



IMPLEMENTATION STRATEGIES OF AESTHETIC EDUCATION IN PHYSICS

Tingting LIU, Haibin SUN

College of Physics and Electronic Engineering
Taishan University, Tai'an City, China 271000

Abstract— Scientific beauty plays an important role in science and science education. Scientific beauty exists in physics, not only reflecting in the theoretical achievements of physics, but also in the creation process of physicists. Physics teaching can develop students' aesthetic consciousness and aesthetic taste, and help students to enjoy the artistic beauty of physics.

Keywords— Scientific beauty, Aesthetic education, Physics education

I. INTRODUCTION

Beauty is the specific perceived image which can bring physical and mental pleasure to people. There are three basic forms of beauty; namely natural beauty, artistic beauty and scientific beauty, among which natural beauty is the foundation. The three forms of beauty are connected with each other and can interconvert into each other. Scientific beauty and the artistic beauty are based on natural beauty. They are the advanced forms of beauty created by human according to the laws of beauty. Scientific beauty is generated when the aesthetic psychology and aesthetic consciousness of human reach a higher development stage, and the theoretical thinking and aesthetic consciousness are interactive and mutually penetrated into each other [1].

Like art, physics also can satisfy people's aesthetic need, which has the connotation of beauty and aesthetic value [2-4]. Therefore, the physics education with teaching physics knowledge as the main task plays a good role of aesthetic education. Physics teaching can develop students' aesthetic consciousness and aesthetic taste, as well as their thinking ability and aesthetic ability. As a result, physics teaching should not only enable students to master the knowledge of physics science, but also should represent the physics knowledge artistically in teaching, thus enabling students to understand the scientific beauty of physics and the artistic beauty of physics teaching. It is the highest realm pursued by each physics teacher to realize the perfect combination of the scientific beauty of physics and the artistic beauty of physics teaching, and show the beauty of physics to students artistically [5].

II. LET STUDENTS TO GRASP THE SCIENTIFIC BEAUTY OF PHYSICS THROUGH PHYSICS TEACHING

A. The scientific beauty in physics

Scientific beauty objectively exists in the scientific knowledge, discovery and invention created by human. It is the achievement created by human in the process of exploring and discovering the laws of nature. As pointed out by Heisenberg: Initially, scientific explorers usually understand and discover truth in the shining of science. The history of scientific development reflects human's pursuit and creation of beauty. The science itself is beautiful, but the scientific exploration process is even more beautiful.

Scientific beauty exists in physics, not only reflecting in the theoretical achievements of physics, but also in the creation process of physicists. The characteristics of scientific beauty in physics can be summarized into four aspects: first, the physics phenomena, concepts, processes, rules and theories should comply with the aesthetic laws such as symmetry, harmony, simplicity, and variety in unity; second, the physics concepts and rules are the correct reflection of the objective world, as well as the unification of truth and beauty; third, the scientific beauty in physics can be perceived, understood and evaluated only in the process of physics research and study; fourth, the scientific beauty in physics also has the perceived image which can bring physics and mental pleasure to people.

B. Teaching of the scientific beauty in physics

The purpose of carrying out aesthetic education through physics education is to cultivate and improve students' aesthetic psychological structure, so that their abilities in various aspects can achieve harmonious development. In order to fully explore the inner beauty of physics teaching contents, in physics teaching, physics phenomenon, concept, rule, experiment, method, image and history of physics should be used to reveal the simplicity, symmetry, harmony, and variety in unity of the physics world.

