

Combining collaboration spaces: Identifying patterns of tool use for decision-making in a networked learning environment

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Abstract

This paper describes a study that examines the processes of two groups using a combined collaboration space (a synchronous chat and an asynchronous wiki). It uses data from the combined space to analyse the way that group processes change over time. We examine the tasks about which students made decisions during a month-long collaborative learning project, undertaken as part of a larger course. In order to examine the processes of collaboration, particularly in relation to the tools used and the decisions made, both chat and wiki data were coded for the task, sub-task and decision being made by the students. The data were rendered as visual forms which allowed us to describe the different ways in which the two groups used the tools in their collaboration for different types of decisions. We make an argument for the value in identifying Alexandrian properties in the structure of the collaboration, using *deep interlock and ambiguity* as an example. Identification of such properties, we think, will aid the future development of educational design patterns.

Deep interlock and ambiguity was identified in the structure of the groups' collaboration. We discuss the structure in terms of the tools that the groups used – chat, wiki and email. For some tasks and subtasks, the use of the tools was simple, and decisions were made during a single chat. However, some decisions resulted in a complex use of both the wiki and the chat, and Group A in particular used both tools synchronously, tying the ideas they discussed in the chat back to the knowledge recorded in the wiki, as they chatted. We concluded that the flexibility that the two groups were given meant that they could determine the pattern of tool use and collaboration that best supported their collaboration. We found the visualisations to be extremely useful in identifying the collaboration of a group over time, and in visualising the multiple streams of data that were analysed. The identification of these patterns of learning and collaboration would support the patterns approach to educational design. We propose that this initial study be expanded to include other measures of process.

Keywords

Processes of learning; patterns; synchronous collaboration; asynchronous collaboration; online chat; wiki; decision-making.

Introduction

Advances in hardware and software have increased the ease with which multiple streams of data can be collected that each describe a different view of the same collaborative experience in networked learning environments. Methods to integrate this data and visualise it are needed to better understand the processes of learning. This study presents initial work within a larger program of research in which we aim to identify educationally significant recurrent patterns in networked learning and computer supported collaborative learning (CSCL) process data. This work focuses upon the identification of such patterns in *combined* online spaces that afford both synchronous and asynchronous collaboration.

A combination of synchronous and asynchronous tools were used in a networked learning environment in which two groups of learners had a chat (synchronous) and a wiki (asynchronous) available to them during a month long collaborative learning project, undertaken as part of a larger course. The streams of data resulting from this project were integrated and then used to visualise the patterns of tools use for different types of task within the assignment. We make the argument that Alexandrian properties (2002) are an appropriate framework to identify

patterns in the structure of collaboration. We identified one property that relates to the combined use of the wiki and chat tools.

Background

Our argument in this paper is based on the key concepts that: (i) time, and the order of events, are essential to researching the processes of learning (Jones, Dirckinck-Homfeld, & Lindstrom, 2006; Reimann, 2009); (ii) the qualities of form (Alexander, 2002) can be identified in the structure of networked learning environments. The long-term aim of this research is to further relate these to educational design patterns (Goodyear & Retalis, 2010). Further, the complex relationship between agents and technologies suggests that these processes should be examined in practice (Jones, et al., 2006). Building upon these ideas, the work presents a structured approach to the integration and visualisation of multiple streams of data from a combined collaboration space.

Processes of CSCL

The analysis of multiple processes is still relatively rare, with methods of analysis and the impact of the theoretical perspective still under debate. Research that has addressed the interaction of multiple processes has discussed decisions around segmentation, unit of analysis, time constraints, and methods of automation (Schrire, 2006; Weinberger & Fischer, 2006). The main work examining multiple perspectives has been labelled *multivocality*; it has focused on the overlap of differing theoretical perspectives on one source of data (for an overview see (Dyke et al., 2011)). Other work that has explored the integration of data sources includes papers incorporating screen capture with audio files (Kennedy-Clark & Thompson, 2011a, 2011b) or in using screen capture to align students' interaction with a model and their recording of observations in an online setting (Thompson, Kennedy-Clark, Markauskaite, & Southavilay, 2011). Within this field of research, the tool that is addressed is usually either synchronous (Ding, 2009) or asynchronous collaboration (for example, (Hull & Saxon, 2009; Weinberger & Fischer, 2006)), but few address both. Tinoca, Oliveira & Pereira (2010) use a grounded theory approach to analyse the way that final group products are influenced by the online collaborative interaction within a group forum and chat environment and are able to make suggestions based upon the patterns that they find.

