Basic Computer Teaching Research and Practice in Universities Based on Computational Thinking

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Keywords: Basic Computer Education; Computational Thinking; Teaching Iidea;Teaching Design; Teaching Pattern

Abstract. With the rapid development and extensive application of information technology, basic computer education in universities is facing severe challenges. In this paper, we analysed the reason why computational thinking was introduced to basic computer teaching in universities.We proposed a targeted teaching idea based on computational thinking, elaborated the implementation of basic computer teaching reform in teaching design and teaching pattern.The teaching results show that basic computer teaching based on computational thinking is a more effective way to improve quality of teaching.

Introduction

Non-computer professional computer basic education relates directly to cultivation talents of all-round development,spirit of Innovation and ability of practice[1].In recent years,with the rapid development and the extensive application of information technology,the social informatization is further developed unceasingly and deeply,information technology is more and more integrated into all walks of life,teaching and research to universities.Non-computer professional computer level is in an increasingly high demand,so basic computer education on universit non-computer-majors is.Meanwhile,the education has changed very substantially with many new problems, consequently,the education is facing more serious challenges,which highlights as follows.

- The Ambiguous Orientation. The basic computer education doesn't have clear boundaries and close connection to high school information technology courses.
- Teaching Objectives Not Clear.The education specialize heavy knowledge and skill instruction, light thinking and ability raise
- Obsolete Teaching Content.The education lacks of modernity and attractivity.
- Single Teaching Means. Teacher-centered teaching and less classroom interaction is hard to stimulate undergraduates' interest in learning,and instructors lack of a sense of achievement.

Furthermore, With the development of times and social progress, after the 90s college freshmen have certain computer foundation generally. Education system and social needs of a variety of negative effects lead to college students' insufficient learning motivation, causing teaching main body to be more difficult to play a full role in studying. On the other hand,more university teachers' education concept and professional ability should be improved as soon as quickly.

In short,The poor teaching orientation, teaching objectives, teaching content, teaching means and other human factors together lead to poor teaching quality and effect,which will be difficult to meet the demand of society,specialty and undergraduates. So we have no choice but to carry out teaching reform.But how? The answer is that core mission of basic computer teaching is to cultivate and develop computational thinking ability[2].

Why Introduce Computational Thinking To Basic Computer Teaching?

A. What's Computational Thinking?

In March 2006, Professor Jeannette M. Wing, head of computer science department, Carnegie Mellon University(USA.) gave the definition of computational thinking in *Communications of the ACM*,which involves solving problems,designing systems, and understanding human behavior, by

drawing on the fundamental concepts to computer science. Computational thinking includes a range of mental tools that reflect the breadth of the field of computer science.Computational thinking is a fundamental skill for everyone, not just for computer scientists. To reading,writing, and arithmetic[3].

B. Why Introduce Computational Thinking to Basic Computer Teaching?

Basic computer teaching commonly use computer as the carrier and tool.Humans and computers are both processing information tools. In the development of the interaction of both, human has constantly been giving computer passion and wisdom,computer has continuously strengthening people's computing capability,the inseparable combination of both can greatly improve the efficiency and quality of people's thinking.

The emergence and popularity of computer has turned theory into reality of computational thinking.Since computational thinking is a common cognitive activity and a kind of universal skill and has penetrated into our study,work and life,we should be well thought of it and whether it's appropriate for basic computer teaching.

Over the years, we aren't fully aware of the importance and necessity of computational thinking to cultivate talents from a strategic height, Ignoring the inspiration of thoughts and the training of thinking[4]. Since computational thinking is a common cognitive activity and a kind of universal skill and has penetrated into our study,work and life.It is time to think of it and take full advantage of it.So, in order to deal with the challenge for the basic computer education,we must introduce the computational thinking concept to the teaching.

C. What's the Teaching Idea Based on Computational Thinking?

Through the teaching practice, the teaching idea based on computational thinking goes as follows.

