The computer in the classroom: a medium for enhancing social interaction with young people with autistic spectrum disorders?

Angela Jacklin and William Farr

Angela Jacklin is a senior lecturer in education and director of student support at the University of Sussex. William Farr is a teacher at a primary school in Sussex, and a former MA student at Sussex University. In the project reported in this article, they worked together to consider how valuable the computer may be as a medium to enhance social interaction with pupils with autistic spectrum disorders. The research took place in a special school for pupils with severe learning difficulties in the South East of England and involved 12 children from the school's unit for pupils with autism. From this initial group, three pupils were selected for more focused study. Using a mix of qualitative data gathering and analysis stragegies, the research highlighted the importance of social interaction around the computer and indicated that the computer could be a useful tool for enhancing social interaction. This was found to relate in part to the adult's ability to follow the child's lead, as well as the complex intermingling of events known as 'tricky mixes'. Where this happened, use of the computer appeared to result in more sustained and more positive interactions for young people with autistic spectrum disorders.

Key words: **autism, computer assisted learning, interaction, social development.**

Introduction

For many of us, communication is a relatively unproblematic process. We learn to interpret everyday visual and auditory cues, such as facial expressions, body language or the intonation of a voice. We learn that other people may see things differently. In turn, this helps us create a world in which we engage in social interaction and communicate with others fairly easily and effectively (Dockrell & Messer, 1999). However:

> '…imagine yourself alone in a foreign land. As you step off the bus, the local people crowd toward you, gesticulating and shouting. Their words sound like animal cries. Their gestures mean nothing to you. Your first instinct might be to fight, to push these intruders away from you: to fly, to run away from their incomprehensible demands; or to freeze, to try to ignore the chaos around you.'
>
> (Happe, 1994, p. 49)

For many individuals with autistic spectrum disorder (ASD), this imagined scenario may be their social reality: social interaction learnt amid confusion. Where language is present, it is often functionally limited, out of context or even random (Frith, 1989). An inability to interpret social cues (a key feature of ASD) means that many techniques of social interaction are not acquired naturally and must be learnt. As Jordan (1999) argues, people with ASD need to be taught what communication and social interaction (however basic) are actually *about*.

We wondered if and how a computer, a common feature now in classrooms, could be used to enhance social interaction among young people with autism. We were especially interested in this possibility since Jordan (1999) has argued that individuals with ASD may actually learn faster with a computer, partly because the stress of having another person present is taken away. However, she also warns that while those with ASD may learn faster using a computer, they may not actually be learning about interaction (Jordan, 1999).

The nature and social consequences of ASD are complex, with causation, diagnosis and treatment still debated. Frith's three-level model is often helpful in trying to understand ASD, since it encourages a consideration of the biological, behavioural and cognitive aspects of autism (Frith, 1989). It is the behavioural level that is perhaps the most immediately recognisable for staff in schools as it is behaviour that can be observed and must be managed in the classroom. However, as Jordan (1999) highlights, while behaviours are important, we need to move beyond reactions to behaviours towards an understanding of the way the individual with ASD is thinking.

At the cognitive level, as well as failing to appreciate the thinking of others, individuals with ASD have what is known as weak 'central coherence' (Happe, 1994). Both factors directly affect learning capacity. Central thought processing gives priority to meaning and, without this, interpretation, comparison and 'storage' of information are problematic. The child with autism, as Frith (1989) explains, tends to ignore 'the picture and therefore can still see the individual puzzle pieces in the completed picture'. In addition, learning can be very context-bound, with difficulties evident in generalisation and the taking of meaning from experiences (Jordan, 1999).

In some respects, there are similarities between the functional processing of the computer and cognitive functioning in, for example, in relation to autism, the inability to make inferences. Computers allow for a tunnelled, selective, individual focus so they can become part of and emphasise an individual's 'attention tunnel' (Murray, 1997). The computer allows us to become wrapped up in its processes enabling the outside world to be shut out. It has an element of predictability and none of the social confusion that is inherent in everyday social life. Ironically then, while at one level being well-suited to promoting learning in individuals with autism, computers may, in fact, create a more obsessive focus, and encourage less interest in social interaction. Here lies the central problem concerning the use of computers with youngsters with ASD.

Jordan (1995) has highlighted how computer use has been slow to develop, mainly because of concerns raised by academics and teachers that computers may reinforce certain autistic behaviours and result in increased withdrawal from the social world (see, for example, Moore, 1998). In addition, there is a problem with the availability of appropriate software. As a result, research has tended to focus on language development (see Heimann, Nelson, Tjus & Gillberg, 1995; Heimann & Tjus, 1996; Murray, 1997), a key concern being the enhancement of communication (see ASILESP, 2001).