In attempting to integrate and visualise the data from collaborative interaction within a combined space, time is important in terms of the duration and rates of change at which events occur, as well as the order in which they occur (Reimann, 2009). Reimann (2009) goes on to suggest that when people meet repeatedly, the group has a history, and this history affects their learning; some of the methods suggested for analysing this are sequence mining, pattern identification, and process mining – these allow researchers to represent the data at a more abstract level and to make subsequent claims about the data. By taking time into account, we begin to be able to answer questions around how technologies and tools affect individuals and groups over time.

Tools for CSCL

Students in this study collaborated within a combined space. A distinction that is useful for analysing and comparing tools for CSCL is the notion of synchronicity, whether collaborators have instant (synchronous, e.g. (Ding, 2009)) or delayed (asynchronous e.g. (Hull & Saxon, 2009)) communication, with each recognized as having different characteristics. Students in this study had access to both types of communication (e.g. (Yeh, 2010)).

Wikis can be used for collaborative information compilation or knowledge construction (Dohn, 2010). They allow students to create pages that can be linked to other students' pages, and to edit each other's work. Most research on processes using asynchronous tools, however, has focused on discussion boards rather than wikis. An exception is Zenios and Holmes (2010) who investigated the ways in which new knowledge was created in communities of developing researchers through asynchronous text-based discussions and wikis, and synchronous audio and video. They initially provided students with a discussion board, then students were required to develop collaborative wikis. They only began to use Skype once collaboration in the asynchronous environment stalled. Their findings suggest that the social affordances of a wiki are limited due to the difficulties involved in engaging in a dialogue on the wiki; but that when students use online chat (Skype) to reflect on, discuss and modify what they have written (in the wiki) then collaboration occurs. Zenios and Holmes (2010) suggest that dialogue before and after the development of collaborative wikis is important, and they note that the Skype chat offers social affordances such as the "swift sharing of ideas and exchanges of emotions and personal comments of a more informal nature" (p. 476), which are absent in a wiki, concluding

that the combination of the chat and the wiki were necessary for epistemic tasks to take place, and group cognition and new knowledge to be developed.

Alexandrian Qualities of Form

Alexander’s (2002) ideas about form provide us with a framework to discuss the structure of the groups’ collaboration. Alexander describes 15 principles of form, and we have focused on deep interlock and ambiguity. All the principles revolve around the existence of centres. Alexander (1999) defines centres as “field-like structures that appear in some region of space. They don’t have sharp boundaries, but they are the focal organizing entities that one perceives at the core of all pattern, all structure, and all wholeness” (p. 78). Alexander deliberately used the term centre instead of whole, because the relationship between entities in a design is considered extremely important (Alexander, 2002). For this paper, we see the tools provided for the learners to use, the chat and the wiki, as representative of the structure, and these can be seen as centres. In this context, deep interlock and ambiguity (pp. 195-199) describes situations where centres are “hooked” into their surroundings, in a way in which it makes it difficult to disentangle the centre from its surrounds. In buildings, it can be done literally, or with spatial ambiguity – a zone that belongs both to the centre and to its surroundings. We see the different ways in which the chat and wiki tools are used as representative of this quality. That students can use the wiki to tie ideas that are raised in the chat, to previous work of the group, and this can be referred back to by the group. The time-scale at which this occurs differs depending on the complexity of the decision being discussed.

