

Musical Method in Programming Education

Takeo Tatsumi, tttt@cc.tuat.ac.jp

Information Media Center, Tokyo University of Agriculture and Technology

Mitaro Namiki, namiki@cc.tuat.ac.jp

Graduate School of Technology Management, Tokyo University of Agriculture and Technology

Abstract

To learn computer programming language(CPL), student must learn many terms, definitions, syntaxes and semantics. For young pupils/students, there are too many elements to learn CPL. That is why the number of students who are learning CPL in K12 is on the decrease worldwide.

August 1998, Tatsumi, first author, pointed out that there are many similarities between learning musical scores and learning CPL. There are many typical structures in music. For example, the notion of correct sequences of notes in several measures, a branching several forms of notes by visiting times.

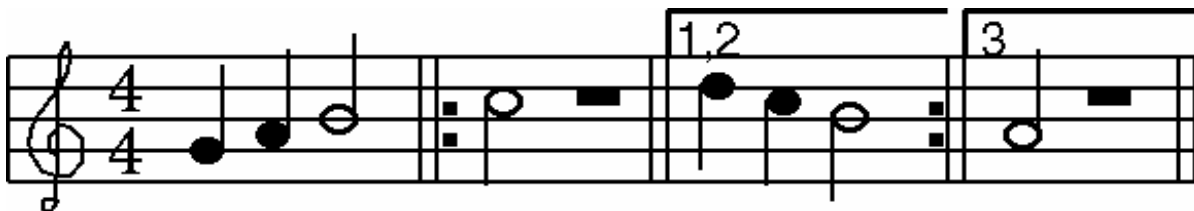


Figure 1: playing different measures by visiting times

This example is good to explain of the similarities of musical score and computer program. Also, "Tripartite form: A-B-A", "Rond form: A-A-B-A", "Sonata form: proposal, disclosure, re-propose." Students will know that any computer can read only the script he/she wrote. So our proposal is that musical method in education of CPL must be included to teach programming for music teachers and to teach musical script for ICT teachers. We think that music is good educational subject for scripting education in K12. The reason is as follows: 1. Music is independent from another educational subject, 2. Student can find a bug in the score in playing, 3. Music includes almost technique in computer programming, 4. Music is joyful for study.

October 2001, he proposed the musical method for learning CPL. His method can be one of helpful methods in learning CPL.

Dolittle is a name of a programming language and integrated tools. Dolittle project is organized by Prof. Kanemune, Prof. Kuno and their group from 2000. First implementation of Dolittle has only Turtle Graphics commands, controls. So many researchers think Dolittle as some Japanese version of Logo. However, the syntax of Dolittle based on OOP(Object Oriented Programming) style which is different style of Logo. Namiki, second author, made some contributed works to Dolittle project from 2002. November 2003, Tatsumi got a post of associate professor in TUAT to which Namiki belong. We started collaborated research.

September 2005, we proposed many specifications for Dolittle project. In this paper, We describe why musical method is effective in a class of learning CPL. We proposed adding many musical terms to Dolittle.

Keywords

computer programming education, music

Education of Computer Programming Language

For these years, the development of Information and Communication Technology (ICT) is changing our daily life and the way of thinking. Education is affected too. Many teachers and students seek good efficiency in their classes using ICT in education. In many researches and reports, many people confuse "ICT education" with "education using ICT". These concepts must be distinguished. Although "education using ICT" is important, "ICT education" is important too. In Japan, many teachers of K12 think little of education of "Computer Programming Language (CPL)". In many classes of CPL, teacher like to set a goal too high. The textbook of CPL is too difficult for beginner. Many lectures of CPL are tedious because the teacher of CPL has no experience in entertainment of art, music and sports. In this situation, there are many experiments to break through. Some experiments are in successes and some are in fail.

Music education using ICT

Some result of music education using ICT

In BBC's web page, the article about class of music by Mr Adrian Pitts who is music teacher of England.

Computers are playing an increasing role in music, especially in secondary schools. Now software can enable students to compose and arrange music and develop their musical creativity, even when they can't play an instrument. But provision is patchy and can depend upon the enthusiasm of your child's music teacher.