It was the problematic nature of computer use with young people with ASD that provided the rationale for this research. We were interested in the usefulness of the computer in the classroom. Would it add value to social interaction? How did teachers make use of the computer? Could the computer be effective and, if so, how?

The context for the study: Handel School

The research took place in an all-age special school for pupils with moderate and severe learning difficulties. Handel School is situated on two sites, with children in Key Stages 1 and 2 (age range four to 11) in the main building, and those in Key Stages 3 and 4 (11 to 16 years) and the further education department (16 to 19-year-olds) on the co-located site. Within the main building, there is a unit for children with ASD which is split into four classes known as EY, A1, A2 and A3, the classes ranging in age from reception to the end of Key Stage 3 (see Table 1).

Table 1: The unit for pupils with ASD at Handel School

Class	Age range	Number of pupils	Number of staff	Teacher	Case study pupils
EY (Reception – Year 1)	4–6 yrs	6	4	Mrs Reeves	Ryan
A1 (Years 2–5)	6–10 yrs	5	3		
A2 (Years 6–8)	10–13 yrs	5	4	Mr Peters	Paul
A3 (Years 9–10)	13–15 yrs	3	3	Mr James	John

Handel School was chosen for this study mainly because of familiarity and access. One of the authors teaches in a primary school adjacent to Handel and, for the last two years, has been involved in the development of links between the two schools. Thus, although not directly *the* classroom practitioner, one of the authors was *a* working practitioner and was often present in Handel School for purposes other than research. The focus of the project, which was developed through negotiation with staff, was to investigate the use and potential of the computer as a way of enhancing social interaction among young people with autism.

The research strategy and approach

The study was small-scale and largely qualitative in approach, aiming to explore actions and interactions in the context of the classroom (Cohen, Manion & Morrison, 2000). Data collection used a mixture of participant and non-participant observation together with focused interviews with staff who worked with the three case study pupils (Ryan, Paul and John). The project had two main phases: an initial observational period which involved 12 pupils and a main (case study) phase which focused on the three pupils. The initial observational data provided for a more 'broad-brush' analysis and informed the focus for the case studies. The case studies themselves allowed for more detailed analyses. We focused on naturalistic interactions and tried to analyse the different styles and methods of interaction around and with the computer, as well as away from it. We looked in particular at communicative behaviours and focused on periods of more positive or more negative social interaction and levels of engagement. The behaviours fell broadly into three categories:

- vocalisation;
- facial expressions, gestures and other non-verbal communication;
- motor behaviours such as taking or giving objects, or touching/poking/grabbing someone or something.

The initial observation phase

Following a pilot study, data were gathered from 43 observations, varying in length from ten to 20 minutes, comprising approximately ten hours of observation in total. Codes were developed to facilitate data gathering and analysis, drawing on pilot observations and informed by key literature (Wing & Gould, 1979; Frith, 1989; WHO, 1993; Wing, 1996; Baron-Cohen, 1997). The attempt to code the data was problematic: some codes were difficult to define clearly and, in practice, some overlapped; most importantly, the coding ignored the social context of computer-based work. During the pilot study, categories were refined and later used analytically rather than for the collection of data. The latter became qualitative in approach, using a mixture of observation schedules and field notes. Critical incidents that occurred around a computer were also recorded. The process of developing and defining categories was itself useful in the clarification of the focus of the research. Data were later re-analysed in relation to interaction.

The case studies

Many of the teachers at Handel School were interested in the project. Those who showed a particular interest were approached to discuss the viability and practicality of data gathering within their classroom. As observation of the pupil working with the computer was clearly important; it was essential that careful negotiation was carried out with the teachers concerned. During the observation phase, three case studies were identified (from the initial 12 pupils) using criteria sampling, and more detailed fieldwork was carefully planned. Each case study pupil was subsequently observed a minimum of four times, in contexts involving the computer as well as contexts away from it. Informal and semi-structured interviews, specifically aimed at following up the observational data, were carried out with the teachers and teaching assistants who worked with the three case study pupils. Questions ranged from the more general (for example, focused on the perceived value of the computer), to the more specific (for example, how usual specific, observed patterns of behaviour were thought to be, or whether respondents had noticed any changes in interaction when the pupil was around the computer). A research diary was used for recording and some interviews were also taped. Other data sources were pupil work, work records and Statements of Special Educational Need.

