British Journal of Educational Technology *Vol 35 No 1 2004* 69–80

The role of cognitive style in educational computer conferencing

Hilary Cunningham-Atkins, Norman Powell, David Moore, Dave Hobbs and Simon Sharpe

Hilary Cunningham-Atkins is an Associate Lecturer with the British Open University and a doctoral student in the School of Computing at Leeds Metropolitan University. Dr Norman Powell is a Research Officer, Dr David Moore a Principal Lecturer and Simon Sharpe a Senior Lecturer in the School of Computing at Leeds Metropolitan University. Dr Dave Hobbs is a Senior Lecturer in the School of Informatics at the University of Bradford. Address for correspondence: Hilary Cunningham-Atkins, School of Computing, Leeds Metropolitan University, The Grange, Beckett Park Campus, Leeds LS6 3QS, England. Email: H.Atkins@lmu.ac.uk

Abstract

This paper reports an investigation of the impact of students' cognitive style on their effective use of educational text-based computer-mediated conferences. The research centres on an empirical study involving students from three courses run by the British Open University. Statistical analysis of the data does not suggest that cognitive style has a strong influence on student participation in the conference, but does suggest that, contrary to expectations, 'imagers' may send more messages to conferences than 'verbalisers'. The data also suggest a possible link between certain cognitive styles and course completion, and that the interaction of different styles within a group, as described by Riding and Rayner's (1998) team roles, may have an indirect influence on task completion.

Introduction

Recent years have seen a rapid rise in the number of courses taught wholly or partially online (Palloff and Pratt, 2001). It is often argued (eg, Weller, 2002; Palloff and Pratt, 2001) that whilst many institutions merely post course material on a web site and call it online learning, the potential benefits offered by online learning come from the opportunities for interaction and collaboration through the use of computer-mediated communication (CMC).

The benefits and drawbacks of CMC have been thoroughly discussed elsewhere (eg, McConnell, 2000; Furnell, 1999; Forsyth, 1998; Collis, 1996; Skillicorn, 1996; Bates, 1995). One of the main educational benefits of CMC is its use as a tool for groupwork and collaboration (Ryan *et al*, 2000). It potentially combines the perceived benefits of

Published by Blackwell Publishing Ltd., 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

cooperative learning with modern technology to provide an online collaborative environment where understanding is deepened through discussing issues with others; students can manipulate concepts, put them in a wider context and see them from other perspectives (Alexander, 2000; McConnell, 2000; Kaye, 1989). CMC is held to allow for equal participation, concealing gender, ethnicity and disability (Salmon, 2000; Light and Light, 1999). Many students find the support available from other students via CMC to be of major benefit (Weller and Mason, 2000). This support is particularly important to distance learners, who can feel isolated and may find that the confidence they gain from an online peer community can transform the experience of distance learning (Alexander, 2000; Bates, 1995). Further, the textual nature of CMC can encourage more thoughtful contributions than would be possible in a face-to-face situation (Ryan *et al*, 2000; Salmon, 2000).

All these advantages, however, are fundamentally dependent upon active participation by the students in the CMC conferences. And there are increasing concerns about low participation levels in such conferences (Preece, 2000; Light and Light, 1999). Indeed, Mason (1994) suggests that students fall into three distinct groups: those who actively participate by reading and posting messages regularly, those who read messages but do not participate in the discussion and those who take little or no part. Weller (2002) splits Mason's first two groups into three different categories: those who regularly post a lot of messages; those who read most, but not all, of the messages and occasionally post a message; and those who regularly read messages but rarely, if ever, contribute. Weller's fourth category comprises students who do not read messages or contribute to the discussion and therefore equates to Mason's third category. The active participation of all students is required in activity-based conferences if collaborative exercises are to succeed (Plumpton, 2001; Weller and Mason, 2000), and Weller (2002) argues that students enrolled in wholly online courses are unlikely to pass the course if they fall into either his or Mason's last categories.

