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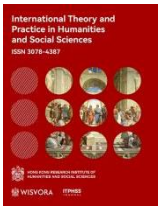

Action Research of IPA Curriculum Based on the C-STEAM Education

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Abstract

C-STEAM education is based on STEAM with the addition of the C symbolizing culture, which is a new concept of using culture to lead STEAM education just proposed by Chinese scholars in 2020. This study integrated the C-STEAM concept into the course of Integrated Practical Activity (IPA) in Chinese elementary school, constructed a complete curriculum design model and conducted three rounds of action research iterations with 20 students selected on a voluntary principles in the upper grades (grades 5/6) of Primary School S in Yunnan Province, the research data were obtained through 2 questionnaires, and the quantitative data obtained from the pre-tests and post-tests were tested using SPSS with the use of paired sample t-tests. It was finally verified that IPA based on C-STEAM had excellent results and promoted students' creativity and cultural identity.

1. Introduction

"Integrated Practical Activity" (abbreviation - IPA), is a new course with an interdisciplinary nature.In 2001, Ministry of Education of China made this course explicitly compulsory at the primary and junior high school levels (Yang, 2015). IPA emphasizes students' ability to learn from authentic problematic situations to participate in social life, apply interdisciplinary knowledge as well as their current level of experience to solve problems, and cultivate social responsibility and acquire innovative abilities in the process of practice (Hu, 2019). IPA is managed by schools in each locality, and the specific curriculum content is developed by the schools on their own; however, due to the lack of appropriate content and teaching methods, the implementation of IPA is not as effective as it should be (Weng, 2021), so there is an urgent need for new educational concepts to guide this course and make it scientific. How can the effect of IPA be improved? C-STEAM education concept came into being.

STEM has taken an important place in the global educational arena (Alam & Ram, 2022). Then with the changing needs of the times, human-centered education - STEAM became the mainstream of the times (Wang et al., 2021). After STEAM education was introduced to China, Chinese scholars (Zhan, 2020) proposed C-STEAM education in combination with the traditional Chinese culture, in which the C stood for culture, and the main purpose is to use local culture to lead STEAM education and make the model more adaptable to Chinese education. This study attempts to integrate the concept of C-STEAM education into the IPA of elementary school in ethnic minority areas in China, with the aim of promoting the effects of IPA. C-STEAM education, which puts culture in the first place, is a new concept. The author conducted a search on CNKI, the largest search website in China, with the keyword "C-STEAM" and there were only 46 articles as of January 2024, and most of these articles were theoretical studies, and there are only two practical studies applying C-STEAM concepts to the curriculum (Li, 2020; Liu, 2022), which is the Practical Gap of this study. The essence of this study is the integration of "C-STEAM" and "IPA", which is the first attempt to integrate "C-STEAM" and "IPA" and curriculum design based on the theme of ethnic minority culture. Therefore, this study can fill the gap of C-STEAM education and explore the practical value of C-STEAM.

Due to factors such as unbalanced economic development, there is a significant educational gap among regions in China (Tong, 2023), especially in remote ethnic minority areas where educational resources and achievements are relatively backward (Li, 2021). Due to the backwardness of basic education in ethnic minority areas and the fact that each ethnic minority has its own ethnic culture and language, the teaching content and models in other cities of China are not applicable to ethnic minority areas (Weng, 2021). How can the teaching effect of IPA in ethnic minority areas be improved? To solve this problem, the author, in combination with the literature theory, found C-STEAM education. The C-STEAM educational concept advocates breaking the boundaries among various subjects, emphasizes culture-centered teaching, pays attention to the relevant connections between knowledge and real life, and cultivates students' creative thinking ability in practice (Susan, 2019). The IPA in primary schools attaches great importance to the integration of multiple disciplines, focuses on real situations, emphasizes the creation of educational experiences in specific teaching activities, and promotes the overall development of students (Shi, 2010). The two have a high degree of compatibility in stimulating students' interest in learning and guiding students to actively generate activity experiences. How can IPA in primary schools in ethnic minority areas of China improve teaching with the help of the C-STEAM concept? This is the original intention of this study.

