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# Problem solving with learning technology in the music studio

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## Abstract

*This article presents some of the findings from a mixed-methods case study that investigated studio recording for undergraduate students collaborating in pairs. The students were actively engaged in experiential learning (Dewey 1966) and the idea that students will develop within an environment with their peers (Pear and Crowne-Todd 2001). Using a stratified purposive sampling technique students were matched with a learner of similar ability via a pre-test, often referred to as a social-conflict approach (Schneider 2002). The groups of students were then allocated a support mechanism (either a learning technology interface or paper-based manual) to provide contingent on-demand assistance (Wood and Wood 1999) during the recording of a drum kit. Analysis of observational data revealed the types of studio-based problems the learners were encountering, and that the learning technology solution suggested a quicker and more reliable form of support.*

## Keywords

recording
learning technology
studio practice
music
problem solving
contingent learning

## Introduction

While to date there have been no empirical investigations into the use of learning technology to support activity in the recording studio, there have been a number of studies both within the music domain and outside; we will deal with the latter first.

Chang (2001) describes and evaluates a case study in the earth sciences using learning technology to support the completion of a test. In addition to the computing technology, the student also has access to a number of other resources such as maps, weather images and precipitation data. Spicer and Stratford (2001) investigated the use of computing technology to implement a virtual field trip for students with embedded questions within the hypertext. Not surprisingly, students reported that they preferred the actual visits to the virtual.

In addition to these studies that centre on computers supporting practical activity, there are also a number of other studies in the area of computer-supported collaborative learning (CSCL). Weinberger and Fischer (2005) propose a framework for analysing knowledge construction in a CSCL environment. This is analysed and segmented into four different dimensions of learning: participation, epistemics, argument and social construction; while Baker *et al* (2003) specifically highlights argument within an online collaborative learning environment.

Within the music domain there has been considerable research into using computers to support or develop skills such as music analysis, aural awareness and music synthesis by groups of researchers at Huddersfield (the CALMA project) and Edinburgh universities. Other empirical studies include the development of a unique symbolic language for the study of composition in the form of networked drum steps (McCarthy *et al* 2005) and Harmony Space (Holland 1989), which is an interactive interface to aid both novices and more experienced composers with aspects of tonal harmony.

More recent researches into the use of computers in music education involve designing online communities for creative musical activities (Salavuo 2007) and how young people listen to, compose and share music with technology (Gall 2007). Dillon and Brown (2007) discuss the philosophical implications of introducing technology into music making, and put forward methods and ideas for exploration. The need for an investigation area of practical activity in a situated environment (Lave and Wenger 1991) such as the recording studio has thus far been neglected.

## Technology in the studio

The use of technology in the music curriculum poses a problem for the educator: how can students gain access to support when using complex tools in creative work, and what is the nature of the problems they are encountering? Software packages such as Cubase and Pro Tools offer support in the form of online help and minimal manuals embedded within the software; however, little help is provided beyond the procedural knowledge (Anderson 1996) concerned with these tools. In addition, support for the use of hardware recording devices such as mixing desks, signal processors (noise gates, compressors) and signal generators (reverb, delay, chorus etc) usually relies upon either the student's ability to take effective notes in a workshop, or the use of manuals.

These hardware recording devices are often used by audio professionals and the manuals are written for this particular audience, and this can present a problem for the student of music and technology. A survey of 150 students over three years conducted at the University of Hull revealed that students were more likely to seek studio support guidance from a member of staff (43%) or a peer (41%) than a manual (16%) or a textbook (0%). Indeed, while overburdening the student with technical specifications and data concerning maintenance of a particular item, rarely (if ever) do textbooks or manuals include within their pages pedagogical strategies for problem solving. It is possible to see the number of potential pitfalls for a student when considering a basic input (Figure 1).

