

Self-Reporting Emotional Experiences in Computing Lab Sessions: An Emotional Regulation Perspective

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Abstract

This paper reports on a study in which we compared two technologies for the self-reporting of emotional experience when learning to program: EmoSense and the Subtle Stones. Students used each technology concurrently during their computing lab sessions to report on the emotions that they experienced while programming, such as frustration, enjoyment, pride, etc. We found that the Subtle Stone, a tangible, hand-held device, was preferred by students, and offered a number of advantages over EmoSense, a desktop based widget. Most notably, it allowed students to become more aware of the emotions they were experiencing, and to change their behaviours and problem solving strategies as a result of this increased awareness. Because of its visibility, the Subtle Stone also allowed students to become more aware of each others' emotional states, and to respond in helpful ways. We argue that the preference for the Subtle Stone can usefully be considered through the lens of emotional regulation, and the opportunities that the Subtle Stone provides for both self and mutual regulation.

1. Introduction

Learning to program is a difficult endeavour, and students may experience a range of emotions when writing code, from confusion over concepts that are difficult to master, frustration at code that will not compile, and pride when a program finally accomplishes what the student intended it to do. Learners may not be fully aware of the emotions they are experiencing at the time, yet research has shown that emotions can impact greatly on the effectiveness of a learning interaction, for example, the ability to listen to a lecturer, complete a programming exercise, or willingness to contribute to a seminar discussion (Meyer & Turner, 2002). Giving students the tools to reflect on their emotions as they occur, and to communicate those emotions to others, may have a positive role to play in a learning context. However there are a number of issues that need to be considered. For example, would students see the benefit of reflecting on their emotions whilst learning? Would they want to communicate their affective state to others and if so, to whom, in what ways, and in what format? How would they want this information to be used?

The research described in this paper builds on previous work which explored the use of a tangible technology to allow students to report on their affective state in a classroom environment, and to communicate that information to their tutor (Balaam, Fitzpatrick, Good & Luckin, 2010). In that work, the context was a language learning classroom environment with high school students aged 12-14, where students often experience anxiety because of the public nature of speaking when learning a second language. In contrast, our focus was on learning programming, and so we were interested in potential differences between learners' affective experiences in these two contexts. Although programming does not have the same performative element as language learning, programming lab classes may well produce anxiety because one's work is displayed on the screen with a tutor passing by. Furthermore, the nature of the lab session puts the onus on the student to ask questions of the tutor when they may find it very difficult to formulate those questions in the first place. More broadly, the learning trajectory in programming is not linear, and students often hit plateaux where

their learning seems to stall, and concepts elude them. This can lead to frustration, and decreases in confidence, some so severe that students drop out, or change degree.

The broad focus of our research is on understanding the emotional experience of learning to program in higher education, with a particular interest shyness. In carrying out this research, we aim to understand how the emotional experiences of students change over the course of the term, as different programming topics and concepts are introduced to the learners, and students feel more or less confident in their work. We also seek to explore the impact of a self-report technology which allows students to express, communicate and share some of the emotional and behavioural aspects of learning to program with their tutor, or fellow students.

As a first step, we were interested in investigating how technology might best support students in reporting their emotions as they are learning to program in a computing lab class. In order to do so, we carried out an initial, exploratory study over the course of a two term, first year programming course in a higher education setting. We were interested in gauging student attitudes towards the concept of emotional self-report as a whole: sharing one's emotional experience in a formal educational setting is rather a novel concept, and perhaps more so in the hard sciences such as computing. It may well have been that students were uncomfortable or even unwilling to engage with the process altogether.

In addition, we were interested in looking at the types of technology which might best support students in such contexts, therefore, we used two devices which allowed students to capture their emotional experiences in a lab based computing setting, one of which was a desktop-based widget, EmoSense, and one of which was a tangible device, the Subtle Stone. We were interested in looking at how the features of each device supported different types of interaction, both between the student and the technology, but also between students and their peers, and students and tutors.

