be the focal points to check the basic operating ability, ability of analyzing the data from experiment report/research paper, ability of extracting the conclusion from the data, standard degree of writing paper etc. Certainly, these should be the destination of the experiments. For details, checked the following sections.

Teaching Design of Experiment Courses of Life Science

Guidance to the Experiment

Importance of the Experiments

Though great majority of the students (also including teachers of the experiments) always thought that it was a very normal matter to start the experiment link after some time of theoretical classes, in point of view from teaching design, it was essential to choose expertly several examples from the great achievements of theory and great finding so as to emphasize the key roles of experiment links before started doing the experiment. Many works awarding the Nobel Prize all based one or several normal experiment results or test phenomena. Here it should not give unnecessary details.

Systematical Introduction about the Whole Contents

Following the emphasized the significance of the experiments, it should give a detail introduction about the experimental contents with referencing the contents of corresponding theory class. To make the students realizing the outline of the present experiment was just one task, but the greater task was to impel the students to understand the characteristics of mutual aid among each experiment in whole system and coordinating between the theoretical lessons and experiment lessons. It also was a good and basic habit for research work after graduation.

Recognition the Importance of some Little Details of Experiment

Following above introduction, it also should emphasize the importance of little details of experiments with several simple demonstrations or imitate operations. For example, when using the very general
pipettes used in most laboratory to extract definite amount of liquid (For example, only 50μL, i.e., one
dope), there was some liquid adhesive to the head of tip and that liquid was uncalled-for the test. The
high viscosity of the liquid, the more amount of liquid sticking to the tip. The amount of the liquid was
estimated about 0~50μL. It did look like using the chopsticks to stick the oil-like liquid, the amount of
the liquid sticking to the chopsticks directed ratio to the deep which the chopsticks inserted in liquid.
Therefore, when we used the pipettes to extract definite amount of liquid, we must paid more and
more attentions to control the deep which the tip or head of the pipettes inserted in liquid. There were
a lot of examples liked above and so they could not be demonstrated one by one. In one word, the little
detail decided the success or failure. The idea of good operation should be taught repeatedly many
times and it might come into action and the good habit of the students operation might grew
successful.

**Experiment Designing and Process Scanning**

**Orthogonal Test**

The experiment designing in this paper only indicated the orthogonal test, which it was one scientific
method of combining several factors with several levels into a series of different combinations based
Bio-statistics, so that was different from designing the protocols for the experiment mentioned above.

The different experiment had different training destination, but it was valuable to consider that how
to provoke the students to know, to grasp and to use freely the method of orthogonal test in the normal
conventional experiments or comprehensive experiments. In another words, the students should
design the protocols based the contents and tasks of the experiment and gain the effects of each factor
to results. That was to be said how to use the idea from orthogonal test in course of “Bio-statistics” to
manage the experiments. According to orthogonal test, there were many factors and each factor had
several levels, for example, temperature, time, the amount of the target enzyme or substrate an so on
were factors, in item of temperature, division of high, middle and low temperature. The others should
not be listed in details. After designing the experiment, many different combinations occurred, but
each group only finished one or two combinations. In process of conventional teaching, all the groups
operated in same protocols, same samples, same chemical reagent etc. Each group only collected and
dealt with themselves data after finished the experiments. Compared with conventional way of
teaching, in the process of the new way, though all the groups used the same protocols, same samples, same chemical reagent etc., the detailed conditions of every group was different with each other and
the more important link was that each group should collected the whole results from all groups and
dealt with these data after they finished the experiments. During analyzing the data, method of
Bio-statistics was necessary. Therefore, these methods would be applied in process of finishing
graduation thesis for themselves, even for using in stages of graduate student and research work in
future.

The method of orthogonal test would usually be used in engineering experiments especial in
optimization of conditions. Therefore, to the normal conventional experiments, this work should
emphasize the basic operation, orthogonal test and data analysis based all results from whole groups.
To the comprehensive experiments, this work should emphasize the basic operation, orthogonal test
and writing the research report. To the engineering experiments, this work should emphasize the basic
operation, orthogonal test, synchronizing the whole groups, data analysis based all results from whole
groups and emerging and comparing the target products.

**Divided into Groups and Division of Labour of one Group**

It was a general teaching way to separate the whole classmate into several groups, 2-4 person/group.
In the ordinary training experiments, it was two students a group and in the comprehensive
experiments, 3-4 students a group. According to the general idea, 2 person/group was the best
arrangement which it could gave more training chance for the students, and in comprehensive
experiments, the persons in one group could be adequate more than that in the general, in the writer’s
opinion, this idea was actually a misunderstanding. The comprehensive experiments or the X great
experiments did base on a series experiments about one sort of enzyme, or one sort of protein, or one
sort of cell, or a series of relevant experiments should be finished in long and continued time (The
ordinary training experiment usually lasted 2-3 classes). Therefore, more students in one group
usually should be due to the limited instruments, so it was not the standard of the comprehensive
experiments.

In another hand, in the two persons/group or multi-persons/group, the members should cooperate
with each other and every member had a relative independent duty in the experiment, for example,
acted as head of the group, recorder, checker and so on. This way of work would correspond to the
scenes occurred in daily work after graduation later, same like signature was a standard in the protocol
of works usually appearing in a film, so this way of work should be aid to impel the experiment
working stately and omitting-less and recording completely.

