Focus groups to ascertain the presence of formative feedback in CAA

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First year mathematics undergraduates were asked about their experiences of using computer-aided assessment (CAA) in their mathematics modules. It forms a small component of their summative scores in some modules. The aims of these focus groups were to establish how students use CAA systems and how they respond to its feedback. This paper discusses why these should be of interest, how students responded, and the implications on future work.

Keywords: activity theory, computer-aided assessment, formative feedback, undergraduate mathematics.

Introduction

The aim of this PhD project is to examine the effectiveness of the feedback offered by computer-aided assessment (CAA). Many CAA systems feature practice tests to attempt formative feedback, which in literature is described as effective, as we discuss later. First we discuss what formative feedback is and why it is considered effective.

In defining formative feedback, we observe that student response is a necessary component: how students act and react during practice tests is intrinsic to our study. We use activity theory to inform and direct our study of students' activities when undertaking practice tests and we discuss the merits of doing so in this paper.

Formative Feedback

Defining formative feedback is no trivial task: indeed it is one that is often challenged – particularly when we seek a distinction between formative assessment and formative feedback. Taras (2002, 505) believes that for feedback to be effective there are three conditions: "(1) a [community] knowledge of standards, (2) the necessity to compare these standards to one's own work, and (3) taking action to close the gap".

When discussing formative feedback, Taras (506) insists there must be evidence to demonstrate improvement, indicating formative feedback satisfies the third condition of effectiveness. Wiliam and Black (1996, 543) further insist that formative assessment requires a comparison between an accepted standard and the student's work, as well as there being evidence an improvement has been made: satisfying Taras' first and second conditions. Indeed Sadler (1989), citing Ramaprasad (1983), repeats the condition that feedback needs to be acted upon in order for it to qualify as formative. However, while Ramaprasad writes of 'feedback', Sadler discusses 'assessment'.

It would appear that formative assessment and formative feedback are used almost interchangeably. We settle on the phrase 'formative feedback' and, following definitions hitherto, we define formative feedback to satisfy three conditions:

1. A judgement is made against a given standard.

2. Advice is offered to bridge the gap between the judgement and the given standard.
3. Evidence is available to demonstrate that an improvement has made with respect to this gap.

Having established what formative feedback is, it must be noted that it is not only useful but its impact is profound. Concluding from the Beaton et al. (1996) analysis of the TIMSS (Trends in International Mathematics and Science Study) 1995 study, Black and Wiliam (1998) suggest that nationwide best-effect formative feedback would propel England from mid-table of those countries measured for mathematical achievement to the top five of the forty-one studied.

Due to the definition of formative feedback, it follows that the process involves bilateral input: educators offer advice; and students provide evidence that they have improved. If successful, students reach the expected standard and educators no longer need to provide advice at the culmination of this process. Yorke (2003, 496-7) argues that this is a path towards independence: students ought to be able to complete the assessment without the support they were offered previously.

Additionally, Hattie and Timperley (2007, 87-90) argue that feedback has a role in teaching self-regulation. Part of this process involves establishing sources to obtain feedback. They suggest that too many students neglect this responsibility and "view feedback as the responsibility of someone else" (Hattie and Timperley, 101).

Having established what formative feedback is, its power, and how it encourages independence and self-regulation in students, our attention turns to computer-aided assessment (CAA).

Computer-Aided Assessment

One difficulty with assessing mathematical knowledge is determining the best way to communicate mathematics between the student and computer. Mathematics-based CAA systems use computer algebra systems to compare a student's response to stored solutions (Sangwin 2007; Beevers et al. 2008) alongside multiple-choice questioning, numerical input and selection-based responses (Greenhow and Gill 2004; Pidcock, Palipana, and Green 2004).

Each has its own qualities, but one of the more common traits is of interest to us: the implementation of formative feedback. Many of them feature a practice system, whereby a student may make unlimited attempts at practice tests, improving on highlighted weaknesses, before attempting a summative test (Pidcock, Palipana, and Green 2004). It has also been used to allow lecturers to tailor their early lectures in light of students' initial performances (Greenhow 2000).

It is through practice tests that students obtain feedback. Sangwin (2007) argues that providing immediate feedback gives students the motivation to attempt the assessment again. It is clear that the intention is formative but, as we observed in the works of Ramaprasad (1983), Sadler (1989), Wiliam and Black (1998), Taras (2002) and Yorke (2003) in the preceding section, without a demonstrable reduction of the knowledge gap it is not sufficient for this feedback to be deemed 'formative'.

Though CAA systems might record practice test attempts, we do not believe these records reflect students' current level of performance: for example, a student might omit questions he previously answered correctly when attempting subsequent tests. Therefore it is not possible to judge whether students' scores are improving through analysis of system data. That is, without introducing a pre-test to the existing

tests, we are unable to determine whether CAA is formative without discussing the issue with the students themselves.