In carrying out the study, the following questions formed the focus of our research:

- What are the design / technology requirements for self-reporting emotions in HE contexts?
- What are students prepared to share about their emotional experiences and feelings of shyness, and with whom?
- How does a tangible tool for reporting emotional experience differ from a screen based tool in terms of students' understanding of emotion, willingness to use the tool, etc?
- Will students engage with such tools and, if so, in what ways do they use and appropriate them?
- Do students see the utility of such technologies for their learning?
- Does the expression of affective experiences during learning have behavioural implications?

In the sections which follow, we first describe the Subtle Stone and EmoSense, then go on to outline the study in which these technologies were used. We consider the findings from the study, and conclude with a discussion of the results, with some thoughts on the concept of emotional regulation as a plausible explanation for the results which we observed.

2. Technology Tools for Self-Report

2.1. The Subtle Stone

The Subtle Stone (Figure 1) was designed by Balaam (2008) to be used in a classroom setting to allow students to communicate their emotional experiences to their tutor in a private manner.



Figure 1: A Subtle Stone

The Subtle Stone was originally designed as an off-the-shelf juggling ball. It has a rubberised, ribbed exterior, and contains LED lights which cycle through 7 different colours when the ball is squeezed (one colour per squeeze). Each Subtle Stone has been augmented with a transmitter which wirelessly sends a signal to the teacher's computer each time that the Stone is squeezed. Students are typically provided with a list of seven emotions associated with learning settings, as identified in the literature (Pekrun, 2002). Each student can then map these emotions onto the 7 colours of the Subtle Stone in order to create their own colour:emotion language. When they are using the Subtle Stone, information about each change in colour, and hence emotional state, is sent to the teacher interface.

This information is represented to the teacher as a map of the classroom (Figure 2), with an icon for each student: when a student is displaying a "positive" emotion (e.g. pride, enjoyment), the student is shown in green, when a student is displaying a "negative" emotion (e.g. frustration), the student is shown in red. The tutor can access the specific emotion being communicated by each student via rollover text.

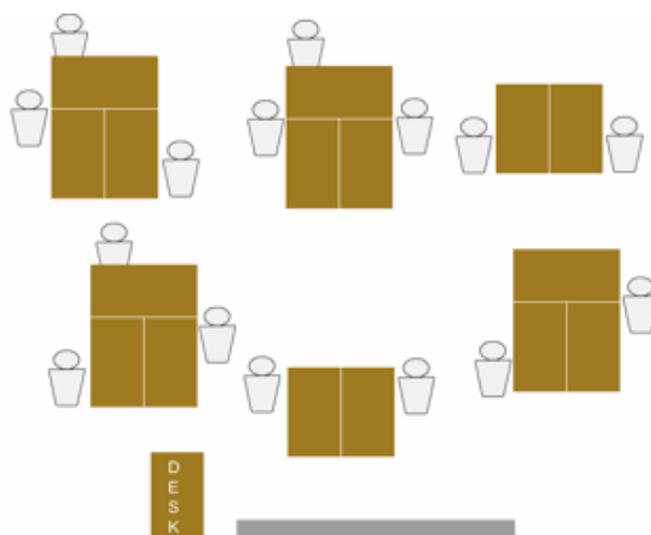


Figure 2: The Subtle Stone Teacher Interface

2.2. EmoSense

EmoSense (Figure 3) is a desktop based widget designed specifically for the purposes of the study. It shares a number of features with the Subtle Stones, most notably, it allows the learner to report a subset of emotions typically associated with academic settings through the use of colour, and these

emotions can be communicated to the tutor. However, given that EmoSense tool was specifically designed to be used in a computing lab class, we made the decision to develop a technology that was desktop based rather than tangible. Additionally, although the design of the Subtle Stone is compelling in its own right, its interface is limited to the display of colour, and a single one at any given time, and we were keen to take advantage of the interface design possibilities of the desktop display to investigate such issues as student reasoning behind their emotional choices, etc. Furthermore, as a result of our own previous empirical work (Balaam, Fitzpatrick, Good & Luckin, 2010), and the work of others (Fagerberg, Ståhl and Höök, 2004), we decided to make various design modifications with respect to the Subtle Stone. EmoSense differed from the Subtle Stone in that it offered:

- the ability to report on multiple emotions simultaneously (a desire which had been expressed by learners in previous Subtle Stones studies);
- the ability to report “degrees” of emotion (based on work by Fagerberg, Ståhl and Höök, 2004);
- a tick box labelled “I want to ask a question but daren’t” (designed to look at how emotions related to shyness might manifest themselves behaviourally, based on work by Crozier (2004));
- a “twitter style” text box in which students could write down any reasons for the emotional states they were experiencing, or any changes in these states.