The case studies

The three case studies (Paul, John and Ryan) were chosen to illustrate issues that emerged from the study, but mainly to allow us to focus in more depth on pupils of differing abilities as well as differing ways of interacting with the computer and with other people. Paul presented with the most challenging behaviour and tended to interact only with the computer in what his teacher called a 'dual carriageway' of interaction. John interacted with the software as well as with the computer, but required much prompting. Ryan's skills of social interaction and communication were the strongest of the three pupils. He worked with the computer and his teacher in a much clearer triangle of interaction, with turn taking more specifically established. This section introduces each pupil and describes typical behaviours around the computer.

Paul (aged 12, class A2)

Paul had limited language and was encouraged to communicate primarily through sign. His Statement of Special Educational Need stated that he required:

> *'…opportunities to develop independence (concentration, initiative, sharing, planning) and co-operation with others… [and] a teaching environment where stress can be kept to a very minimum'.*

One of the initial reasons for Paul's inclusion in the study was that his Statement suggested that something like computer-assisted instruction could help reduce stress, as well as help to foster sharing and interaction skills. His teacher, Mr Peters, was also very keen that Paul had extra time around the computer. He was very positive about the benefits of the computer for enhancing social skills because of, as he explained, the way it:

> *'responds in a particular way. Response is fundamental to any interaction or action-response. For example, a conversation can go any number of ways but, with a computer, because of the way it is structured, it can be set up so that there is only one possible response.'*

When observed working alone with the computer, Paul tended to be restless, fidgeting, standing or sitting and moving away from the computer, or at times jumping up and down if the computer reacted in a way that he liked. When an adult was present at the computer, Paul tended to become more possessive. He knew when it was his turn to use the computer and was always excited when using it. Typically, Paul holds one hand up around his face, palm inwards. Sometimes he would be looking really closely at his hand, at other times, Paul would get right up close to the computer screen and speak directly to the screen as if it were another person.

At times Paul would spend up to five minutes on one piece of software before losing interest. At other times he did not seem to lose interest but would revert to more obsessive, repetitive behaviours and would quite happily make the computer keep repeating a phrase or screen over and over again. However, it was at this point that his teacher would intervene, generally asking him whether he wanted a new piece of software. For Paul, changing the CD-ROM seemed to be important in terms of developing social interaction skills and his ability to turn take. The example below was typical of the nature of the interactions that occurred:

Mr Peters:	*Paul, no!* (Paul had tried to wander off and disturb another pupil who was working nearby. The teacher tries to bring Paul back to the computer and takes his hand.)
Paul:	(Yells)
Mr Peters:	*Liam is trying to work…*
Mr Peters:	(to observer) *He would quite happily repeat that screen all day but…* (Gets distracted by Paul who is pulling on his arm.)
Mr Peters:	*Paul, do you want a different CD?*
Paul:	(stops pulling) *Uhhh.*
Mr Peters:	*Do you want a different one? Tweenies*? (Mr Peters gets the CD and hands it to Paul.)
Paul:	*Uhh, ehh.* (Claps, presses button to open CD-ROM drive and inserts the disc very carefully, looks at the computer screen and, through a rather convoluted method, gets the computer to load up the disc. He then clicks on the screen which asks him if he wants to quit.)
Mr Peters:	*Paul, are you sure you really want to quit?*
Paul:	*Staaart* (then clicks on screen onto a nursery rhyme).
Computer:	*One, two, three, four, five, once I caught a fish alive…*
Paul:	(Continues to clap with his face near the screen.)
Computer:	*…which finger did it bite?*
Paul:	(Starts to navigate, apparently aimlessly, around the CD.)

Mr Peters: *What do you want to do? Painting? Writing? Choose.* (Mr Peters leaves Paul to attend to another child.)
Paul: (Clicks on painting.)
Computer: *Messy time, I love messy time*.
Paul: (Claps then clicks apparently randomly for a while.)
Computer: *Story time!*
Paul: (Continues playing in this way until Mr Peters returns.)
Mr Peters: *Time to finish now, Paul.*
Paul: (Ignores Mr Peters and continues to explore.)
Computer: *One more time, please!*
Mr Peters: *Good boy, Paul, that's it, you're finishing really well.*

It is the second part of the example above that best illustrates what Mr Peters aptly described as the dual carriageway of interaction between Paul and the computer. It also clearly illustrates, first, the way in which Mr Peters intervened to establish more 'action-response' and, second, the importance of human interaction *around* the computer and *with* the computer. The computer cannot be seen as separate from the social act. It is within the social context of the classroom and part of the social act.

