THE Value of Combining Mathematics and Computer Applications

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Abstract. With the development of technology, computer-based and web-based teaching environments have become interactive tools for teachers and students. However, the numbers and calculations used in computer language and applications are entirely different from those of pure mathematics; namely, the calculations used by computers must be executable calculations with specific formats. This study used information technology to transform "mathematical formulas" into animation, designed through the computer programming language. The dynamic composition process, where points constitute lines and lines constitute planes, enable learners to understand the mathematical theories behind the composition of the programming language, as well as when mathematics is applied to dynamic digital product design. Therefore, learners are able to create mathematical animation to enhance learning ability, comprehension, and application capabilities. This study takes the dynamic hyperbola of mathematical formula design as an example. Parameter equations could be applied to ship positioning in the sea, orthogonal trajectories in engineering, closed curves in the agro industry, the intensity time curve in medical science, etc. Learners could learn to use programming language to design animation media, then combine applied mathematics to contribute to the application design of industry products.

Keywords: Dynamic Hyperbola, Programming Language, Dynamic Composition, Digital Product

1. Introduction

Mathematics is a language tool developed through the study of the various phenomena of regularity, and is a product of rational human thinking, as well as a common foundation of natural and social sciences. With the 20th century invention of the computer, the "quantitative" and "mathematical" transformations of various subjects increased. As a result, new technology can be combined with geometry and algebra, and even be integrated into their design, which enables technology to meet the creative needs of teaching mathematics, such as the design of geometry and algebra software [1].

Consequently, the future objective of mathematical education is to gradually attach greater importance to the use of new technology in training learners' mathematical problem-solving abilities through the contemporary learning culture of seeking rapid solutions by avoiding traditional time consuming calculations[2].

However, [3] suggested that mathematics is usually regarded as a difficult subject, as learners cannot understand the relationship between geometry and algebra. However, learning mathematics should focus on integrating the concepts of abstract and concrete, image and symbol, and comprehensive algebraic and geometric applications, in order to reflect the universality and essentiality of mathematics [2]. Learning mathematics accentuates that, geometry and algebra are two important aspects of mathematics.

Although it is not necessary for everyone learning computer programs to learn mathematics or acquire a mathematical foundation to meet the future needs of industry, it is a fact that mathematics is an important foundation for the development of program design. Students that understand mathematics, and can apply tools and a programming language, can readily cultivate literacy in software engineering, thus becoming qualified talents for future software industries. When students understand mathematics, they can apply more efficient algorithms. The development of Google, a company focusing on search efficiency, is subject to such mathematical understanding. Therefore, students with such an ability are highly sought after talent.

2. Motivation and Purpose

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The two main approaches, experimental and theoretical, have been applied to conduct scientific and technological studies in the past; however, through integrated computer science technologies, various subjects have created improved research tools and methods at a rapid pace. To date, the calculation and simulation functions provided by computer science have become important experimental and design tools in research.

This study instructed students in the use of calculus functions, and presented dynamic digital function images through application program designs that further calculate and simulate path development images, which enable learners to construct concepts of mathematical planes and spaces, thus, enhancing both learning interest and ability in calculus. By using a mouse on web-based teaching platforms, learners could switch and observe dynamic images from different perspectives and angles. During the switching process, they could identify and correct errors in the images, and through observations, teachers could immediately understand whether students were developing any misconceptions during the learning process of calculus, and rapidly provide feedback and correction regarding mathematical theories.

3. Literature References

Mathematics plays a very important role in program design. In order to cultivate literacy in software engineering, one must understand mathematical theories, the use of tools, and programming language. As they can apply more efficient algorithms, talent with these abilities are in high demand by the software industry, which competitive market requires efficiency and results.

3.1. Industries of mathematical application

Many industries depend on the use of mathematics. [4] suggested that the development of the Wireless Sensor Network (WSN) was rapid, and with a comprehensive application scope, and that security devices for detection and protection of important exhibits in museums used such technology, as the WSN nodes are distributed throughout the monitored area. By using a mathematical geometric model to sense quality data from sensor node segments arranged in straight lines, and transforming the geometric images into digital signals, the algorithm design can assess optimal coverage and calculate the best and worst coverage areas of the WSNs, thus, achieving the objectives of detection and protection of important exhibits in museums.

Moreover, to meet the needs of all customers and achieve the objective of minimizing total distance, waste cleaning and transport industries can apply mixed integer programming models to sub-problems for the calculation of the best location and departure times for new and old customers [5]. The issue concerning the scheduling of vehicles must be solved using mathematical methods, such as optimization. Methodology optimization development requires mathematical foundations, including the basic theories of vector-matrix calculation, linearity, algebra, calculus, and real number analysis [6].

3.2. Industries requiring applications of programming language

In addition to the optimal mathematical application planning software required by the transport industry, as mentioned above, the international express transportation industry must consider relevant operational constraints to achieve the objective of minimizing operational costs. Operators require a model that can effectively consider the relationships between cargo processing time and the operational costs of each station in order to determine the best arrival time to meet the short-term international express flight schedules of various stations. Therefore, the C computer programming language can be integrated with mathematical planning software and develop effective algorithms to obtain the best solution [7].

3.3. Value of free software

Based on the spirit of open source and free software applications, the prevalence of the internet enables internet mechanism to gather more human resources and shorten the time for software synchronous development and debugging. As the quality of free software can compete with that of commercial software, the use of open source free software resources can be effectively integrated, thus, improving the reuse rate of software, shortening the time for software development, improving the quality of software and level of technology, and enhancing the advantage of software creation in Taiwan [8].