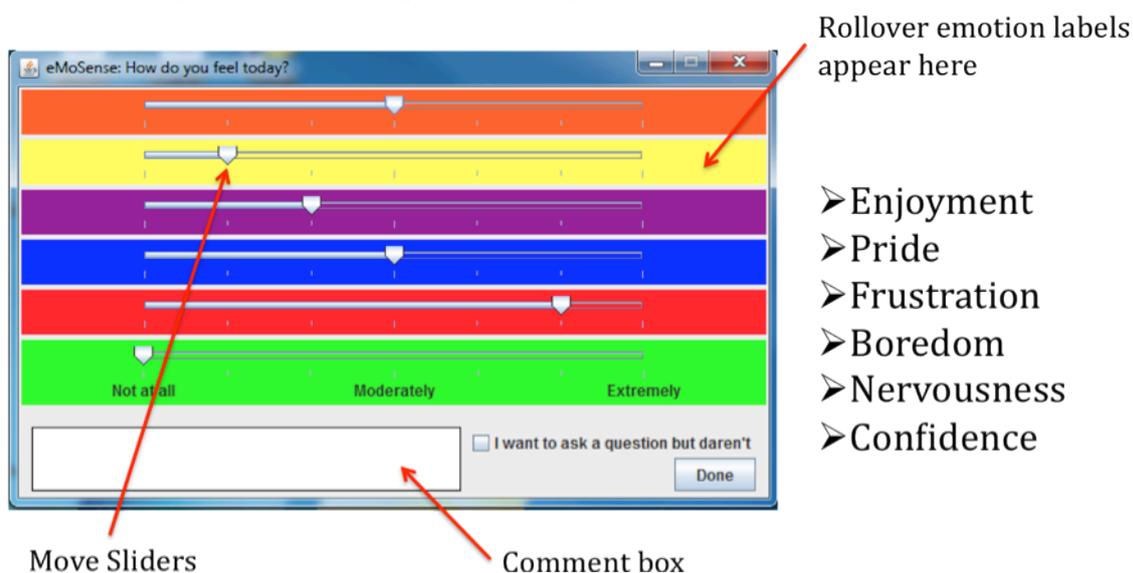


Figure 3: The EmoSense Tool

The widget features six emotions which were selected as being those which were most likely to be experienced in educational settings (Pekrun, Goetz, Wolfram & Perry, 2002): enjoyment, pride, frustration, boredom, nervousness and confidence. Like the Subtle Stones, students could map colours onto emotions, choosing which colour would represent which emotion. Unlike the Subtle Stone, they were not limited to a small range of colours, but could instead choose from those available on a typical computer display.

3. The Study

In this study, we were interested in comparing the two technologies described above, and the rest of the paper focuses exclusively on this issue. However, the study also considered the experience of shyness in higher education, and how that might impact on learning to program: this is described in another paper in this volume (Rimmer, Good, Harris & Balaam, 2011).

The study we conducted was largely exploratory in nature. The consideration of emotions in learning contexts is still a fledgling research area, and it is unlikely that our computing students had ever been asked to actively reflect on and report their emotional experiences while learning. Therefore, we were interested to know whether they would want to engage with the technologies in the first place.

The study took place in a Further Programming course which ran over the spring and summer terms in the first year of a Computer Science undergraduate degree. Students were learning Java, and covered such topics as algorithms and data structures (arrays, lists, trees, graphs, depth- and breadth-first search, the minimax and A* algorithms). Students attended three lectures per week, and one two-hour lab session: the study was focussed on the lab session. During the session, students had programming exercises to complete, and worked at their own pace. The lecturer who taught the course was available during the lab sessions to answer any questions and provide help when needed.