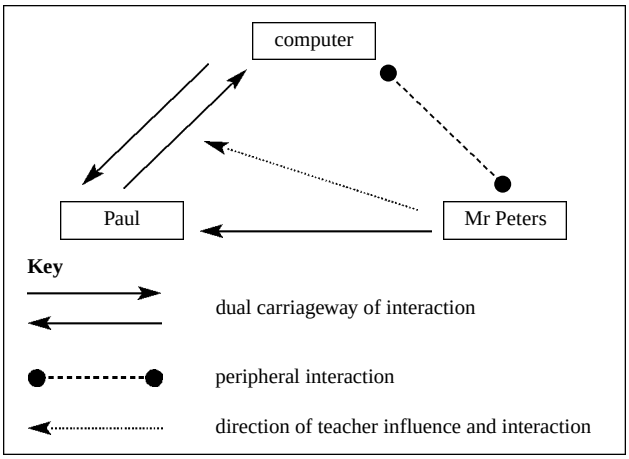
In the first part of the above example, which occurred over approximately a four-minute period, it can be seen that Paul, although having lost interest, was motivated by use of the computer and that the teacher was able quickly to regain Paul's interest by offering another CD. It becomes more apparent how important this typical interaction is when compared with another incident involving the teaching assistant (TA) that occurred away from the computer:

Mr Peters: *Come on then, Paul, get your coat on.*
Paul: *Uhh.* (Starts to cry and then drops to the floor and starts to roll around.)
Mr Peters: *Come on, Paul. Playtime.*
Paul: (Starts to yell and moan while looking at Mr Peters.)
Mr Peters: *Paul, you need to go outside, it's not cold.* (TA walks in.)
TA: *Shall I take him so you can go?*
Mr Peters: *Yes, please, the others are already outside.* (leaves the room).
TA: *Come on, Paul* (picks him up and starts to put on his coat).
Paul: (Responds by hitting TA.)

In this incident Paul eventually went outside but only after being almost carried out. This was not the only time away from the computer that Paul presented this form of behaviour. For instance, in a group activity, when the four pupils in A2 were being introduced to the day, Paul would not join in or respond positively to any teacher directions. Although in this example Paul's behaviour could possibly be explained by the group context, conversely it was felt that it was actually the context of the computer that helped provide not only a learning context, but also a context for developing skills of social interaction.

What is interesting to note is that in both examples above (with and without the computer), Paul did not initially want to comply. In the first incident, the computer acted as a motivator and Paul was brought back on task. In the second incident, neither the teacher nor the teaching assistant were able to get him to comply. Could the marked differences in behaviour highlighted in these two instances perhaps be explained by Paul's interest in the computer itself? His teacher thought this was unlikely: although something he enjoyed doing, the computer was not acknowledged to be one of Paul's obsessions. Observation in the classroom would support this. However, what appeared to be happening was that turn taking and more positive interaction and social interaction were increased around and with the computer. Mr Peters' interventions followed Paul's lead and seemed to be interrupting the 'dual carriageway' and increasing social interaction (see Figure 1, below), for instance, when Mr Peters asked Paul if he really wanted to quit.

Figure 1: Model showing the dual carriageway of interaction between Paul and the computer



John (aged 15, class A3)
Like Paul, John had limited speech. He was also heavily medicated and seemed physically uncomfortable with himself at 18 stone. John was chosen as a case study because of his interest in the computer – particularly a music-maker program – and because, according to his Statement of Special Educational Need, he required a *'structured environment where interaction is clearly organised'*. Did the computer help in this? John's teacher, Mr James, was very interested in the notion of computer-assisted instruction and was also keen to take part in the research.

Initial observation data from all 12 cases had indicated that, around a computer, there seemed to be a change in interactivity. Some specific behaviours, such as rocking, clapping, yelling or screaming, seemed to reduce. Some evidence suggested that the computer discouraged unwanted repetitive and stereotypical behaviour. The computer also seemed to encourage more positive social interaction, requiring less instruction from the teacher to effect a positive (and requested) response. Continuation of interaction increased, whereas negative responses to requests seemed to lessen. This was well illustrated through

Paul's case study. In John's case, however, initial observation data revealed little difference between on and off computer behaviours (as illustrated in the examples below). How useful, therefore, was the computer as a medium for enhancing social interaction?

