Collaborative Learning Support Solution Based on Speech Visualization

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Abstract

In response to the novel coronavirus disease (COVID-19) pandemic, businesses operating in the education sector that provide support for students, teachers, and learning itself are now actively seeking to develop new and more versatile systems for learning and teaching. NEC's Smart School Business has developed a Collaborative Learning Support Solution designed to support and facilitate group activities in online learning such as remote active learning. By visualizing and analyzing various characteristics of an individual student's speech (how often learning keywords appear, speech frequency and rate, etc.), this solution makes it possible to tailor instruction for each student.

Keywords

education, collaborative learning, validation, speech recognition, NEC's education cloud OPE, COVID-19

1. Introduction

As Japan intensifies its efforts to transition to Society 5.0 — a concept put forward by the Japanese government — it is moving forward with digitization in as many different areas of society as possible. Education, in particular, has been targeted for reform with plans to integrate information and communications technology (ICT) in all aspects of the learning process.

NEC provides NEC's education cloud, the Open Platform for Education (OPE)[1)], and its education support service, the Collaborative Learning Support Solution. This paper introduces the outline and the future approaches of these services.

1.1 Educational reform – revised curriculum guidelines

Partial revision of the School Education Law introduced in April 2019 allows use of digital textbooks in addition to conventional textbooks. In accordance with the revised curriculum guidelines, computer programming and foreign language studies were introduced at the elementary school level in fiscal 2020.

At the core of the revised curriculum guidelines as set forth by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is an emphasis on fostering the qualities and capabilities that will be needed in the new era. Taking its cue from data analysis, MEXT is calling for qualitative improvements in education through an enriched learning experience that is both independent and interactive (active learning, collaborative learning, etc.) and by improving methods for evaluating students' progress.

In line with the new guidance proffered by the revised curriculum guidelines, schools across the nation are introducing new in-class learning systems that focus on interactions with and between children. The next step is to develop systems that can evaluate collaborative learning classwork based on quantitative evidence.

1.2 Educational reform – GIGA School Program

At almost the same time as it introduced its revised curriculum guidelines, MEXT announced the GIGA School Program[2)] in December 2019. GIGA stands for Global and Innovation Gateway for All.

Features of the GIGA School Program include the provision of a device for each student and the construction of a high-speed, large-capacity communications network for students in the Society 5.0 era. Cloud databases will be a key component of this program and will be supported by a system for ICT device procurement and maintenance, distribution of representative device usage cases, and implementation of the PDCA cycle in device usage. In so doing, GIGA is expected to facilitate continuous achievement of individually optimized learning at schools across the nation, ensuring equitable access for students with diverse capabilities, including those with disabilities. In addition to addressing the long-standing demand for effective utilization of leading-edge technology based on ICT, this program is also aimed at resolving delays in the construction of subsidized school ICT environments, as well as the digital divide between local authorities.

Since April 2020, all of these trends were accelerated by the novel coronavirus disease (COVID-19) pandemic, and even more emphasis is now being placed on ensuring that children can continue with their studies using ICT even during an emergency such as the one that resulted in the government temporarily shutting down schools in an effort to prevent the spread of COVID-19. Thanks to these efforts and support from MEXT, the GIGA School Program has accomplished all of its initial goals — which originally planned to be completed in four years — in just the last year.

2. NEC's Smart School Business

To support MEXT's efforts to reform education as quickly as possible, NEC is pushing ahead with its Smart School Business. These products include the following.

2.1 OPE educational cloud

In addition to supplying devices for students as part of the GIGA School Program, NEC introduced in fiscal 2020 an educational cloud platform called OPE, that enables seamless access to learning materials with a single sign-on (**Fig. 1** & **2**). Students can access learning systems that will train them in practical English skills, computer programming, and much more. Drill materials for all subjects are also provided, enabling students to study more efficiently.

2.2 Collaborative Learning Support Solution

The combination of active learning and collaborative learning makes possible an enriched experience that is both independent and interactive. In order to instruct and evaluate students accurately, teachers must have access

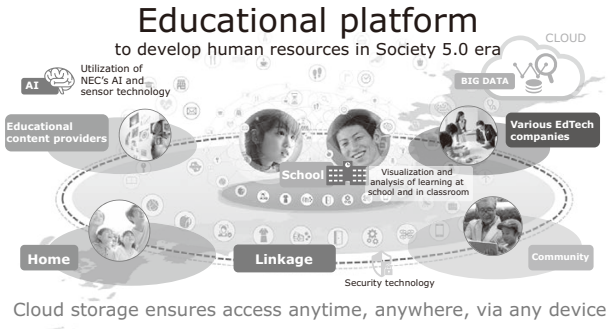

Fig. 1 NEC's educational cloud OPE.

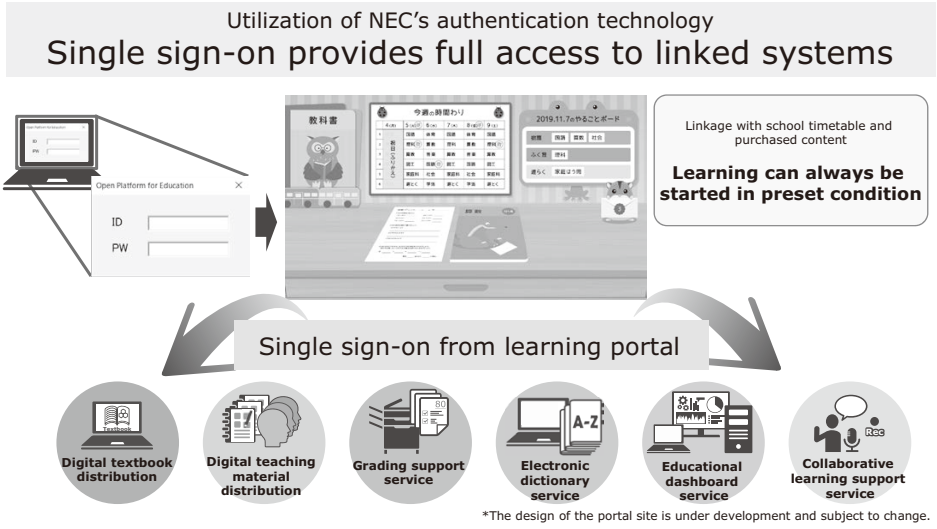

Fig. 2 Strength of NEC education cloud OPE.