Figure 1 illustrates the various stages followed by a source sound (such as a voice or guitar) through a mixing-desk channel: sound is converted from acoustical to electrical energy by the microphone, transmitted out of phase via a balanced cable and then put back into phase at the mixing desk. The student of sound recording is then faced with a series of options: selection of the type of input (microphone or line), whether the phase of the signal needs to be inverted, the possibility to decrease the input amplitude (pad switch), a gain (potentiometer) dial, parametric equalization, auxiliary sends, panning, signal routing (to a group fader or main studio monitors) and finally the slider that controls the overall amplitude of the signal. If any stage is set incorrectly, this can lead to an unintentional

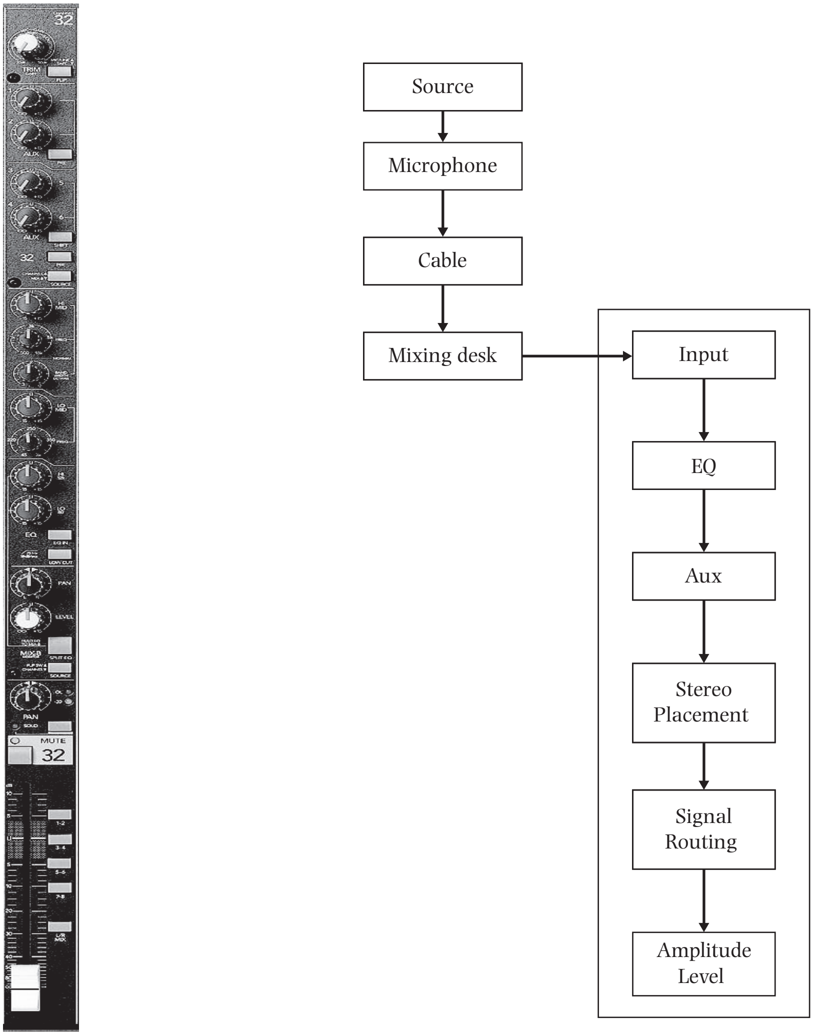


*Figure 1: Mapping out the process from sound source into the mixing desk channel.*

alteration, misdirection or colouration of the sound; alternatively (and more typically) it will result in no sound being produced at all.

Thus it is possible to see the complexity of using such tools in the creation of a recording in the studio, especially when what we have outlined so far is one of the most basic of operations: that of routing a microphone signal through a mixing-desk channel. Often student users require on-demand support to solve problems in the studio. However, the studio session is generally conducted outside of normal office hours (65% of studio sessions take place after 6 p.m. or at the weekend), when the level of technical support is either reduced or non-existent. In the following sections an investigation of the use of learning technology in the studio is presented.