Physics concept and rule is the summarization, conclusion and sublimation of the essential attribute and inner connection of the physics phenomenon and process. Therefore, in form, physics concept and rule is subjective and abstract while in content, it is objective and concrete, which determines its



figurativeness. The common methods in physics, such as the ideal model method and equivalent method, all possess very good aesthetic characteristics. For example, particle, point charge, simple pendulum, electric field line and Rutherford's atomic planet model are very simple, embodying physicists' continuous pursuit in scientific and concise beauty. Others such as the movement and stillness, gravitation and repulsion, reflection and refraction, positive and negative electrical charges, action and reaction, electromagnetic and magnetic electric, and particle and anti particle all fully demonstrate the symmetry beauty in physics; acceleration and deceleration, and the unification of object motion on the ground and planetary movement in the sky reflect the self-consistent and maturity of the scientific theory; energy transformation and conservation law reveals the unity between force, thermal, electromagnetic, optical, chemical and other natural phenomena; Einstein's mass energy equation not only unifies the mass and energy of the material world, but also shows the stable and balanced proportion between these two unknown quantities with a very simple form, seemingly very beautiful.

In physics teaching, the images in physics world described by teachers should not be separated, broken and one-sided, but should be associated, ordered and regular; namely a perfect picture of the nature. However, this picture is not described by colors and line, but by physics concept, rule, experiment and formula. Teachers should be good at guiding students to treat physics with a view of beauty and reveal the highly unification of physics concept and formula. For example, after learning mechanics, teachers can guide students to connect the knowledge of each chapter and draw an interrelated mechanics knowledge structure, incorporating numerous physics concept, rule and formula into a complete and strict knowledge system. No matter elasticity, friction force, gravity, or large objects or tiny particles can be incorporated into the scope of Newton's law and comply with the unified law of motion. From the formula $F=ma$ of Newton's Second Law, the relationship between force and acceleration the very obvious. Then, we are tempted to think that acceleration is the time variation law of speed and speed is the time variation law of displacement. In this way, a series of knowledge about kinematics becomes very clear. In view of this, students can fully realize the perfectibility of $F=ma$, as well as its great strength of incorporating classical mechanics: its harmony and unity seems like a very beautiful poem.

Historical materials of physics can play its role of aesthetic education. In the development of physics, there are no lack of typical examples of scientists revealing the general laws of the physics world via their intuition, imagination of artistic beauty and spirit of pursuing scientific beauty. For example, the establishment of Copernicus's heliocentric theory, Dirac's negative electron prediction and experimental verification, and the establishment of de Broglie's matter wave theory are closely related with the idea of scientific beauty. For example, the dean of modern physics, Einstein is not only a great

scientist, but also is an art admirer and lover. He thinks that he plays the violin much better than physics. While the German physicist Heisenberg believes that the contribution of Einstein's relativity to scientific beauty "seems like Da Vinci or Beethoven in the field of art". American physicist Field, the positive propagator and cooperater of Einstein's relativity deeply feels that "the theory of Einstein is far beyond that of others in aspects of beauty, depth, and logic reasonability". It can be said that Einstein devoted his whole life in revealing the unification of truth, kindness and beauty of the universal order. Hence, students can recognize, the reason why scientists can obtain more, deeper and stronger aesthetic experience than ordinary people from scientific research is that they have stronger spirit of aesthetic exploration and greater scientific appreciation and aesthetic capacity. Therefore, the aesthetic education in physics teaching can also provide similar exploration tools of scientists for students' physics learning, so that students can carry out more in-depth exploration of "true" knowledge according to the principle of physics beauty.

In teaching activities, teachers should pay attention to students' position of aesthetic subject, let students discover, appreciate, and enjoy the beauty in physics to the maximum and motivate students' learning enthusiasm, thus encouraging them to learn physics with an urgent attitude to explore the mysteries of the universe, and get an intuitive understanding of the truth and beauty of physics. Students' understanding of physics beauty is also helpful to perfect and improve the cultivation of their observation ability, experiment ability, intuitive thinking ability, imagination ability, and creation ability. Through revealing the "truth" and "beauty" of physics, students can improve the appreciation state, cultivate the soul, develop the intelligence, enhance the taste, train their healthy and positive aesthetic feeling as well as the beauty appreciation and creation ability, thus realizing the coordinated development of students' perceptual thinking and rational thinking, and shaping a sound personality.