not only to each student's results, but also to data about their individual learning processes. In addition to work sheets, test results, and so on, information that is especially important to student evaluation is what students say in class, how active they are in debates, and if they say something that triggers an exchange of opinions. This necessitates technology to make it possible for teachers to check what students say in the collaborative learning process during or after class and to use that information for evaluation of students and improvement of classwork.

The solution is a teaching support service that utilizes multiple AI technologies and will be provided on the OPE. When a collaborative learning class is held, the microphone connected to the device introduced in the GIGA School Program on a one-device-for-one-student basis captures what teachers and students say during the class. By visualizing this, this solution meets on-site needs from schools from the viewpoint of provision of evidence in evaluation of students as well as improvement of teachers' instructions.

3. Creating educational value

This section discusses the educational value provided by the Collaborative Learning Support Solution and explains the mechanism to visualize the speech information.

3.1 Educational value

The educational value made possible by this solution can be broken down into three main parts.

The first is that teachers can give instructions and talk to students if necessary while they walk around the classroom. In collaborative learning, multiple groups comprised of multiple students concurrently proceed in discussions on different subjects while a single teacher is supervising those discussions. This solution notifies the teacher of particular groups and individuals who should be prioritized, allowing the teacher to offer suggestions to the whole class, to individual groups, and to specific individuals as and when required. Notifications are delivered to the teacher's device in real time as alerts during the class (**Fig. 3**). This system is especially useful because of the importance of providing effective instructions to students in class during limited school hours.

The second factor contributing to the educational value of this solution is that it provides teachers with a text record of what they said during the class and how actively students exchanged opinions. When required, this text information can be played back as audio (**Fig. 4**), enabling teachers to apprehend nuances such as tone in the vocal utterances of both teachers and students as well as the atmosphere in the classroom. These kinds of details — which are difficult to pick up with text information alone — provide much greater context to the discussion.

The third component is the ability to check statistical information such as the transition of the number of times teachers and students speak based on learning data collected in previous classes. This capability is useful for the teachers as it allows them to statistically

Fig. 3 Real-time visualization of learning conditions and notification function.

Fig. 4 Class review and analysis function (per group).

Fig. 5 Learning history analysis function.

review their own classes to improve their teaching accordingly. It is helps the teachers keep up with how the students have grown and changed (**Fig. 5**).

3.2 How we created this solution

To achieve this solution, we combined the authentication function incorporated in the OPE with several of NEC's most advanced AI technologies including voice recognition, speaker recognition, and emotion recognition which convert a vast amount of data drawn from what teachers and students say into useful information for teaching. (**Fig. 6**) (related patent pending).

Using microphones connected to the teacher's and students' devices, this system works by recording whatever is said by the teacher and by each student during collaborative learning and converting the audio data into voice information. After identifying the speaker, the system processes the voice data into various contextualized data points, including text lines, number of times an individual spoke, changes in emotion, and how often desired keywords appeared. Based on this data, the solution is able to alert the teacher in real time to which groups and individuals should be given the most attention at any particular moment (see the first component of educational value above).

The processed data is organized and linked to voice data in a way that makes it accessible to classes and individuals. This makes it possible to play back each utterance in a single unit of text, thus making it possible to continuously play back voice information in specific ranges (see the second educational value above).

The system's design ensures that accumulated data not only can be managed as the teacher's instruction history and as each student's learning history that took place in each class but also as statistical information across the board (see the third educational value above).

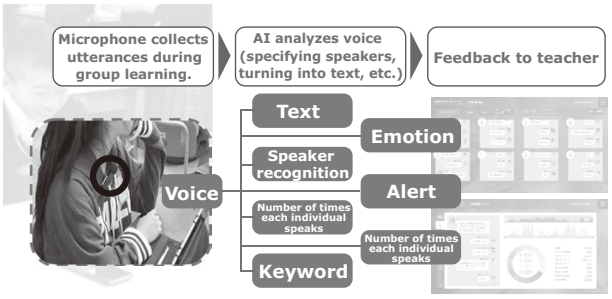

Fig. 6 How the Collaborative Learning Support Solution works.

Photo Validation at school in Kyoto.

4. Conclusion

As of 2021, this solution is still in the of validation stage. Validation procedures regarding visualization and evaluation of learning conditions in collaborative learning[3)4)] have been conducted continuously since 2019 at four demonstration schools in Kyoto (two elementary schools and two junior high schools. The idea is to help achieve learning that matches each student and improve teachers' instruction capabilities at the stage of compulsory education (**Photo**).

Initially, the validation tests were based on the assumption of collaborative learning in conditions where teachers and students were close to each other. Due to COVID-19, however, validation is now underway in an environment where teachers and students are physically distant from each other. In other words, we are hypothesizing various use cases to address various issues in terms of environment and technology.

We are committed to continuing our efforts to achieve a more nourishing and collaborative learning environment that benefits from application not only of NEC's proprietary technologies, but is also open to collaboration with vendors specializing in other technological fields.

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