## Problem solving with learning technology in the studio

The participants in this study completed a drum kit recording in the studio in pairs. The students had access to support material to carry out the task: a learning technology interface (LTI) and a paper-based manual (control). The information contained in the support materials was identical. The students were given a specific amount and type of studio apparatus (discussed below) and then expected to complete the task using the available resources. The information given to the students in the support material was to provide technical support; issues such as aesthetics were not covered. For example, the learner could access the support material for information on how to use parametric equalization and what, in essence, is its function. However, information such as 'for more low-end weight on the kick drum apply some boost at 70–90 kHz' was not included. There is a multitude of different ways to achieve different drum kit recordings depending upon the kit, the style of music, the acoustic of the room and the player. It was the intention of the support materials merely to aid the novice user to overcome problems such as signal routing, while also providing an understanding of areas such as equalization, although suggestions were made regarding the position of microphones and which of the available apparatus might be more appropriate on a certain part of the instrument (such as using the D112 for the kick drum). Thus, what can be examined is the ways students are able to solve problems using the equipment and support materials available.

## *Design and methodology*

The empirical research carried out for this study was motivated from a social-constructivist standpoint. Students of similar abilities were paired together after analysis of pre-test results (the pre-test was a written paper that assessed the students' knowledge and experience of recording-studio practice), and in line with the social-conflict (Schneider 2002) theory of learning. Learners were set the task of recording a drum kit during a two-hour studio session (the drum kit was already set up). The idea was to reflect professional studio practice in which recording time is at a premium and studio users need to be able to deliver within strict time constraints. The goal of the session was to produce a 2-minute audio recording of a drum kit on compact disc.

The study had a between-subjects design, and used an opportunity sample of 64 undergraduate students reading for a BA (Hons) in Creative Music Technology at the University of Hull (mean age = 18.4 years). Based on pre-test scores, students were matched according to performance and assigned to pairs. The groups were divided equally into group 1 (experimental) and group 2 (control). There were two dependent variables (DV): (1) the pre- and post-test percentage scores for each student; and (2) the completion of the set task. The independent variable (IV) was the use of an LTI for one group (experimental condition) and the use of handouts for the other (control condition). The handouts contained exactly the same information as the LTI, but were in the form of a manual.

## *Materials and apparatus*

The apparatus used in the study is shown below. The following list details the main hardware associated with the drum-kit recording that is located in the recording studio as well as the equipment used for observing the students during the study:

- Multimedia computer (AMD 2.2 GHz, 1024 megabytes of RAM, 200 gigabyte hard disk and a compact disc writer)
- Soundcraft Ghost mixing desk and microphones
- Signal generators and processors
- Multi track (Alesis HD24) and two track recorders (Tascam CD writer)
- Microphones (2 x AKG 414, 1 x Shure SM57, 3 x Sennheiser e604, 1 x AKG D112) and
- Three Panasonic VHS video cameras, each mounted on a Velbon tripod.

The support material included either the LTI or a manual, one of which was placed in the control room of the recording studio. The drum kit was set up in the studio floor for the duration of the study, while all the necessary cables, microphones and stands were stored in the studio ready for use.

The following material was used in the assessment and evaluation of the study:

- A blank compact disc (CD)
- A pre-test and post-test
- A feedback questionnaire.

A blank CD was given to each pair of students for their audio recording. The pre-test and post-test were designed to evaluate students' knowledge of the theory and practice of drum-kit recording. Both tests followed the same format, so the nature and standard of questions was equivalent. The feedback questionnaire contained open and closed questions (see Oppenheim 1992; Gillham 2000) to allow students to comment on the task and the support material.

### *Procedure*

The directions given to the participating students are shown below. Note that each pair was allocated a 2-hour session in the studio to complete the set task and the drummer was available in the studio to perform when required. The musician did not interfere with the music technology students, except to play a drum sequence.

Preliminary task:
- Complete pre-test.

Main study (1 week later):
- Complete set task with student peer using the support material for guidance as required
- Produce audio-CD recording of drum kit (2 minutes in length)
- Complete feedback questionnaire.

### *Data analysis*

A considerable amount of data was produced as part of the study. For the purposes of this article the following data was analysed:

- 64 completed pre-tests
- 16 data logs of students' interactions with the LTI (group 1 only)

- Video data (32 recording sessions of maximum 2 hours each)
- 32 audio recordings of a drum kit.

