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Paper Title: Improving Genetics Instruction in Junior High Schools in the Republic of China

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Improving Genetics Instruction in Junior High Schools in the Republic of China

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INTRODUCTION

After two years study, from the results of the interview instrument , Hung (1990) indicated that there were difficulties and misunderstandings experienced by students on the concepts related to "the recognition of homologous chromosomes," "the process of meiosis," and "the relationships between genes, chromosomes, and traits." The results also indicated that the students who had high achievement test scores did not necessarily understand related concepts. From the results of the paper-penicl instrument , Haung (1992) indicated that on questions related to the movement of chromosomes during meiosis, the relationship between alleles and chromosomes during gamete formation, and the calculations involving the Law of Dominance, the Law of Segregation, and the Law of Independent assortment, seventh and tenth graders had difficulty.

According to the results of the paper-pencil instrument and the interview instrument, the researchers try to design a better teaching method in order to improve genetic

instruction in junior high schools. After one year's research and pilot study, the researchers developed a teaching method. The main points of this designed teaching method are: to emphasize the concepts related to "the recognition of homologous chromosomes," "the process of meiosis," and "the relationships between genes, chromosomes, and traits;" to encourage students' involvement in the instruction; and to use the designed instructional tools for genetics teaching.

According to the content related to genetics of the textbook, teaching plans were designed by the researchers on the following four topics: cell division; meiosis; chromosomes, genes and traits; the inheritance of ear lobs and the usage of Punnet square. In these teaching plans the following concepts were emphasized: the "pairing" relationship of chromosomes; the "movement process" of chromosomes during meiosis; and the "relationships" between the chromosomes, the genes and the traits. In order to make these concepts easy to be described, we designed a set of instructional tools. They were the enlarged figures of textbook made by heavy paper. Because the back of these tools with a section of tape, they could be moved easily on the blackboard during instruction. The benefits of these designed instructional tools are cheap, easily made, and easily manipulating on the blackboard during instruction. In the designed teaching method, we emphasized students' involvement. When teaching these important concepts, we suggested to follow the following procedures: the teacher's demonstration with the designed tools on the blackboard, the student's demonstration with the designed tools on the blackboard, and the practice of each student with paper-pencil by himself until he understood.

The purpose of this study is to prove the effects of the designed teaching method. There are three questions served as guidelines for the study:

1. Do significant differences exist in the achievement scores between the students instructed by the designed teaching method and the conventional teaching method?
2. Do significant differences exist in the feeling of learning difficulty of genetics between the students instructed by the designed teaching method and the conventional teaching method?
3. How do students feel the function of the designed instructional tools?

Question one and two were restated in the form of null hypotheses. Each was tested at the .05 level of significance.

Ho 1. No significant differences exist between the achievement test scores of the students instructed by the designed teaching method and by the conventional teaching method.

Ho 2. No significant differences exist between the scores of learning difficulty of the students instructed by the designed teaching method and by the conventional teaching method.

METHODOLOGY

Select Experimental and Control groups

In order to compare the effects of the designed teaching method and the conventional teaching method, there were fourteen pairs of biology teachers in junior high schools selected as subject teachers. One of each pair was randomly selected as the experimental teacher who would be trained to use designed teaching method, the other was the control teacher who would use his conventional teaching method. The criteria for selecting the pair of the experimental and the control teachers were: the difference of age was between five years; the same sex; graduated from the same university; the difference of teaching experience was between five years; and the students they taught were random arrangement in the class.

There was a one-day workshop for the experimental teachers in the winter vocation in 1992. The program of the workshop was to introduce and practice the designed teaching method and to make the designed instructional tools. One class of each teacher's was randomly selected by the researcher as the subjects to study.

Validation of the Instrument

A paper-pencil achievement test was designed as the pre-test and post-test. The items of this test were related to the following subjects: (1) the identification of homologous chromosomes; (2) the process of meiosis; (3) the relationships between genes, chromosomes and traits. This instrument had been pilot studied. The reliability of internal consistency coefficients is .88. The validity is according to the two dimensional content analysis. The pre-test and post-test were the same but the order of items was rearranged. The score and content of each item were listed in table 1.