The primary research method of this study is the Action Research Cycle, that is, through the iterative cycle of the steps of "planning → action → observation → reflection". Firstly, through literature review, based on Skillbeck's curriculum design theory and Zhan Zehui's "6C" model, the curriculum design model of IPA based on the C-STEAM concept was constructed. Using this model, three theme project courses centered on minority cultures were designed. Then, 20 students from the upper grades (grades 5 /6) of S Primary School in Yunnan Province were selected as the experimental subjects to carry out three rounds of action research. Finally, the paired sample t-test was used to analyze the questionnaire data to verify that IPA based on the C-STEAM concept can promote students' innovation ability and cultural identity.

2. Literature Review

By reading and organizing the literature related to IPA and C-STEAM, the basis for the feasibility of integrating the C-STEAM concept into IPA was found, and the theoretical basis of

this study was also clarified.

2.1 Feasibility of Integrating the C-STEAM Concept into IPA

IPA is a new and unconventional course (Pan, 2018), and this definition breaks the internal logical structure and content organization form of traditional disciplinary courses that acquire knowledge from indirect experience. IPA is a new type of curriculum that reflects the integrated application of multidisciplinary knowledge (Zhang, 2001). By deeply understanding the definitions of IPA and C-STEAM and the related research contents, the author found that the IPA in primary school emphasizes cultivating students' ability to solve problems by applying interdisciplinary knowledge based on real problem situations and ultimately achieving the improvement of comprehensive quality (Xie & Guo, 2018), this coincides with the concept of C-STEAM education. Therefore, the author comparatively analyzed C-STEAM education and IPA from five aspects: goal orientation, integration method, activity carrier, evaluation method and attitude towards culture, and theoretically clarified that the concept of C-STEAM education is suitable for integration into the IPA of primary schools.

- Consistent goal orientation

C-STEAM education integrates disciplines such as culture, science, technology, engineering, art and mathematics. Through the organic unity of cultural guidance, scientific inquiry, technical operation, engineering design, artistic infiltration and mathematical methods, it enables students to improve their scientific inquiry ability, practical ability and innovation ability in the process of hands-on practice (Lu, 2021). IPA emphasizes starting from students' life situations, obtaining rich practical experience through contact with individual life, social life and natural life, and focuses on cultivating students' practical ability and innovative ability to solve real problems with interdisciplinary knowledge (Li, 2020). It can be seen that both C-STEAM education and IPA focus on student-centerness, respect students' interests and needs, give full play to students' individuality and subjective initiative, promote students' autonomous development and lifelong development. Both have a high degree of consistency in the talent cultivation goal of improving students' comprehensive quality and innovation ability.

- Interoperable integration methods

In C-STEAM education, science promotes people's regular understanding of the world, engineering and technology support people in transforming the world as needed, art helps people enrich the world in an elegant way, mathematics provides people with ways of thinking and analytical tools for the application and development of science, engineering, art and technology, and culture is a bond that links all the links. The concept of this kind of education can be summarized as: based on mathematics, interpreting science and technology through engineering, culture and art (Zhao & Lu, 2016). IPA, based on students' interests and needs, selects comprehensive activity themes that can reflect individuals, society and nature, promoting the reorganization, extension and application of disciplinary knowledge in activities (Cheng & Wang, 2011). Compared with the traditional subject-based teaching, both C-STEAM education and IPA are new breakthroughs. They both focus on the cross-integration of related multiple disciplines to promote the transfer and application of knowledge. In actual teaching, teaching contents are integrated through interdisciplinary approaches, forming a comprehensive knowledge system, which is conducive to promoting students to feel the universal connections existing among different disciplines from multiple perspectives.

- Similar activity carriers

C-STEAM education mainly adopts project-based learning as the main teaching method, and mostly conducts activity design, cooperative exploration and communication sharing in the form of groups (Dang, 2019). The main forms of IPA include investigation and inquiry, social service,

design and production, and vocational experience, etc. Each form emphasizes that students personally experience various activities (Jiang et al., 2018). Both start from the real life situations of students, taking practical activity methods as the main carrier. Through diverse activities and rich themes, they cultivate students' communication skills, hands-on abilities and practical abilities, enabling the curriculum to break free from the constraints of traditional learning places such as books, classrooms and schools, and deeply integrate teaching into various scenarios of nature, society and students' own lives and provide students with opportunities for personal experience and on-site experience.