When used appropriately ICT can deepen pupils' understanding of music without being reliant on the pupil's physical ability to perform the music written

Students made the best use of ICT when they had been taught the building blocks needed to compose. Musical software alone was not enough to ensure success

In a class of music, students learn how to sing a song, how to play musical instruments and how to read musical scores. In recent years, music education are changed by many computers and networks. Before this change, student had to use pencil or pen to take down in musical notation. Student had to count numbers to check correctness of their rhythm. Student had to play many musical instruments to adjust the harmony of their music. After this changing, composer software play the great role in the field of music education. Student use composer softwares to compose, edit, check and play their score. It is easier way than old way of composing. Many music teacher got an easier way to write down a practice sequence for their students.

Application of ICT for another school subjects

In this section, We describe the school subject of "Information" and the application of ICT education for another school subjects.

School subject of ICT in Japanese high school

In Japan, the Ministry of Education decided the national regulation of K12 schools. After 2003, "Information" is listed as a name of school subject of Japanese high school. In many countries, there is no school subject on "Information and Communication Technology" independently. In stead of "Information", many countries set the regulations of many school subjects including computers and networks technologies.

Application of another school subjects

Also in Japan, besides teachers of “information”, many teachers of many school subjects use computers and networks in teaching their own classes.

For example, some teacher teach mathematical geometry using computer graphics application software. Some teacher teach dynamics using computer simulation software. Some teacher teach Japanese language using word processor software. In this paper, I define the such improvement of the school subject as "Informationalization".

Teacher of another school subject can teach computer programming. For example, teacher can teach making a program of sweeping any matrix. Teacher can teach making a program of simulating the rule of genetics. Teacher can teach making a program of estimating the national population.

The aim of a school subject does not involve the aim of another subject.

As I wrote above, the aim of another school subjects does not involve the aim of ICT. Mathematics teachers want to teach not programming but mathematics. Physics teachers want to teach not programming but physics. If a teacher want to teach programming, then he/she must put his/her goal in ICT education.

If a teacher of ICT want to teach programming relating another school subjects, then he/she would use the methods of these school subjects. So, August 1998, Tatsumi thought of the musical methods to teach computer programming. The goal of this method is in not music but ICT.

Musical Method in ICT education

In 1998, Tatsumi talked about “Musical Method in ICT Education” at “Joho-Kagaku Wakate no kai” (Young researchers annual forum on Informatics) about this similarities. Musical scores are written using some rules: repeating, jumping, skipping and other controls. These rules are also used in a programming language. So understanding these musical rules can help to read computer program. That is why musical method is good candidate to develop new method of learning CPL. October 2001, Tatsumi wrote the paper titled as “Musical method in ICT Education” and he posted proposals for several grants. However, all proposals were rejected. Because Tatsumi do not know the name who writes codes using MIDI and understand the project meaning, Tatsumi has paused this project after 2003.

Dolittle - from birth to v1.24

In 2000, Prof. Kanemune who was researching educational programming language (EPL) has developed "Dolittle". Many teachers might think that Dolittle look like Logo because Dolittle adopt Turtle Graphics. Dolittle is designed in object oriented programming (OOP) structure. The language specification of Dolittle allows multiple definition using natural language like Japanese, Korean, and English. For example, you can use Japanese words and Kanji characters in Dolittle to write a program which is composable using English words. Prof. Kanemune and Prof. Kuno developed Dolittle in cooperation and several Japanese teachers of K12 joined the project of Dolittle. They had many experimental class in elementary schools, junior high schools, high schools and universities. They added many functions to Dolittle. Displaying characters, operation of robot and communication via network. June 2004, Dolittle got new function of playing simple melody. Students have been able to control MIDI device using new Dolittle. However Prof. Kanemune has added new function thinking the structure of MIDI specification. So, Dolittle had some strange grammar in playing music.

Rendez-Vous avec Dolittle - after v1.25

Tatsumi has deeply studied "Music education using ICT" and "ICT education using Music" from 1998. Namiki is a professor of TUAT(Tokyo University of Agriculture and Technology) from 1993. October 2003, Tatsumi moved to TUAT. Then our collaborated work has started. Namiki

is a researcher of computer operating software and system software. Namiki also related the project of Dolittle. Tatsumi was invited to Dolittle project 2004. September 2005, Tatsumi tried to make manuscript of the textbook of musical method which can be used in the class of Dolittle. Then, Tatsumi noticed which terms in Dolittle are inadequate for music. So, Tatsumi proposed new grammar and specification to include adequate musical terms into Dolittle. Prof. Kanemune added new code of Dolittle interpreter. November 2005, Dolittle v1.25 was born. New Dolittle was used at Oyumino elementary school in Chiba city, Japan. To control musical devices for pupils, it was easier new Dolittle than old one.

