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Real-Time and Non-digital Feedback E-learning Tool

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Abstract—This paper provides a new method for enhancing feedback to a lecturer while he/she is teaching in real-time. It is well accepted that interactive teaching enhances learning and critical thinking. However, in a practical situation the lecturer cannot continually ask if the students have any questions and students are normally hesitant to ask questions, especially with a large cohort. Various eLearning tools that provide feedback are available such the Poll Everywhere, Sli.do, Glisser, Turning Technologies ARS, OMBEA, Socrative, iClicker, ARS Nova, Top Hat, Shakespeak, Sendsteps and Via Response. They are well received by students, but these tools are digital in the sense that they are limited to multiple choice. With this new method, the student can highlight on their devices the part(s) that he/she does not understand, and the system provides a real-time analysis and feedback in the form of display on the lecturer’s screen. This device has been built and tested on a small number of students and the feedback from staff and students is very encouraging.

Index Terms—e-learning, educational technology, real-time feedback

I. INTRODUCTION

It is very difficult, if not impossible, to teach a unit (module) within an optimum time. This is due to many factors such as predicting the number of questions, the level of students, especially for a large cohort, the disparity in students’ prior knowledge, prior educational experiences and interest in the subject and so on. For instance, at the University of Bristol we teach the Applications of Electronics unit as a service course to 420 first year students from five departments: mechanical, aerospace, engineering design, civil and engineering mathematics. Some students have been introduced to electronics before enrolling to the University, some have it as a hobby and some have no idea of electronics. This is an issue for the lecturer since the pace of the lecture delivery can be very fast for the less experienced and slow for the experienced. In addition to this, students find it very intimidating asking questions especially when a large cohort is involved even in a friendly and motivating environment [1]. The key point is that a lecturer should know what the students know and do not know [2].

When teaching a large cohort, it is difficult to continuously monitor students’ understanding. Asking questions continuously can be tedious for the lecturer, time consuming for both students and lecturer and may be boring for students. It has

always been reported that quality feedback to students is very important, but little emphasis has been placed on the quality of the feedback provided to the lecturer. Using an audience response system (ARS) like Poll Everywhere [3] or its direct competitors [4], [5], [6], [7], [8], [9], [10] will require the lecturer to ask specific questions and the answers are always digital, correct or incorrect. The issues with such a feedback method have been addressed in Kay and LeSage’s review [11].

II. SYSTEM DESCRIPTION

If the lecturer has continuous and real-time feedback while he/she is talking, that will eliminate the unnecessary questions/answers, save time and avoid boring the students. Some products attempt [12], [13], [14] to provide this through open question and answer (Q&A) sections. However, this falls short of requirements as the lecturer must take the time to read the textual questions during the lecture and respond individually. There is no statistical element or quick visual indication of problematic material. Furthermore, it relies on students being able to properly identify their misunderstandings and form these into coherent questions, which a student may be unable to do. It would be preferable if the student could indicate the area they don’t understand and the lecturer elaborate on it when enough students indicate an area as problematic.

From an engineering point of view, an analogy for this system could be made with a control system, see Figure 1. In a closed loop control system, such as a motor speed controller, the precision of the control will depend on the quality of the feedback element. This control system can be mapped to a real scenario of a teaching setup as shown in Figure 2. Each filter shown in Figure 2 represents that either the information

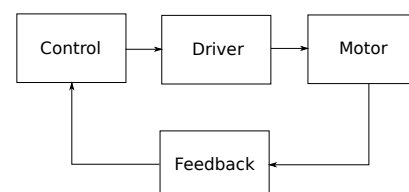


Fig. 1: Analogy with a closed loop control system.

