The Construction and Practice of the Core Curriculum of Environmental Science Specialty Based on the Theory of Multiple Intelligences

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Abstract. Based on the theory of multiple intelligences, the core courses of environmental science were designed and implemented, and the students were surveyed before and after the experiment. The results show that the weak intelligence failed before the test includes language intelligence, music intelligence and logical-mathematical intelligence, while the weak intelligence failed after the test only involves language intelligence and logical-mathematical intelligence. In addition to introspection intelligence and natural observation intelligence, the test implementation improved the scores of other intelligences, and the order of improvement was music intelligence > language intelligence > interpersonal communication intelligence > spatial intelligence > logic mathematics intelligence > body kinesthetic intelligence. Music intelligence and language intelligence were significantly improved after the test. The improvement of female students' multiple intelligences was more obvious than that of male students, and the improvement of female students' spatial intelligence was higher than interpersonal intelligence, while male students' interpersonal intelligence was higher than spatial intelligence. Through the project practice, the student's overall multiple intelligence was improved.

Introduction

In 1983, Howard Gardner, an American psychologist of psychological development and education, published the structure of intelligence: the theory of multiple intelligences, putting forward the theory of multiple intelligences for the first time [1]. Human intelligence is diverse, has 9 kinds of intelligence, including speech-language intelligence, logic-mathematical intelligence, visual-spatial relationship intelligence, music-rhythm intelligence, body-movement intelligence, interpersonal intelligence, self-reflection intelligence, natural observation intelligence and existence intelligence [2, 3]. Different combinations of intelligence reflect the intelligence differences between individuals, each person's strengths and interests, as well as the methods of analyzing problems and solving problems are different, and their development potential is also different, so we should develop their potential, give play to their intelligence strengths, strengthen their intelligence weaknesses [4], and improve students' ability and quality. In the United States, more than 100 schools have adopted the theory of multiple intelligences to develop students' intelligence [5, 6]. In other countries, the theoretical research and experimental exploration of multiple intelligences have also been carried out vigorously [7, 8]. Multiple intelligence theory is introduced into China at the end of the twentieth century, Through research and practice of the "15" planning project of "how to use the theory of multiple intelligences to develop students' potential practice research" from the Chinese society of education [9], such as the theory has become one theory support of the basic education curriculum reform, and successfully applied to the teaching system of many subjects, such as English [10], math [11], and politics [12], has received the widespread attention and practice in the primary and secondary school education. In recent years, basic courses such as foreign language [13], computer [14] and physical education [15] have also been explored and practiced in colleges and universities.
and good results have been achieved. Multiple intelligence theory as a kind of effective teaching strategies and means, has become one of the mainstream education thought in the 21st century, is valued by many national education system, in our country has received the widespread attention in the education of primary and secondary schools, the exploration and practice in basic course such as foreign languages etc. in colleges and universities, but most of them were theoretical studies of curriculum reform, and few of them are practical discussions, especially in the theory of multiple intelligences perspective, exploring the teaching reform and practice of professional course of colleges and universities is not much. Therefore, this article attempts from the teaching practice, based on the theory of multiple intelligences, combining with the characteristics of environmental science professional core courses and intelligent characteristics of students, the application of the theory of multiple intelligences to the practical research in the course teaching, aimed at promoting the improvement of teaching quality and provide useful reference value for teaching reform.

Research Methods and Objects

First using the literature material method and the method of psychological measurement design multiple intelligence inventory, at the beginning of term in spring 2019, a multiple intelligence questionnaire survey was carried out for 2016 environmental science students, after statistical analysis to understand the basic characteristics of students' intelligence, environmental impact assessment, environmental engineering and other professional core courses according to the theory of multiple intelligences has carried on the teaching design and teaching implementation, after the final exam, once again, the measurement of the multiple intelligences, finally summarized and carried on the teaching reflection, form a summary report and essay.

The sample size was 50, including 21 males, accounting for 42% of the total sample size. There were 29 females, accounting for 58% of the total sample.

Results and Analysis

Measurement Scale of Multiple Intelligences

With reference to a large number of literatures and psychometrics, the multiple intelligence scale is designed as follows.