Methodology

Choosing methods that yield a representation of the majority of students undertaking CAA in various institutions and subjects across different systems was not possible at this early stage of the project. Methods, such as questionnaires and large-scale individual interviews, require questioning techniques that examine the central issues in detail, whilst also following a structure that facilitates comparisons and generalisations. It follows that determining the central issues must be a priority.

Focus groups appeared to be the best way to invoke discussion of the key ideas: they permit an open-endedness of questioning and responding, and the opportunity to probe further as required. On this basis, focus groups were chosen to initiate the investigation with the intention of using questionnaires at a later time to test the generalisability of focus group conclusions.

Before the Easter vacation in 2011, students attending a lecture of a first-year calculus module with CAA tests were invited to volunteer. They each had similar exposure to the Questionmark Perception CAA system over the first semester and the start of the second semester. Seventeen students of 237 students registered for the course filled in a response slip to indicate times when they were free to attend. From these, we invited twelve students that chose the most popular time slots. They formed two groups (seven in the first, five in the second). On the days of the interviews six of the first group attended; only two attended the second group. Convenience payments were not offered on either occasion.

Both focus groups were asked questions from a prepared list with the current question displayed on a laptop computer. In attendance, beyond the participants, were an interviewer (the first author) and a moderator (a research student) that made notes of the discussion. Two audio recordings were made in each focus group and were transcribed by the interviewer. Each focus group lasted forty-five minutes.

The transcriptions were coded according to the research questions. Essentially, it was the purpose of this coding to help us answer the research questions using quotations from the students, accompanied by commentary and interpretation.

For the sake of brevity and consistency, we discuss only the findings that relate to the following research questions that address formative feedback and self-regulation.

1. Can the feedback offered by CAA be considered “formative”?
    - To what extent does CAA allow students to ascertain their learning gaps?
    - Is there evidence to suggest that students reduce their knowledge deficits by means of this assessment?
2. What reactions and behaviours do students exhibit when they receive feedback through CAA?

Analysis

With respect to these research questions, we examine the feedback that CAA offers and compare this to our definition of formative feedback. Naturally our focus turns to student activity and we discuss how our findings relate to activity theory.

CAA as formative feedback

Some students see CAA as the opportunity to identify learning gaps. As Hattie and Timperley (2007) propose, it is only through assessments that some students identify problems: one student said, “sometimes you think you understand something and then assessments bring up stuff that maybe you're struggling with”. Others find CAA helpful to consolidate what has been explained in lectures: “it's drawn my attention to bits I probably missed in the lectures and… it's causing me to learn it again”.

The participants disagreed whether the feedback given by the CAA systems they used are adequate for them to improve. On the one hand, the feedback is sufficient for them to complete the summative assessment, “if there is a question I can't do I generally have a look at the worked example... and then just go back through until I can get 100% on the practice test”. However, there are several complaints with this approach.

First, the prescriptive nature of some feedback removes the challenge from the assessment: “The information in the practice tests is possibly in such a way that anybody without having attended any of the lectures... could probably answer and do fairly well in the actual test”.

Secondly, the quality and detail of the feedback is inconsistent: “sometimes you can click... and it will say slightly more than ‘this answer is wrong’. Occasionally it will say 'consider this'... or 'this is the kind of concept involved'... but there's equally a chance you get there and there's just a big cross”.

An important aspect of formative feedback is improving students' knowledge. When asked, students were quite scathing in their interpretation of their gains in knowledge and understanding: “with computer assessments... generally if I don't understand something going into it I don't really understand it when I come out”.

Another respondent said that the feedback in practice tests allowed students to copy the given solution and make appropriate numerical adjustments to mechanically retrieve answers for similar questions. He suggested that feedback should give “suggestions on how to solve it so people will still have to use a bit of brain”. A fellow participant lamented being able to “write down the answer without thinking”, explaining, “you're not actually learning any good skills”

One student suggested that there is not enough feedback in CAA for it to be deemed “formative”. He believed that CAA was useful to revisit key points at the end of a topic but that it did not guide his learning. This student also complained about the lack of feedback from the summative test: “it would be nice to have feedback on the questions – the ones that you get wrong where you've gone wrong rather than just a tick or a cross”. Others echo this sentiment.

As Hattie and Timperley (2007) suggest, students place the responsibility of finding learning gaps on their assessors. One might pose the question: do students stop trying to improve if they are no longer receiving feedback from their assessors? If that were the case it might suggest that students believe there is no need for independence once the summative test is completed. However, it might also appear that this student has not acquired the independence to obtain feedback independently or to self-regulate learning.

Despite their apparent dissatisfaction with the feedback they receive, they use it nonetheless. They believe the feedback from the practice tests is detailed enough to enable them to answer the summative test questions. Indeed, some students will not attempt the summative test until they achieve perfect scores in the practice tests. To that end, students described CAA as formative: “a computer test is a formative

assessment. Whilst it doesn't always sort of guide learning it can flag up useful things which you'll pick up on in terms of preparing for your [exam]"; "straight away that made me think that computer-based assessment is formative".