Free software can design a control system that conforms to the ability of the system manager and meets its own needs, such as an operating recovery system for batches of computers in school classrooms and network flow monitoring, which can effectively reduce maintenance [9].

4. Research and Analysis

This study took the curve drawing tool, as developed from the hyperbolas function of mathematical parameter equations, as an example.

In mathematics, a hyperbola function is defined as a conic curve, which lies perpendicularly to a plane where a conical surface is divided into two parts. The equation of general hyperbolas is as follows:

The hyperbola center at $(x_0, y_0 \pm c)$ is $\frac{(x-x_0)^2}{a^2} - \frac{(y-y_0)^2}{b^2} = 1$, where $c = \sqrt{a^2 + b^2}$, $c > a > b > 0$, (vertices): $(x_0, y_0 \pm a)$ (asymptotes): $y = \pm \frac{a}{b}(x - x_0) + y_0$ crosses at the midpoint of the hyperbola.

The number and calculation used in computer language differ from those used in pure mathematics, namely, the calculations used by a computer must be executable calculations with specific formats. This study used the Python program code to design a dynamic hyperbola. The program codes are defined, as follows:

```
#equation of lower left curve:
mylab=label(space=0.4,pos=(9,-9,0))
message="(x**2-2*x+4)/(x-2), for -5<=x<=1.6"
message+="\n[ x<-5 and x>1.6]"
mylab.text=message

#equation of upper right curve:
mylab2=label(space=0.4,pos=(-5,8,0))
message2="(x**2-2*x+4)/(x-2),\n for 2.49<=x<=8"
message2+="\n[ x<2.49 and x>8]"
mylab2.text=message2

#Colors are beneficial to visual difference
# xy axes
x=curve(pos=[(-15,0,0),(15,0,0)],color=color.white)
label( text="X axis", space=0.2, pos=(15,0,0), opacity=0.5)
y=curve(pos=[(0,-15,0),(0,15,0)],color=color.white)
label( text="Y axis", space=0.2, pos=(0,15,0), opacity=0.5)

#scale of x axis (To set up the box label and to determine whether to show the frame
; the frame will not be shown if it is 0)
x1=curve(pos=[(2,0.5,0),(2,-0.5,0)],color=color.green)
label( text="2",space=0.2, pos=(2,-1,0), opacity=0, box=0)
x2=curve(pos=[(4,0.5,0),(4,-0.5,0)],color=color.green)
label( text="4",space=0.2, pos=(4,-1,0), opacity=0, box=0)
…
…

#scale of y axis
a=curve(pos=[(-0.5,2,0),(0.5,2,0)],color=color.green)
label( text="2", space=0.2, pos=(-1,2,0), opacity=0.5, box=0)
b=curve(pos=[(-0.5,4,0),(0.5,4,0)],color=color.green)
label( text="4", space=0.2, pos=(-1,4,0), opacity=0.5, box=0)
…
…
# The descriptions shown on the image can help learners understand the information
label( text="Vertical asympotoe:x=2", space=0.2, pos=(3,12,0), opacity=0.5, box=0, color=color.cyan)
…
```

…

The dynamic hyperbola, as developed by the program, is as shown in Fig.1:

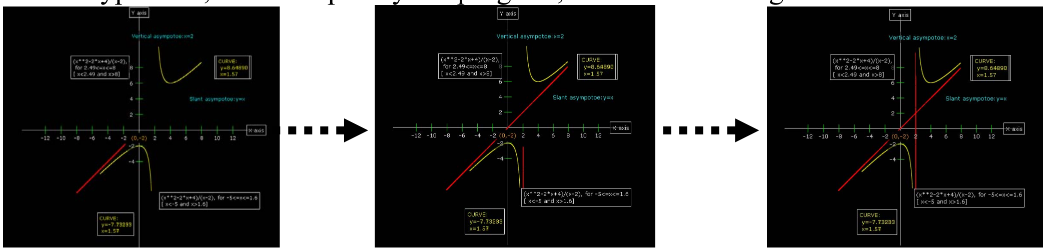

Fig. 1: Dynamic hyperbola, as developed by the program

4.1. Practical application

Using the example of ship positioning in sailing. Three to four launchers can jointly form a network of contact on the ocean. The signal received on the ship to be positioned can be used to measure the difference in time, based on when the radio signals of two different launchers are received, namely, the difference in distance between the ship and two launchers. The trajectory of the difference is a hyperbola. At least two hyperbolas can be obtained from different launchers, which can be used to calculate the location of the ship according to the intersection of two hyperbolas.

Moreover, the hyperbola is the largest curve bearing stress, and its nature can be applied to various architectures, such as the safety designs of bridges, tunnels, and reservoirs.

5. Conclusions

The development of the computer and its software technology and multimedia make it possible to solve complicated calculations and algorithms that could not be solved in the past. The integration forms a new technology called “mathematical technology,” which has gained enormous power in contemporary high-tech and social developments. Therefore, as said in the 1980s about the 20th century “People barely understand that the nature of the high tech they highly praise is mathematical technology” [10].

Calculation and simulation are the new research tool tends in the creation and development of new sub-disciplines. The “calculation obstacles” faced by many scientific and application analyses have been overcome due to the breakthroughs of high-speed computers and relevant calculation methods. Moreover, sub-disciplines, such as dynamic stock, real-time earnings analysis, computational dynamics, meteorological numerical prediction, etc. are developed. Through the collection and analysis of specific data, computer information, and the participation of decision-makers, it is possible to make the optimal choices for enterprises or organizational activities.

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