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Construction and reform of art design teaching mode under the background of the integration of non-linear equations and the internet

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Abstract

In the continuous application and development of network technology, the reform in Internet information will inevitably bring about major changes in college education and teaching. Based on this background, the paper puts forward the influence of 'Internet+' on art design education. At the same time, the article explores the influence factors of the Internet on art design teaching based on the non-linear equation model. We use the parameterised cubic clipping algorithm to find the roots of non-polynomial equations. Through performance analysis and comparison, it is found that the root-finding algorithm proposed by us has better parallelism and lower-storage requirements. This algorithm has certain advantages in solving the weight of the factors that influence the Internet to art design teaching.

Keywords: environmental art design teaching, model space, non-linear equations, design ability, teaching reform

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1 Introduction

Cultivating design ability is the core task of environmental art design education. The environmental art design is a process with clear goals and a planned search for practical solutions to problems. The design process generally includes the following steps: interpreting design requirements, collecting data, analysing and researching space to generate creative expression ideas and improving design plan evaluation. In this process, space research plays a pivotal role in environmental art design. It is the main object of environmental art design research and design's object [1]. The design requires a bridge and tie to intervene in creativity. Enough attention should be given to our teaching. Therefore, what kind of teaching methods is used to train students to research space, how students should design and how to think are invaluable factors and are included in our discussion.

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The accurate solution of the non-linear wave equation is very helpful to understand the nature of the non-linear equation. Especially for the numerical solution of non-linear equations, the analytical solution helps verify the correctness of the numerical solution [2]. Therefore, the analytical solution of solving non-linear equations occupies an important position in non-linear problems. Recently, many new methods for finding accurate solutions to non-linear wave equations have appeared, such as homogeneous balance method, hyperbolic tangent function expansion method, trial function method, non-linear transformation method and sine cosine method. Some scholars have discussed solutions to non-linear equations. However, these methods can only obtain shock wave and solitary wave solutions of non-linear wave equations but cannot obtain periodic solutions of non-linear equations. Although some scholars have obtained accurate periodic solutions of some non-linear wave equations, applying the Weierstrass elliptic function is relatively cumbersome. So we proposed the Jacobi elliptic function expansion method. We used this method to obtain the periodic solutions of a large class of non-linear wave equations, including the corresponding shock wave and solitary wave solutions. This article uses this finite series expansion method and uses different Jacobi elliptic functions to expand. A new periodic solution is obtained to solve the weight of the factors that influence the Internet on art design teaching. These solutions can also degenerate into corresponding shock wave or solitary wave solutions.

2 Analysis of methods for cultivating space research ability in the current environmental art design teaching system

Environmental art design education has been carried out for >10 years. At present, the teaching methods of space research in major colleges and universities mainly use teacher theoretical explanations and student plane analysis. Through graphic drawings and words, students rely on imagination to construct space in their minds for space research. This traditional teaching method is obscure, empty and divorced from reality in space research training. This method has obvious drawbacks [3]. First of all, it isn't easy to comprehensively study the whole content of three-dimensional space with plane drawings and language expression. Second, the teaching parties did not have the conditions for intuitive interaction with the designed space, which weakened the guiding and enlightening effect of the space image, sense of volume and contrast stimulation on the designer's creativity. In addition, the situation of most students at this stage is that their art skills are not solid enough, which leads to poor spatial, logical thinking, weak spatial understanding and insufficient three-dimensional thinking structure ability in the study of professional design. We do not have enough class time to improve the students' art skills

Fig. 1 Environmental art teaching system architecture

in the existing teaching arrangements. At the introductory stage of learning environmental art design, most students are accustomed to only plane-thinking and it is difficult to establish three-dimensional spatial thinking. And environmental art design needs students to have this ability. Usually, we use language and pictures to teach more, while students use sketches and language to express that students are communicating ideas, creativity, or spatial knowledge. However, students only rely on drawings, sketches and language to express that they always feel pale, empty, and fragmented [4]. Therefore, the lack of intuitive spatial analysis often makes the formed ideas and plans of the given space. We must find a new method or intervene in the existing teaching method to improve this situation. Figure 1 shows the current environmental art teaching system structure.

3 Overview of model space research methods

The research method of model space originated from architecture and it is still widely used. It is the main method of architectural research space. The architects Antonio Gaudí, Le Corbusier, Frank Gehry and Pei I.M. admire this method. Today, this method is also applicable to environmental art design.