III. ENCOURAGE STUDENTS TO ENJOY THE ARTISTIC BEAUTY OF TEACHING THROUGH PHYSICS TEACHING

Teaching is not only a science, but also an art, which however, is often overlooked by many teachers. They consider physics teaching as teaching knowledge, which has nothing to do with art enjoyment. In fact, teachers are more artists than educators, who provide students art enjoyment through physics teaching. Teachers with aesthetic sense should pursue the perfect effects of physics teaching, just as the artists' pursuit of artistic beauty. This requirement appears to be more urgent under the background of new curriculum reform. Art of physics teaching relies on teachers' physics professional quality, including their broad and profound physics knowledge, education knowledge, and education practice, wide aesthetic taste, vivid performance skills and strong organizational ability. The artistic beauty of physics teaching is mainly embodied in aspects of teaching design beauty, teaching process beauty, teaching language beauty, teaching manner beauty, blackboard-writing beauty and



teaching management beauty. Physics teachers should delve into the teaching materials, study teaching methods, master teaching rules and strive to explore the beauty contained in the textbooks. They will reprocess according to their own aesthetic sense and elaborately design the teaching process, so that students can fully perceive the beauty of physics. Physics teachers should seriously explore the connotation of the physics beauty in teaching activities, present its aesthetic features from multi-aspects and try to create the artistic conception as possible, enabling students to enjoy the scientific beauty of physics at the same time learning physics scientific knowledge.

A. Create a physics classroom teaching atmosphere with the form of beauty

In classroom teaching, teacher and students are both the main body of the aesthetic education. Both teachers' "teaching beauty" and students' "learning beauty" are dynamic, which is reflected in the two-way interactive process of "teaching" and "learning". In new curriculum reform, physics classroom teaching with the form of beauty should draw reference from the interaction and exchange principles in the process of art appreciation. Teachers should be responsible for creating a harmonious and lively teaching atmosphere with a rich sense of rhythm and a vivid image while students should be the master of the classroom in learning. Teachers should recognize that: the creative activity of teachers and students are interactive, inter-motivate and inter-promotion; in other words, teaching benefits teachers as well as students.

Physics teachers' art of introducing new classes, art of creating situations, classroom management art, teacher-student psychological communication and exchange art, blackboard-writing art, experimental demonstration art and art of organizing extracurricular activities all have good aesthetic value. In physics classroom teaching with teacher-student exchange, teachers try to transfer their love for physics and physics teaching to students artistically through a variety of methods while students transfer the emotions of physics teachers into the driving force to learn physics. In classroom teaching, physics teachers' skillful and patient guidance, humorous and witty witticisms, well documented culture background, novel experimental design, intuitive experimental demonstration, dignified and suave teaching manner, and innovative teaching style all show the imperceptible aesthetic education cultivation and can inspire students' full passion of learning. Such physics teaching with strong emotional communication can enable students to be plunged into learning and enjoy the artistic beauty, thus producing emotional resonance and transference such as understanding, interest and love. The psychological "resonance" between teachers and students will make the creative activities of teachers form the centripetal force and cohesion in teaching, which can move students with strong appeal and inspire students' strong desire of creation, so as to experience the unique creation beauty of science. In the interaction with students, teachers are also inspired a motivated to further modify, improve and enrich their own teaching art.

B. Present the beauty of physics artistically

First of all, artistically present the structure beauty, inner beauty and application beauty of physics. At the same time presenting the rigorous and difficult side of physics, physics classroom teaching should also present its visual, vivid and cheerful side. The implementation of physics aesthetic education refers to combine the aesthetic psychological characteristics and physiological characteristics of middle school students and show the structure beauty of physics teaching materials, the application beauty of physics methods, and the inner beauty of physics rules. While teaching physics knowledge, teachers provide students an overall structure of physics through the restructuring the teaching contents, forming a complete image of the physics world. Only the overall structure of the physics knowledge and the psychological structure of students are identical to each other can the teaching contents become a rich source of aesthetic, and the students can draw an analogy, get to know the similarity between theories in physics and other disciplines, and comprehend and universality of the physics theory. The application of physics methods also embodies the aesthetic characteristics of physics. For example, observation and experiment, analysis and synthesis, comparison and classification, induction and deduction, analogy, idealization, assumptions, mathematical method, intuition and inspiration, opportunity, scientific imagination and conjecture, and symmetric method all reflects the beauty of physics methods from different perspectives in the application of solving physics problems.