- Diverse evaluation methods

The quality evaluation of STEAM education integrates different evaluation methods, mainly based on international assessments such as PISA and TIMSS. In addition, it also combines various evaluation metrics such as demonstration evaluation, oral demonstration evaluation and team presentation (Zhang, 2020). On this basis, C-STEAM education discovers and affirms students' potential and personality by combining multiple evaluation methods. IPA mostly involves some autonomous learning activities such as thematic exploration, research projects, scheme design, and hands-on operation. Its evaluation is mainly carried out through realistic records, establishing portfolios, conducting discussions, self-evaluation and mutual evaluation, etc. (Wang, 2011). The evaluation of C-STEAM education and IPA is significantly different from the traditional single evaluation. Both advocate diverse developmental evaluation methods. Through various evaluation tools and multiple evaluation subjects, a comprehensive evaluation of each student is conducted from multiple evaluation perspectives, ensuring the objectivity and scientificity of the evaluation (Xu, 2018).

- Value the role of culture

In C-STEAM education, "culture" is the most important component. Culture is like a pulling bond that enables students to quickly enter familiar and interesting situations (Li, 2020), thereby triggering their conscious learning. In the IPA of primary schools in ethnic minority areas, the rich ethnic cultures are their unique wealth. Integrating these ethnic cultures into the curriculum themes and projects can not only rapidly enhance students' interest in learning, but also promote traditional culture. Therefore, to promote the teaching effect of IPA in primary schools in ethnic minority areas, C-STEAM education is the best way.

2.2 Literature Review Third-level Heading (Times New Roman, 13, Bold)

Skillbeck's curriculum design model: As the professional practice of education, the curriculum is the fundamental basis of teaching activities and directly affects the quality of talent cultivation (Cui, 2018). However, the implementation of the curriculum requires the guidance of the curriculum model, because a scientific, systematic and rigorous curriculum design model is a necessary condition for the design and development of curriculum teaching activities (Chang & Zhang, 2018). This study adopted Skillbeck's situational model theory. He divided the curriculum design into five steps, namely Analyze the situation, Forulating goals, Creating program, Implementation, and Monioring and evaluation. This study curriculum design according to this model.

The 6C Model: Zhan Zehui formally proposed the concept of C-STEAM in 2020. The "6C Model and Practical Cases" she published has also become the theoretical basis of this research. 6C corresponds to the six links of the C-STEAM project (composed of six phrases with the initial letter C), namely Contextual Experience (C1), Connotation Comprehension (C2), Characteristic Inquiry (C3), Create Artifact (C4), Connect Society (C5), Conclusive Reflection (C6). Figure 1 demonstrates that the six segments form a stepwise logic and emphasize interactions and

iterations between activities from sensing, understanding, exploring, creating, promoting, and evaluating. The 6C model guides the curriculum implementation process of IPA based on the C-STEAM concept.

