Twenty-One Things to Do with Scratch in the Twenty-First Century Classroom

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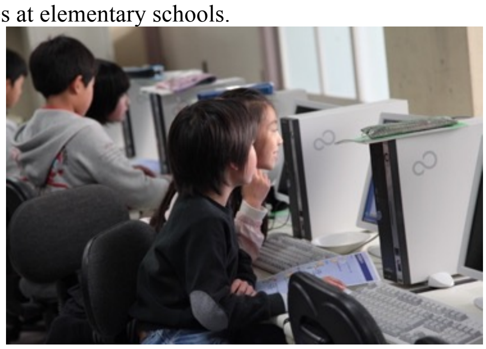
Introduction

Globally, programming education for children is receiving widespread attention as a part of twenty-first century skills. Learning programming is not just about learning to code, but it also helps children learn how to learn. However, unlike traditional classes where students mostly learn from teachers' teaching, learning through programing (in a broad sense, "making") needs to be approached differently. To make programming education more successful in elementary school classrooms, students must be self-learners, and moreover, teachers need to encourage students to be self-learners by acting as facilitators, mentors, or peers (and occasionally as teachers). Classrooms have many physical limitations, and school curricula, especially elementary school curricula, have even more limitations, such as time and subjects. How can we introduce programming and making to twenty-first century classrooms?

Upon its publication, "Twenty things to do with a computer" (Papert & Solomon 1971) impacted both teachers and researchers. In this paper, I will share twenty-one things that I have been doing with Scratch and the tiny programmable computer "Cricket," invented by MIT Media Lab, in Japanese elementary school classrooms to maximize students' learning through making, in over 700 hours of classes for 15 years.

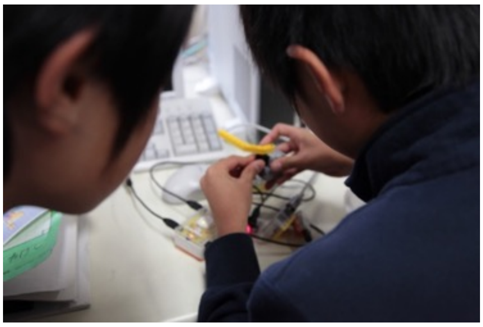
21 Things to Do with Scratch or Other Programming Tools in the Classroom

Making is an extremely playful activity for students. While it is most important to have fun while engaging in these activities, it is also necessary to have structures to ensure that students do not spend their time in class just by having fun. Below are the items that I consider when I design and run classes at elementary schools.



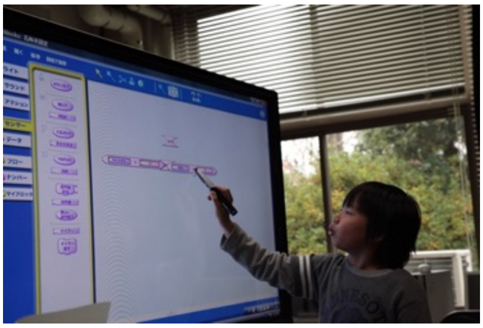
1. Become Professionals

To learn through making, it is necessary to become active learners rather than passive learners. Encouraging students to become professionals or experts, such as inventors, designers, and researchers, makes it easier for them to find personal meanings in activities. When students have their own meaningful purposes, it becomes easy to find their way back when they get lost while tinkering with and exploring activities.



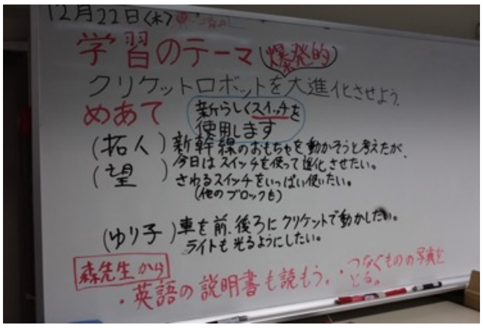
2. Make Students Small Teachers and Teachers Big Students

Encouraging students to be small teachers and actively helping other students who are facing difficulty with making is a good way to run classes. In making activities, various problems arise, as many as the number of students. Solving problems by themselves is a learning for students, but when they are faced with problems that cannot be solved by themselves, adequate advice from experts, including teachers and other students who understand the problem well, is needed at an appropriate time. As only a limited number of students can be supported by a teacher, students teaching other students is an effective means to run classes.



3. Write Out a Goal in the Class

Creative Learning Spiral (Resnick 2007) is an effective way to learn from making. To realize the Creative Learning Spiral process in a time-constrained class, it is necessary to understand the activities of "Imagine" - "Create" - "Play" - "Share" - "Reflect." By writing out the purpose of these activities in the class, students can direct the activities within the class and create a chance for "Imagine."



12月22日(木)

学習のテーマ(爆発的)

クリケットロボットを大進化させよう。

めあて　新らしくスイッチを使用します

(拓人)新幹線のおもちゃを動かそうと考えたが、今日はスイッチを使って進化させたい。

(望)さわるスイッチをいっぱい使いたい。(他のブロックも)

(ゆり子)車を前、後ろにクリケットで動かしたい。ライトも光るようにしたい。

森先生から

・英語の説明書も読もう。・つなぐものの写真をとる。

4. Work Collaboratively with Other Students

Working on activities through collaboration with multiple people is one of the fundamental approaches for constructionist learning to create opportunities to learn through making. In addition, by encouraging individual works and collaborative works, teachers can prevent students from relying on groups without doing anything on their own, and students can engage in effective interaction between individual learning and group learning.

5. Reflect on Activities in the Class

Reflecting on the activities of each class is done in the latter part of the class and is divided into two parts. In the first part, students reflect on the activities of the class and summarize them in their notebook so that they can share their findings with the class. In the second part, students listen to other students' findings and summarize their reflections again, including what they want to try the next time.

