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On the Use of Computer Algebra Systems in Mathematics Education

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30.1 Network in mathematics education

The Internet is booming currently as mathematics education in Japan. However, it is still at the beginning stage when it comes to using it for school education, especially to meet each level required in elementary school, junior high or senior high schools. We are attempting to find its efficient use. There have been few practices of Internet reported of its school education use, much less we have hardly heard about how effective it worked. Yet, its infrastructure is being constructed at a great speed. In no distant future, or in the very near future to come, we will have to seriously consider the efficient use of Internet. Now, let us shift the focus to mathematics education. It is not our purpose to teach how to use the Internet. Our task is to give knowledge of mathematics to students and let them do mathematics.

Well, we will summarize what we can do with the Internet.

1. telnet

This system enables us to use a distant computer. By using this, you can operate any computer in the world under the Internet and long distance operation is made possible.

2. News

Using the Internet, you can not only be the receiver of the information but can also be the sender of news. There is a variety of exchange of information received or sent, such as opinions, questions, gossips, jokes, data and programs.

3. WWW

WWW is one of the excellent futures mentions when they introduce Internet on TV. Using this system, you can easily receive or send multi-media informations such as texts, figures, photos, sound and voice or images. Pictures or menus appear on the screen. When you click them with a mouse, you can get linked information one after another.

4. FTP

This system enables you to get from the site such data as papers and programs.

30.2 Computer algebra systems in mathematics education

Great importance is attached to education, particularly teaching mathematics, to meet future needs. It is 'efficient use of computer algebra' in mathematics education. In teaching mathematics, there are two important aims:

- Understanding the mathematical knowledges and concepts.
- Understanding the mathematical thoughts for problem-solving process.

We must consider 'efficient use of computer algebra in teaching mathematics' on the above two aims. The most attention is paid to keep the students' attitude of positive participation, and to support the active study. Needless to say, the educational activity is not a routine.

Efficient use of computer algebra gives the traditional education the innovative and qualitative changes which include the revision of educational materials and/or enhancement of lecture style. Computer algebra systems enable us to do mathematics using computer.

30.3 Styles of the computer users

The styles of computer users, a rough design of class may be drawn as follows.

(I) Situation lead by teacher

(II) Situation lead by student

In the near future, the computer softwares for the educational use can be classified into these categories. (I) is the situation in which computer is used as the presentation tool for teachers. For example, teachers will give graphs of functions or various curves as suitable materials in this situation. It is necessary to research how to give the educational materials.

In the situation(II), the students utilize the computers as the tools for their thinking. They are able to inquire mathematical facts and find them. The use of computer algebra systems is efficient enough in these situations. In general, certain application software packages are usable as the tools for the students' thinking. However, it must not be ignored that these programming languages or application software are not designed to aim at the use of mathematical education. They are designed for the education of computer science, software development, or use in an office.

To make the use of computer algebra systems in these situations efficient enough, the further research on educational user-interface is expected.

The use of computer algebra systems is the test plans to design the class. It is based on the principle which says that the desirable change of mathematical education is from traditional one-sided lecture with a blackboard to students' activity supported by computer algebra systems. Several approaches by using computer algebra systems are necessary to give the well-selected exercises which make the students confirm the materials in various ways.

30.4 The use of computer algebra systems under the network

There are few computers in the classrooms of Japanese schools on which one can run computer algebra systems efficiently. So enabling students to access the workstations via a computer network would provide them with a better opportunity to use computer algebra systems efficiently.

Then computer algebra systems was used as a creative tool for conjecturing and finding. Students can search geometry on the basis of direct and repeated experience, assimilate geometrical concepts, and acquire a positive attitude toward the geometrical world. Moreover, if it is used under proper guidance, it will be a good tool for encouraging students to think mathematically. This example comes under the above situation (II).

The usage of the software may be facilitated by the enhancement of user interface. In particular, input interface of computer algebra systems is not useful for educational activity.

We should construct the ftp site of educational programs for the computer algebra systems which are created by teachers and students. This site can be used for the development of teaching

materials. We developed the educational materials (mathematica programs). Now, as experimental attempt, they were put in anonymous ftp site([IPR:133.30.130.1]).

Mathematica is a sophisticated software package designed for use in mathematical education. Students manipulate figures and mathematical information related to them interactively. With these good user-interfaces designed for educational use, students can enjoy manipulating constrained mathematical concept, and can clarify or correct their own ideals through practical activities.

The efficient use of computer algebra systems expects the students to discover, to think and to confirm the contents of lesson through their experimental activity. After the individual exploration, it is effective to give the students an opportunity to report or to discuss their discoveries with each other.

30.5 Conclusion

The use of computer algebra systems in mathematics education will be a very effective way of changing current mathematical classes into the ones that allow students to assimilate mathematical concepts through their own directed and repeated experience. The learning activity of the students supported by computer algebra systems should supersede the traditional one-sided lecture. To approach the ideal use of computer algebra systems, it is necessary to study the way to integrate the various uncoordinated attempts into an integrated learning system. However, as the efficient use of computer algebra systems has already shown, the focus of the lesson should move to the students' activity supported by computer. There is a lack of good computer algebra systems that provide easy-to-use educational (input) interface.

We would like to stress here that in using computer algebra systems the knowledge of mathematics is much required. It has become more important than ever what to teach at what stage when you apply the system in mathematics education.

We are now in the era of new technology and mathematics education or to speak broadly, mathematical science education is changing and must change. Computer algebra systems and network hold the key to the innovation in mathematics education.