Secondly, present the beauty of physics through the scientific and rational use of physics teaching language. Physics teaching is mainly carried out through classroom teaching of physics teachers while expressions, gestures or specific images are used as assistance in exchanging information. Physics teaching language is a kind of teaching art with the strongest aesthetic sense, which not only plays a special role in the transmission of information and knowledge, but also has a strong function of emotional encouragement and infection. The beauty of teaching language embodying in written or oral language should be scientific and accurate, vivid, and full of emotion humor. The superb language art of teachers can make the description of physics language full of wit and humor and the classroom atmosphere active. Teachers' intuitive language description and imagery analogy, in particular, can promote students' understanding of knowledge and arouse students' imagination.

Thirdly, present the beauty of physics through making use of various means of teaching arts. In physics teaching, means such as experiment demonstration, slide show and brief strokes should be used scientifically and reasonably to reflect the intuition and fun of physics teaching; audio-visual education means such as projection, video and multimedia can be used to create the real physics situation, enabling students to remove difficulties, grasp key points and master knowledge rapidly in physics situations. Physics experiments also contain a wealth of beauty. Galileo's ideal experiment method, Millikan's oil



drop experiment, for example, their ingenious design ideas and exquisite experiment skills provide people with aesthetic enjoyment exquisite beyond compare. Taking the “extrapolation method”, which is used to handle experimental data, as another example, it fully shows the simple, harmonious, rigorous and logic beauty of physics experiment method: through extrapolation, physics data beyond the range of experimental data and the experimental conclusions in limit cases can be obtained.

Finally, the blackboard-writing of physics has high generality and the form beauty of blackboard-writing can strengthen the classroom teaching effect. Blackboard-writing integrates the structure of teaching material s and the idea of teachers in teaching, which is an indispensable part in the teaching process. The blackboard-writing should have neat script, proper size, reasonable layout, standardized order and clear outline. Especially the figures used to describe physics phenomena and physics processes, which still need physics abstraction or imagination, should express the basic characteristic of the described object with the simplest technique within the shortest time. The form beauty of the blackboard-writing can further strengthen students’ perception of beauty, and generate their thinking of beauty, promoting students to understand and master the knowledge they have learned. Good blackboard-writing requires physics teachers to be equipped with solid and masterly basic skills of teaching brief strokes.

IV. CONCLUSION

In a word, in the teaching activity in pursuit of beauty, physics teachers will keep experiencing the beauty of physics and teaching, continuously adjust their own teaching behaviors and daily behaviors, and gradually perfect the physics teaching art personality, so that they are more attractive to students in professional knowledge, practical ability and even moral norms, thus truly realizing the purpose of imparting knowledge and educating people.

V. REFERENCE

- [1] J.W. McAllister. *Beauty and Revolution in Science*. Ithaca NY: C.ornell University Press.1997.
- [2] J. Silk. Physics: The impulse of beauty. *Nature*, Vol. 523 No.7559, pp.156-157,2015
- [3] R. Sinha. New physics with beauty. *Pramana*, Vol. 55, No. 1, pp. 219-228, 2000..
- [4] C. Anastopoulos, E.B. Thacker, J. Catmore, et al. Physics analysis tools for beauty physics in ATLAS. *Journal of Physics: Conference Series*, Vol. 119, No. 3, pp. 032003, 2008
- [5] L. Leon. Don't overlook the beauty in physics. *Physics Education*, Vol. 41, NO. 4, PP. 288, 2006.