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More than a "Clicker": Scaffolding Learner-Learner Classroom Talk with a Tablet Application

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Abstract: Student talk centred initiatives show promising learning gains when compared with the status quo. In this paper we introduce a web-based application to scaffold learner-learner talk intended for use in the secondary science classroom, on the subject of electricity. The programme builds upon what is successful in a well-known "clicker" type application and furthers it in line with previously established good practice for collaborative task design. Additional tasks, including simulations, group discussion work and think-pair-share, have been implemented, collecting answers from learners (and sometimes providing feedback to them) at each stage. The application, "Talking Circuits", goes beyond the implementation of a simple "clicker system" with the addition of scaffolding hints, a course specific e-Book and a function to request help from the teacher.

Motivation

The benefits that dialogic teaching methods afford to the learner, specifically the promotion of student collaborative talk, are well documented and are the main motivation for the development of the application to be shown. A "collaborative task" in the (science) classroom can take multiple forms, but in short, what is meant here by a "collaborative task" is a group of learners with a common goal, using talk as their main method of communication. In 2017 a report issued by the Educational Endowment Foundation showed the efficacy of using dialogic teaching across the curriculum in a large-scale comparative study of year 5 classes ($n_{\text{Classes Treatment}} = 38$) (Jay et al., 2017), in which learners made significant learning gains across the three "core subjects", of English, Maths and Science. Similarly, interventions in higher education, found that implementing peer instruction (Crouch & Mazur, 2001; Karabulut-Ilgu et al., 2018) increased scientific concept knowledge acquisition when compared with traditional lecture-based teaching. Furthermore, in a recent meta-analysis, peer interaction interventions in secondary school students were shown to have an effect strength on the upper end of medium (Hedge's g = 0.62) (Tenenbaum et al., 2019). These effects however seem more difficult to reproduce in our specific setting, with no significant learning gains being found in the epiSTEMe project (Ruthven et al., 2017). However, with this intervention being ten years in the past (2010-11) and purely analogue, there is promise of building on the approach, integrating successful ideas from this research as well as that conducted by the co-authors (Howe et al., 2013) on the use of simulations in school science.

The application presented here, "Talking Circuits", hopes to offer teachers and learners a practical tool, suitable for use in secondary schools, which builds upon the current understanding of effective collaborative task design. The application goes beyond currently available "clicker" systems, in that it is made to directly scaffold the talk phase both providing support with subject knowledge as well as scaffolding learners to engage in productive talk.

Theoretical considerations

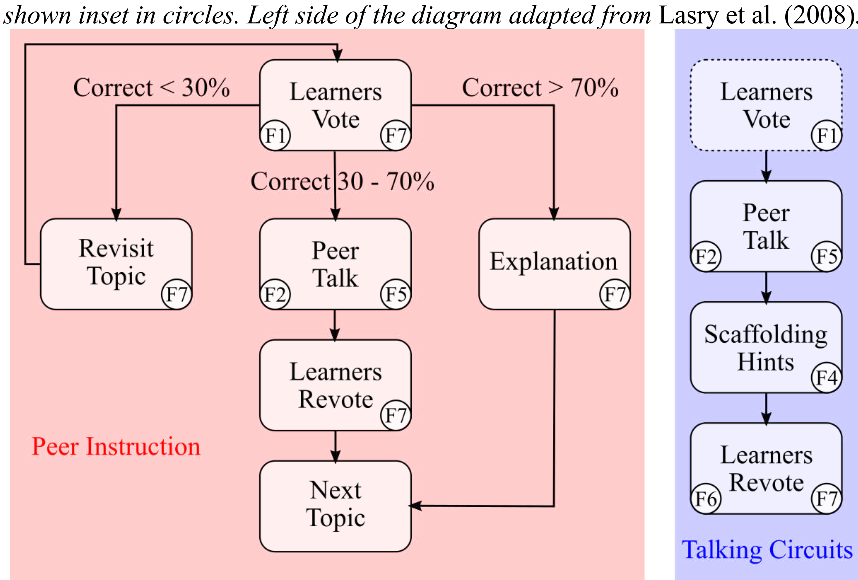
Heeg et al. (2020) establish seven features of fruitful collaborative task design, which we can use to analyse the features of current technology and highlight the need for an additional tool to scaffold the learning processes. The features are listed below, as they appear in Heeg et al. (2020), with a design requirement from each written in brackets afterwards.