Methods

Educational Design

The study has been described previously in papers making use of the chat data (Reimann, Thompson, & Weinel, 2007a, 2007b), however we will describe it briefly here. Postgraduate university students participated in a 13-week course about learning, change and systems. Their participation in the course was synchronous, through weekly chat sessions with the lecturer, and asynchronous, through regular contributions to the wiki. As a requirement of the course, students were divided into groups containing 3-4 members, and given an assignment to complete during one month. They were encouraged to meet regularly in the chat environment, and to record any interactions, or notes related to the assignment in the wiki. The assignment was to redesign an existing system dynamics model such that it could be used for educational purposes.

Table 1: Tasks and subtasks discussed during the collaborative learning experience

Task	Choosing a model		Additions to the model		Implementation		Overall task	
Subtask	Criteria	Group A: 2	Additions	Group A: 7	Additions	Group A: 3	Planning	Group A: 3
		Group B: 5		Group B: 4		Group B: 4		Group B: 2
	Process	Group A: 4	Resources	Group A: 2	Resources	Group A: 1	Dividing Roles	Group A: 1
		Group B: 2		Group B: 0				Group B: 1
		Process	Process	Group A: 1		Other	Group A: 4	
				Group B: 1				Group B: 3

Specific tasks were not communicated to students as part of their assignment. In the two groups, students identified similar tasks themselves, and subtasks within these, seen in Table 1. There were relatively similar numbers of decisions made for each of the subtasks for each of the groups.

Data collection and preparation

A sub-set of the data presented in this paper has already been analysed for decision-making (Reimann, et al., 2007a, 2007b), and the analysis of the processes were reported on in Reimann, Frerejean & Thompson (2009). In that research, process modelling and mining were used to focus on the temporal aspects of group decision-making in a chat. Poole & Roth’s (Poole & Roth, 1989a, 1989b) model was used, that states that groups work on multiple threads, or decisions at the same time, and that the decisions with respect to all these are mixed together in observable behaviour. The 2009 study concluded that the decision process is unstructured, complex, and cyclic, but that within that, differences could still be identified. Group A’s data produced a model in which the cyclical nature of the process was far more pronounced. Group B’s model showed a more linear approach to their decision-making, however it was noted that some of their collaboration was not conducted in the chat.

In this paper we have included the wiki data and some additional chat data in our analysis in order to examine the way in which learners combined their use of the tools. Data will be reported on from wiki entries and chats coded to the level of the decision that was made. An utterance in the chat data was one line of the chat, as it appeared in real time. Coding of wiki data to the level of the decision resulted in 98% agreement for 2006 data and 100% agreement for 2007 data. An utterance in the wiki data was one iteration of a page that involved substantial changes – for example the addition or removal of text, not formatting changes. .

The data collection method and the sample have been described in other papers (Reimann, et al., 2009). Data were collected using a tool called Snooker (Ullman, Peters, & Reimann, 2005) from a group of graduate students who worked on a design task of adding instructional design features to an existing system dynamics model, without meeting face to face (Reimann, et al., 2007a). Students were expected to coordinate their own work for this task, which required frequent decision-making about the task and managing the group work. We focus on two groups. Group A was composed of three female students and one male student. Group B was composed of three female students. The data spans a one-month period.

Analysis - integrating and visualising the data

Multiple streams of data were brought together by organising and representing what has been collected in such a way that patterns could be observed. One way to describe this is taking the behaviours of the students and placing them into a structured representation.

Visualisations of the collaboration

In order to reveal the patterns within the student behaviours, the collaboration was represented visually across time using the representations below. The first addresses just the tool use for the two groups. Wiki-email was separated for Group B because many of their wiki entries involved pasting copies of emails between group members into the wiki pages, which we considered to be different from the expected contributions to wiki pages. Figure 2 represents how this tool use was distributed amongst the four tasks (Table 1) for the two groups. We then selected two decisions that were made in the *instructional additions to the model* subtask – what to add, and the instructional approach. These were selected because of the differences in tool use observed between the two groups. The representation of tool use by the two groups can be seen in Figure 3.