John presented little in the way of characteristic ASD behaviours and generally worked positively, following commands and instructions without problem. The main concerns seemed to be with continuation of interaction and with concentration; John needed to have an adult present to maintain attention on task. Around the computer, he tended to show more interest, although he still required a lot of prompting to achieve tasks. Interestingly, though, as with Paul, there was clearly more turn taking occurring when the computer was involved. Also at these times John seemed to take on a more active role, at times even becoming animated. He sometimes made noises, some of which were monosyllabic and which those working with him recognised as words. John had mastered the use of the mouse and understood when the computer was talking to him. He particularly liked software that promoted action-response or that required something to be built on screen which was then played back to him.

A number of incidents occurred when John was working with the computer which were of interest with regard to his interaction with the adult helper and his reaction to their assistance. In the example shown below, with the help of his teacher Mr James, John was working with a piece of software that presented birds or other animals in a tree; these were counted and then more were added. The task for John was to add the two sets of numbers together.

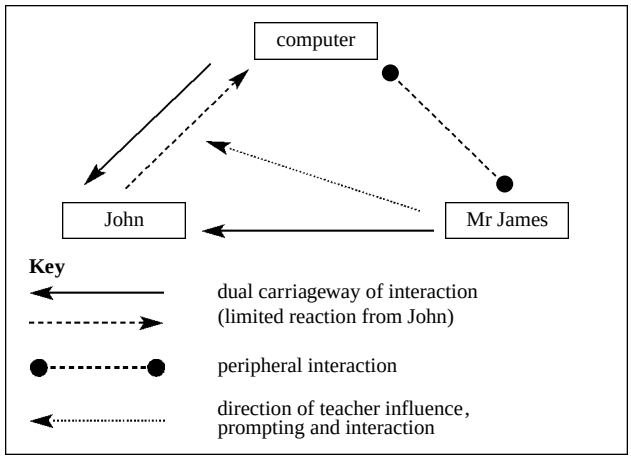
Mr James: *No, trial and error, Jo Jo. Eight – where's eight? Seven before eight*.
John: (Clicks on eight.)
Mr James: *Nine before… Jo Jo… Yes, ten.*
Computer: *Yes, good*.
Mr James: (wanting to move John onto a higher level) *Start again, Jo Jo. More adding, one plus one makes...?*
John: (Clicks on eight.)
Mr James: *No, Jo Jo, t…t…*
John: (Clicks on two.)
Computer: (with Mr James joining in as well) *Two little birds sitting in a tree, one more comes and that makes three.*
Mr James: *Looking – good boy.*
John: (Reaches for the screen.)
Mr James: *No, number three, Jo. Hands down. Now looking, Jo.*
John: (Looks at the computer screen again.)
Mr James: *Looking, John, good boy. Now John, no, hands down, number four, four John, looking John, one, two, three, four, and…*
Mr James: *Come on, four plus one. John* (physically picks up John's hand and moves it to the screen), *where is it, John?*
John: *Mmmmm.*
Mr James: *Come on, John.*
John: (Waits and then begins to click randomly.)
Mr James: *Come on, John, what do you need? Four and one. Four plus one makes…*
John: (Clicks on five.)
Mr James: *Well done, Jo Jo!*

This may be compared with the following which occurred when John was away from the computer. In this example, John was placing coloured number pegs into the correct hole on a number board according to number and colour.

Mr James: *John* (who is nodding off), *John!* (Mr James nudges John.) *Where does that peg go, Jo Jo? What number is it?*
John: *Umm. Phew* (sighs). *Fa…*
Mr James: *Good boy Jo, four, now where does it go?*
John: (Places peg apparently randomly on the number ten slot.)
Mr James: *No, Jo, you know that's not right. Where does…?*
John: (Picks up peg and replaces it in the four hole.)
Mr James: *Well done, John!*

In both examples it is clear how John generally needed prompting, although with the computer the teacher tended to use more, and more varied, verbal input. On the pegboard work, John was trying to deal with two issues at once: first, the number he was looking for and second, placing the peg in the correct hole. In contrast to Paul, though, there is less difference in the examples above between John's typical interactional patterns with and without the medium of the computer. Mr James saw the main value of the computer as being able to remove some challenges for John, for instance, by providing *'a very bare kind of interaction'*. He also felt that it had the potential to provide a stronger incentive and *'an opportunity to facilitate social interaction'*. Mr James prompted and consciously interacted with John, taking turns, and rephrasing questions to encourage engagement and the development of interactional skills (see Figure 2). What often remained unclear, however, was whether John was responding to the computer and/or to Mr James.

Figure 2: Model showing John's interaction around the computer



Ryan (aged six, EY class)
Ryan's vocabulary was limited and communication tended to be non-verbal. Overall he appeared to be a positive and happy individual. According to his Statement of Special Educational Need, he needs to develop *'use of eye contact'* and have *'guided and supported interaction in order to extend his range of social behaviours with adults and peers'*.