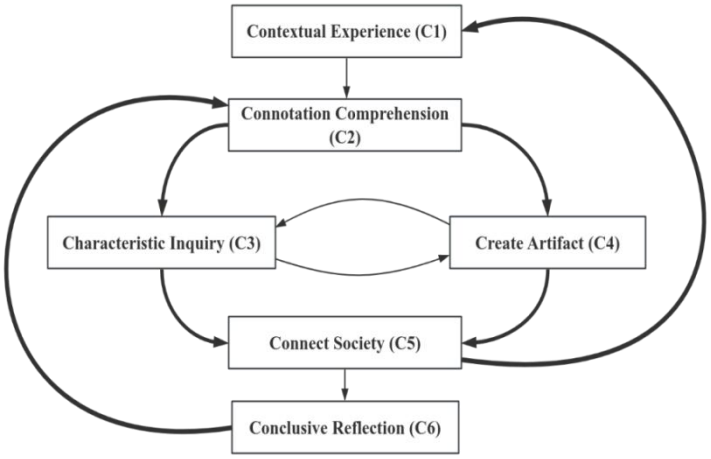

Figure 1.1: The 6C Model of C-STEAM Education

3. Methodology and Procedures

3.1 Feasibility of Integrating the C-STEAM Concept into IPA

The essence of this research is to test the effectiveness of the new teaching methods, so the main method adopted is action research. Action research aims to solve a certain practical problem and emphasizes a comprehensive research method that combines the research process with practical actions (Xie, 2015). Action research involves researchers or practitioners gradually adjusting and correcting the original design in an iterative cycle of design, implementation, evaluation, reflection and redesign, in order to achieve theoretical innovation and practical improvement (Bao et al., 2015). This study adopted the **Action Research Cycle** proposed by Kemmis and McTaggart (1988), which includes the spiral of **"Planning - Action - Observation - Reflection"** links. Its main manifestation feature is iterative loop, that is, the research design is gradually improved in a long-term and constantly circular practice process. This research went through three rounds of curriculum implementation. Each round was based on the themes of ethnic minority cultures in Yunnan Province (Figure 1.2). The core of the C-STEAM education concept is culture, so in this study the authors focused on the minority cultures of Yunnan Province to design three cultural thematic courses: the culture of dragon boat of Miao nationality, the culture of rice wine of Yi nationality, and the culture of paper-cutting of the Dai nationality. These ethnic minority cultures allow students to learn in a familiar context and enhance their interest in the lessons.

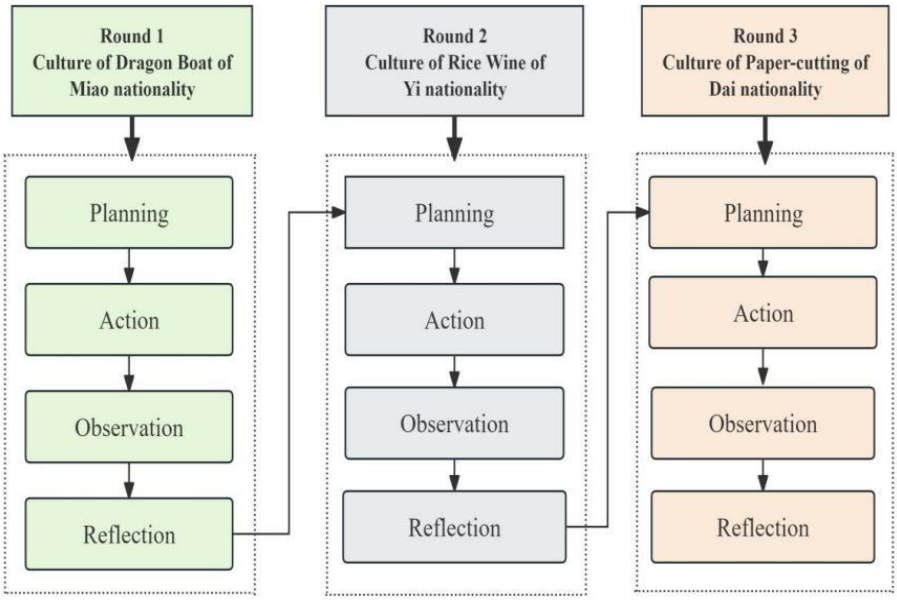

Figure 1.2: Action Research Cycle

3.2 Population and Sampling

S Primary School in Yunnan Province was selected as the subject of the case study. The first reason is that the majority of students in S Primary School are from ethnic minorities, making it a representative of primary schools in minority areas. As of 2024, the school will have a total of 2,280 students. According to statistics, there are a total of 1,280 students from ethnic minorities in this school. The largest ethnic minorities are the Hui, Dai and Yi nationnality. Reason 2 is that this primary school attaches great importance to STEM education. In 2022, it was awarded the title of "Model School for STEM Education". The senior students (grades 5 and 6) have certain programming skills, which are more helpful for curriculum design based on C-STEAM. Usually, students voluntarily sign up for the projects they are interested in. Therefore, the "IPA" series of projects based on C-STEAM designed by the author was also voluntarily signed up by students, with the number of applicants being 20. Therefore, in this project, students from Grade 5 (8 students) and Grade 6 (12 students) are mixed.

