Extended Abstract

KETCindy – supporting tool to convert students' findings into knowledge in collegiate mathematics education

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Introduction

In this technological era, various ICT tools are used to help students' learning. In case of collegiate mathematics education, the typical tools are Computer Algebra Systems (CAS) and Dynamic Geometry Software (DGS). By using them, students can have rich experiences concerning mathematical facts and mechanisms. Some of these systems are usable not only on PCs but also on iPads or tablets, which seems to make students' learning much more effective. The following picture shows one scene of using Cinderella, one of the most popular DGS, in mathematics classroom.

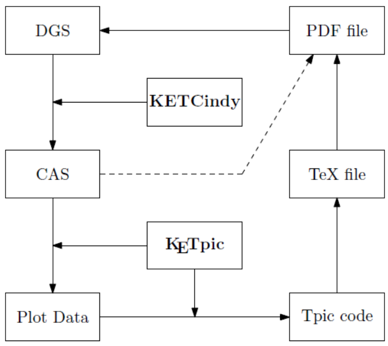
Figure 1. Use of Cinderella in mathematics classroom

Though the experimental and interactive learning with these systems should enable students to learn by experience, it is also necessary to prepare some facilities to ensure close linkage to paper and pencil based learning in order to convert the students' findings into their established knowledge (as shown in the above picture). Since TeX is one of the most popular tools to edit printed teaching materials in collegiate mathematics education [1], we developed KETpic, a macro package for some CASs (Maple, Mathematica, Scilab, etc.), and KETCindy, a macro package for Cinderella, to convert the graphical outputs of these software into TeX graphics code. They are freely downloadable at http://ketpic.com. In this presentation, we will show some effective samples produced with KETCindy and the procedure to generate them.

Methods and Results

The procedure to generate final TeX (PDF) output with high-quality graphics is summarized in the diagram of Figure 2 (KETCindy cycle).

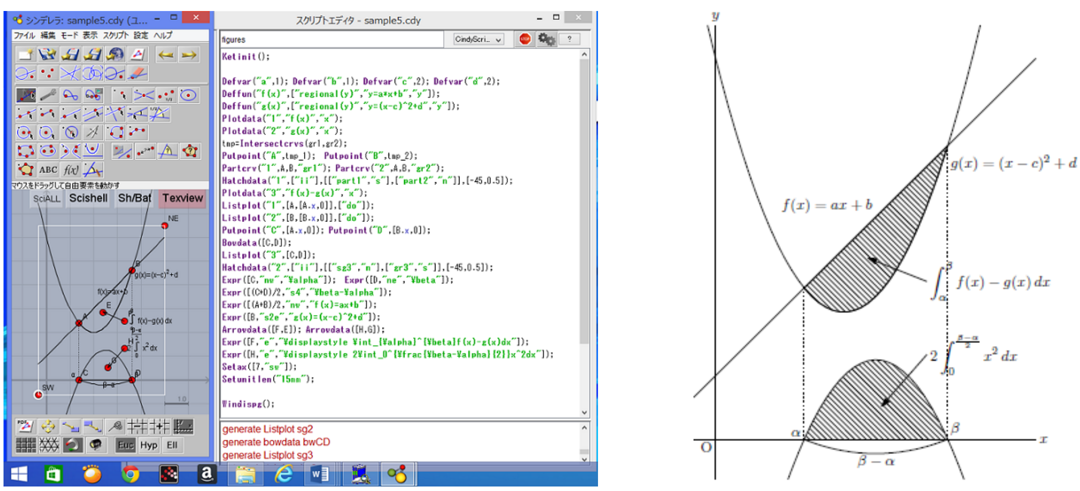
Figure 2. KETCindy cycle



Once KETCindy is loaded, users are requested simply to execute commands in Cindyscript (the scripting language for Cinderella) in order to plot mathematical data. Cinderella-embedded KETCindy commands generate additional TeX source code and files (with the aid of Scilab-KETpic procedure), which are subsequently compiled in TeX in the usual manner. These Scilab and TeX procedures can be executed through simple batch processing (as shown with dashed arrow). If you find any points to be corrected in the final PDF output, you only need to modify the commands in the Cindyscript file.

For example, materials in Figure 3 were used to explain the background of some formula in the integration of quadratic functions.

Figure 3. Material generated with KETCindy



When the former figure on Cinderella screen is displayed, the functions *f(x)* and *g(x)* can be modified interactively. Through such "experiments", students can understand that the background mechanism of the formula is valid in any case. Also by using the latter figure on PDF printed output, students can deduce the precise formula through paper and pencil based calculations. The important points are that

(1) The figure on Cinderella screen and that on PDF output are completely the same.
(2) The modification of the former figure can be directly reflected to the latter figure.
(3) Students can use the printed material containing the process of their calculations and deductions in classroom also after school repeatedly.

Though some facilities to make effective linkage between algebraic computation capabilities and interactive graphics capabilities on PCs or tablets have been developed [2], there still remain some risks that students' understandings become only transient, especially in case of collegiate education. KETCindy should serve as a powerful tool to convert their findings into their established knowledge. Because only half a year has passed since the development of KETCindy started, there were not so many opportunities that its products are used in real classrooms. The authors are planning to execute many experimental lessons using KETCindy outputs in near future.

Conclusions

Using interactive graphics capabilities of DGS, many attractive teaching materials have been produced [3]. It seems that the aim of using those materials is to inspire students' interest to mathematical facts and mechanisms through experimental approaches. Static graphics generated on printed teaching materials should play another role in mathematics education. They help students to convert the information they obtained through various channels into their established knowledge by paper and pencil based activities. The materials produced by using KETCindy enable students to access both types of resources simultaneously. Therefore, KETCindy should have a great possibility to provide completely new type of teaching materials. The authors will try to provide such new kind of materials and share them with wide range of educational researchers and teachers through many channels as listed in [3].

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References and Notes

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