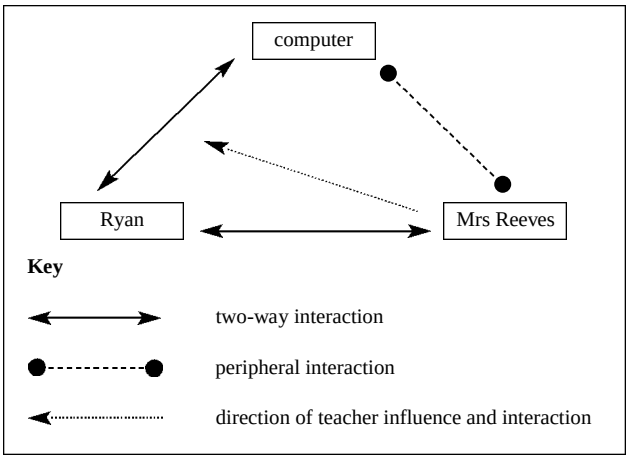
An unexpected outcome of the initial observation data of all 12 cases was that, with some pupils, more eye contact seemed to occur in the presence of the computer. This was interesting because it seemed to suggest that working with the computer did not necessarily distract attention away from the individual who was providing assistance. This was an unexpected result as it had been anticipated that the computer screen would be a point of distraction; that interaction would be mainly, if not entirely, between computer and pupil; that instruction would be predominantly heard and seen through the program and the use of the mouse on the screen (many pupils used touch-sensitive screens). As it was, there were times when the pupils stopped and looked at the individual providing assistance and seemed to listen to or look at what was being said. This was important and unexpected and directed our attention to the different types of interaction that occurred around and away from the computer. Ryan's case study provided for more detailed analysis of this issue.

Ryan enjoyed using the computer, so much so that it did at times become a source of obsession. Around the computer he was lively and energetic and seemed *'completely enthralled with the PC'* (research diary entry). Ryan, like Paul and John, had learnt how to use the mouse, but only recently had he begun to use and understand its significance (rather than the touch-sensitive screen). Ryan did not like other people working on the computer with him if they tried to interfere with what he was doing, but he was generally attentive with adults. His teacher, Mrs Reeves, was particularly alert when Ryan worked with the computer, and she saw the computer as important in developing social interaction. The importance of this for Ryan is shown in the following incident which involved a computer program that presented pictures of various objects, the first sound of which was said by the computer when the object was clicked. Ryan's task was then to choose the word that went with the first letter sound and the picture:

Mrs Reeves: *That's 'Z', isn't it, Ryan? Now…*
Ryan: (Clicks the mouse again.)
Computer: *Zzz*
Mrs Reeves: *So what is the word Ryan, the picture is a Ze, … Zeb…?*
Ryan: (Clicks on the word 'zebra' twice, then smiles at the teacher.)
Mrs Reeves: *Well done, Ryan. Now* (points to screen) *what is the next one? Q* (Mrs Reeves is temporarily interrupted by another teacher entering the classroom.)
Ryan: (Loses concentration on the task itself almost immediately and instead turns up the sound on the computer and clicks repeatedly on the goodbye button in the corner of the screen.)
Computer: *Goodbye everybody.* (Computer repeats phrase with every click of the goodbye button.)
Mrs Reeves: *Turn the sound down, Ryan … can you say girl* (pointing to a new picture on the screen)?
Ryan: *Gir…girl* (simultaneously clicks girl on the screen).
Computer: *Well done.*
Mrs Reeves: *Good.*

What was particularly noteworthy in this interaction around the computer, was the spontaneous smile at his teacher when Ryan got the word 'zebra' correct. In addition, it seemed that a two-way rather than dual carriageway of interaction was more evident (see Figure 3). However, this example also illustrates how Ryan could quickly lose concentration when his teacher was temporarily distracted, and also how he quickly reverted to repetitive behaviours.

Figure 3: Model showing Ryan's interaction around the computer



Away from the computer, in the following illustration, even though Ryan is able to complete the task, the interaction that occurred was much more simplified.

Mrs Reeves: *Can we match them up?*
Ryan: (signs Amber)
Mrs Reeves: *What does this say? Maaaarrr…*
Ryan: *Mark* (and also signs Mark).
Mrs Reeves: *And this one? R-y-a-nnn.*
Ryan: *Ryan!*
Mrs Reeves: *You're a star, aren't you? Aren't you clever!*

Other observations away from the computer tended to follow this format. Ryan seemed to be less independent and reverted to simple repetition rather than working things out for himself as he seemed to be more inclined to do around the computer. Initiation of activity (such as with the volume and clicking 'goodbye') was markedly less, as were other aspects of interaction (such as the smiling at his teacher).