The video cameras collected around 200 hours of data. Three cameras were used to collect the data (two in the control room of the studio and one on the studio floor). In order to analyse this data, the tapes from the three video cameras were played simultaneously on separate monitors. This was then dual-coded (verbatim) and utterances were categorized using Interactive Process Analysis (IPA) (Bales 1999). IPA is a method of categorizing utterances based upon direct observation. There are twelve categories of utterance (e.g. shows tension release and asks for opinion) which are further sub-divided into four main areas: positive and negative social emotional responses, and questions and answers concerning a task. These are sub-classified further into the following six areas: orientation, evaluation, control, decision, tension management and integration. It is then possible to assign a particular utterance to one of the twelve observational categories. Afterwards, a comparison of the quantity and type of utterances with the mean profiles developed by Bales is possible. Bales and his team analysed thousands of groups of different sizes and in different contexts to discover the types and amount of utterances the individuals used. All this data was compiled into a single set of tables that investigators can use to compare their own work.

## Analysis

Broadly speaking, it is possible to consider the process of studio recording in three main areas: pre-production, production and post production. Pre-production involves preparing for a session by setting up technical equipment (microphones, mixing desks and recording apparatus) and musical (drum kit) instruments. Production is the actual recording, and post-production the modification and balancing of the recorded tracks. However, it is worth pointing out at this stage that some industry experts (and educators) prefer to think of the process more holistically and the term *production* is used to describe the whole process. For the purposes of this study it is easier to consider the recording in these three stages in order to understand the problems encountered by learners, and at what stage of the process they arise.

The most common problem to emerge in the recording sessions for all of the students was the use of the talkback system. Using the timings recorded in the transcriptions, it was also possible to work out how long it took for each pair to arrive at the solution. It is evident from this data that all of the students who encountered problems using the studio talkback were able resolve the problem by using the LTI. The average time spent using the LTI to resolve the problem was 2 minutes 57 seconds. The data relating specifically to those students who used the manual shows that only three of the seven pairs in the group were able to resolve the problem of using the studio talkback. The average time spent using the manual to resolve the issue was 6 minutes 30 seconds for all of the pairs; for the three pairs who managed to resolve the problem, the average time taken was 7 minutes 10 seconds. In all cases, the students tackled the problem by consulting the support material.

A range of other problems was encountered across each stage of the recording session. For example, technical problems at the pre-production stage included positioning the microphones and deciding upon their proximity to the instrument. The following four problems at the production stage were especially common:

- Phantom powering (when to use it and where to locate it)
- Alesis HD24 recorder (how to set up and record the drum tracks using this device)
- Signal routing (getting sound into the mixing desk, and out again through the monitors)
- Using the auxiliary sends (for adding effects such as reverb).

These problem areas reflect a similar story to the issue of using the studio talkback: while all of the students who had access to the LTI were able to resolve a given problem having consulted the support tool, the problems that hampered the students who were using the manual were not always resolved. Moreover, in these cases the students did not always manage the problem by exclusive use of the manual; use of trial and error was evident. The average time spent resolving these technical issues was 1 minute 36 seconds for pairs in the LTI group, and 4 minutes 18 seconds for pairs using the manual.

The problems encountered during the post-production stage of the recording sessions were as follows:

- Signal processing
- Recording practice
- Signal routing.

Interestingly, more problems arose at the post-production stage for students in the LTI group than those in the manual group (this relates to the fact that the latter adopted an alternative process (without signal generation) at this point).

In addition to the technical problems discussed above, a number of task-related issues arose in the recording sessions. Overall, there were four main areas of task-related discourse:

- Problem-solving (mainly technical)
- Planning/management of task
- Division of labour
- Feedback.

Figure 2 provides an example of one of these four mains areas.