Research has begun to consider reasons behind low participation in CMC conferences. For example, Romiszowski and Ravitz (1997) argue that CMC, which is primarily text-based, may not be equally suited to all subject matters, whilst Kaye (1989) suggests that the pedagogic value of computer-based collaboration depends on "the educational perspective adopted, the nature of the specific discipline and the characteristics of the learners" (6). It is the last of these factors with which the research reported in this paper is concerned. The aim is to study the nature and extent of any impacts of preferred learning style on the effective use of CMC.

The main reason for our interest in the influence of learning style on CMC use is that CMC is essentially a medium of written discourse. Consequently, it may perpetuate the inequity of an education system that discriminates against students who talk and listen better than they read and write (Salmon, 2000; Light and Light; 1999, Rimmershaw, 1999; Mason, 1994). Further, lessons gained about the relationships between learning style and CMC use will be potentially important for practice, since they will enable measures to be taken to make the medium equally beneficial to all learners, irrespective of

learning style. Despite such arguments, there has thus far been relatively little research into the area (Ryan *et al*, 2000).

A prerequisite of such research is a suitable model of learning styles. There have been many investigations into learning style, giving rise to a large number of different style labels. Riding and Rayner (1998) report a review of over 30 style labels, which led to the development of the Cognitive Styles Analysis (CSA). We argue elsewhere (Atkins *et al*, 2001) that this CSA model is the most suitable approach with which to study the use of CMC, as it examines cognitive style, which is considered to be the underlying aspect of an individual's style most likely to influence their approach to learning. The model suggests that style can be divided along two dimensions: *wholist-analytic* (W-A) and *verbal-imagery* (V-I). The former relates to the manner in which an individual would organise information—as a whole or in parts. The V-I dimension concerns how people represent knowledge—in words or mental pictures. The V-I dimension would intuitively appear to be highly relevant to CMC, given the latter's predominantly text-based nature.

Context

The study was naturalistic in that it investigated ongoing educational conferences involving students of the British Open University (OUUK) using First Class computer conferencing as part of their programme of study. Five groups were studied, from three courses, one from each of the three academic levels of undergraduate courses offered by OUUK. All the students studied part time through distance education, and most had other outside obligations such as a job and family commitments. Furthermore, OUUK has an open entry policy whereby students are drawn from a variety of backgrounds, many having no qualifications, whilst others may have already attained high-level qualifications through work-related or academic study. This generally leads to a wide range of experience and abilities in each tutor group. A wide range of factors can therefore be expected to influence participation and cooperation in the conferences.

The study examined the tutor group conferences (TGCs) associated with three tutor groups from the course T171 (A, B and C) taught by one tutor, and one tutor group each from courses THD204 and T396, taught by a different tutor. The TGCs were studied for the entire duration of the course (one academic year).

T171, entitled 'You, Your Computer and the Net', is a level one OUUK course. It is taught entirely through electronic media, using a combination of the Internet and the First Class computer conferencing system. A face-to-face introductory meeting is held prior to the start of the course. CMC is an integral part of T171, with several national conferences running alongside the TGC. Contributions to conferences are not specifically marked, although examples from the conferences are required for the tutor-marked assignments (TMAs) and the end of course assessment.

THD204, entitled 'Information Technology and Society', is a multidisciplinary level two OUUK course, taught through a combination of face-to-face tutorials, printed texts and

electronic media. CMC is an integral part of the course, with students being marked on their contributions in two TMAs. The final TMA is specifically group orientated, with the groupwork conducted via CMC.

T396, 'Artificial Intelligence for Technology', is a level three OUUK course, taught through a combination of face-to-face tutorials, printed texts and electronic media. T396 has a national CMC conference, together with a local TGC, to facilitate group discussion of topics arising from the course material. CMC is described as an integral part of the course, although contributions are not specifically marked.

Method

At the beginning of their course all students were asked to complete a pre-course questionnaire and work through a diskette containing software which would provide their individual Cognitive Styles Analysis. At the end of the course students were asked to complete a post-course questionnaire. All of this data collection was carried out via the postal service; response rates for the different stages of data collection ranged from 38% to 78%. As students worked through their respective courses, full transcripts of all messages in the TGCs were collected. In addition, data regarding gender, course completion, group membership and the number of messages sent was available for all the students in the sample (a total of 118 students).