- Confirm the teaching goal, put forward problems
- Set the scene or modeling,present problems
- Train the thought,analyze problems
- Draw the conclusion, summarize the rules
- Further applications, innovate thinking

The idea reflects that computational thinking makes the most of the fundamental concepts from computer science to put forward problems, present problems,solve problems,which is in accordance with the cognitive pattern from individual to general and from practice to theory,also with the transform rule of knowledge and theory, methods and skills,applications and literacy.

Implementing Basic Computer Teaching Based on Computational Thinking

The central task of basic computer teaching based on computational is to cultivate students thinking ability. we are conducting helpful research and trials in the teaching,and the teaching quality and effects have been improved to some extent.

"Analog Audio Digitization" is a key and difficult part in *Multimedia Technology and Application* course,let's take it for example to elaborate the teaching based on computational thinking.

A. Confirm the Teaching Goal, Put Forward Problems.

The teaching goal is to master the concept and the principle,and to solve practical problems finally.

The problem is analog audio digitization. To facilitate the teaching of it,we make use of the decomposition of thought from computational thinking to divide the problem into three subproblems,which is what's analog audio and digital audio? why to digitalize? How to digitalize?

B. Set the Scene or Modeling,Present Problem

To be honest, analog audio digitization is abstract and obscure.If we begin with the explanation of the problem without preamble, most students in the class must be completely confused.Here we set an intuitive scene which is a computer recording as follows.

After switching on the projector,opening sound,and running the Adobe Audition software application on your computer with a microphone,we ask a student,good at singing,to sing our university anthem, *A row of young poplars on our campus*,before the microphone.During this recording process,a piece of nice song signals are transformed into a series of digital waves by the

computer,which is intuitively showed all the students in the classroom by multimedia technology,who are deeply attracted by the scene and enjoy it too much.

After a moment,the analog audio digitization is finished.They have gained the perceptual knowledge,and then we will discuss a targeted thing.

C. Train the Thought,Analyze Problems

At the moment,students are eager for the truth behind the scenes.What a good sign!

1) What's analog audio and digital audio?

Analog audio is continuous audio in time and amplitude, as shown in the Figure 1(a). we hear voice and music in our life are all analog audio.

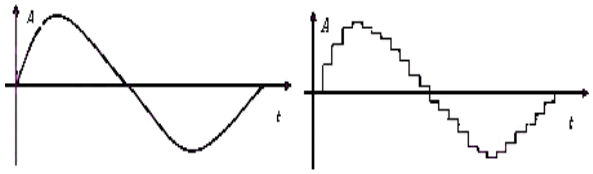

Figure 1. audio signals: (a) analog audio. (b) digital audio.

Compared with analog audio,digital audio is discrete audio in time and amplitude represented by binary numbers,as shown in the Figure 1(b).By the demonstration,the sound pick-up process to computer is just the switching process from analog to digital.

Just so you know,the switching process reduces the amount of data of the original analog audio,which can lead to quality distortion.Whether digitalization has the necessity and feasibility or not.It is the problem to be solved then.

Issue-driven approach teaching with tight logic is more helpful to cultivate the students' thinking ability.

2) Why to digitalize?

For human ear,analog audio is easy to receive sound.But every coin has two sides.,Analog audio signal processing has many disadvantages,such as poor anti-interference ability,being prone to distortion, non-facilitated long distance transmission,and so on.While storage,processing,and transmission of digital audio are not easy to distortion. As previously noted, Computers is an important tool for information processing,but only if data must be converted to digital form can data be identified,computed,and analyzed.So, digitalization is the foundation of the electronic digital computer,multimedia technology,even information age and information society.Today, digitalization shows strong vitality and development prospects.

In addition,does distortion caused by digitalization damage to quality severely? Speaking with facts,just play the recorded audio and listen to it carefully.The answer is No. By the interpretation of pro and con, critical thinking is being cultivated unconsciously.

Let's continue on our digital way.

3) How to digitalize?