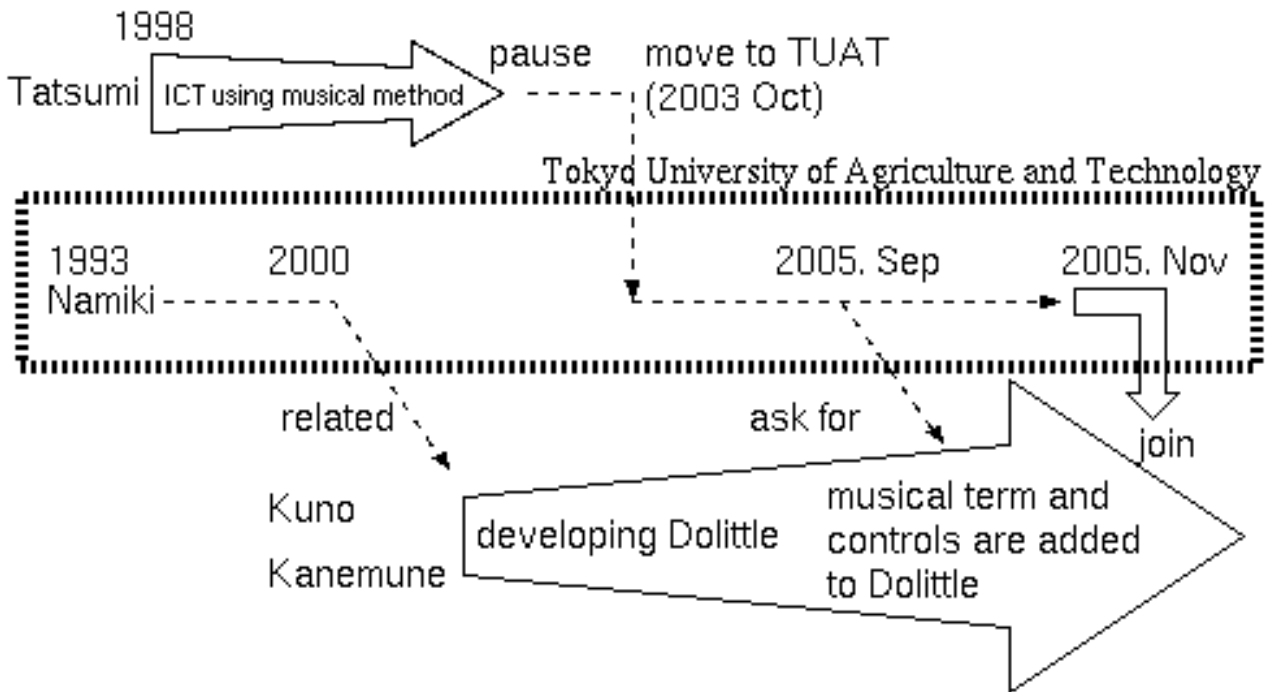


Figure 2: The history of our projects

Should programming be included or not?

After 1990's, in Japan, there were many discussions about the adoption of K12 subject programming. Keyboard typing, mouse handling, word processing, spreadsheet, presentation, e-mail, web, media literacy, ethics, copyright. Which subject have priority? Or, what subject have priority? Also there were many discussions about the adoption of programming as K12 subject. October 2005, Japanese universities and high schools teachers discussed about this topic on IPSJ symposium "now and future of high school ICT education."

The goal of ICT education

The committee in the ministry of education whose goal is researching the plan of ICT education of K12 reported "For the future ICT education in structural curriculum." The report said the goals of ICT education are put in three sections. First is "literacy of information", second is "understanding information with science method", and third is "behaviour in participating informationalized society."

IPSJ's project

Many researchers of computer science and computer technologies think "understanding computer's conduct" is helpful for achievement of three goals. For example, computer architecture, mathematical rules of computing, computer software, and the role of protocol



Figure 4: repeat notes

repeats within few measures



Figure 5: repeat in two measures

jump to the starting point and stop.