Data analysis

This paper is concerned with the statistical analyses of the data. Qualitative analysis is the subject of ongoing research. Analysis of the pre- and post-course questionnaires has thus far not yielded any results of significance. The remainder of this paper therefore considers conference participation per se.

Number of messages written

Recall the aim of the research: to study the nature and extent of any impacts of preferred learning style on the effective use of CMC. We argue that the number of messages sent by any given student is a suitable indicator of effective use of CMC, since it gives a clear indication of the actual levels of active participation of that student in each TGC.

In a naturalistic setting it is impossible to control the potential explanatory variables. This necessitates a method of data analysis that checks the relative levels of influence of all the explanatory variables, not just cognitive style. In order to do this, we use regression models for the statistical analysis of the data, on the grounds that multiple regression offers a more sophisticated analysis than simple statistical tests, and thus is particularly well suited to the investigation of 'real-life' situations (Pallant, 2001). Our main multiple regression model addresses the possible explanatory variables of gender, age, tutorial group, W-A score, V-I score and course completion (and cross-terms of these variables). The model was run repeatedly, removing the least significant variables until only statistically significant variables remained. The number of messages was transformed (taking natural logarithms) such that it

had the required normal distribution and independence of variance for multiple regression (Norusis 1999).

Course completion

Another possible indicator of the successful matching of cognitive style to CMC is whether or not the student completes the course. In order to investigate this, a logistic regression of the explanatory factors mentioned above was conducted. Logistic regression is analogous to multiple regression for dichotic response variables such as course completion. As with the multiple regression, the model was run repeatedly, removing the least significant variables until only statistically significant factors remained.

Models of participation

Both Mason (1994) and Weller (2002) group the participants by levels of participation in the course, indicated by a combination of the number of messages read by the participants and the number of messages sent. In order to see how well these models reflected the behaviour of the students in this study, the relationship between the number of messages written and the number of messages read was observed. These data were available only for T171 groups A and B.

Results

Number of messages written

The main results of the regression models are shown in Table 1. Under 'sample size' in the table, 'minimum' refers to the number of cases with no missing information, and 'maximum' to the total number of cases in the group. The R^2 values indicate the percentage of variation in the messaging activity that is described by the model.

Table 1: Results of multiple regression models

Model	*Sample size*	R^2 *value*	*Significant variables*	*Significance*
Full data set	Minimum 78 Maximum 118	0.668 (66.8%)	• Member of T396 • Completed • Completed * member of T396	<0.001 <0.001 <0.001
THD204 and T171	Minimum 61 Maximum 66	0.518 (51.8%)	• Age • Completed • completed * age	0.003 0.001 0.060
T171	Minimum 46 Maximum 51	0.572 (57.2%)	• Gender • Age • Completed • Member of T171 B • Completed * age	0.048 <0.001 0.001 0.010 0.024
All completers	Minimum 46 Maximum 53	0.834 (83.4%)	• Member of T396 • Member of T171 B • V-I score	<0.001 0.011 0.061

Table 2: Number of messages by group

Group	Number of students	Total messages	Tutor messages	Average no. of messages per student
T171 A	18	643	146	28
T171 B	21	1162	136	49
T171 C	33	1459	281	37
THD204	20	643	36	30
T396	25	61	17	2

Table 1 shows that tutorial group is one of the strongest factors to influence levels of participation. Table 2 shows the varying levels of participation between the tutorial groups.

Course completion

Logistic regression of course completion showed that membership of T171 A (p = 0.018), age (p = 0.028) and V-I score (p = 0.036) affected the chance of completing. Figure 1 illustrates these relationships.

Models of participation

Observing the relationship between the number of messages read and the number posted revealed no evidence of distinct or overlapping groups of participants. Rather, linear regression showed a highly significant ($p < 0.001$) exponential relationship (Figure 2).

Discussion

Number of messages written

A large sample size is required for effective use of multiple regression, posing a problem for the current study given our large number of variables and relatively small data sample (Table 1). Thus, the findings from the multiple regression models need to be treated with a certain degree of caution. However, the sample was sufficiently large to allow confidence in the most significant variables.