With the progress of teaching, students' attention is highly concentrated.It's time to start our key part,which is the basic idea of audio digitalization.

Firstly,recall recording details just now,we set some parameters with Adobe Audition, as shown in the Figure 2,which includes *sampling frequency*(Sample Rate in the figure), *quantization bits* (Resolution)and *channels*.Secondly,the pricinple of the digitalization is that sound is converted into a series of electrical signals through a microphone to computer,the analog signals into digital form by D/A convertor on sound card, in which the key procedures are sampling, quantization and coding,what's more,the digital data is saved to a .wav format file on the hard disk by Adobe Audition.

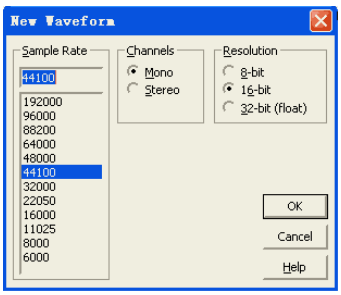

Figure 2. New Waveform

Finally,let's discuss the abstract concepts such as sampling, quantization and coding.

Sampling means collecting samples of the analog audio,a bridge between continuous-time signals and discrete-time signals,that is a sample from continuous signals is collected at a specified time interval(here for T_i),as shown in the Figure 3(a).Sampling rate is represented by sampling frequency,unit for Hz,for example,44.1kHz mentioned above means collecting 44,100 samples per second.Obviously,the greater sampling frequency,the more samples collected,the less distortion and the better quality to recovered.The frequently-used sampling frequency is for 11.025kHz,22.05kHz,and 44.1kHz.After sampling process,the continuous-time signals become discrete on the timeline.

Quantization means mapping continuous amplitude values into a set of discrete values, as shown in the Figure 3(b).Quantization bits represent the step size of quantization,that is 2^n,n as quantization bits,unit for bit,give an example,16 bit mentioned above means the amplitude values can be divided into 2^{16} discrete values.Apparently,the greater quantization bits,the more data quantity and the better quality to recovered. The frequently-used quantization bits are 8bit and16bit.After quantization process, the continuous-amplitude signals become discrete,and also discrete on the timeline by sampling already.

Coding means converting each quantized value into a digit,commonly uses binary number,0 or 1, as shown in the Figure 3(b).

Here,analog audio is really converted into digital audio.

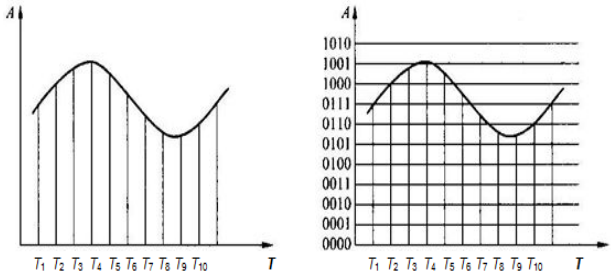

Figure 3. digitalization: (a) sampling. (b) quantization and coding.

D. *Draw the conclusion, summarize the rules*

Through the above analysis,we can draw the conclusion that the audio digitization must be needed three processes such as sampling,quantization and coding,as shown in the Figure 4, the continuous-time signals become discrete on the timeline by sampling, the continuous-amplitude signals become discrete on the amplitude-line by quantization, binary coding converts the discrete amplitude value into a binary sequence values.

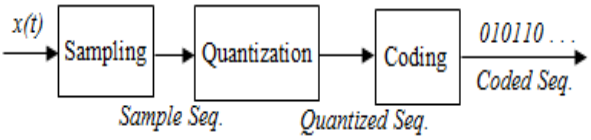

Figure 4. Analog audio digitization process

Let's recall the digitalization processing,we can also say the process that analog audio is collected or recorded to computer is the digitization process.Here we still have a digitization video to help students to come to a better understanding and thinking.

E. Further applications, innovate thinking

Although we have accomplished the teaching task according to the teaching goal,in order to broaden students' horizons,expand their application,innovate their thinking,we'd better keep on moving to solve more intelligent problems.