Table 1 The score and content of each item of the achievement test

No.	No for the pre-test	No. for the post-test	Subject	Score
1	I.1	III.	Homologous chrs	2
2	2	2	"	2
3	3	3	"	2
4	II.1.	VI.1.	Genes-chrs-traits	2
5	2.__	2.__	"	1
6	__	__	"	1
7	__	__	"	1
8	3.__	3.__	"	1
9	__	__	"	1
10	III.	VIII.	Process of Meiosis	4
11	IV.1.	I.1.	Genes-chrs-traits	1
12	2.	2.	"	1
13	3.	3.	"	1
14	4.	4.	"	1
15	5.	5.	"	1
16	V.	VII.	Process of meiosis	3
17	VI.1.	I.1..	Genes-chrs-traits	2
18	2.	2.	"	2
19	VII.1.	IV.1.	"	3
20	2.	2.	"	3
21	3.	3.	"	3
22	VIII.1.	V.1.	Homologous chis	3
23	2.	2.	Process of meiosis	3

In order to get some information of the students' feeling of selected classes to their biology classes, one item was added in the pre-test as:

I __very like
__like
__don't like
__hate to attend the biology class.
Because_____

In order to get information related to students' feeling to genetics learning after this instruction, one item was added to the post-test as:

After learning the topics of cell division and genetics, I feel this content is
__very difficult
__difficult
__easy
__very easy to understand.

In order to get information of the effects of the designed instructional tools, one item is add to post-test for experimental students. It was:

The tools which teacher used to describe the process of meiosis are
__very useful for my understanding.
__make me confused.
__of no use for my study.

Collection of Data

Before the instruction of geneticsHuang - Geneticstest to the schools of the selected classes. At the beginning of the fall semester of 1991, the experimental teachers used the suggested teaching method while the control teachers used the conventional method to teach genetics. After the periods of genetics instruction around three weeks, the post-test were mailed to the selected schools.

After receiving the tests mailed back from selected schools, the data were recorded and analyzed. The score of each item is listed in table 1. If the student was right on the item then get the score of 1-4 according to the number of the item; otherwise got the score of 0. Then use t-test to compare the difference of the scores of the experimental students and the control students. The significant level is set at $p<.05$.

The scores of the students' feeling to the biology class are set as: very like, 4; like, 3; do not like,2; and hate, 1. Then use t-test to compare the difference of the scores of the experimental students and the control students. The significant level is set at $p<.05$.

The scores of the students' feeling of difficulty to the genetics learning after instruction are set as: very difficult, 4; difficult, 3; easy, 2; very easy, 1. Then use t-test to compare the difference of the scores of the experimental students and the control students. The significant level is set at $p<.05$.

RESULTS AND DISCUSSION

The scores of pre-test, post-test and the increasing scores after instruction were listed in table 2. When t-test was used to compare the increasing scores of the experimental class and the control class, nine of these fourteen class pairs existed significant differences. And seven of them indicated that the increasing scores of experimental students were significant better than the control students'. Only two of them indicated that the increasing scores of control students were better than experimental students'. Five of them indicated no

significant difference in increasing score of these two group students. When we compared the increasing score of all the experimental students with all the control students', there existed significant difference. The increasing score of the experimental group was better than the control group. Therefore the suggested teaching method could improve genetic learning.