Our results suggest that, counter to our expectations and prima facie argument (Atkins *et al*, 2001), cognitive style did not appear to play a significant role in conference participation. However, for the model that considered only those completing the course, V-I style was found to be bordering on significance (p = 0.061). The relationship is positive, suggesting that the students who were 'imagers' sent more messages. An important issue for practice and future research, therefore, is to verify and explain the factors behind this relationship, and to consider means of redressing the balance towards verbalisers.

In a larger study it is possible that this effect may be more clearly defined or disappear, becoming merely a feature of the 'noise'. It may be interesting to speculate why this

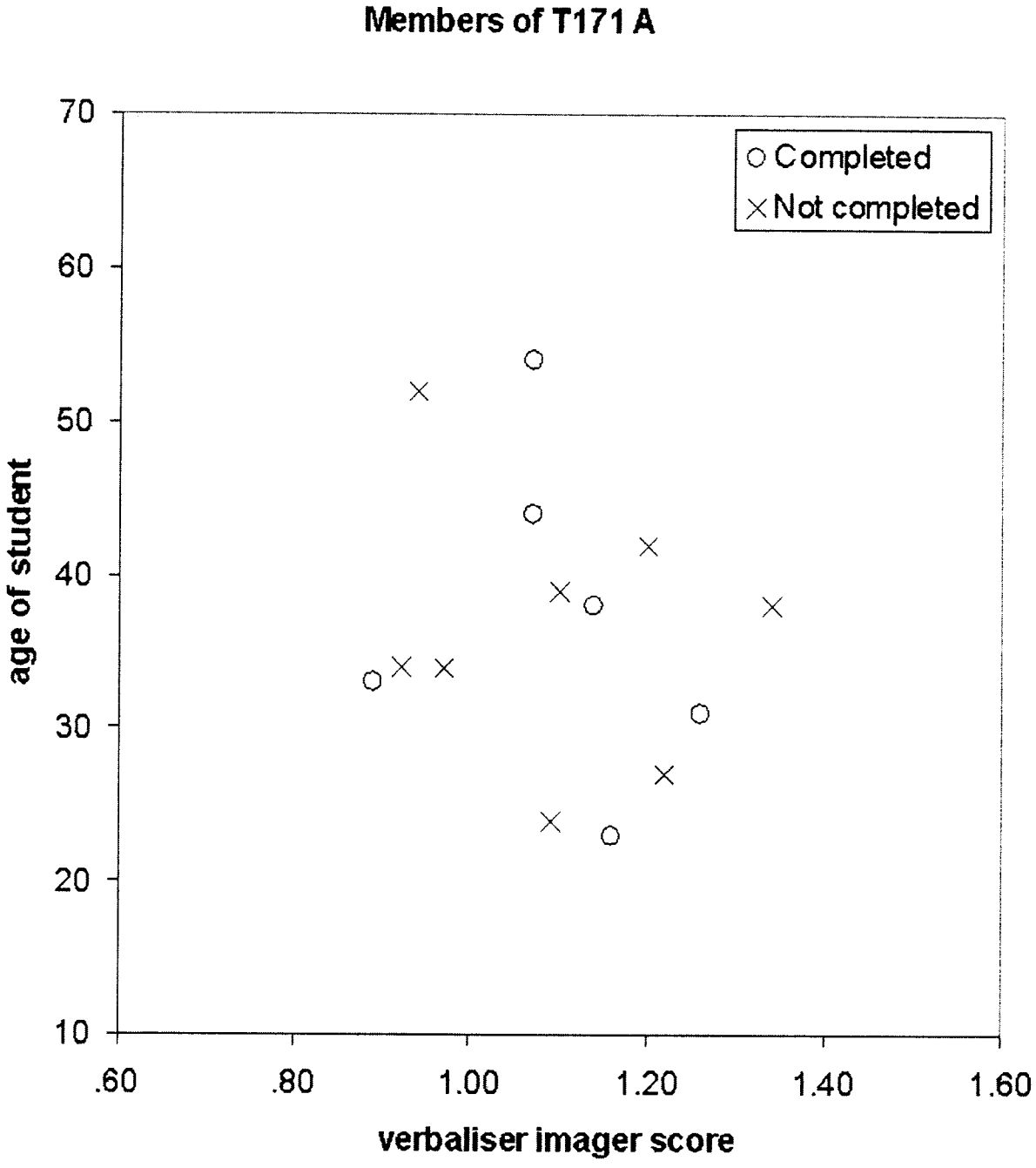

Figure 1: Results of logistic regression

effect, if real, was not apparent when both completers and non-completers were considered together. The data from the two groups differ in a number of ways. For completers the number of messages sent spans the duration of the whole course, whereas non-completers leave the course at different times. As well, the pattern of tutorial exercises and hence the messages associated with them are not uniform across the course. It may also be argued that the non-completers form a much more heterogeneous group than the completers: someone leaving the course due to a sudden change in circum-