Therefore, teachers should reform the traditional teaching pattern and methods in order to better fulfill the teaching tasks and improve students' overall thinking ability.

1) Why 44.1kHz?

In the process of setting the sampling frequency parameter,some attentive student already noted the detail and expressed doubt.Indeed,it's a worthy question to explore.

It's well known that humans can listen to the sound waves with frequency bandwidth from 20Hz to 20kHz. According to the Nyquist sampling theorem,during the analog-to-digital converting process,when sampling frequency,f_s, is greater than 2 times of maximum frequency,f_{max},that is $f_s >= 2 f_{max}$,digital signals after sampling can fully retain the original information[5].Therefore, theoretically 40kHz,why 44.1kHz?Here is an interesting story,hard disk was more expensive before CD invention, The digital audio signal is usually stored in the videotape,with 30 piece per second,490 line per piece,and 3 sampling signals per line,so all the signals add up to 44,100(30*490*3),and then CD took advantage of the standard for the sake of development,This is the reason why 44.1kHz came from[6].

Through heuristic teaching, we can guide students to develop the habit of exploring the truth behind the curtain.

2) How about the size of digital audio?

After having qualitative understanding the digital audio,we should learn about a clear quantitative knowledge of it,the size of .wav format audio file.Besides,we can also come to a better understanding the important concept,sampling frequency,quantization bits,and channels.

The .wav file size depends on above-mention parameters and the time length of a file.Supposing sampling frequency equal 44.1kHz,quantization bits 16bit,channels 2,but the time length is the actual value,228 second.The .wav file size as follows.

44100Hz/sec.*16bit*2*228sec./8/1024/1024≈38.36MB

Just as you see,it is less than 4 minutes, but approximately 40MB,which poses a big pressure on data storage,processing,transmission.How to deal with this?It will come to involve another important question,audio data compression.

In this way, This is a chain effect,which will lead students to go further and further in to their search for knowledge.

3) Audio data compression

So far,you have correctly understood the the necessities of data compression,how about the feasibility of it?

we can begin to discuss the topic from generally familiar with mp3 player to .mp3 format file,generate this kind of file with *Save as* command in Adobe Audition immediately,the file size is less than 4MB,one tenth of .wav file.Effects?Let's play the .mp3 file and listen to it carefully.Once more with .wav file.No one can tell the difference from both files.Facts speak louder than words. We should strike while the iron is hot to talk about why .mp3 is so powerful?On one hand, there is usually a large amount of redundancy in the audio data,On the other hand,The human ear is not sensitive to certain distortion,so we can do the lossless and lossy compression,what's more important,it is necessary to make lossy compression.

The abstract,boring teaching content becomes vivid and interesting.Like this,we can learn about knowledge in the training of the thinking.

4) From theory to practice

For education,the ultimate goal of learning knowledge,developing skills and training thinking is to solve actual problems.

After mastering audio digitalization,you should also know the reason why we can hear music played by computer is through digtal-to-analog conversion.

Based on what you have learnt about,can you try the following questions?

How about widely used IP telephone?

What's the commonalities between audio and image digitalization?

Why .mp3pro is better than .mp3?

…
Of course,you shoud be permitted to have access to information after class.
Certainly,we believe you can.

Conclusion

The essence of computational thinking is thinking about data and ideas, and using and combining these resources to solve problems. Teachers can encourage students to “think computationally” by moving technology projects beyond “using” tools and information toward “creating” tools and information[7].

Combined with our teaching practice,basic computer course should be the most dynamic and attractive one of all university courses,so the teaching should be meet the demand of rapid development and the extensive application of information technology.For this, we must deeply explore computational thinking and apply it to the teaching,innovate the teaching pattern, improve the teaching quality and effect, cultivate students thinking ability in the teaching practice.

Acknowledgment

The author would like to thank Communication University of China for supporting this work.

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