3.3 Data Collection

After the completion of three rounds of action research, to test the teaching effect of IPA based on the C-STEAM concept, this study defined that IPA based on the C-STEAM concept has a good effect from two aspects: students' innovation ability and students' ethnic minority identity. Therefore, two questionnaires were conducted for different test effects.

- **"Williams Scale"**

In the effect evaluation and test of IPA based on the C-STEAM concept, a comparison between pre-test and post-test will be adopted to evaluate whether students' innovation ability has increased. The curriculum based on the C-STEAM concept is conducive to cultivating students' innovation ability, and innovation ability is the core manifestation of creativity. This study adopts the "Williams Scale" to measure whether the "IPA" teaching based on the C-STEAM concept can enhance the innovation ability of primary school students. This scale was originally developed by American psychologist Frank E. Will and is suitable for teenagers aged 6 to 18. It has more advantages in testing students' thinking and personality. It mainly evaluates students' innovative thinking and innovative personality and is one of the effective tools for measuring innovative

ability (Yang, 2022). This scale includes four dimensions: Curiosity, Imagination, Complexity, and Risk-Taking, with a total of 50 questions.

- **"Ethnic Minority Cultural Identity Questionnaire in Primary Schools"**

The pre-test and post-test comparisons were adopted to evaluate whether students' cultural identity increased. The courses based on C-STEAM are oriented towards cultural inheritance and are conducive to enhancing students' cultural identity. Cultural identity is the way and process through which an individual generates a sense of cultural belonging and "our sense" (Pan, 2017). For primary school students, the identification with culture cannot be internalized at the value level like that of adults, but is more manifested as an emotional attitude (Liu, et al., 2020). Therefore, this study draws on the "Questionnaire on Cultural Identity of Ethnic Minorities in Yunnan" compiled by Hu et al. (2014), which consists of 16 questions, covering three dimensions: cognition of ethnic minority culture in Yunnan province, behavior of ethnic minority cultural identity, and attitude towards ethnic minority cultural.

In order to ensure the authenticity and validity of the course evaluation effect, the above two questionnaires were sent to the 20 participants in the project respectively before the project research and after the project ended. Finally, SPSS 27 was used to conduct paired sample t-tests on the obtained quantitative data to analyze the teaching effect.

4. Results and Discussion

4.1 Constructed a Curriculum Design Model for IPA Based on the C-STEAM

Based on Skillbeck's curriculum design theory and Zhan Zehui's 6C model, a curriculum design model for IPA based on the C-STEAM concept was constructed, which was divided into three stages: stage of preparation, stage of implementation and stage of evaluation, with 12 detailed steps: Select a minority culture, Analyze the learning condition, Identify the project theme, Define the teaching objectives, Resource integration, Design of teaching process, Contextual Experience, Connotation Comprehension, Characteristic Inquiry, Create Artifact, Connect Society, Conclusive Reflection. The model was used to design three lessons on the theme of minority cultures and conducted 3 rounds actioin research. The first round of action research, which unfolded with the culture of dragon boat of Miao nationality, guided students to 3D modeling to design a new type of dragon boat. In the end, by the evaluation form found some revealed problems such as unclear teacher roles and untimely guidance and help. In the second round of the culture of rice wine of Yi nationality, starting with the spirit of the Yi people's reverence for wine, students were guided to understand the process of wine making and to make their own rice wine and design wine cups. The design of the teaching process was modified in this round of implementation by adding two columns for teacher's task and student's task to refine the teaching process. The teaching practice in the second round was obviously much better than that in the first round, the tasks of teachers and students were clearer and the students' motivation became higher. At the same time, problems were also found: the teaching time of the course was compact and the tasks of the project works were heavy. The third round of culture of paper-cutting of Dai nationality, dominated by the Dai traditional paper-cutting craft, guided students to use AI tools to design and 3D print paper-cutting works. This round of action research was changed from 10 hours to 12 hours, leaving more time for students to self-explore, giving students the right to make mistakes, and throughout the process at the end of the teacher provides students with methodological skills such as mind mapping, brainstorming forms, and so on, to promote the students' innovation ability. The final found that the third round was very effective overall and students' classroom performance was richer than in the first two rounds (Figure 1.3),