Scanning the Process of Experiment

As relative intact teaching link, except the ordinary directing, touring etc., the teacher should have a
notebook for recording the process of experiment, i.e., setting up a table for writing down the unusual
phenomena, the typical errors of operating, querying from students, valuable recommended good
habit of operation, results of middle stage and final results from every group and time of submitting
results. At the meantime, the teacher also regulated the groups and kept in similar speed. Here,
keeping in similar speed was the meaning of urging every group proceeding in a relative steady speed.
In lack of instruments, the teacher should arrange and separate the whole into several big groups and
the big groups started in different time. Another example, after all the groups finished the operation of
Step one, their products from the middle stage should be collected and mixed and then distributed
equally again to each group for the Step two or not, the other problem and so on and so forth.

The Other Designing for Improving the Teaching

In proceeding of experiment, the good vision specialty in operation was broadcasted continuously; at
the meantime, the group was encouraged to give problems from the experiment to share with other
groups, and so on.

Summary

After all the experiments were finished, every group should show their results to classmate and
teacher in word or ppt form and give answer to the querying. This link was the main component of the
experiment mark. This link was especial important for the carrying of comprehensive experiment. In
the summary of our courses “Experiments of Bioseparation” and “Comprehensive experiments of
biotechnology”, phenomenon similar to competition even disputation or quarrel ing occurred among
the groups. This might be one of the desirable targets. In theoretic or experiment class, the
phenomenon which the teacher could not answer the student’s question temporary was appreciative,
the phenomenon which the student could not answer the student’s question also was next-best thing
[11], too.

Writing the Experiment Report or the Research Report

As mentioned above, everybody had known all the results and the whole queries in the summary link.
According to demands, he or she should write the experiment report or the research report
independently. In item of data analysis of report, the repetition of the results and the effects of
operation details to results should be emphasized. Related to the engineering experiments and
comprehensive experiments, because of having more experiment combination, it should emphasize
the effects of every factor to results, especial the key factors.

The research reports must be written after the engineering experiments or comprehensive
experiments was finished, and what is more, the reports must be written abiding by the definite
pattern. In general, the patterns usually referenced the important scientific periodicals, including the
topic, writer and the co-worker, abstract, key words, text (including preface, materials and methods, results and analysis, conclusion) and references wrote in standard.

**Evaluated the Experiment Reports or the Research Reports and Information Feedback Students**

The teachers ought to evaluate the experiment reports quickly after the reports were collected and submitted to their hands. The typical errors should be collected and analyzed quickly and back to every student so as to avoid the students to make the same mistakes again. Certainly, the excellent ideas and suggestion also collected and feedback the students.

Summing up, the suggested teaching designs and traditional teaching arrangement were gathered in table 1.

Table 1. Comparison of the new model of teaching designs and traditional teaching arrangement.

<table>
<thead>
<tr>
<th>item</th>
<th>new model of teaching design</th>
<th>traditional teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Improving the teaching quality; connection to methods for research</td>
<td>Improving the teaching quality; strengthen the skill training</td>
</tr>
<tr>
<td>Report of preparing before class</td>
<td>must</td>
<td>must</td>
</tr>
<tr>
<td>Division to groups orthogonal test</td>
<td>Yes, changed in essence</td>
<td>Yes</td>
</tr>
<tr>
<td>Scanning the process</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Other methods for improving the teaching</td>
<td>Systematic scanning</td>
<td>General scanning</td>
</tr>
<tr>
<td>Summary</td>
<td>Many, could quantify</td>
<td>Few</td>
</tr>
<tr>
<td>Form for experiment report</td>
<td>Must</td>
<td>Occasional</td>
</tr>
<tr>
<td>Feedback to students after evaluation</td>
<td>Same to periodical paper</td>
<td>General</td>
</tr>
<tr>
<td>Reference</td>
<td>Must and in standard</td>
<td>No</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Easy to quantify</td>
<td>Not easy to quantify</td>
</tr>
</tbody>
</table>

**Ending and Conclusions**

Different from the way of class teaching and examination of theoretic lesson, the links of experimental teaching was more complicated. This process should be related to more workers, more matters (including experimental materials, reagents, instruments etc.), often more rooms, not easy to control the order, difficult to examine and quantify the effects of teaching, and so on. In condition of limited teaching resource, how to improve the quality of teaching did not only assess the intelligence of the teacher and assistants, but also examine the ability of the accepter to accept the new model of teaching. According to knowing and thinking from the courses “Experiments of Bioseparation” and “Comprehensive experiments of biotechnology” for undergraduate in our school, the authors put forward a new model of teaching designs and tried in practice, and consequently gained the satisfied effect. The new teaching design included five easy-operative key links, i.e. Guidance of the experiments, experiment designing and process scanning, showing and summarizing the results, writing the experiment report or research report in standard, evaluating and feedback the relevant information on time. The new way of teaching design did not need adding more materials, reagents, and it did not add the quantity of the installed instruments, so it should be supplementary to the present model of teaching reformations.
Acknowledgments

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References