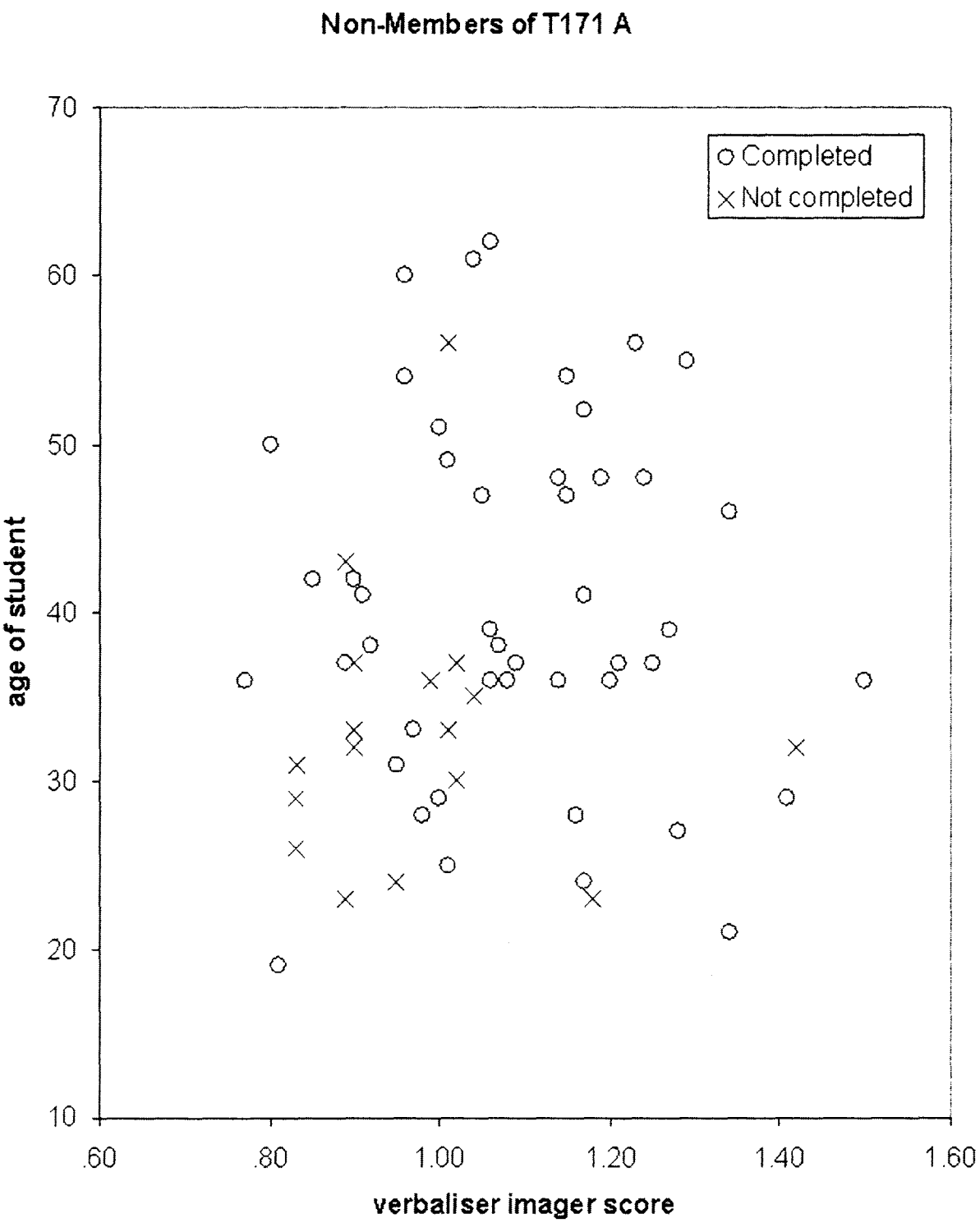

Figure 1: Continued

stances will have a very different messaging profile from someone who never engaged with the course and then left. For these reasons it is arguable that considering only completers provides a clearer picture, allowing the more subtle effects of cognitive style to emerge.

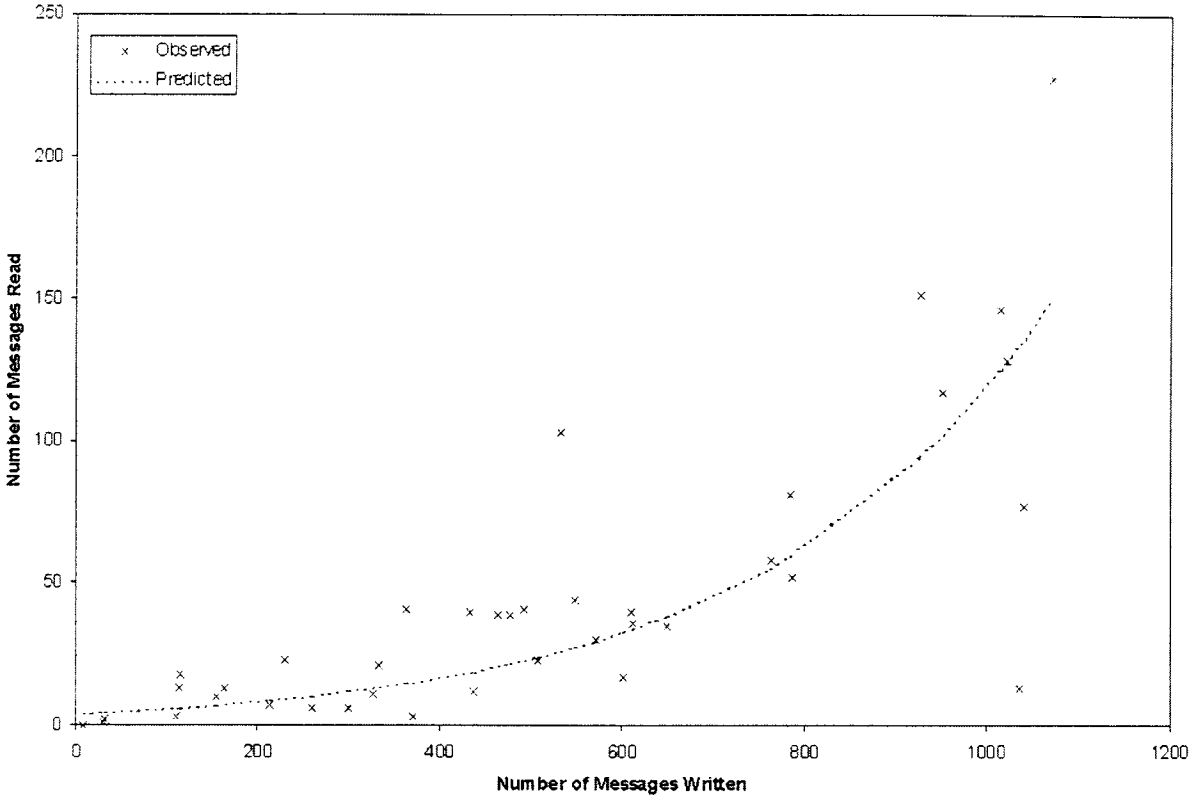

Figure 2: Relationship between number of messages read and written

Course completion

Logistic regression of course completion showed that membership of T171 A, age and V-I score affected the chance of completing. Figure 1 reveals that for tutorial group T171 A, there is no relationship between completion and age or V-I score. For the other tutorial groups, however, it can be seen that the majority of the non-completers are clustered in the younger, verbaliser quadrant of the graph.