and they were willing to try to solve challenging problems. Three rounds of action research were conducted in the upper grades of Primary School S in Yunnan Province, culminating in a system curriculum design model of IPA based on C-STEAM.

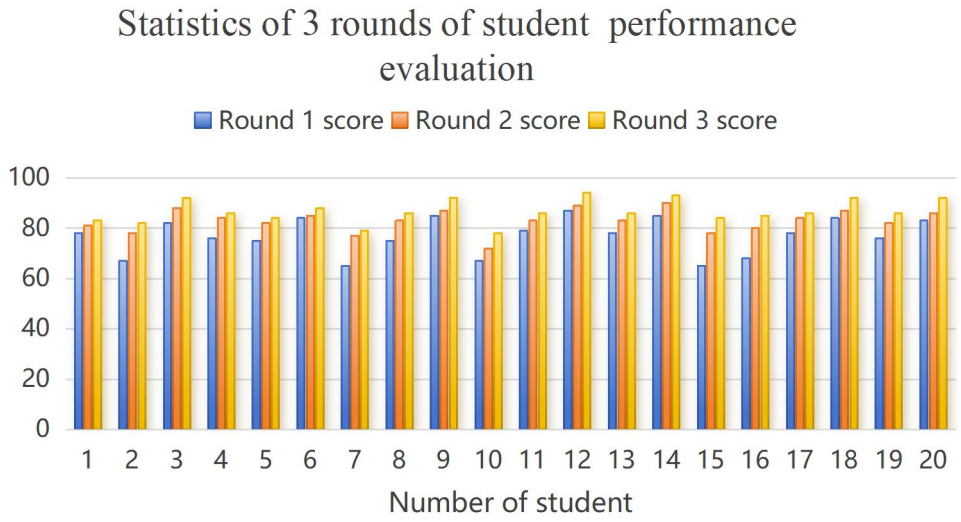

Figure 1.3: Third round of action research: statistics for student performance

4.2 IPA Based on the C- STEAM Achieves Excellent Results

4.2.1 Innovation ability of students

Table 1.1: Statistic of Pre and Post-Test of Students' Innovation Ability

Measurement Term	Dimension	Test (Mean ± S.D.)	
		Pre-test（N=20）	Post-test（N=20）
Innovation ability	Complexity	22.15±2.93	27.30±3.81
	Curiosity	22.55±2.70	27.10±3.81
	Imagination	23.50±2.33	28.75±2.00
	Risk-Taking	24.40±2.54	28.95±2.60
	Total	92.60±7.09	112.10±8.08

Table 1.2: Paired Sample T-test of Students' Innovation Ability

			Std. Error	95%Confidence Interval of the Difference				
	M	SD	Difference	Lower	Upper	t	df	Sig.
Paired 1	-19.500	4.662	1.043	-21.682	-17.318	-18.705	19	.000
Paired 2	-5.150	2.455	.549	-6.299	-4.001	-9.380	19	.000
Paired 3	-4.550	1.234	.276	-5.128	-3.972	-16.485	19	.000
Paired 4	-5.250	2.149	.481	-6.256	-4.244	-10.925	19	.000
Paired 5	-4.550	1.276	.285	-5.147	-3.953	-15.943	19	.000

Table 1.1 shows the mean and standard deviation of the pre-test and post-test data. The sample size N is 20. The mean total score of the pre-test is 92.60, and that of the post-test is 112.10. The mean total score of the post-test is 19.5 points higher than that of the pre-test, and the indicators of the four dimensions have all been improved to varying degrees. It indicates that after three rounds of learning through the innovative teaching mode, students' innovation ability has been significantly enhanced. In order to further compare whether the two effects have reached the level

of statistical difference, a paired sample t-test is also required. As can be seen from Table 1.2, the difference between the pre - and post-tests of students' innovation ability: t=-18.705, P=0.000, less than 0.05. Indicating that there is a significant difference in students' innovation ability before and post-tests. This also indicates that IPA based on C-STEAM can promote the innovation ability.