Conflict and its manifestation in activity

Participants used phrases like 'simple', 'not complicated', 'easy' and 'lazy' when discussing CAA. They like CAA, but admit this is out of laziness: "Again, the lazy part of me – because it's easy marks – would [choose] computer assessment [over traditional assessment]"; "If you want to make your life easy, then everyone will go for computer assessment. If you want to learn something and gain something out of the subject, then traditional assessment is better".

This is an indication of the conflict that lies within students. Students feel the need to acquire good marks in order to progress and ultimately gain a good job after university; however, these students have chosen a challenging subject that rewards exploration and perseverance. It seems students find the two incompatible: a student noted "I would like to be comfortable with the material and then as a result get good marks", but appeared not to be convinced that this is a viable path. However, they appreciate the need for mathematical understanding: "You want to be able to get to the next year of the course so you want the marks to be able to do that… but in later years you'll fall down if you don't know what you're talking about".

These students remain unconvinced that CAA is making them more adept at mathematics: "If you want to learn something and gain something out of the subject, then traditional assessment is better"; though they concede that CAA tests more of the module content than traditional forms of assessments: "You keep focussing on little bits, it might be a better way of learning".

It may seem a trivial point that students have a confused view of what CAA does for them and what their overall objectives for the course are. However, it is this confusion that we must understand in order to interpret how students are adapting to CAA. We turn to activity theory to structure these confusions and to inform our study.

Kaptelinin and Nardi (2006, 199) explain the associations between motives, needs, the students as subjects, and their activity. An intrinsic point they make is that subjects and their motives are not directly observable and these can be discovered through analysing their activity.

What is also clear is that students interpret their needs differently and their motives are influenced by this interpretation. We might, therefore, expect students to behave differently – perhaps uniquely – when presented with a CAA task to complete. However, these students appeared to act in similar ways. The participants all said that they practised until they achieved perfect scores, with variations such as note taking and using lecture material. We might conclude that their motives are similar.

Conclusions

Students believe that CAA offers formative feedback. It identifies areas of weakness and tests more of the module content. They do not believe that it is the best method of testing mathematical ability, but they believe it narrows learning gaps.

They feel that CAA is easy and describe their preference for CAA over traditional assessment as a 'lazy' choice. The feedback that CAA offers is close to the feedback they want and expect; but concede that the feedback is prescriptive and removes some of the challenge that mathematics ought to present. Students feel that

CAA is effective for improving their procedural adeptness, but there are better methods for assessing their conceptual understanding.

We might conclude that students like CAA because it is compatible with their motives, but it is to this point that we must turn our attention. There is a need to study how the activity system interacts with individuals' subjectivities; and activity theory suggests that to do so requires that we observe students' activity when undertaking CAA tests. As such, activity theory directs us towards observations in our future work to understand students' conflicts, motives and independence.

References

Beaton, A.E., I.V.S. Mullis, M.O. Martin, E.J. Gonzalez, D.L. Kelly and T.A. Smith. 1996. *Mathematics achievement in the middle school years.* Chestnut Hill, MA: Boston College.

Beevers, C.E., D.G. Wild, G.R. McGuire, D.J. Fiddes and M.A. Youngson. 2008. Issues of partial credit in mathematical assessment by computer. *Association for Learning Technology Journal* 7(1): 26-32.

Black, P., and D. Wiliam. 1998. Assessment and Classroom Learning. *Assessment in Education* 5(1): 6-74.

Greenhow, M. 2000. Setting objective tests in mathematics with QM Designer. *Learning Technology Support Network Connections* 2(1): 21-6.

Greenhow, M., and M. Gill. 2004. Setting objective tests in mathematics using QM Perception. In *Proceedings of the 8th CAA conference 2004,* ed. M. Ashby.

Hattie, J., and H. Timperley. 2007. The Power of Feedback. *Review of Educational Research* 77(1): 81-112.

Kaptelinin, V., and B.A. Nardi. 2006. *Acting with technology: activity theory and interaction design.* Cambridge, MA: MIT Press.

Pidcock, D.R., A.S. Palipana and D.R. Green. 2004. The role of CAA in helping engineering undergraduates to learn mathematics. In *Proceedings of the 8th CAA conference 2004,* ed. M. Ashby.

Ramaprasad, A. 1983. On the definition of feedback. *Behavioural Science,* 28: 4-13.

Sadler, D.R. 1989. Formative assessment and the design of instructional systems. *Instructional Science* 18: 145-65.

Sangwin, C.J. 2007. STACK: making many fine judgements rapidly. In *CAME 2007 – the fifth CAME symposium* 1-15.

Taras, M. 2002. Using Assessment for Learning and Learning from Assessment. *Assessment & Evaluation in Higher Education* 27(6): 501-10.

Wiliam, D., and P. Black. 1996. Meanings and Consequences: a basis for distinguishing formative and summative functions of assessment? *British Educational Research Journal* 22(5): 537-48.

Yorke, M. 2003. Formative assessment in higher education: moves towards theory and the enhancement of pedagogic practice, *Higher Education* 45(4): 477-501.