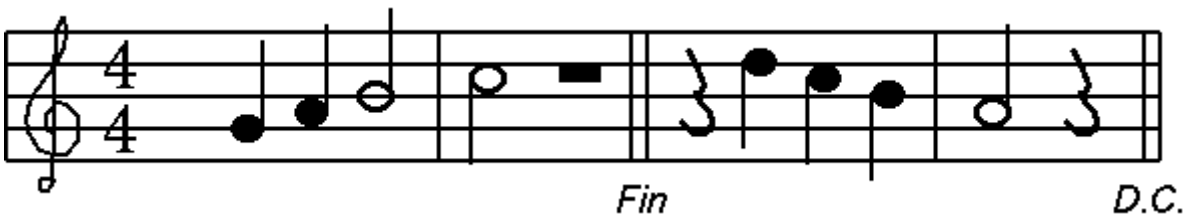


Figure 5: D.C. and Fin. Jump to starting point and stop.

branching some forms of notes by visiting times.

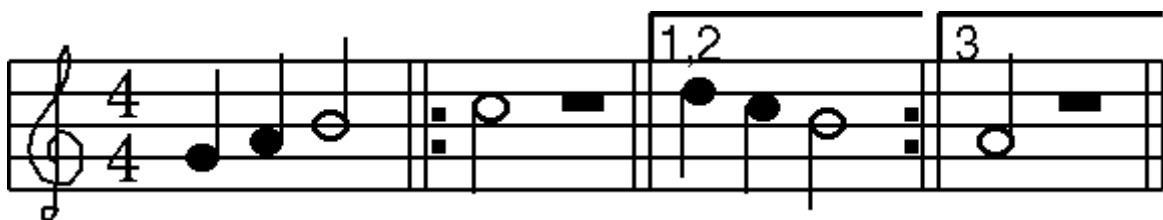


Figure 7: playing different measures by visiting times

Macro structures of Music/Score

1. Tripartite form, for example
 - A-B-A
 - A-B-A-C-D-C-A-B-A
2. Rond form, for example
 - A-A-B-A'
 - A-B-A-C-A-B-A-C'

- A-B-A-C-A-C'
 - A-B-A-C-A-D-A
3. Sonata form, for example
- proposal: 1st theme - bridge - 2nd theme
 - disclosure: varieties of main theme
 - re-propose: 1st theme - bridge - 2nd theme - fin.

You can find "repeat in score" as follows.

- essential in playing
- D.C. and Fin.
- D.S. and Coda

Synchronizations in Score is appear in

- harmony in a code
- many instruments
- lyrics and music

What is important for education of scripting?

We think that understanding the structure of scripting/programming is important because musical score system involve many controls. Students will know that any computer read only the script you wrote. So our proposal is that musical method in education of CPL must be included to teach programming for music teachers and to teach musical scripts for ICT teachers.

Dolittle programs for music

In this section, we describe the music specification in Dolittle.

Turtle Object

A typical program of Dolittle is shown as follows.

```
Crush = Turtle ! create.
Crush 100 forward.
```

Basic style of Dolittle programming is:

1. create object and name/nominate object
2. send a message to the object

Melody Object

Old version of Dolittle has several object name. Melody object is used as follows.

```
Twinkle = Melody ! create.
Twinkle ! "DO DO SO SO RA RA SO -" add.
MyInstrument = Instrument ! "Piano" create.
MyInstrument = (Twinkle) ! set.
Instrument ! Play.
```

In first line, create melody object and name "Twinkle". Add short melody to the object and, play the melody.

Reputation

```
'Score ! "DO DO SO SO RA RA SO -" add.' ! 2 repeat.
```

Control

```
x = 1.
'
  if 'x == 1' ! then
```

```
Score ! "FA FA MI MI" add.  
else  
Score ! "RA SO FA MI" add.  
do.  
x = x + 1.  
'Score ! "RE RE DO -" add.'  
' ! 2 repeat.
```

The definition of melody

In music subject, there are three types of melody.

- very short melody motif
- short melody phrase, theme
- long melody Score

In old Dolittle, there were confusions of the definition of 'melody'.

Description of Player(s)

In old Dolittle, there are few strange usages in description of music player(s).