An example of planning is given above. The students planned the task by deciding what to do first, then worked collaboratively with the support materials, deciding which microphones to use in which part of the drum kit, and how they should be positioned. There is evidence here of both long-term planning (overall session) and short-term planning (pre-production: how to allocate and manage the resources to set up the recording).

| Row | Student | Discourse/Action | IPA | Apparatus | Time |
|---|---|---|---|---|---|
| 1 | A+B | [pick up and start to read support material] | | Manual | 0'00 |
| 2 | B | "What shall we do first? Shall we set up the mics or look at mic positions?" | 8 | Manual | 0'30 |
| 3 | A | "Yeah." | 3 | | 0'33 |
| 4 | A | "I reckon we should turn this [points at mixer] on first." | 5 | | 0'38 |
| 5 | A+B | [Look at microphones and position in the manual.] | | Manual | 0'45 |
| 6 | A | "I'll make a start." [goes to studio floor] | 4 | | 1'45 |
| 7 | B | [Continues to look at manual] | | Manual | 1'46 |
| 8 | A | [Sets up microphone on bass drum] | | D112 | 1'55 |
| 9 | B | [Leaves studio floor and heads for control room.] | | | 2'43 |
| 10 | A | [Takes microphone to position on snare drum.] | | SM57 | 2'50 |
| 11 | B | "What shall I do?" [up to this point he has been watching A] | 8 | | 4'20 |
| 12 | A | "Just jump in." | 4 | | 4'23 |

*Figure 2: Example of planning/management of task (Pair 18, manual group).*

It should also be noted, however, that other pairs in the manual group did not consult the support material at the pre-production stage at all, so the management of the task arose in a more ad hoc fashion. Figure 3 is an extract of transcript taken from the pre-production stage of a session in which the students launch immediately into the practical activity without consultation about the process. Here, management of the task is implicit and not made verbally explicit, so there appears to be a lack of planning in how to go about the task.

In Figure 3, student B requires information regarding the deployment of the microphones; student A gives mixed information based on personal knowledge. If the manual had been consulted, these students would have found out that while the SM57 can be used with a floor tom, it could be a

| | | | | | |
|---|---|---|---|---|---|
| 1 | A+B | [Students leave control room and go straight to studio floor] | | | 0’00 |
| 2 | A | [Starts to position microphone on bass drum] | | D112 | 0’32 |
| 3 | B | “What do you use this microphone on?” | 7 | SM57 | 0’45 |
| 4 | A | “It’s a SM57 so snare or floor tom.” | 6 | | 0’50 |
| 5 | B | [Positions SM57 on floor tom] | | SM57 | 0’55 |

*Figure 3: Example of management (Pair 21, manual group).*

more suitable choice for the snare drum in this particular set-up because of the microphones available. From the outset, therefore, the students have perhaps deployed a less suitable microphone on the snare drum, considering the other microphone resources available.

## Discussion and future directions

### *Learning technology facilitated problem solving by reducing trial and error*

In the learning process, one of the main areas of task-related discourse concerned problem solving. Examples of problems encountered in the recording process were drawn from across the data, using the transcriptions, and were discussed with reference to how they were resolved (what mechanism was used) and how long this took. The students in the LTI group solved problems more rapidly than those using the manual. In the latter case, the resolution of problems was often prolonged by the use of trial and error techniques either before or after aborting consultation of the manual. Learning technology thus facilitated problem solving by reducing the need for trial and error (studio equipment is expensive and sensitive; learning by trial and error can sometimes damage this equipment).

### *Learning technology facilitated problem solving by enabling (guaranteeing) resolution*

On some occasions, students in the manual group could not solve the problems they encountered. In particular, one of the main problems noted across the data concerned the use of the studio talkback facility. All of the students in the LTI group who had difficulty operating this equipment managed to solve the problem after consultation of the support tool. The students in the manual group, however, did not always manage to overcome this problem and, as a result, had to perform the task without the studio talkback. In these cases, the consequent lack of communication through the sound-proofed glass between the control room and the studio floor slowed down activity (students had to continually walk from area to area to communicate with the musician). This problem (among other unresolved ones) did not impinge directly upon task performance because all of the students in the manual group completed and passed the set task.

### *Learning technology facilitated problem solving by reducing the time taken to overcome problems*

As mentioned above, the students in the LTI group completed the set task more quickly than those in the manual group. Given that problem solving was the most prevalent area of task-related discourse, it is important to reiterate the impact of time on the completion of activity: the data showed that problems were solved (on average) more quickly by students using the LTI. This contingent tool, therefore, facilitated problem solving by reducing the time taken to find a solution, and this in turn influenced the overall time required to complete the set task. This point also implies that, if less time were taken resolving problems, more time could be devoted to fine-tuning performance on the set task.