Table 2 The comparisons the scores of the experimental students and the control students

Pairs	Pre-test Scores	Post-test Scores	Increasing Scores	2-tailed Probability
1E(50)	8.48	26.74	18.26	.000 **
1C(47)	16.66	18.45	1.79	
2E(44)	12.77	24.75	11.98	.321
2C(48)	9.10	23.00	13.90	
3E(39)	16.21	26.82	10.61	.006 **
3C(40)	10.88	16.68	5.8	
4E(42)	16.93	23.83	6.9	.883
4c(40)	14.23	21.25	7.02	
5E(45)	19.98	29.02	9.04	.000 **
5C(48)	10.06	28.38	18.32	
6E(39)	15.18	25.85	10.67	.228
6C(38)	15.58	28.55	12.97	
7E(44)	13.98	22.23	19.12	.005 **
7C(46)	11.43	24.96	13.53	
8E(50)	16.96	30.44	13.48	.021 *
8C(48)	20.27	29.90	9.63	
9E(49)	10.96	23.90	12.94	.001 **
9C(49)	21.24	28.55	7.31	
10E(38)	12.82	20.39	7.57	.419
10C(41)	14.44	20.83	6.39	
11E(38)	12.47	25.11	12.66	.000 **
11C(41)	17.63	18.61	0.98	
12E(42)	9.71	27.40	17.52	.001 **
12C(43)	16.58	28.21	11.56	
13E(41)	15.10	29.61	14.37	.000 **
13C(42)	15.50	22.33	6.76	
14E(37)	11.38	22.86	11.49	.663
14C(37)	12.27	24.81	12.32	
TOTALE(598)			11.94	.000 **
TOTALC(608)			9.20	

Was it possible that the difference was made by the attitude of students to biology class? When compared the attitude of students to biology class, the results were listed into table 3.

Table 3 The comparison of the scores of feeling to the biology class

pair	Experimental students	Control probability	2-tailed
1	3.14	3.13	.979
2	2.91	1.00	-
3	3.13	2.88	.061
4	3.00	3.00	1.000
5	3.10	3.04	.514
6	3.03	3.oo	.861
7	2.86	2.76	.384
8	3.02	3.04	.785
9	3.10	3.00	.320
10	3.00	3.13	.329
11	2.63	2.78	.345
12	3.22	2.62	.000 **
13	2.83	2.76	.661
14	3.11	3.06	.699

It indicated that except the class pair of number 12, they didn't exist significant difference in scores of the attitude to biology class between the experimental students and the control students.

After instruction with the suggested teaching method and the conventional teaching method, would be the feeling of learning difficulty to genetic different? The results of students' feeling to learning difficulty were listed in table 4. The results indicated that within the fourteen pairs of classes, four of them existed significant difference in the scores of learning difficulty. All these four pairs indicated that the feeling of learning difficulty of experimental groups lower than the control groups'.

Table 4 The comparison of scores of learning difficulty of students

Pair	Experimental students	Control probability	Two-tailed
1	2.9	3.0	.219
2	2.80	2.75	.741
3	2.32	2.97	.000 **
4	2.88	2.87	.982
5	2.56	2.83	.033 *
6	2.66	2.48	.231
7	2.70	2.82	.423
8	2.74	2.73	.933
9	2.80	2.61	.190
10	2.53	2.83	.043 *
11	2.56	2.74	.256
12	2.21	2.86	.000 **
13	2.73	2.83	.480
14	2.73	2.60	.554

According to the results we believe that he suggested teaching method has good effects on genetic learning.

Would the designed teaching tools have some benefit to this result? The scores of experimental students feeling on the usefulness of designed tools were listed in table 5. More than ninety percent of experimental students felled that the designed tools could help their understanding.

Table 5 The percentage of experimental students' feeling to designed instructional tools

class	very useful for my understanding	make me confused	of no use for my study
1	89.4	4.3	6.4
2	81.8	11.4	6.8
3	92.1	0.0	7.9
4	90.2	2.4	7.3
5	95.0	2.5	2.5
6	86.8	10.5	2.6
7	93.2	0.0	6.8
8	94.0	4.0	2.0
9	91.8	6.1	2.0
10	92.1	7.9	0.0
11	91.7	2.8	5.6
12	95.1	2.4	2.4
13	87.8	4.9	7.3
14	91.9	0.0	8.1
Total	90.9	4.3	4.8

According to the results of this study, they indicated the designed teaching method has good effects on genetics learning. There are some questions need to be studied in the future: Why the same teaching method will result in different results? What factors influence the genetics learning? How about the retention of the suggested teaching method?

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