1. Score created as melody
2. set score to instrument(s).
3. send 'play' message to instrument(s)

For example, in old Dolittle, you will wrote,

```
MyInstrument=instrument! "Piano" create.  
instrument ! play.
```

So we propose new usage.

1. Score created as melody
2. set score to MyInstrument
3. send 'play' message to MyInstrument

```
MyInstrument=instrument ! "Piano" create.  
MyInstrument ! play.
```

Synchronization

Old Dolittle had a waiting function for only the timer waiting. Student can not write a program using synchronization between music and display. We proposed a waiting function for the end of playing the part of score. Using new Dolittle, you can make "Dolittle KARAOKE" in synchronized lyrics and playing.

Experiences in schools

We had two experiences in real school. First one is at a elementary school in Chiba city held by Mr. Sato, Mr. Nishigaya, Mr. Aoki, Mr. Kurabayashi and Mr. Hara. Second one is at a junior high school in Matsusaka city held by Mr. Idosaka, Mr. Kuno, and Mr. Kanemune. Using old Dolittle, pupil must write at least five lines and that was difficult for them.

```
Twinkle=melody ! create.  
Twinkle ! "DO DO SO SO RA RA SO - " add.  
MyInstrument=instrument ! "Piano" create.  
MyInstrument ! ( Twinkle ) set.  
instrument ! play.
```

Example 1 of New Dolittle

Using new Dolittle, pupil can write only one line to complete score.

```
MyInstrument!" Piano" create
"DO DO SO SO RA RA SO -" add play.
```

In this exercise, all pupils wrote musical score in Dolittle.

Example 2 of New Dolittle

Control and Reputation are treated as follows.

```
Twinkle = melody !create.
Twinkle ! "DO DO SO SO RA RA SO -" add.
Twinkle ! "FA FA MI MI RE RE DO -" add.
Twinkle ! "DO DO SO SO RA RA SO -" add.
Twinkle ! "RA SO FA MI RE RE DO -" add.
Twinkle ! "DO DO SO SO RA RA SO -" add.
Twinkle ! "FA FA MI MI RE RE DO -" add.
Twinkle ! play.
```

convert to

```
MyScore = melody !create.
x=1.
'|x|
MyScore ! "DO DO SO SO RA RA SO-" add.
'x==1'!
    then 'MyScore ! "FA FA MI MI" add.'
    else 'MyScore ! "RA SO FA MI" add.' do.
    x=x+1.
MyScore ! "RE RE DO -" add.
' ! 3 repeat.
MyScore ! play.
```

Example 3 of New Dolittle

In this program, pupils had understood the concept of "array" and the randomizing function.

```
Okinawa-scale = array ! create.
Okinawa-scale ! "Do" insert
    "MI" insert
    "FA" insert
    "SO" insert
    "SI" insert.
my-score=melody !create.
'my-score
    ! ( Okinawa scale ! (random(5)) look-up) added' ! 16 repeat.
```

After experiments

After this experiments, some girl pupil became enthusiastic in programming after musical method. And few girl pupils answered "I like musical method." Musical method seems to be better for girl students than boy students.

Conclusion

In this paper, we described these topics.

1. Education of CPL is important for K12 students to fill the gap in school and social skills.

2. Musical method in ICT has good properties for K12 which is joyful, easy to verify, structural - continues, control, repeat, synchronization.
3. Dolittle is good CPL for ALL beginner students.
4. New Dolittle is designed for musical method programming
5. Tested result shown that all pupils can script score. Some girl pupils became to like programming after musical method.

Planning next examination

We and my co-researchers are now conducting the plan of musical method of ICT education in this school year with helping the grant by YAMAHA Music Foundation. In this examination, we will prepare some placement tests, questionnaires and post tests.

References

- TATSUMI Takeo and Kakehi Katsuhiko. (1998) *What subject of EPL should be taught in high school(In Japanese)*, In the proceedings of IPSJ Summer Programming symposium, pp.55-66.
- TATSUMI Takeo. (2001) *Musical Method in ICT education(In Japanese)*, In the proceedings of IPSJ research report on Computer and Education, Vol.2001,No.101, 2001-CE-61, pp.39-46
- Adrian Pitts. (2001) *How computers can help children learn music*. In the web article of Computers & Music in Schools, Parents' Music Room, on BBC.CO.UK.