During the spring term, the EmoSense tool was available for all students to use during their lab class. EmoSense “nudged” the students every 15 minutes, asking them whether they would like to record how they were feeling. They could ignore the prompt if they chose, or use the sliders to denote changes in their emotions, and any reasons for these changes. At the end of the spring term, students were contacted and asked to take part in an interview: 10 students responded. The interviews were semi-structured, took part both individually and in small groups, and focused on the students’ experiences of the course, of their first year of university in general, and on their use of the EmoSense tool. Interviews lasted for approximately one hour.

In the summer term, the Subtle Stones were available for use, and students were contacted to continue taking part in the study. 16 students chose to take part. A Subtle Stone was made available to each of these students during their lab sessions.

Although EmoSense and the Subtle Stone tools were similar in that they were technologies designed allow students to record and communicate their emotions in learning settings, and both used colour as a means of doing so, they differed with respect to prompting: while EmoSense prompted students to record changes in their emotions at regular intervals, the Subtle Stones did not, and students were free to change the colour being registered when they wished. Students were given the following seven emotions: pride, enjoyment, frustration, confusion, confidence, nervousness and boredom, and then chose which colour to map to which emotion.

At the end of the summer term, students were contacted and asked to take part in an interview: 15 students responded. The interviews were semi-structured, and focused on the students’ experiences of the course, and on their use of the EmoSense of the Subtle Stones tools, including their likes/dislikes, the ways in which they used each tool, etc. Interviews lasted for approximately one hour.

4. Findings

A number of interesting themes emerged from the interview data which were informative in terms of the original research questions asked, and also provided further insight into the relative merits of the respective tools for emotional self-report. Additionally however, the study highlighted a number of issues around the affordances of the tools, particularly the Subtle Stones, and the unexpected ways in which they were appropriated by the learners. We discuss these below, with reference to the interview data (note that where quotations from the interviews are shown, pseudonyms have been used).

4.1 Design/Hardware Issues

EmoSense was designed as a prototype for the purposes of the study only, and the Subtle Stone is a research prototype, however, even allowing for this, it’s clear that there were design and hardware issues that students found problematic, and that prevented them from engaging with the tools as fully as they might have.

With EmoSense, we experienced a number of network problems in the early part of term, which led to a large number of students simply abandoning the use of the tool. With the Subtle Stones, students

commented that it was sometimes necessary to click twice on the Stone in order to change colour: although annoying, they nonetheless persevered with the use of the tool.

4.2 Tool Preferences

Although not unanimous, there was nonetheless a very strong preference for the Subtle Stones over EmoSense. This was somewhat surprising, as EmoSense had been designed to take into account findings from previous empirical work with the Subtle Stones and incorporate improvements. For example, EmoSense provided students with the ability to record more than one emotion at a time, a desire which had been expressed by learners in previous studies with the Subtle Stones.

Students' negative stance towards EmoSense seems to have been due in part to aspects of its functionality and in part to its design, which was not engaging. In terms of functionality, students singled out the prompt which, compared to the Subtle Stone, shifted the locus of control from the learner to the device:

If you're in the middle of a very annoying piece of programming, EmoSense pops up. That is also annoying. So you'd be like, 'Oh go away.' But this [*Subtle Stone*] is actually detached from the computer. Like it's sort of an innocent thing, whereas EmoSense is just sort of preying on your emotions. (Marcus)

The number of emotions which can be expressed at any one time, and degrees of emotion were also picked up on, with many students expressing a preference for a simpler interface:

But I think EmoSense is just far too complicated, because you have to think . . . so you think to yourself I'm pretty bored right now, so you put the boredom scale right up. And then you go frustrated, I don't know, am I frustrated, like 30% frustrated, what does that mean and it was just . . . and then you have to adjust all the other scales as well. (Mike)

You can't really measure different weights either. You're either frustrated or you're not. It's sort of like you're either confused or you're not. You're not really . . . you can't measure, say about, if you're more emotional than another. It's a better way of saying what your overall emotion is and not what a combination is. (Robert)

In addition to its rather basic aesthetics, a final flaw with respect to EmoSense was a lack of clear feedback when learners had made changes:

There's nothing appealing about the application, nothing at all I don't think, because there's thousands of apps like that and thousands of apps better than that. It just doesn't . . . I think one of the main problems is it doesn't show that you've actually changed it. At least with that [*Subtle Stone*], you changed your light and actually you can see it. But whereas when you just slide it, I can't remember if it applied or anything or it was there already. You just slide it. (Miles)

Functionality aside, the design of the technology was a determining factor in students' preference for the Subtle Stone: its appearance was engaging from an aesthetic point of view and its tangible, physical nature made it more appealing than a standard desktop interface.