The model takes the display of physical space as its speciality and brings together the strengths of other means of expression [5]. It shows people the visual image of three-dimensional space independently and unique way of expression. It is a way to reproduce the artistic atmosphere of the environment by combining the designer's design concept, design style, anticipated design effect and model-making process. First realise the actual inspection of the anticipated space design and plan. It can then help us determine the entire spatial relationship and the entire design plan. There are many types of models, which can be divided into application models and programme display models in terms of function. The programme application model is mainly used to test the feasibility of the programme and the rationality of the demonstration space. The plan display model is mainly exhibits the performance of the final effect of the design plan and requires sophisticated model-making skills. According to the teaching requirements of the environmental art design course, we only choose the programme application model. This is because its production is simple and feasible, and it is convenient for space research.

In addition, practicality is one of the characteristics of outstanding teaching. Psychological research shows that the human brain has some special and most creative areas. When the hands are engaged in fine and dexterous movements, the vitality of these areas can be stimulated. Otherwise, these areas are in a dormant state. From a certain perspective, "the hand is the teacher of the brain," so I believe that the teaching of environmental design should pay attention to the operation of the model. Paying attention to the exercise of students' hands can promote students' spatial thinking [6]. We need to train three-dimensional thinking ability and model teaching throughout the entire teaching process. Through a plan or space design, we have to complete a model to meet a need, solve a space problem, etc. This allows students to experience the process of demand generation, space design, material selection and evaluation and improvement. And then help students master the basic spatial thinking methods to improve the ability to apply knowledge and skills to solve practical problems.

4 Non-linear equation model solution method

A type of non-linear equation is expressed as follows:

$$\frac{\partial u}{\partial t} + au^2 \frac{\partial u}{\partial x} + \beta \frac{\partial^3 u}{\partial x^3} = 0. \quad (1)$$

Substituting formula (1) into the above equation, we obtain

$$-c \frac{du}{d\xi} + au^2 \frac{du}{d\xi} + \beta k^2 \frac{d^3 u}{d\xi^3} = 0. \quad (2)$$

From equation (2), we see

$$O\left(u^2 \frac{du}{d\xi}\right) = 3_n + 1, \quad O\left(\frac{d^3 u}{d\xi^3}\right) = n + 3. \quad (3)$$

Now, get a balance between the two

$$n = 1. \quad (4)$$

Therefore, equation (1) has a periodic solution of the following form:

$$u = a_0 + a_1 \operatorname{cn} \xi. \quad (5)$$

Note that

$$\frac{du}{d\xi} = -a_1 \operatorname{sn} \xi \operatorname{dn} \xi, \quad (6)$$

$$u^2 \frac{du}{d\xi} = (-a_0^2 a_1 - 2a_0 a_1^2 \operatorname{cn} \xi - a_1^3 \operatorname{cn}^2 \xi) \operatorname{sn} \xi \operatorname{dn} \xi, \quad (7)$$

$$\frac{d^3 u}{d\xi^3} = [-(2m^2 - 1)a_1 + 6m^2 a_1 \operatorname{cn}^2 \xi] \operatorname{sn} \xi \operatorname{dn} \xi. \quad (8)$$

Then, by substituting equation (5) into equation (2), we have

$$[c - \alpha a_0^2 - \beta(2m^2 - 1)k^2] a_1 \operatorname{sn} \xi \operatorname{dn} \xi - 2\alpha a_0 a_1^2 \operatorname{cn} \xi \operatorname{sn} \xi \operatorname{dn} \xi - (\alpha a_1^2 - 6\beta m^2 k^2) a_1 \operatorname{cn}^2 \xi \operatorname{sn} \xi \operatorname{dn} \xi = 0. \quad (9)$$

From this

$$a_0 = 0, \quad a_1 = \pm \sqrt{\frac{6\beta}{\alpha}} mk, \quad (10)$$

$$c = \beta(2m^2 - 1)k^2$$

Substituting the above into equation (5), we obtain

$$u = \pm \sqrt{\frac{6\beta}{\alpha}} mk \operatorname{cn} \xi = \pm \sqrt{\frac{6c}{\alpha(2m^2 - 1)}} \cdot mk \operatorname{cn} \sqrt{\frac{c}{\beta(2m^2 - 1)}} (x - ct). \quad (11)$$

This is another exact periodic solution of the mKdV equation (1). It requires $\alpha > 0$, $\beta > 0$ or $\alpha < 0$, $\beta < 0$. Taking $m = 1$, formula (11) is transformed into

$$u = \pm \sqrt{\frac{6\beta}{\alpha}} k \operatorname{sech} \xi = \pm \sqrt{\frac{6c}{\alpha}} \operatorname{sech} \sqrt{\frac{c}{\beta}} (x - ct) \quad (12)$$

This is the solitary wave solution of the mKdV equation (1). It requires $a > 0$, $\beta > 0$, $c > 0$ or $a < 0$, $\beta < 0$, $c < 0$.