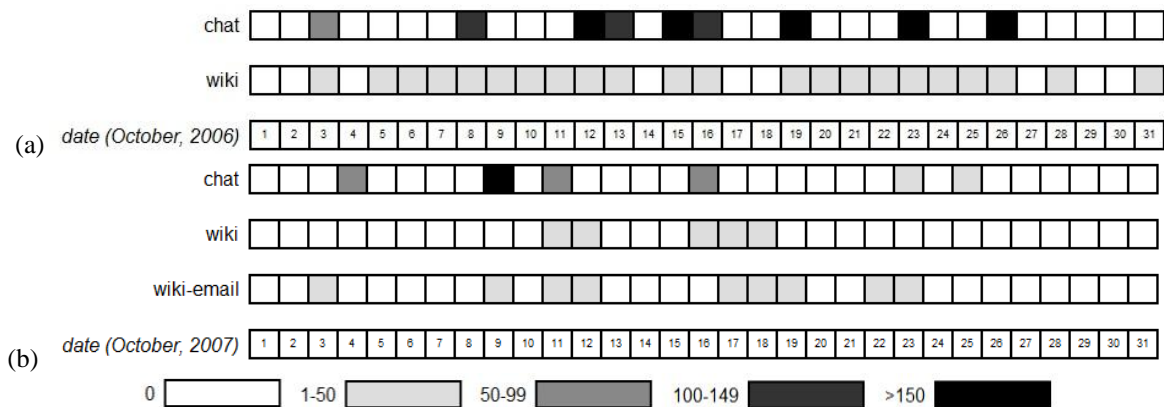


Figure 1 Number of utterances per day for each tool for: (a) Group A; and (b) Group B

Figure 1a shows that Group A held their first chat on the 3rd of October, and the wiki was first added to on the same day. This group added to the wiki almost every day between then and the second chat on the 8th October. From the 12th of October, both the chat and wiki were used most days. The last day that students met in the chat environment was the 26th October, and they made their final changes to the wiki on the 31st, when the assignment was due. Figure 1b shows that Group B held their first chat was held on the 4th October. After the 18th October the wiki was no longer updated unless to paste students' email communication. The final chat occurred on the 25th October.

Figure 2 shows the tasks about which learners in Group A and Group B were making decisions, represented according to when during the month-long collaboration they occurred, and separated by tool use. The four tasks

that students did to complete the assignment were choosing the model, deciding on additions to the model, implementing the changes, and overall issues such as planning or trouble shooting.