| First, language intelligence                                                                 | Five, music intelligence                                               |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1. Like to imitate dialects ( )                                                              | 1. Like to listen to all kinds of sounds ( )                            |
| 2. Have the habit of keeping a diary ( )                                                     | 2. Be accompanied by music every day ( )                               |
| 3. If I have time, I will hold a book ( )                                                    | 3. A new piece of music that you can hum after listening to a few times ( ) |
| 4. Good at talking to all kinds of people ( )                                               | 4. Good at capturing the meanings expressed by various tunes ( )       |
| 5. Always able to listen patiently to others talk about ( )                                 | 5. Like to purchase a large number of audio tapes and other audio and video data ( ) |
| 6. I feel a rush of ideas when I write ( )                                                   | 6. There are many associations when you hear different music ( )       |
| 7. Interested in learning foreign languages ( )                                            | 7. Give a piece of music and you can tell what it means ( )            |
| 8. You can always convince others when you disagree with them ( )                          | 8. Be able to play an instrument ( )                                   |

| Second, logical mathematical intelligence                                                   | Interpersonal intelligence                                            |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| 1. Be very clear about the functions of various items ( )                                   | 1. Be filial to your parents ( )                                       |
| 2. Have the habit of weighing objects ( )                                                    | 2. You can feel like a family friend when you talk to strangers.      |
| 3. I like doing math problems ( )                                                            | 3. Have a lot of friends who keep in touch ( )                        |
| 4. Good at finding the logical relationship between things ( )                              | 4. Ability to deal with people at all levels effectively... ( )       |
| 5. Finding mathematical formulas easier to understand than verbal descriptions ( )         |                                                                       |

Table 1. The Multiple Intelligence Scale (Very Consistent 2 Points, very Consistent 1 Point, Inconformity 0 Point).
Teaching Designs Based on the Theory of Multiple Intelligences

For core courses such as environmental impact assessment and environmental engineering, based on the theory of multiple intelligences, teaching design and specific implementation methods are as follows.

Table 2. Teaching Design and Specific Implementation Methods.

| Multiple intelligences | The teaching design                                                                 | Specific implementation method                                                                 |
|------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| **Language intelligence** | 1. Create a language learning environment so that students can learn to speak effectively  
2. Help students learn by listening  
3. Ask students to write their learning notes | 1. After the effect display in the teaching process, the observer puts forward feedback information to the presenter, so as to make mutual comments between students and exercise students' language expression ability  
2. Encourage students to ask questions during class  
3. Writing learning experiences after class to cultivate students' writing language ability  
4. Effective communication between students and students, teachers and students in the form of teaching, so as to develop students' language communication ability  
5. In the role replacement, the teacher's role is used to train and develop students' language organization ability in teaching practice |
| **Logic - mathematical intelligence** | 1. Use different questioning strategies and ask questions for students to answer  
2. Ask the students to judge their statements and opinions | 1. In the teaching of techniques and tactics, let students give full play to their imagination, encourage them to think with open mind and judge the right and wrong  
2. Use the theoretical knowledge of chemistry, physics, biology and mathematics to analyze the teaching focus |
| **Body kinesthetic intelligence** | 1. Promote intelligent development through experimental practice  
2. Teaching by acting | 1. Strengthen teaching practice in teaching and increase the time and frequency of practice  
2. In the teaching process, students should show themselves through effect display and teaching competition |
| **Spatial intelligence** | 1. Create a visual learning environment for students  
2. Use video recording and real | 1. Multimedia and other intuitive teaching methods are adopted in the teaching process to enhance students' observation ability  
2. Encourage students to watch more videos and objects to imagine |
objects to understand the teaching content and understand the teaching contents

| Music intelligence | 1. Make music a part of learning | 1. Students study with relaxing music conducive to thinking |
|--------------------|---------------------------------|----------------------------------------------------------|
|                    | 2. Use music to stimulate students' creativity | 2. Encourage students to arrange the learning content into songs |

| Interpersonal intelligence | 1. Realize true cooperative learning | 1. Encourage and cultivate team spirit, collectivism spirit and dedication spirit in the teaching process |
|----------------------------|------------------------------------|-----------------------------------------------------------|
|                            | 2. Learn to grow through contact with others | 2. Learn to properly handle the relationship between students and between students and teachers |
|                            | 3. Cultivate students' organizational ability | 3. Cultivate students' organizational ability |

| Introspection intelligence | 1. Guide students to set up their own goals and work hard to achieve them | 1. Adopt phased target teaching to encourage students to set up learning goals and achieve them step by step |
|----------------------------|-------------------------------------------------|-------------------------------------------------------------|
|                            | 2. Use positive feedback effectively | 2. Let students learn to evaluate themselves, discover their advantages, improve their potential and correct their shortcomings |
|                            | 3. Pay attention to emotional learning and promote students to learn to reflect | |

| Natural observation intelligence | 1. Promote intelligent development through teaching practice | 1. Strengthen the field teaching practice in teaching, and increase the time and frequency of practice |
|---------------------------------|---------------------------------------------------|-------------------------------------------------------------|
|                                 | 2. Open design experiments | 2. Students independently designed experiments to exercise their observation ability |