- F1: Becoming aware of one's own conceptions (Enable self-reflection)
- F2: Externalising individual ideas (Externalisation)
- F3: Initiating comparable situation models (Embedding in a context)
- F4: Ensure active involvement for all (Scaffold involvement)

- F5: Offering each learner opportunities to reflect on each other's conceptual understanding (Scaffold the talk phase)
- F6: Integrating decision-making processes (Lead towards consensus)
- F7: Offering the teacher measures to monitor the learning process (Enabling feedback)

A common use of "clicker" technology in the field of physics education is through Peer Instruction, although the way in which the Peer Instruction works does not necessitate having a collaborative phase at all; its ubiquity makes it a useful comparison. As is shown in Figure 1, this method includes most of the features listed by Heeg et al. (2020), with the notable exception of features four and six (F4 & F6), ensuring involvement for all and integrating decision-making processes. As the method is primarily used in a university setting, it could be argued that the learners are already equipped to engage in discussion without needing explicit scaffolding, rendering F4 unnecessary. Furthermore, that ensuring that both learners in dyads come to a consensus, limits the outcomes. This is not intended as a criticism of the method, rather, the intention is to show a possible modification to allow its success to be replicated with younger learners, as shown on the right of Figure 1. The modification of the teaching structure necessitates the development of new software, different to anything currently available.

Figure 1
Comparing the learning processes between Mazur's Peer-Instruction and the activity structure using "Talking Circuits". Sub-activities shown in blocks, with features shown inset in circles. Left side of the diagram adapted from Lasry et al. (2008).



The technologies used when implementing Peer Instruction reflect the fact that the voting is seen as a diagnostic of what has been learned, rather than as the result of a decision to be arrived at collaboratively. Voting is done individually using either specially designed hardware or software such as PINGO or ARSnova. These "clicker" systems, otherwise known as classroom, student or learning response systems, focus on collecting individual (sometimes anonymous) responses, for teachers delivering whole class feedback. Other applications allow additionally for asynchronous assessment and quizzes, such as Socrative or Formative, facilitating giving feedback at an individual level, but are not structured for collaboration. The authors are not aware of any software explicitly with the aim of supporting pair work or offering scaffolding for the talk phase either with regards to providing hints to help overcome problems with the subject matter or encouraging the learners to engage in productive talk.

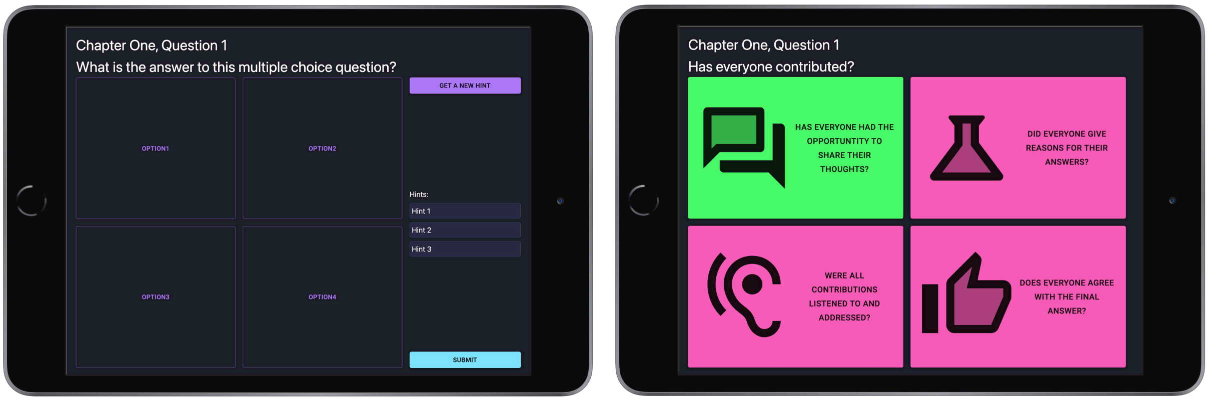
It is worth noting at this point that feature 3 (F3), initiating comparable situation models, does not appear in either flow chart, realisation of this feature happens at the level of individual task design. On the topic of the task design, the application will not be limited purely to single-choice questions as is usual with Peer Instruction, widening scope to a larger range of collaborative tasks. Learners will have the opportunity to engage with simple simulations of circuits and colour-code diagrams according to the potential. Through this, learners not only get a more varied set of activities, they are also able to actively manipulate the systems rather than just reflecting on possible single-choice answers. All features of the course material are available through one application, with the aim of reducing cognitive load for the learners (Chandler & Sweller, 1991).