6. Share Findings in the Class

To share what students discovered in the class, a short presentation time at the end of the class works well for students. Also, to create informal sharing opportunities during the class, it is important for students to be able to walk around the classroom when they find something interesting. Students are always active in sharing ideas informally, and it is often found that students make similar project to the ones sitting nearby.

7. Be Good Imitators

Students may not like imitating or being imitated. Teachers need to make them understand that they can imitate good ideas and incorporate them into their work actively. While doing so, teachers also need to encourage students to come up with new ideas and respect the student who created the original idea.

8. Present Own Projects

It is important to make time to present students' projects to other students. If the making class is held over several number of classes, it is good to have enough time to prepare for presentations in addition to short presentations in each class. By summarizing thoughts in a presentation and receiving opinions from other students, students are likely to get new ideas.

9. Evaluate Oneself by Oneself

Unlike other classes, it is difficult to uniformly determine learning goals in classes where students work on their own making projects. Therefore, it is important to set each student's own goal by himself or herself, and evaluate the activities on his or her own in reflection parts.

10. Make Failures Meaningful

Debugging in programming is the most powerful tool for students' learning (Papers 1980). Most students do not like facing failures. Teachers need to tell students that making mistakes in the class is good, and it is most important for them to find their own answers from their mistakes.

11. Give Chances to Re-Try

To create opportunities for students to learn from trial and error, teachers need to allocate more time to students for programming and making things on their own. In some cases, it is impossible to try new ideas unless the work is fundamentally changed. By giving students opportunities to work on more than two times, it becomes easier to newly incorporate the experience of the previous project and apply ideas gained from other students.

12. Ask Students to Help in Preparing the Classes

Students are likely to participate actively in classes when they themselves participate in the preparation for classes instead of simply working in prepared environments. It is good to ask students to gather materials for their making projects and bring them to classes. It is also beneficial to assign students to prepare the class with teachers (although it sometimes takes more time for teachers to prepare the classes with students.)

13. Ask Students to Clean up the Classroom

It is hard for teachers to take part and clean up everything when using a lot of materials in tasks such as robot making. When students do the cleaning by themselves, it becomes an opportunity for them to reflect on the making process as they disassemble and clean up the projects they made.

14. Sharpen the Progress of the Class

When students concentrate on making, it often becomes difficult to shift to the next activities, such as listening to teachers. It is good to ask students to listen to teachers when teachers talk. However, it is still and always difficult for them to move from their making activity to the next activity. Instead of forcing students to follow orders like a computer program does, teachers need to understand how students actually concentrate on making.

15. Become Non-Teaching Teachers

Teachers cannot teach students everything in the class of making, especially when new technologies are introduced in the class. By giving up teaching everything and trying to explore unknown things together with students, teachers themselves are released from the fear of dealing with new educational materials.

16. Look at the Form of Students' Elementary Learning

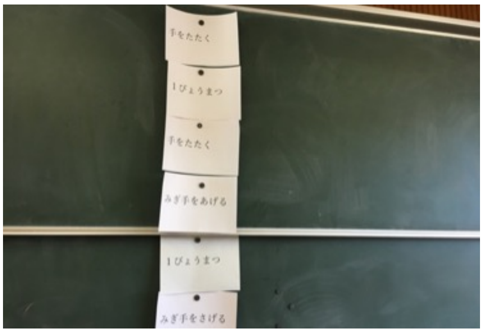
In subject study, many students have learned related knowledge at the cram school in Japan, so it is difficult to see the elementary picture of students. Making activities also provide an opportunity to see the figure facing students' activities to check how they face learning itself. (However, recently, there are more places outside the school where students experience programming and robot making, so it is necessary to pay attention.)

17. Leave Students for a While

Students' interests are diverse. Even if it seems for teachers to be far from students' goals, guiding students may be a necessary process for them. In order not to teach them too much, teachers need to leave students for a certain period of time. However, technical problems need to be supported immediately.

18. Think with the Body

When students engage in programming, they only think with their brain. It is important for students to learn to use not only their brain but also their body when they are learning (Papert 1980). It is a good introduction for students that they become like computers and move their body according to commands, such as "raise your hand" when teachers ask (program) them to do so.



19. Think about Computers and Programming Related to Students' Familiar Things

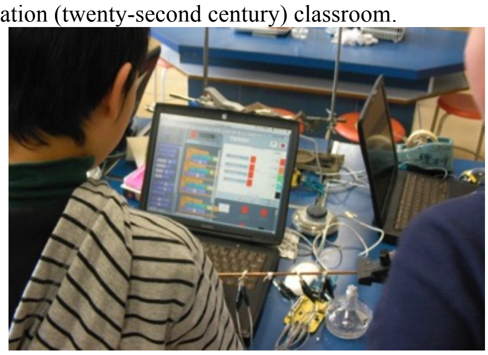
Computers are embedded in a lot of things around students, from appliances to toys and video games, and these things are controlled by computer programs. Thinking about how their familiar things work and making those things by themselves also deepen their understanding of computers and programming.

20. Tell Students Programming Is for Learning How to Learn

Many students, parents, and teachers still think that programming education is necessary for mastering programming (coding) skills. Teachers need to tell them that programming is useful for learning how to learn, and making things as well as programming are the same ways of learning how to learn. (I had an experience where a first-grade girl told me that programming is unnecessary for her as she wants to be a florist in the future.)

21. Think about How to Make Use of the Experiences in Other Classes

Both students and teachers can use their making experiences in classes for other subjects. Thinking about how students and teachers can make use of them concretely, it is possible to introduce new learning into ordinary classes as well, and it will also provide a chance to add one more thing to the next-generation (twenty-second century) classroom.



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