Measurement Results of Multiple Intelligences

As can be seen from Table 3, students' intelligence strengths before and after the test were all introspective intelligence, all of which exceeded 70%. Before the teaching experiment, the weak intelligence failed before the test includes language intelligence, music intelligence and logical-mathematical intelligence, language intelligence is only 47.6%, but the percentage of logical-mathematics intelligence strength divided by the number of people reached 60%, which indicates that it is necessary to strengthen the cultivation of students' language expression, thinking and music appreciation ability. After the experiment, although language intelligence and logical-mathematics intelligence were also the weak intelligence failed, they were improved to varying degrees, by 6.3% and 2.5% respectively.

| Multiple intelligence | Language intelligence | Logical mathematical intelligence | Body kinesthetic intelligence | Spatial intelligence | Music intelligence | Interpersonal intelligence | Introspection intelligence | Natural observation intelligence | Total score |
|-----------------------|-----------------------|---------------------------------|-------------------------------|---------------------|-------------------|------------------------|----------------------------|--------------------------------|-------------|
|                       | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After | Before | After |
| Average               | 7.62   | 8.62  | 9.14   | 9.54  | 10.22  | 10.4  | 9.62   | 10.2  | 10.3   | 10.1  | 10.06  | 10.5  | 12.26  | 11.17 | 9.60   | 9.42  | 77.40  | 80.6  |
| Sample size           | 38     | 34    | 37     | 32    | 35     | 36    | 32     | 34    | 32     | 39    | 37     | 43    | 35     | 32    | 29     | 41    | 42     |
| Degrees of freedom    | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   | 35.6  | 35.6   |
| Percentage of strengths | 38.0  | 54.0  | 60.0   | 54.0  | 70.0   | 72.0  | 64.0   | 68.0  | 64.0   | 64.0  | 74.0   | 78.0  | 86.0   | 70.0  | 64.0   | 58.0  | 82.0   |
| Number of weaknesses  | 31     | 22    | 21     | 23    | 15     | 13    | 18     | 15    | 21     | 17    | 12     | 10    | 7      | 14    | 17     | 20    | 9      |
| Percentage of weaknesses | 62.0  | 44.0  | 42.0   | 46.0  | 30.0   | 26    | 36.0   | 30    | 42.0   | 34    | 24.0   | 20    | 14.0   | 28    | 34.0   | 40    | 18.0   |

Paired-samples T Test Results of Measured Data before and after the Teaching Experiment

Paired-Samples T Test between the intelligence scores after the test and it before (Table 4) shows that in addition to introspection intelligence and natural observation intelligence, the test implementation improved the scores of other intelligences, and the order of improvement was music intelligence > language intelligence > interpersonal communication intelligence > spatial intelligence > logic mathematics intelligence > body kinesthetic intelligence, total score improved by 3.28. Among them, music intelligence and language intelligence were significantly improved after the test, by 7.6% and 6.3% respectively, reached the experimental design target.
Table 4. Paired-samples T Test of Multiple Intelligence Measurement Data before and after the Teaching Experiment for All Students.

| Paired-Samples Before the test - after the test | Paired Differences | 95% confidence interval of the difference | t | df | Sig. (2-tailed) |
|-----------------------------------------------|--------------------|----------------------------------------|----|----|----------------|
| Mean                                          | The standard       | Standard error mean                    | Lower | Upper |                |
| Mean                                          | deviation          |                                        |                  |        |                |
| Language intelligence                          | 1.0000             | 3.12984                                | 0.44263         | 1.8895 | 0.1105         | 2.259 | 49 | 0.028 |
| Logical mathematical intelligence              | 0.4000             | 3.65335                                | 0.51666         | 1.4383 | 0.6383         | 0.774 | 49 | 0.443 |
| Body kinesthetic intelligence                  | 0.2000             | 3.50510                                | 0.49570         | 1.1961 | 0.7961         | 0.403 | 49 | 0.688 |
| Spatial intelligence                           | 0.6200             | 3.44573                                | 0.48730         | 1.5993 | 0.3593         | 1.272 | 49 | 0.209 |
| Music intelligence                             | 1.2000             | 3.44218                                | 0.48680         | 2.1983 | 0.2417         | 2.506 | 49 | 0.016 |
| Interpersonal intelligence                     | 0.5000             | 2.54149                                | 0.35942         | 1.2223 | 0.2223         | 1.391 | 49 | 0.170 |
| Introspection intelligence                     | 0.4800             | 3.20866                                | 0.45377         | 0.4319 | 1.3919         | 1.058 | 49 | 0.295 |
| Natural observation intelligence               | 0.1800             | 4.39708                                | 0.62184         | 1.0696 | 1.4296         | 0.289 | 49 | 0.773 |
| Total score                                    | 3.2800             | 18.43471                               | 2.60706         | 8.5191 | 1.9591         | 1.258 | 49 | 0.214 |

Table 5. Paired-samples T Test of Multiple Intelligence Measurement Data before and after the Teaching Experiment for Boys.