Design implementation

The “Talking Circuits” application seeks to integrate both of the missing features into a simple activity structure, which teachers and learners can use, within the topic of electrical circuits. All content in the application is provided by the authors of this paper and is based upon the already successful curriculum for teaching electric circuits (Burde & Wilhelm, 2020). The structure of the programme allows for the addition of other multiple choice or text input questions, although currently not by user input. So, although the programme has been developed with use in the science classroom in mind, with adjustment to the content it could be used in any school subject. To ensure its availability to as wide an audience as possible, the application is platform agnostic, developed using ReactJS.

Learners log in to the application on their device and can view learning materials and complete set homework at any time. When engaging in the collaborative phase, learners begin with an optional opening vote, in a session initiated by the teacher. Initial voting would help teachers gauge to what extent the activity has improved learner understanding, however it is optional. We do nonetheless encourage an individual phase in some form as its inclusion has been shown to improve learning outcomes when compared to learning without (Olsen et al., 2019). Learners then pair themselves using a code input, inputting that of their assigned or preferred partner. One tablet then becomes the input for the question and the other scaffolds their talk with prompts, as seen in Figure 2, on the left- and right-hand side respectively. The “Question Screen” (Figure 2, left) shows the task under instruction as well as three hints structured in a variety of ways, as scaffolding questions, reminders of required information or methods of solution, which are made visible one-by-one through clicking on “Get a New Hint”. When the learners have exhausted these hints, the option becomes available to ask the teacher for help. The teacher receives a prompt to their tablet or computer, allowing them to address the problem with the learners. We hope that allowing learners to request assistance this way will reduce unwillingness to show misunderstandings, as it is a less visible (more anonymous) manner of asking for help. This functionality also allows teachers to see which learners need help, without them needing to keep their hands up, as well as helping to keep track of who needs assistance in which order. Learners must confirm that they have kept to four guiding principles based on Mercer’s “Rules for Exploratory Talk” (Mercer et al., 1999), on their “Talk Screen” (Figure 2, right) before they submit their answer. This implementation seeks to address both the missing features from PI. A single input necessitates the learners achieve a consensus and the second screen provides learners with additional scaffolding and frees up input space for scaffolding of the social interaction, while hints and the ability to call the teacher ensure that the application gives learners the opportunity to progress instead of purely assessing learning. The teacher, additionally to being able to respond when a dyad needs help, after exhausting all their hints, can see how many hints each dyad has used, as well as if dyads have answered the question and whether that answer is correct or, in the case of a free text answer, which answers were inputted.

Figure 2
Screenshots showing the two screens simultaneously visible to a learner dyad. Question answering is carried out on the left screen, whereas the right screen acts as scaffolding for learners, checking some features of “exploratory talk”.



Outlook and ongoing studies

A study is being carried out over in multiple schools in the UK to compare the effectiveness of integrating collaborative learning by means of the application with delivery using an identical content structure without CSCL, by comparing learning outcomes and motivational factors. Process data and recordings of learner-learner talk will be recorded, in order to facilitate an insight into how learner talk-style, alternative conceptions and subject vocabulary develop and influence outcomes over a set of ten lessons using the tool. If the implementation is successful, the tool could be expanded to include other topics and other question formats, as well as enabling user generated content.

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