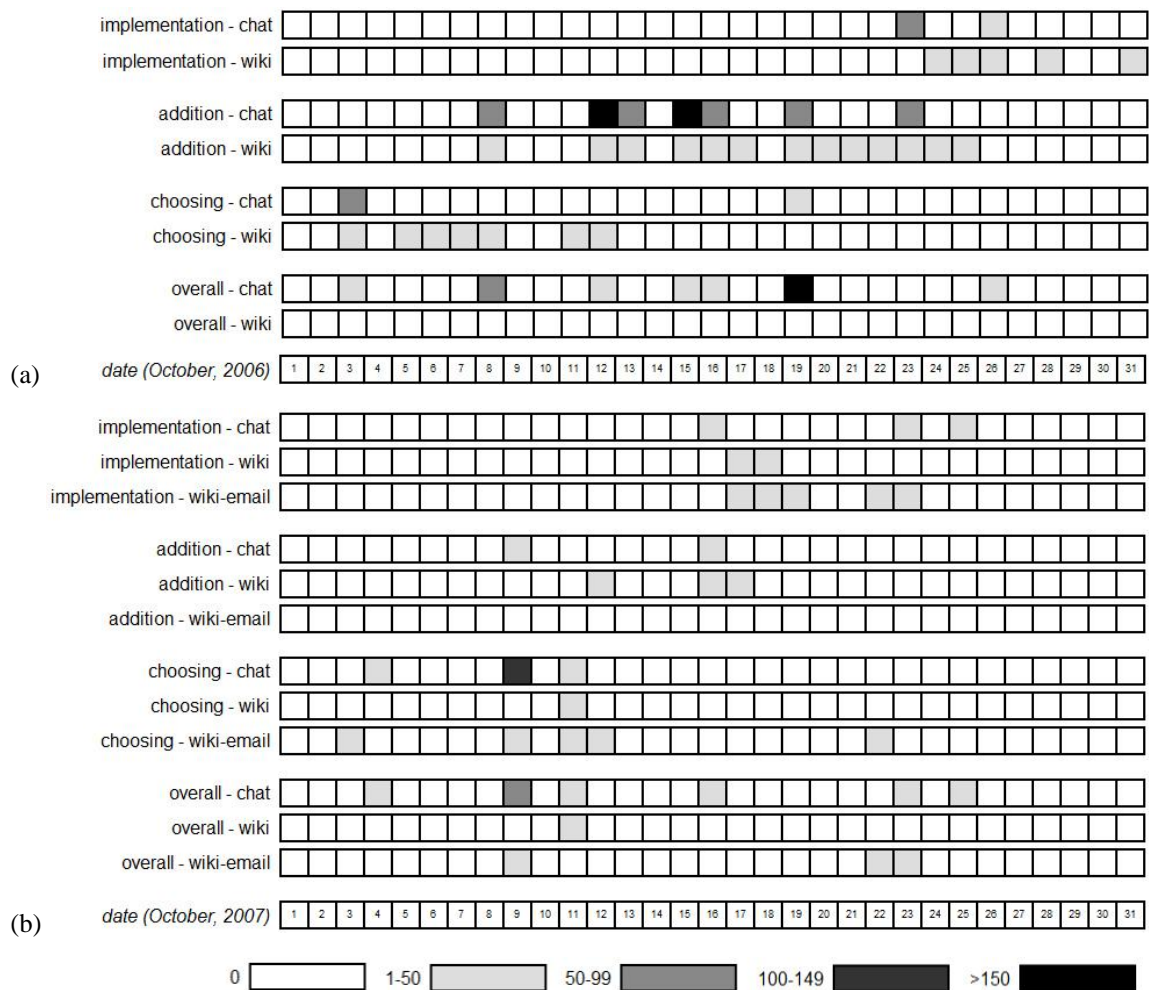


Figure 2 Number of utterances per day for each task for: (a) Group A; and (b) Group B

Figure 2a shows that the members of Group A spent a large number of utterances discussing the additions to the model (the point of the assignment), fewer on choosing the model and the implementation, and a relatively large amount, over a number of weeks, on the overall planning of the assignment. There were also many instances, over a number of days, that each of these tasks was discussed. In Group A, students discussed choosing the model during their first chat. They followed this with several days of work on the wiki, and revisited an element of this task on the 19th October. Most of this work appeared between the 3rd and 12th. Additions to the model were discussed between the 8th and the 25th of October. The chat and the wiki were both used. After the initial chat on the 8th October, the remaining work began on the same day as the final wiki change related to choosing the model. Discussions that involved implementation began in a chat on the 23rd of October, followed by two wiki changes, another chat and the remaining work carried out in the wiki, this was finalised on the 31st October. Finally, the overall tasks were discussed only in chats, and always occurred when other tasks were also being discussed. These occurred throughout the collaboration between the 3rd and the 26th October.

Figure 2b shows that Group B made decisions about the overall planning throughout the collaborative task, however decisions about the other tasks – choosing the model, additions to the model, and implementing the additions, had far less overlap than that observed in Group A. They appear to finish on one phase before beginning the next. In general, Group B produced fewer utterances about any tasks than did Group A. Choosing the model was discussed in the first chat, followed by emails and further chats until the 12th October. The wiki was added to only once. Additions to the model were discussed between the 9th and 17th of October, and were discussed during two chat sessions, each with subsequent additions to the wiki. Emails were not used. There was

some overlap in time, with discussions about choosing the model. Implementing the changes was first discussed on the 16th of October, in parallel with the second discussion about the additions. Subsequent communication was via email, wiki, and chat. The work on the wiki occurred at the beginning, and then versions were sent via email rather than posted. The final discussion was in the chat on the 25th of October. Overall issues were discussed in chats, the wiki and via email. In all cases they were discussed at the same time as the other tasks were addressed.