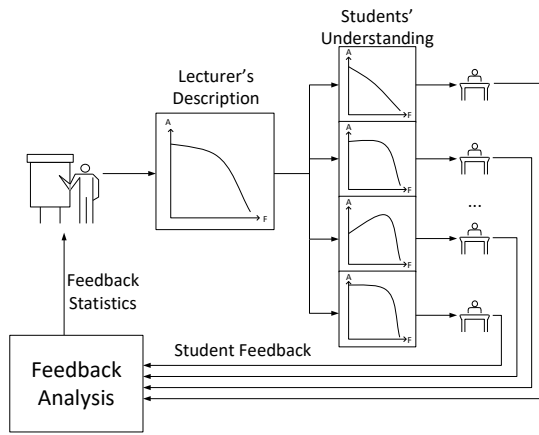


Fig. 2: Real Scenario of a teaching setup.

is not passed correctly or the information is not received well. Notice that each student has their own filter. This is true in the sense that the lecturer is not conveying the information properly or the students are not understanding.

To improve the feedback to the lecturer each student can select the information and highlight it on their device. All information is then analysed in real-time and fed to the lecturer. The analysis algorithm is tuneable and could, for instance, perform some statistical analysis on the feedback and alert the lecturer when the number of students who do not understand hits a threshold. The lecturer can then either re-iterate or elaborate on information, or acknowledge postponing the questions.

The usage of statistical analysis is important as it allows the lecturer to filter the noise from the feedback and target the areas that the class doesn't understand. Student misunderstanding will manifest in the feedback as one of three different symptoms: an entire slide covered in large boxes, which implies a conceptual misunderstanding by the class, a cluster of small boxes, which implies a misunderstanding or absence of details, and a sparse distribution of boxes, which implies individual students failing to properly ingest information. The first two symptoms should always be addressed by the lecturer as they affect the entire class, whereas the lecturer may decide to filter out the last symptom depending on time pressures and the importance of individual points.

An accurate feed-forward system is almost as important as an accurate feedback system. As there are multiple feed-forward paths and only one feedback path, tuning the feedback for one feed-forward will come at the expense of another feed-forward, unless the two are the same. Therefore, having matched feed-forward paths is beneficial to optimum operation.

In a teaching scenario, the mismatches in the feed-forward paths are mainly caused by room acoustics. There is also noise made by other students which will also affect the received information (inter-channel interference). Other than this, there are sometimes viewing problems where students are in unsuitable situations to view the entirety of the presented

content. These scenarios could be partially or fully solved by relaying the presented content to each student individually.

III. SOFTWARE AND HARDWARE IMPLEMENTATION OF THE SYSTEM

The feedback section of the system has been implemented as a prototype web application which presents to users the slides being shown by the lecturer. From here, the users can draw shapes over the sections of the content that they are unsure on and need further explanation. This information is then transmitted to a web server which collates the data (Figure 3). The lecturer's interface is similar to the students', except that it shows the shapes of the entire class. In addition, using graphical transformations the system allows the lecturer to determine the number of students that are concerned over a section by observing the intensity of the shapes' colours over that section. The graphical transform can be altered to increase or decrease the effect of each student, thereby allowing the lecturer to tune the system for maximum effect.

As the system displays the feedback on top of the slide, the lecturer would need two screens. One, the main projector for the class, would have the slides without the feedback so that the students are able to view the content without impairment. The second screen, visible to only the lecturer, would have the feedback contents displayed on it. This reduces the effect that unruly students would have on the rest of the class by not transmitting the feedback they give to the other students (only the lecturer needs to observe the feedback).

One important point to note about the system is that it is capable of providing individual data points as well as statistics. In most feedback systems, the feedback is purely statistical (e.g. How many students understand a concept) and is only available when the lecturer specifically requests it (e.g. Asking the students to vote on a question). With this system, however, the lecturer is able to see individual responses and receive feedback when they have not specifically requested it (e.g. on contents that would normally go unquestioned). This results in a significantly more accurate view of student understanding.

The system currently is anonymous, but could be integrated with a central authentication system to allow individual responses to be linked to students and hence allow lecturers to proactively help students that are falling behind out-of-lectures. To this end, the lecturer could invite outlier students individually or as a small group to extra sessions to help them catch up.