My impression of the actual physical object, I thought it looked interesting. It's something I'd like to touch. It's some kind of material and things and you just think, 'Oh, I'd love to touch that and see what it feels like, what it looks like'. (Doug)

EmoSense was just sort of a boring little program, whereas this [*Subtle Stone*] is like a cool light up ball. (Marcus)

Furthermore, the Subtle Stone afforded a physical interaction which was not possible with EmoSense, and which appeared to be very compelling. Almost all of the students mentioned the "fiddle factor" in some guise:

When I first got it, I must admit I did squeeze it quite a lot. I think when I was programming, if it was red [*student's colour choice for frustration*], I used to hold it

on its side, so I wouldn't press the button and just like put pressure on it just so I can have . . . like kind of like a stress ball, just so I can have something to grip. (Kevin)

Yeah, it was quite fun to have a thing to hold. I already said distraction, but it was a distraction. It was quite nice. So if I was thinking about something, it'd be quite fun to sort of hold it and roll it around. (Jack)

Like I said the joy of just bouncing it around, thinking about stuff, rolling it around the table, squeezing the rubber. (Doug)

I quite like using the stones. I don't know why. But I found it quite therapeutic. Just being able to hold it and roll with it and play with it while coding. The fact that it was a lot easier to change between emotions made it a lot easier to use, because the application was quite complicated and it kept prompting to say have you done it. (Robert)

4.3 Effectiveness of the Self-Reporting Tools

The design of the Subtle Stones was such that it served as a constant reminder of a student's current emotional state, assuming, of course, that the Stone had been updated recently. This was in contrast to EmoSense, which could be tucked away and ignored. As such, the Subtle Stones were more effective at making people aware of their emotions:

I thought it was a cool idea. It just makes you . . . having used it, definitely has made me more aware of what I'm feeling, because I'll just think I'll update the ball to what am I actually feeling and you just sort of change it and it makes you more aware of your own emotions as you're programming. By the time we'd finished the last couple of lab classes, I'd be writing a bit of code and it wouldn't be compiling and I wouldn't even think about what I was feeling, but I just know to change the ball to frustration because it's just like 'I want to get this out'. (Kevin)

In addition to the real time display of emotional state provided by EmoSense and the Subtle Stones, both tools generated graphs of students' emotional state over the course of a lab session. We reviewed these log files with students during the interviews. Although they require students to think back to the session and remember what activities they were engaged in, and hence what triggered the emotions they were experiencing, they can be useful in uncovering patterns in emotional experience:

I mean if you could seek out the readouts, kind of the rough times during the seminars, you would kind of be able to look back and see yes, I usually get annoyed at these kind of stages, and then kind of try asking people or students and discuss those kinds of rough points in time so you don't carry on feeling bored or stressed out. I mean kind of talking with other students, you can see the problem how they see it and come from different angles. (Darren)

4.4 Behavioural Implications of Emotional Awareness

As mentioned above, the fact that the Subtle Stones were visible seemed to increase students' awareness of their emotional state while they were programming during the lab class. Some also began to recognise patterns of emotion, and points during programming when such emotions might be experienced.

For some students, this heightened awareness also led them to proactively change their behaviour in response to their emotional state, for example, to seek help, or take a break or change their problem solving strategy. In many of the quotes below, it's clear that students began to engage in internal, metacognitive dialogues as they considered possible strategies for dealing with their emotional states:

It did try and help as a sort of reminder to stay calm kind of thing. Like you'd see it glowing on red [*frustration*] for a good 5 minutes, you'd be like, 'Well, time to chill out, go outside, smoke a rollie and then come back and get back to work'. (Kevin)

I guess if you look at it and you set it to 'I'm bored' or 'I'm frustrated' or 'I'm confused' and then you'd sort of set it and then look at it and think, 'My God, why

exactly am I bored, shall I make myself not bored?'. I guess it's the kind of thing that you try and . . . if it's a negative emotion, you try and cancel out I guess, if you saw it there just floating in red. (Marcus)