The age relationship may be partly explained by the likelihood that younger students have more external pressures on them from families and careers, and so are more likely to leave the course; or it may be that older students develop better learning strategies that enable them to overcome problems and continue study. Either way, the finding is important for practice and future research, for it suggests that means may need to be developed to facilitate success of younger students in distance learning contexts.

The relationship with V-I score is less likely to be explained by external factors and suggests that verbalisers are less likely to complete the course. Thus, means of ameliorating this problem should be investigated.

Models of participation

It was noted earlier that both Mason (1994) and Weller (2002) suggested that distinct groups could typically be found in CMC conferences. However, our data suggests that

neither of these models applied to T171; instead there was an exponential relationship between the number of messages read and the number posted. This suggests that a continuum of CMC activity from inactive to extremely active may be a more appropriate description than discrete groups.

Cognitive style and groupwork

Our data suggest that group membership has a statistically significant influence on conference participation (Table 1) and course completion (Figure 1). An important point for practice is what makes one group more active than another.

Much of the apparent significance of group membership in our regression model can be attributed to the very low levels of activity in T396. However, there was also a noticeable difference between the numbers of messages sent in other groups, as shown in Table 2. For example, the T171 Group B conferences contained 519 more messages than the equivalent T171 Group A conferences, despite the fact that both groups had the same tutor and were given exactly the same tasks to perform.

A possible explanation is provided by Riding and Rayner's (1998) model of teams. They suggest that there are five key roles within a team that are best filled by particular cognitive styles categories. In the case of initiation of plans in teams, these are 'doer', 'assessor', 'thinker', 'feasibility' and 'restrainer' (135–136). In the case of implementation of plans in teams, they are 'facilitator', 'informer', 'corrector', 'implementer' and 'activator'. Successful teams, Riding and Rayner (1998) argue, would contain members in all five key positions.

Interestingly, our study found that there was a difference in the mix of cognitive styles in each group and an examination of the team roles occupied by each group member suggests that groups with more key roles appropriately filled appeared to post a greater number of messages (Cunningham-Atkins *et al*, 2003). Our study tentatively suggests therefore that Riding and Rayner's (1998) team model may apply in an educational CMC environment. This is an important point for practice and for future research, we argue, since it may reveal means of configuring group membership to facilitate beneficial discussion.

Summary and future work

Our study has suggested, albeit tentatively, three potentially important influences of cognitive style on the use of educational CMC. These are:

- Amongst students who completed the course, imagers sent more messages
- Verbalisers were less likely to complete the course
- The mix of cognitive styles in a group may influence the level of activity

Each of these points requires further empirical investigation. An additional interesting avenue of investigation might be to consider whether students themselves feel they benefit more from the course as a result of the CMC facility and whether there is a relationship between their views and cognitive style.

Currently, however, we are investigating in more depth the possible links between cognitive style and groupwork. As argued earlier, our analyses suggest that different group compositions may result in different activity levels, in terms of numbers of messages. Nonetheless, given the lack of previous research in this area, we cannot judge the behaviour of the groups by purely quantitative means. It is not clear, for example, whether a greater number of messages is an indicator of the group being more or less successful in achieving completion of a task. Qualitative analysis of message content is therefore required. This is the subject of ongoing research, in which we are using an approach based on Bales's (1950) Interaction Process Analysis to investigate communication between group members in a number of conferences. The resulting data will then be cross-checked with the cognitive style data to look for possible links between group behaviour and cognitive style.

This work is important partly because, as Riding (2002) has suggested, further research in the area of team roles is needed, partly because our study would appear to be the first to consider team roles in an electronic environment, and partly and perhaps more importantly, because the work may yield insights into how best to configure online groups for educational collaboration.