We discuss the following equations:

$$\frac{\partial^2 u}{\partial t^2} - c_0^2 \frac{\partial^2 u}{\partial x^2} + \alpha u - \beta u^3 = 0 \quad (13)$$

After transforming (2), it becomes

$$k^2 (c^2 - c_0^2) \frac{d^2 u}{d\xi^2} + \alpha u - \beta u^3 = 0 \quad (14)$$

Substitute equation (4) into equation (14) to balance the non-linear term and the highest order derivative term. Then $n = 1$.

Therefore, equation (13) has a solution of the form of equation (5). Substituting equation (5) into equation (14) to get

$$(\alpha - \beta a_0^2)a_0 + [\alpha - 3\beta a_0^2 + (2m^2 - 1)k^2(c^2 - c_0^2)]a_1 cn\xi - 3\beta a_0 a_1^2 cn^2\xi - [\beta a_1^2 + 2m^2 k^2(c^2 - c_0^2)]a_1 cn^3\xi = 0. \quad (15)$$

From this

$$a_0 = 0, \quad a_1 = \pm \sqrt{\frac{2m^2 k^2 (c_0^2 - c^2)}{\beta}}, \quad (16)$$

$$k^2 = \frac{a}{(2m^2 - 1)(c_0^2 - c^2)}.$$

Substitute the above into (5) to obtain

$$u = \pm \sqrt{\frac{2m^2 k^2 (c_0^2 - c^2)}{\beta}} cn\xi = \pm \sqrt{\frac{2m^2 \alpha}{\beta(2m^2 - 1)}} \cdot cn \sqrt{\frac{\alpha}{(2m^2 - 1)(c_0^2 - c^2)}} (x - ct) \quad (17)$$

This is the exact periodic solution of equation (12). It requires $\beta > 0, c^2 < c_0^2$ or $\beta < 0, c^2 > c_0^2$.

Taking $m = 1$, equation (17) is transformed into

$$u = \pm \sqrt{\frac{2k^2 (c_0^2 - c^2)}{\beta}} \operatorname{sech}\xi = \pm \sqrt{\frac{2\alpha}{\beta}} \operatorname{sech} \sqrt{\frac{\alpha}{(c_0^2 - c^2)}} (x - ct) \quad (18)$$

This is the solitary wave solution of equation (13).

5 Significance of the application of model space research methods

First of all, the model-making process is an important process of analysing and thinking about space. The model-making process is as follows: 1. Determine the overall relationship of the model. First, the spatial relationship formed by the plane and elevation of the model should be studied to determine the model's proportional relationship. 2. Scale the floor plan proportionally as the draft of the model. 3. Arrange the relationship between space and colour. 4. The choice of materials should be based on convenient production, easy cutting, easy pasting and firmness. 5. Group processing parts, make base plates and combine them. Finally, add the scenery. Figure 2 shows the programme flow of space model design in art teaching design [7]. The whole production process requires students to have sufficient data collection for their design schemes. At the same time, students must have a detailed understanding and consideration of the functional layout and facade modelling of the scheme. Students must visualise the space of the physical objects and rotate and compare the appearance of the physical objects formed in their minds. Only then can we judge and construct spaces with different perspectives. Teachers can hardly use this kind of space imagination and conception to instil the relationship of point, line and surface into students with the "art of speech." Only when the research theme of spatial thinking is created in the context of the model can the thinking process of students' self-inquiry be completed. Teaching itself is also a creative activity. It is necessary to be familiar with the cognitive laws and psychological characteristics of students. Students should be left with room for imagination and exploration in activities such as production and processing. This is conducive to the formation of a learning atmosphere for the development of students' personalities. In the model creation, the inspired spatial thinking of students should always be in a state of active exploration [8]. Students can conduct self-discovery and attain self-knowledge at any time. However, students learn to cooperate with others to proactively acquire knowledge, comprehensively apply skills, enhance innovation awareness and