"There were quite a few times where I did think I've actually left it on white [*boredom*] for a good 20-25 minutes, so I might as well just go home because this isn't really going or appealing to me. When it was on red [*frustration*] for too long, I'd be like right, that's it, it's chill time. I'll see if I can get Alien Swarm on Steam or something." (Kevin)

Every 5 or 10 minutes, kind of go, how is this, I've just written a big old bit of code, confident and then it's like I've got my ball set to confident, I'm doing well. Then 5 minutes later, like bored. What's my next task here? What do I actually need to get done? What's the next step? So it would kind of make me think about how it was working, which in turn sort of helped me to work a bit better. (Mike)

...it definitely worked as a reflective tool where you can actually make sure you're more in tune and understand what you're actually feeling. So you could base your studying around what you're actually feeling at the present moment in time. (Kevin)

4.5 Building Communities of Learners

The Subtle Stones were originally designed as a way of allowing students to reflect on their own emotions and to communicate those emotions to their tutor in a private manner. In the original study, with younger students in a language learning context, learners often kept their Stones hidden from view.

We found, in contrast, that virtually all of our students kept their Stones on the table beside them, in full view of the other students in the lab. Furthermore, we found that learners began to share their colour:emotion language with each other, which led to interesting group behaviours which we hadn't anticipated.

I thought the idea of actually a piece of hardware that provides an emotional reflection is quite an interesting idea. You could look around the class and see other people's balls going different colours. (Marcus)

No one knew the colours. I mean I told a few people, but it didn't really matter. I think that might have actually helped, because I think there was a couple of times where I just had it on red [*frustration*] and my friend said after, 'Yeah, I was going to come and say something to you, but I didn't because it was on red. So I thought I'll just let you work for a little bit longer'. In terms of actually hiding it from people, I had no real issue with that. It's just like, 'I'm frustrated now'". (Kevin)

After a few weeks, we all discovered, me and the 3 other people that sat around, that we all had frustration on red. That was just how it felt for me, but they'd all chosen that. So whenever everyone was red, it was like we were all just annoyed. (Mitch)

After a while, we did know each other's kind of colours and association, so we go, 'Yeah, should we get [*the tutor*] over?' and like that kind of did make [*the tutor's*] life a lot easier, just explaining it once to 4 or 5 of us than explaining it 5 separate times. (Darren)

4.6 Self-Reporting Tools and Communication of Emotion

With both EmoSense and the Subtle Stones, there is a tension between using the technology as a reporting tool for one's own personal use, e.g. to increase awareness of and possibly try and modify one's emotional state, and using it as a communicative tool to inform others of one's emotional state.

The latter scenario, where the learner uses the technology to communicate her emotional state to another person, has a number of implications, most notably around control of the communication, and potential audience. In EmoSense, the emotional data collected was logged, but was not being sent in real time to any other party (although if the tool were to be further developed, this information could be sent in real time to the tutor). In contrast, the Subtle Stones transmitted data in real time to a

teacher interface (Figure 2), which allowed another party (usually a teacher, but in the case of this study, the researcher) to view any changes made to each student's Subtle Stone as they happened.

From the above discussion, there appear to be benefits to having tools which allow learners to become more aware of their own emotional state, however, when used as a communicative device, views were more mixed. Some students felt comfortable expressing their emotions to others via the Subtle Stones:

No one really asked [*about the Subtle Stone*], that was sort of a shame. I really didn't mind. It was all the case of I'm here to learn, so it's sort of bad if I don't show that I'm confused or don't show that I'm frustrated. (Robert)

Others expressed more concern, especially if the emotion in question could somehow be seen as a "negative" emotion.

That would be a good idea [communicating to the tutor how you are feeling]. It would also possibly mean that some people sort of don't want to use it because they don't want [the tutor] to come over and like bother them if they're nervous. (Marcus)

I think possibly like if I was sitting with a group of people that I sit with and they were sort of getting on and you were just sitting there sort of semi confused or may be a bit behind, you wouldn't really go out of your way to express that you're really confused because you just want to do it privately perhaps. (Marcus)

I thought may be it's being projected to your thing [*teacher interface, Figure 2*], you might then say to [the tutor] look, Jack is on 'confused', you should go help him. I thought that might be quite scary. Like it would be the same as asking a question kind of thing. I'd maybe leave it on 'enjoyment'. (Jack)

Communicating one's emotions could lead to students becoming concerned about self presentation, and choosing emotions that they feel they *should* be experiencing.