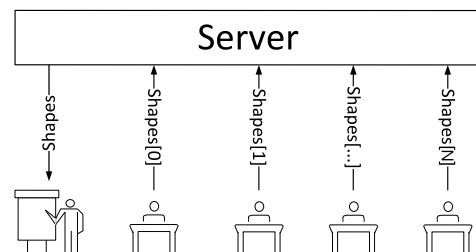


Fig. 3: Data transfer in the feedback system.

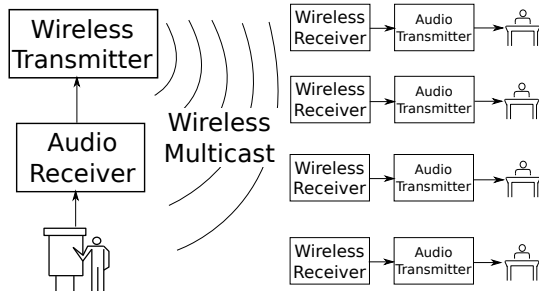


Fig. 4: Alternative and matched path for auditory information.

From a hardware perspective, the implementation of such a system would require that each student had access to a web browser. To a certain extent this could be provided by smartphones, but not all students have access to these devices and so the college or university would need to provide devices (e.g. tablets) for these students to borrow.

To implement a well-matched feed-forward system, it is suggested that the students each have some form of personal audio equipment (headphones, earbuds etc.) to which the lecturer's voice and any auditory media in the PowerPoint can be transmitted via wireless broadcast (Figure 4). As each student will be the same distance from the audio source and have suitable noise isolation, this will reduce the mismatch in the feed-forward channels allowing the single feedback path to be more highly tuned to the feed-forward paths.

IV. RECEPTION

In order to determine the effectiveness of the system, we interviewed students who trialled the system. In general, the reception was positive, with praises for the ability to highlight areas immediately and to precisely point out what wasn't understood rather than waiting for feedback opportunities with traditional clicker systems or interrupting the lecture. However, many possible improvements were highlighted by the students. The students in particular were keen on integrating this system with traditional clicker systems (possibly through the same interface) to provide more general information, such as general understanding of the concept, as well as meta-information such as requests for volume changes, changes in pace and requests to re-visit slides.

Also, some students expressed a desire to be able to annotate when they highlight something. This is more problematic, as it is difficult to statistically analyse annotations, and so is not suitable for real-time feedback to the lecturer. In addition, some students expressed confusion on what to highlight if they don't understand the point of the material, rather than the material itself. We feel this could be solved by the inclusion of a traffic light system. Finally, some students expressed concerns as to how this would operate with lecturers who regularly use the blackboard. This could be addressed by the extensions proposed in section III or a virtualised whiteboard.

V. CONCLUSION

An internet-connected system for real-time non-digital feedback has been implemented. It allows students to highlight

areas of the content being presented that they do not understand so that the lecturer may reiterate the content to increase student understanding. Using the principles of control, we have determined that improving the quality of this feedback from digital ("yes/no") to non-digital will improve the overall transfer of information from the lecturer to the students, and this is reflected in our system's design. We elaborated on the importance of matched feed-forward paths in a single-feedback system and suggested how the matching of the feed-forward paths can be increased using technology. In the future, we will continue to develop this technology and employ it in larger scale tests to determine its scalability and generality.

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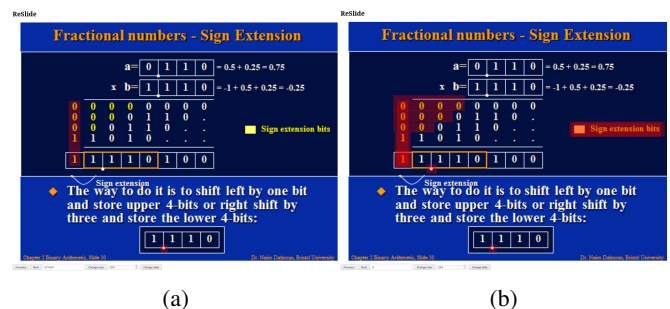


Fig. 5: Screenshots from (5a) a student who did not understand the material and (5b) the lecturer. The sign extension bits are most strongly highlighted.