## Themes within the data

It is evident from this study that problem solving relating to technical issues (such as signal routing) was not the only issue to arise. In addition, it was apparent that there were three other areas of task-orientated discourse: planning/management of a task, division of labour, and feedback. The educator needs to consider these areas when planning effective collaborative assessments. Also, the types of problem encountered by the learners may not always be consistent, because different environments may raise different issues. It is important to note that the students carrying out this project were only 4 weeks into the first year of an undergraduate programme; the fact that they were able to complete the project in a studio they had little experience of using is commendable. Futures studies will involve not only drum-kit recording but also vocal, guitar and keyboards. In addition, a study is planned to examine the use of different types of support material over a longer period of time, with different group sizes, instead of a single studio recording session.

### Works cited

Anderson, J. R. (1996), *The architecture of cognition*, New Jersey: Lawrence Erlbaum.

Baker, M. J., Quignard, M., Lund, K. and Séjourné, A. (2003), 'Computer supported collaborative learning in the space of debate', in B. Wasson, S. Ludvigsen and U. Hoppe (eds), *Designing for Change in Networked Learning Environments: Proceedings of the International Conference on Computer Support for Collaborative Learning 2003* Dordrecht: Kluwer, pp. 11–20.

Bales, R. F. (1999), *Social Interaction systems: Theory and Measurement*, New Jersey: Transaction.

Chang, C. Y. (2001), 'A problem-solving based computer-assisted tutorial for the earth sciences', *Journal of computer assisted learning*, 17, pp. 263–74.

Dewey, J. (1966), *Democracy and Education. An introduction to the Philosophy of Education*, New York: Free Press.

Dillon, S. C. and Brown, A. (2007), 'Realising the possibilities of technology in music education research and philosophy', in *Proceedings of The Fifth International Research in Music Education*, Exeter University.

Gall, M. (2007), 'Youth and the new digital age: how are young people using music technology in their lives?' in *Proceedings of The Fifth International Research in Music Education*, Exeter University.

Gillham, W. (2000), *Developing a questionnaire*, London: Continuum.

Holland, S. (1989), *Artificial intelligence, education and music*, Milton Keynes: Open University.

King, A. (2006a), 'Contingent learning for creative music technologists', unpublished Ph.D. thesis.

King, A., 2006b: 'Problem solving with learning technology', Leeds International Music Technology Education Conference, Leeds College of Music.

King, A., 2007: 'Student collaboration with learning technology in the music studio', in *Proceedings of The Fifth International Research in Music Education*, Exeter University.

Lave, J. and Wenger, E. (eds), (1991), *Situated Learning: Legitimate peripheral participation*, Cambridge: Cambridge University Press.

McCarthy, C., Bligh, J., Jennings, K. and Tangney, B. (2005), 'Virtual collaborative learning environments for music: networked drumsteps', *Computers in Education*, 44, pp. 173–95.

Oppenheim, A.N. (1992), *Questionnaire design, interviewing and attitude measurement*, London: Pinter.

Pear, J. J. and Crowne-Todd, D. E. (2002), 'A social constructivist approach to computer-mediated instruction', *Computers and Education*, 38, pp. 221–31.

Salvuo, M. (2007), 'Both sides now … designing an online community for creative musical activities and learning', in *Proceedings of The Fifth International Research in Music Education*, Exeter University.

Schneider, D. (2002), 'Community, Content and Collaboration Management Systems in Education: A new chance for socio-constructivist scenarios?' *Proceedings of the 3rd congress on Information and Communication Technologies in Education*, Rhodes, pp. 2–11.

Spicer, J. J. and Stratford, J. (2001), 'Student perceptions of a virtual field trip to replace a real field trip', *Journal of Computer Assisted Learning*, 17, pp. 345–54.

Weinberger, A. and Fischer, F. (2005), 'A framework to analyze argumentative knowledge construction in computer-supported collaborative learning', *Computer in Education*, pp. 25–32.

Wood, H. and Wood, D. (1999), 'Help seeking, learning and contingent tutoring', *Computers in education* 33, pp. 153–69

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