4.2.2 Identity with minority culture of students

Table 1.3: Statistic of Pre and Post-Test of Students' Identity with Minority Culture

Measurement Term	Dimension	Test (Mean ± S.D.)	
		Pre-test（N=20）	Post-test（N=20）
Identity of minority culture	Cognition of ethnic minority culture in Yunnan province	10.65±1.23	14.10±0.85
	Behavior of ethnic minority cultural identity	14.55±3.07	22.30±1.34
	Attitude towards ethnic minority cultural	15.95±2.11	23.60±01.19
	Total	41.15±4.98	60.00±2.10

The results of data mean and standard deviation showed (see Table 1.3): pre-test M=41.15, post-test M=60.00. And the indicators of the three dimensions have been improved to varying degrees. It shows that after three themed courses, students' cognition and attitude towards ethnic minority culture have been greatly improved. The paired sample t-test again showed (Table 1.4) that **t=-19.971, P=0.00<0.05**, which indicated that there was a significant difference before and after the test, suggesting that IPA based on the C-STEAM can promote students' cultural identity.

Table 1.4: Paired Sample T-test of Students' Identity with Minority Culture

			Std. Error	95%Confidence Interval of the Difference				
	M	SD	Difference	Lower	Upper	t	df	Sig.
Paired 1:Identity	-18.850	4.221	.944	-20.826	-16.874	-19.971	19	.000
Paired 2:Cognition	-3.450	1.099	.246	-3.964	-2.936	-14.038	19	.000
Paired 3:Behavior	-7.750	2.245	.502	-8.801	-6.699	-15.439	19	.000
Paired 4:Attitude	-7.650	2.368	.530	-8.758	-6.542	-14.447	19	.000

5. Conclusion and Suggestion

Through curriculum design and three rounds of action research, the curriculum design model of IPA based on the C-STEAM concept was obtained. Through the comprehensive analysis of quantitative, it was verified that the IPA based on the C-STEAM concept has a excellent effect. It not only enhances students' learning interest but also promotes their innovation ability. Therefore, the curriculum design model of IPA based on the C-STEAM concept can be extended to the IPA courses in all ethnic minority areas. The C-STEAM education concept centered on culture is also worthy of being discovered and practiced by more educators. This study integrates the C-STEAM concept with the IPA curriculum, filling the practical gap in C-STEAM research. The curriculum design model of IPA based on the C-STEAM concept was proposed and three rounds of practical research were carried out, providing practical cases and curriculum design templates for teachers of the IPA. In addition, this study is dominated by the cultures of ethnic minorities and integrates the characteristic cultures into the curriculum, providing a new idea for education in ethnic minority areas. C-STEAM is a new educational concept. This study hopes to promote the C-STEAM concept to other places outside China, use the culture familiar to students to drive the

teaching process, and enhance the pleasure of learning and comprehensive ability from the culture.

In addition, due to the limitations of various objective conditions in this study, the course was only conducted in s Primary School in Yunnan Province for three rounds with a total of 32 teaching practices, and the implementation subjects of the course were only 20 senior students (grades 5/6). Therefore, it can only be inferred that the IPA based on the C-STEAM concept developed in this study is applicable to objects at a level comparable to that of primary school students in S. Whether this course is applicable to students at other levels or in other ethnic minority areas still requires more experimental studies. Therefore, the subsequent research should expand the experimental sample more. Besides, the subjects of this study were only one group, and the pre-test and post-test were conducted on this experimental group. In the subsequent research, a control group (students taking the traditional IPA course) should be added. The comparison of data between the experimental group and the control group can make the research results more valid. Although multiple evaluation results of this study have proved that this course has certain validity and applicability, the limitations of this sample size and data have also had a certain impact on the research results.

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