Much remains to be done, then, but we anticipate that the work will generate important findings in the fields of both cognitive style and educational CMC.

References

Alexander G (2000) *Re: can anyone help, please?* Available from CMC Research at http://www.open.ac.uk (Accessed on 7 August 2000).

Atkins H, Moore D, Hobbs D and Sharpe S (2001) Learning style theory and computer mediated communication *in* Montgomerie C and Viteli J (eds), *World conference of multimedia, hypermedia and telecommunications, ED-MEDIA 2001 proceedings* 25–30 June, Tampere, Finland, 71–75.

Bales R F (1950) *Interaction process analysis: a method for the study of small groups* Addison-Wesley, Cambridge, MA.

Bates A W (1995) *Technology, open learning and distance education* Routledge, London.

Collis B (1996) *Tele-learning in a digital world* Thompson Computer Press, London.

Cunningham-Atkins H, Moore D, Hobbs D (2003) Learning style theory and computer mediated communication *in* Armstrong S, Graff M, Lashley C, Peterson E, Rayner S, Sadler-Smith E, Schiering M and Spicer D (eds) *Proceedings of ELSIN 2003 eighth annual learning styles conference: bridging theory and practice*, 30 June–2 July, University of Hull, Hull, UK, 116–126.

Forsyth I (1998) *Teaching & learning materials & the Internet* Kogan Page, London.

Furnell S M (1999) Online distance learning: expectations, requirements & barriers *Virtual University Journal* 2.

Kaye A (1989) Computer-mediated communication and distance education *in* Kaye A (ed) *Mindweave: Communication, Computers & Distance Education* Pergamon Press, Oxford, 3–21.

Light P and Light V (1999) Analysing asynchronous learning interactions: computer-mediated communication in a conventional undergraduate setting *in* Littleton K and Light P (eds), *Learning with computers: analysing productive interaction* Routledge, London, 46–61.

Mason R (1994) *Using communications media in open and flexible learning* Kogan Page, London.

McConnell D (2000) *Implementing computer supported cooperative learning* Kogan Page, London.

Norusis M J (1999) *SPSS 9.0 guide to data analysis* Prentice Hall, Englewood Cliffs, NJ.

Pallant J (2001) *SPSS survival manual* Open University Press, Buckingham, UK.

Palloff R M and Pratt K (2001) *Lessons from the cyberspace classroom: the realities of online teaching* Jossey-Bass, San Francisco.

Plumpton B (2001) *How students can make conferencing work* http://t171.open.ac.uk/t171/resources/studentconf.htm (accessed on 3 February 2002).

Preece J (2000) *Online communities: designing usability, supporting sociability* John Wiley & Sons, Chichester, UK.

Riding R (2002) *Re: cognitive style and team roles* personal email communication to Hilary Cunningham-Atkins, 8 November.

Riding R and Rayner S (1998) *Cognitive styles and learning strategies: understanding style differences in learning and behaviour* David Fulton, London.

Rimmershaw R (1999) Using conferencing to support a culture of collaborative study *Journal of Computer Assisted Learning* **15**, 89–200.

Romiszowski A J and Ravitz J (1997) Computer mediated communication *in* Dills C R and Romiszowski A (eds) *Instructional development paradigms* Prentice Hall, Englewood Cliffs, NJ, 745–768.

Ryan S, Scott B, Freeman H and Patel D (2000) *The virtual university: the Internet and resource-based learning* Kogan Page, London.

Skillicorn D B (1996) Using distributed hypermedia for collaborative learning in universities *The Computer Journal* **39** (6), 471–482.

Salmon G (2000) *E-moderating: the key to teaching and learning online* Kogan Page, London.

Weller, M (2002) *Delivering learning on the Net: the why, what & how of online education* Kogan Page, London.

Weller M and Mason R (2000) Evaluating an Open University web course: issues and innovations *in* Asensio M, Foster J, Hodgson V and McConnell D (eds) *Proceedings of Networked Learning 2000*, 361–368.