Figure 3 shows the final representation for two of the decisions made within the *instructional additions to the model* subtask. These two decisions demonstrate different ways of approaching the same type of decision. The first decision was adding to the model (ai1), and the second was the instructional approach to take (ai2).

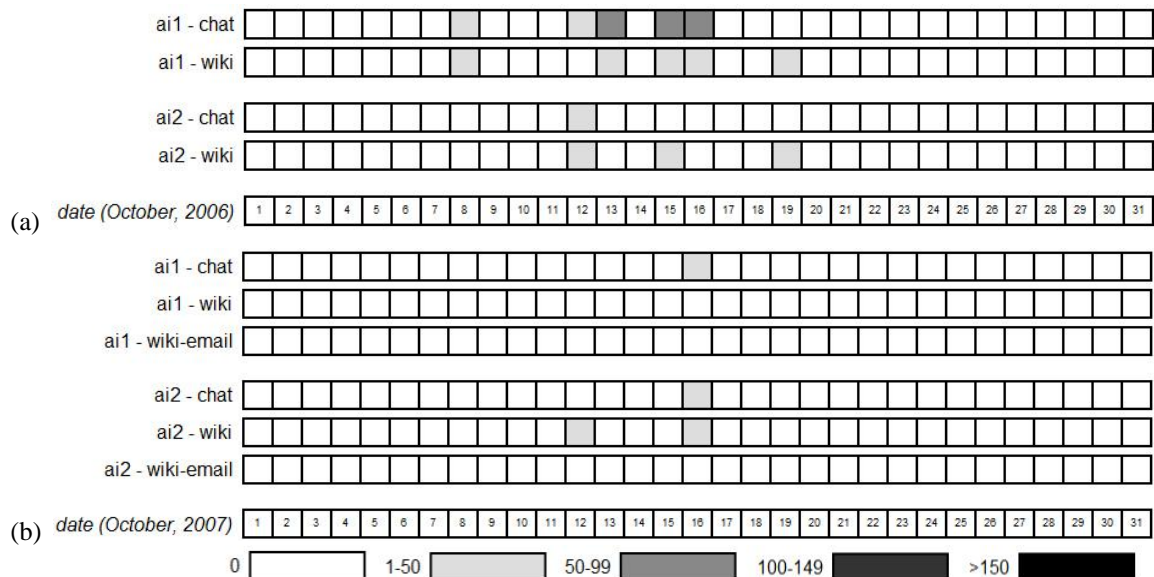


Figure 3 Number of utterances per day for *what to add to the model (ai1)* and *what instructional approach to use (ai2)*: (a) Group A; and (b) Group B

Figure 3a shows that in Group A, *what to add to the model* was a decision that the group discussed from the 8th to the 19th of October, using both the chat and the wiki. On those days when both tools were used on the same day, further examination of the data shows that they were used synchronously. As students participated in the chat, they updated the wiki with notes and ideas for *what to add to the model*. On the 12th/13th October (this was during a chat that began late on the night of the 12th and carried through to the early morning of the 13th), the students used the wiki to vote on proposed additions to the model by adding their names next to existing ideas on the wiki. The process took about 15 minutes. On the 16th of October, one member used the wiki to record ideas as students brainstormed in the chat. He alerted other members of the group when he had updated the wiki. The way in which Group A addressed the *what instructional approach to use* was similar. Members updated their ideas on the wiki as the chat progressed during the discussion on the 12th. This process continued with all members having a turn to update their ideas, and coordinating this via the chat environment. The final wiki change on the 19th was a note evaluating the work on the page by one of the group members.