Discussion

All three teachers saw the computer as valuable in the classroom. Mr Peters highlighted the importance of allowing the child to explore with the computer. Mr James emphasised the usefulness of the computer as a change from regular forms of work and interaction and its ability to reduce stress by not having the extra demands of human-to-human contact. In all cases, the strategic involvement of adults was seen to be crucial and there was also clear agreement on the potential of the computer to enhance social skills, with a 'stimulus' or 'action-response' type of interaction.

In relation to the aims of this study, there was some evidence to suggest that the computer did enhance social interaction when used in a well-defined, individualised way. Mr Peters was clearly positive about the computer's potential for Paul and others in his class. He saw it as valuable across the curriculum but emphasised that it needed to be *'tailored to the individual child'*, not just in relation to issues of access (such as with the use of concept keyboards or touch-sensitive screens). The ways adults interacted with pupils and the levels and degrees of interaction were also important, particularly in the initial introduction of software or hardware. Mr Peters also talked of the importance of a child being *'left to go at it themselves and see where it takes them when interacting with the computer'*. Ultimately he explained:

> *'How you set the computer up, and how you enable the child to work with the computer, will determine what the child will get out of their time.'*

For Paul it seemed that much of the confidence he showed around a computer, particularly with regard to navigation, had come about with limited explicit input from adults. Only through discussion with Mr Peters did the importance of his strategic and highly individualised interventions become apparent, for instance, through enabling Paul to explore the computer environment and learn to use the mouse.

Mr James, John's teacher, was also very positive about the computer's potential and the different sort of stimulus it provides, *'which happens to suit some children's way of operating, and provides an additional resource where otherwise only a human being will do.'* In John's case, the computer provided a context away from the demands of human-to-human interaction, particularly important because of John's evident problems with social interaction. Mr James commented that the 'machine-person' interaction, with its predictability and rigidity of response, was less challenging for John.

Mrs Reeves, Ryan's teacher, talked of the computer's value lying in its ability to provide a *'visual impact on what they are learning'*. More specifically, in comparison with work away from the computer, Mrs Reeves saw it as allowing Ryan more control, especially with the immediate 'action-response' software that encouraged interaction. She explained how she always tried to ensure that there was someone to work on the computer with Ryan, *'otherwise the computer just becomes something to merely occupy.'* She felt that the computer could *'be more beneficial'* than human-to-human interaction if a specific focus on a particular skill (such as turn taking) was required, although this depended on the program used and the child's confidence.

Mrs Reeves had found that, when alone or when pairs of pupils with ASD worked on the computer, children often became silent and interaction of any type ceased, but language and communication could become more focused when children were working with an adult. She believed that the computer could really help enhance social skills and it was particularly useful for developing turn taking, either with the computer, or with an adult or another pupil working on the computer (for example, sharing the mouse). Generally, she felt there was a tendency for turn taking to increase and for *'a bit of interaction between whoever is working on the PC'* to develop. The model developed in this article goes some way to illustrating this. The influence of the adult on the interaction between the pupil and the computer helped to develop more of a two-way interaction rather than a dual carriageway of action-response. What we were particularly interested in, was when interaction included human interaction, and was not restricted to a to-and-fro between the computer and the pupil. However, understanding when this occurred was not unproblematic, as demonstrated in John's case study and in the example below.

Mr James:	*John, where is the eight? Where is eight? Seven is before…*
John:	(Looks at screen and uses mouse to click on eight.)
Computer:	*Yes. Good.*
Mr James:	*Looking… good boy … one plus one makes?*
John:	(Clicks eight again) *Mmmm.*
Mr James:	*John, John, adding … t… t…*
John:	(Clicks on number two.)

In this short interaction, the computer program presents a number of birds in a tree which would change on every new screen. First, there was an initial request made by the teacher to the pupil to find the number eight on the screen. John responded to Mr James's request and/or the computer screen (we do not know which in this example). The computer responded and then the teacher again tried to clarify what John was looking for. This was followed by a (wrong) response from John, a prompt by the teacher and another response (correct this time) from John. This example was chosen to illustrate some of the complexities surrounding interaction. What is problematic here is the question of whether or not John is really responding to the teacher or whether he is perhaps ignoring the teacher and responding solely to the computer. Other communicative behaviours (for example, non-verbal or motor movements such as gesture or touch), as well as contextual information such as what was happening on the screen (for example, non-action until correct answer was selected), were taken into account when analysing interaction.