improve practical ability. In the model making, the spatial separation, the enclosing relationship, the flow of space, and the sense of volume between the planned buildings, activity venues and landscape sketches should be reflected in the model. At the same time, the model should be scaled according to a certain ratio when making the model. This requires students to have a better grasp of the spatial scale [9]. Solving this part of the problem can convey to students the scale of measuring space with the human body. In this way, students can intuitively see whether the scale and proportion of their design are appropriate. From arranging and solving these problems in the model, students can experience and perceive the relationship between light, shadow and form. This can train students' spatial logic thinking to make it easier to understand and master the language of spatial design.

Fig. 2 Scheme process of space model design in art teaching design

Second, students can actively participate in the production of environmental art design models. This can help cultivate students' sense of cooperation. The model making of the environmental art design course is all done by hand. The workload from design to model completion is very large [10]. Therefore, the assignment in the environmental art design course requires several students to cooperate to give full play/potential according to the characteristics of each person. Students are involved in data collection, creative design, drawing of flat and façade and model making. This not only promotes everyone's knowledge and stimulates their enthusiasm but also exercises their ability to cooperate. As every student participates in it, it is possible to find and solve problems in a time-bound manner.

Cooperative learning encourages students to care about each other's learning and convinces them that there is a relationship of 'everyone for me, for everyone.' and they are 'shame and honour.' Every member of the group must realise that all their group members must succeed. Otherwise, it is not possible for them to succeed on their own [11]. They freely think and associate with the design of their works and propose their design schemes. The whole process can be summarised and each individual can express their own opinions and ideas without restriction to form multiple plans. They have to analyse and compare, weigh and make decisions together. The design plan will absorb the design highlights of each member to form a plan that satisfies every member. Then draw the preliminary plan on the manuscript paper and submit it to the teacher for review. The teacher in this process is also a collaborator. The teacher becomes a member of the students' group. He communicates with students on an equal footing, sharing each other's thinking, insights and knowledge. His participation in activities can make teaching full of endless possibilities. At the same time, let students try negotiation and communication skills in model making. Students should know how to reduce costs and improve quality, use their strengths and realise their maximum value [12]. In this process, students learn to find the best solution in comparison. Everyone does it; everyone participates. After a period of busywork, three-dimensional paintings

were born with new ideas and unique designs. The whole process is permeated with the students' hard work sweat, entrusting everyone's ideals and beliefs. This gave them beauty and improvement but also gave them the joy of success.

Ralph Taylor, the father of contemporary educational evaluation, believes that evaluation is finding out how many expected results the formed and organised learning experience brings. At the same time, the evaluation process always includes identifying the strengths and weaknesses of the plan. Implementing the teaching concept of model space research in the environmental art design curriculum enriches teaching evaluation [13]. This allows us to more intuitively measure the learning process and results of students and make scientific judgements. With the help of the model, we can also allow students to evaluate each other and also self-evaluate. We return the power of evaluation to them, highlighting the subject status of their evaluation. Teachers combine teaching practice to teach students the evaluation method to understand themselves better and fully reflect students' main role in learning so that 'teaching' and 'learning' can truly interact. Understanding learning progress through evaluation can help students overcome difficulties in learning, build confidence and discover potential to promote communication among students. In this way, every student can be more effectively improved and developed on the original basis of hands-on and practical ability. Figure 3 shows the teaching evaluation process.

Fig. 3 Flow chart of teaching evaluation

6 Conclusion

Model space research is to build a bridge between plane and three-dimensional model/space. Through the model, students can turn the idea of a two-dimensional plane into the realisation of a three-dimensional space. This paper extends the Jacobi elliptic function expansion method to the Jacobi elliptic cosine function and the finite expansion of the third type of Jacobi elliptic function. A new exact periodic solution of a class of non-linear wave equations is obtained. These periodic solutions can also degenerate into new solitary wave solutions. We get the same solitary wave by solving the Jacobi elliptic cosine function of the mKdV equation and the non-linear Klein-Gordon equation and the finite expansion of the third kind of Jacobi elliptic function with the limit conditions ($m = 1$) of the two expansion solutions untie. This is determined by the properties of the Jacobi elliptic cosine function and the limit ($m = 1$) of the third type of Jacobi elliptic function. This algorithm has certain advantages in solving the weight of the factors that influence the Internet on art design teaching.

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