Figure 3b shows that in Group B, *what to add to the model* was a decision that was made during a single chat. None of the other tools were used. The *what instructional approach to use* decision involved the use of the wiki and the chat. The decision was discussed first in the wiki on the 12th of October then in the chat on the 16th and the wiki also. The first, on the 12th, is the addition of a plan to address the assignment overall. The second reference to this I the wiki is in the style of a conversation. It was one change to the wiki page by one of the members, which addressed each of the other two members by name, assessed a previously mentioned idea, and asked a question of the group about how to progress. The chat occurred a couple of hours after, during which there was a straightforward agreement between group members on the instructional approach to use.

Discussion

The representations used in this paper have allowed us to visualise the ways in which students in the two groups used the tools available to them in a month-long collaborative design exercise. Differences were observed in the two groups, mainly related to how integrated their use of the tools was. Also evident in the visualisations was that different decisions, and tasks, required different tool use – there was no pattern within either of the groups. Some decisions could be made in one chat encounter. Other decisions, however, resulted in far more complex online collaboration, with simultaneous use of wiki and chat and subsequent analysis of decisions made.

The observable differences in the ways in which these groups used the tools indicate that the affordances of these tools are not restricted to those discussed in reference to either wikis or chats separately. There are observable affordances of using the tools *in combination*. This flexibility gave students the opportunity to use these tools in the way they needed, in order to support their collaboration. Group A used both tools as an integral part of their group work; they used the chat often and the wiki as they were chatting, in addition to asynchronously. Group B used it as a place to store the work they did elsewhere. Although less dynamic, this was still an important requirement for extended collaborative work. The ability of researchers to observe the different ways that tools are used *in combination* can give us insights into design, and learning.

One of the aims of this paper was to identify an Alexandrian property of form (2002) in the structure of the way in which the tools were used. Alexander's properties are useful to identify and understand beauty in form. They are then related to his design patterns. To produce a pattern for collaboration in an online environment, without recognising the properties of structure to which the design should be aspiring to will be difficult. We identified *Deep interlock and ambiguity*, which in a discussion about form explains instances of tying the centre into the surrounds. The use of the wiki and chat synchronously simultaneously ties the two centres (tools) together through the ideas generated. The ambiguity also relates to these ideas and decisions, they are at once separate in the wiki, and then in the chat. *Deep interlock and ambiguity*, we would argue, is relevant because of the affordances of the tools that students are using. The wiki was essentially the hub of both groups, and of the course overall, containing class notes, archives of chats, and instructions for assignments. Group A, in integrating the wiki into their synchronous collaboration, was continuously tying them back to the 'classroom' environment. The wiki became an essential part of their collaboration. Group B, however, by only recording items on the wiki after or before a chat session, and the nature of the information that they added to the wiki (copies of emails sent, their own writing, that was not incorporated together, but kept separated), did not engage in this connectedness with the networked learning environment in the same way.

Conclusions

The aim of this paper was to incorporate the arguments of Reimann (2009) and Jones et al., (2006), that time, and the way that groups will change over time are important in considering the processes of collaboration, with those of Alexander (2002), that there are certain properties which are observable in design. The reason for this was related to the work of Goodyear & Retalis (2010), in the creation of educational design patterns. We have described some of the ways in which two groups used a combination of tools to structure their own collaboration space; discussed the ways in which their collaboration around particular types of tasks used these tools in different ways. We looked in depth at one subtask in particular at the complex way in which students simultaneously used the chat and wiki tools.

We relate this work to Alexandrian design principles by analysing existing data to determine that a property of form could be identified in the structure of the collaboration space, and that this facilitated different behaviours. This, we feel, will be a useful step in the future creation of educational design patterns. While the work in that area has been advancing, without a clear goal, such as identifiable properties in structure, this seems to be a challenging task. Identifying the property of *deep interlock and ambiguity* provides opportunities to create patterns at many levels.

This is an initial analysis of the data; future work can broaden the scope of this study, and potentially relate the structure of the collaboration space to the behaviour of the learners. The more we understand about what happens in these complex networks of learners, how learners communicate, the roles they adopt, and the way they integrate tools into their collaboration, the better we can design learning environments that allow learners to achieve the learning outcomes they, and we, want for them.

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