I was quite conscious that I was on bored for quite a lot of the time, and so I thought I'd just probably change it. I'd change it for a minute or so thinking that I'm still quite bored and then change it back, which is why my battery ran out quite quickly because it was the white . . . it was on three lights. Because I knew that you'd know what they were, I thought may be you might think, 'Jack was bored quite a lot of the time, he might have some issues or something'. So I thought I'd change it every now and then. (Jack)

5. Discussion

The findings from this study suggested that students do find value in using technology to report on their emotional experiences while learning to program. Doing so led to an increased awareness of their emotional state and, in many cases, prompted them to change their behaviour as a result. There was also a preference for the Subtle Stones, which students found very engaging, often playing with it and using it as a stress reliever while programming. Its visibility meant that students began to share information about their emotions with other students, which led to a sense of community and, in some cases, decisions to take collective action (e.g. calling the tutor over to get help).

From an interaction design perspective, these results could be explained by the affordances of the Subtle Stone: it was engaging, easy to use and learner controlled. In addition, it was aesthetically pleasing, both visually and from a tactile perspective.

However, we feel that the preference for the Subtle Stone can also be considered through the lens of emotional regulation. Although only in its preliminary stages, this perspective would seem to offer a promising line of enquiry. Emotional regulation can be defined as "the intra- and extra-organismic factors by which emotional arousal is redirected, controlled, modulated and modified to enable an individual to function adaptively" (Cicchetti, Ganiban & Barnett, 1991, p. 15). In other words, emotional regulation involves the ability to modulate one's emotional responses to various internal

and external stimuli, and to maintain an optimal level of arousal, as extreme emotions (either positive or negative) can adversely affect an individual's communication and problem solving skills (REF!).

There are a number of ways in which we regulate our emotional state, and we all do so frequently without giving it conscious thought. Emotional regulation strategies can be broadly categorised in terms of self-regulation and mutual regulation, with behaviours of both types occurring from infancy (Tronick, 1989). With self-regulation, we may engage in physical activities such as exercising (or alternatively eating chocolate or drinking wine) when feeling stressed, or going out for some fresh air during a break in a boring conference. We may also use more cognitive strategies, for example, trying to positively reframe a situation by gathering statistics on safe plane landings if one has a fear of flying. Mutual regulation might involve comforting someone who is upset, or trying to cheer someone up.

When looking at the differences between EmoSense and the Subtle Stones, it would appear that both tools provide increased opportunities for emotional regulation generally by increasing student awareness of their emotional state. This led to cognitive and metacognitive strategies with respect to the students' learning and problem solving. However, the Subtle Stones also provided an outlet for self-regulation through physical means, as suggested by the quotes below, and many of the quotes in Section 4.2:

It definitely acts like a stress ball. I'm quite fidgety. So it gives me something to channel all my fidgetiness into it. (Robert)

Some movement distracts your hands while your mind does some thinking. (Doug)

This physical style of emotional regulation also extended to the group:

It was quite a fun thing to mess around with. We started inventing little games with it. We rolled them into the boxes and things. They were quite a distraction, but I quite like the distraction. (Jack)

Furthermore, the visible nature of the Subtle Stones allowed for mutual regulation to take place more easily. By explicitly highlighting one's emotional state, communication could focus on ways of helping individuals to emotionally regulate (e.g. not risking communicating with someone who was frustrated and possibly increasing their frustration, or alternatively, seeing that others were frustrated and deciding to call the tutor over).

Although it is clear that further work is needed, we are encouraged by the results obtained so far, and feel that there is promise in using technology to allow students to reflect on their emotional experiences whilst learning to program. Future work will focus on refining the technology so as to retain the best features of the Subtle Stones while enhancing the capacity for communicating one's emotional experience to others. We will also be investigating more closely the role that tangible technologies might play in emotional regulation.

6. Acknowledgements

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