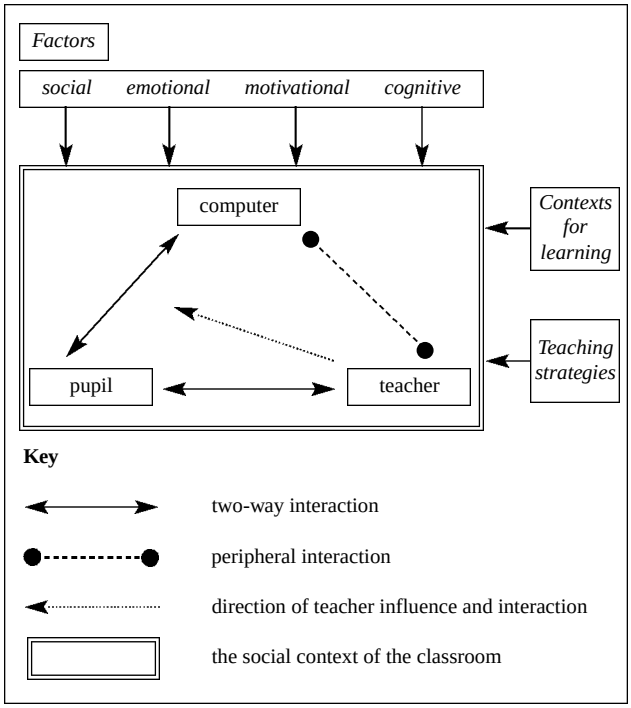
Rare event learning

Data were also analysed within the framework of the 'rare event learning (REL)' theory.

> 'According to this theory it is a rare event to have all relevant and enhancing factors ("tricky mixes") present so that facilitation of learning is maximised.'
>
> (Tjus, Heimann & Nelson, 1998, p. 140)

Tjus et al. (1998) argue that these factors include social, emotional, motivational and cognitive factors; the child's ability to attend to the task; contexts for learning; and the teaching strategies employed (particularly those that make use of all 'information channels'). Drawing on insights from REL theory in relation to the case studies, the complex ways in which the 'tricky mixes' of factors came together were explored.

Figure 4: Expansion of the model showing 'tricky mixes' in relation to interaction around the computer



All three teachers seemed to make ample use of all four factors of the REL model (that is, social, emotional, motivational and cognitive factors) by providing a teaching environment that allowed for the computer to become a positive and socially interactive tool (rather than one which was used purely didactically). For instance, there was evidence from all three cases that the motivational factor of the computer was high. This was most strongly evidenced in Paul's case – he always remembered when it was his time to use the computer. Paul's teacher was also motivated by the computer and had a clear teaching strategy that was guiding Paul's use. Similarly, John was clearly motivated by the computer. He seemed willing to try out software, and showed little frustration or boredom when working on the computer, contrasting with the occasion when he fell asleep while working on the mathematics task.

Similarly, careful attention was paid to the cognitive demands of the tasks, both in relation to the hardware and the software used. For instance, in each of the three case studies, there had been a change from use of a touch-screen to a mouse. 'Tricky mixes' emerged as important in the research. Figure 4 expands the model to illustrate 'tricky mixes' in relation to social interaction around the computer.

Conclusion

The computer has the potential to be a valuable device for communication. What our research showed us was that around a computer, social interaction between adults and those with ASD can become more apparent, engaging and positive. In the case studies, what became clear was the complexity of the teaching strategies employed around the computer. The well-timed teacher interventions, together with their juggling of what has been called 'tricky mixes' (Tjus et al., 1998), appeared to be influential in the development of more two-way (rather than dual carriageway) interaction.

The importance of the social interaction around and with the computer, rather than the use of the computer on its own, was clear. We found that when the adult followed the child's lead, this was more likely to lead to more sustained and positive social engagement. Without social interaction, the computer tended to be used obsessively and the complex interaction of 'tricky mixes' was important in managing this. With careful, planned, strategic interventions, John and Paul were enabled to develop skills in navigating the computer. There were also clear implications for the planning and use of the computer within the social context of the classroom itself. Analysing the computer as part of the social act as well as exploring interaction around and with the computer proved to be fascinating.

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Address for correspondence
Dr Angela Jacklin
School of Education
Sussex Institute
University of Sussex
Falmer, Brighton
Sussex BN1 9QQ
Email: a.jacklin@sussex.ac.uk

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