Using eye tracking to assist teaching reading in schools

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Abstract
As eye tracking technology becomes cheaper and more accessible, the opportunities for integrating this into educational systems increase. One application area is the teaching of reading skills to pupils and students of different ages. If the reader's gaze position is tracked during reading, this can be used to provide automatic assistance to the reader if reading difficulties can be reliably detected. This may be useful during reading classes where the teacher's ability to assist individual students is limited. The data collected from gaze-enabled reading aids being used by several students at the same time can be shared with the teacher. The gaze behaviour in the relation to the text being read needs to be summarised and visualised in a way meaningful to the teacher. This can allow the teacher to examine reading performance of individuals either in close to real time or after the lesson. It can allow the performance of several students reading the same passage to be compared. It can help when making periodic assessments of performance of students in a class. The gaze-enabled reading aid may be used in different teaching situations: early reading of L1 languages; facilitating comprehension of L1 languages; and learning to read L2 languages. Another application is the support of special needs reading teachers, where the gaze-enabled reading aid can be both a diagnostic tool, and a tool to support the teacher in devising and monitoring strategies for individual students to overcome reading difficulties.

Extended Abstract
A gaze-enabled reading aid for use in a classroom or school environment consists of a laptop fitted with a low-sample rate eye tracker and a data connection to a cloud database. The text to be read is presented as discrete pages on screen.
For this to be feasible, the quality of the eye tracking system needs to enable gaze data to be reliably associated with the words being read in close to real-time to enable automatic help to be given to the reader. The system must be robust enough to be started and stopped by the students themselves and must be cheap enough to be affordable by schools.

Performance of a low-cost eye tracker for tracking reading in a classroom

A critical issue is how many lines of text with what font size can presented on a page so that fixations made during reading can be associated with a word on screen with a known likelihood of error, both in real-time and after the whole page has been read.
A data quality study was conducted in a classroom where eye tracking data was collected from second graders in a Finnish primary school 10 minutes (intended to simulate normal classroom activity) after a supervised calibration had been carried out. The data quality obtained from two eye trackers was compared, the intended low-cost tracker (with 30Hz sample rate) and a more expensive remote tracker. Following this, a reading study was then carried in the same class with the same students. Students read three pages of text and 2 algorithms were applied to the data. Both used knowledge of the layout of words on the page and treated these as potential fixation targets. One algorithm mapped fixations to words immediately so reading difficulties could be detected as they happened, while the other deferred mapping until all words on the page had

been read, and the locations of all fixations made reading the page were known. The evaluation used human judges manually mapping the fixations to words on the page. The agreement of each algorithm with the combined judgements of two judges was used as the performance evaluation metric. With immediate or real-time mapping, reliability with the 30Hz tracker in the classroom environment was 93.6% when the page consisted of 6 lines of lines dropping to 88.2% with 12 lines of text. With deferred mapping, the value with both numbers of lines (6 and 12) per page was approximately 96%. [3]

Facilitating unsupervised calibration of the low-cost eye tracker by school children

Eye tracker calibration procedures need to be simple and motivate students as young as eight years old to carry these out themselves carefully to ensure adequate data quality and be short enough so as not to disrupt a lesson. A game-based approach to this is presented, where the calibration task is abstracted, and a game mechanic is devised around this [2]. It was found that the data quality from groups of unsupervised primary school children using a game with the specific calibration mechanic was better than a group of supervised adults using the standard moving target approach to calibration.

Visualisation of gaze data obtained from reading for teachers

A study was conducted in two reading classes, one with second-graders and one with third-graders in a Finnish primary school [1]. The text that the teacher of each class intended to cover over a sequence of five reading classes was mounted into the gaze-enabled reading aid. In each lesson, six students were each given the reading aid and read the text in class from the screen while the others read from the standard class text book. The reading aids were given to another 6 students in the following class and rotated around all in the class. Visual summaries of the data collected from each student in different formats, both static and dynamic, were shown to their respective class teachers. The teachers found different visualisations useful for different purposes. However, both reported at least two students in their class where the gaze data contradicted the impression they had had of the student's reading ability.

Assisting special reading needs teachers

A study is being conducted in a Finnish secondary school with the teacher of 17 and 18-year-old students with reading problems. The teacher has used the gaze-enabled reading aid as part of her initial assessment of students in a new intake. For this, the functionality of the device was extended to record a student reading the text aloud, and to play back the audio synchronised with the dynamic presentation of gaze data. Students are encouraged to use the visualisation of their own data to speculate on the types of reading problem they have. Together with the teacher, they have devised a strategy to overcome the problems identified. The system has then been used to assess whether the devised strategy has been effective or whether it needs modification.

This work is on-going, however the preliminary assessment by the specialist teacher is that the gaze-enabled reading aid is a very useful tool in working with students with special reading needs.

References

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