| Paired-Samples Before the test - after the test | Paired Differences | 95% confidence interval of the difference | t | df | Sig. (2-tailed) |
|-----------------------------------------------|--------------------|----------------------------------------|----|----|----------------|
| Mean                                          | The standard       | Standard error mean                    | Lower | Upper |                |
| Mean                                          | deviation          |                                        |                  |        |                |
| Language intelligence                          | 0.9048             | 3.03158                                | 0.66154         | 2.2847 | 0.4752         | 1.368 | 20 | 0.187 |
| Logical mathematical intelligence              | 0.6667             | 4.49815                                | 0.98158         | 2.7142 | 1.3809         | 0.679 | 20 | 0.505 |
| Body kinesthetic intelligence                  | 0.2381             | 4.01129                                | 0.87534         | 2.0640 | 1.5878         | 0.272 | 20 | 0.788 |
| Spatial intelligence                           | 0.4286             | 3.98210                                | 0.86897         | 2.2412 | 1.3841         | 0.493 | 20 | 0.627 |
| Music intelligence                             | 0.3810             | 2.74729                                | 0.59951         | 1.6315 | 0.8696         | 0.635 | 20 | 0.532 |
| Interpersonal intelligence                     | 0.2857             | 3.11677                                | 0.68014         | 1.7045 | 1.1330         | 0.420 | 20 | 0.679 |
| Introspection intelligence                     | 0.9524             | 3.35375                                | 0.73185         | 0.5742 | 2.4790         | 1.301 | 20 | 0.208 |
| Natural observation intelligence               | 0.1429             | 5.16997                                | 1.12818         | 2.2105 | 2.4962         | 0.127 | 20 | 0.901 |
| Total score                                    | 1.8095             | 20.82215                               | 4.54377         | 11.2877 | 7.6686         | 0.398 | 20 | 0.695 |
Table 6. Paired-samples T Test of Multiple Intelligences Measurement Data before and after the Teaching Experiment for Girls.

| Paired-Samples | Paired Differences | 95% confidence interval of the difference | t | df | Sig. (2-tailed) |
|----------------|--------------------|------------------------------------------|---|----|----------------|
|                | Mean               | Standard deviation | Standard error mean | Lower | Upper |               |
| Before the test| Language intelligence | 1.0690 | 3.25062 | 0.60362 | 2.3054 | 0.1675 | 1.771 | 28 | 0.087 |
|                | Logical mathematical intelligence | 0.2069 | 2.96864 | 0.55126 | 1.3361 | 0.9223 | 0.375 | 28 | 0.710 |
|                | Body kinesthetic intelligence | 0.1724 | 3.16306 | 0.58736 | 1.3756 | 1.0307 | 0.294 | 28 | 0.771 |
|                | Spatial intelligence | 0.7586 | 3.06658 | 0.56945 | 1.9251 | 0.4078 | 1.332 | 28 | 0.194 |
|                | Music intelligence | 1.8276 | 3.79914 | 0.70548 | 3.2727 | 0.3825 | 2.591 | 28 | 0.015 |
|                | Interpersonal intelligence | 0.6552 | 2.07495 | 0.38531 | 1.4444 | 0.1341 | 1.700 | 28 | 0.100 |
|                | Introspection intelligence | 0.1379 | 3.11361 | 0.57818 | 1.0464 | 1.3223 | 0.239 | 28 | 0.813 |
|                | Natural observation intelligence | 0.2069 | 3.83945 | 0.71297 | 1.2536 | 1.6673 | 0.290 | 28 | 0.774 |
| Total score    | 4.3448 | 16.79982 | 3.11965 | 10.7351 | 2.0455 | 1.393 | 28 | 0.175 |

According to the statistical analysis of boys and girls (Table 5 and 6), the total score of girls increased by 4.3, while that of boys was 1.8. The improvement of female students’ multiple intelligences was more obvious than that of male students, and the improvement of female students’ spatial intelligence was higher than interpersonal intelligence, while male students’ interpersonal intelligence was higher than spatial intelligence, which may be related to the gender characteristics of boys and girls.

Conclusions

The weak intelligence failed before the test includes language intelligence, music intelligence and logical-mathematical intelligence, while the weak intelligence failed after the test only involves language intelligence and logical-mathematical intelligence. In addition to introspection intelligence and natural observation intelligence, the test implementation improved the scores of other intelligences, and the order of improvement was music intelligence > language intelligence > interpersonal communication intelligence > spatial intelligence > logic mathematics intelligence > body kinesthetic intelligence. Among them, music intelligence and language intelligence were significantly improved after the test.

The improvement of female students’ multiple intelligences was more obvious than that of male students, and the improvement of female students’ spatial intelligence was higher than interpersonal intelligence, while male students’ interpersonal intelligence was higher than spatial intelligence.

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