Social Information Behaviour in Physical Libraries: Implications for the design of digital libraries

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Abstract
Physical bookshops and libraries are visited by both individuals, and groups of patrons, while digital libraries are designed primarily for individual users. This paper reports on a study exploring the behaviour of groups of patrons in physical libraries, detailing their collaboration and communication during book searches. We aim to identify how characteristics such as location, time, environment, ambiance, layout and personal motivation play a role in a group's search and browsing behaviour. We report the findings of observations of group collaboration in academic and public libraries, and compare the observed book and library use techniques employed by patron groups. Further, we examine the support for group collaboration in digital libraries and discuss the implications of our observations for the design of digital libraries that support group collaboration and interaction among users. To that end, the paper suggests features and functions that could be added to DLs to enable asynchronous group communication and interaction.

1. INTRODUCTION
How people interact with books, with each other, and the physical spaces in libraries is of interest to developers of digital library systems. Individuals and groups employ different strategies and techniques when searching for books, and an evaluation of these differences in library use can aid the design of digital libraries. After previously observing groups of patrons in book shops [4,5], in our current study we look to public and academic libraries, for comparison. We report here the results of anonymously observing 83 groups of two or more patrons visiting two New Zealand public libraries and the library of the University of Waikato. We observed the activities of the patrons as they interacted with each other and the books. Where possible, each group was followed from entry to exit, for a full picture of each visit. The criterion for selecting a group for observation was that one or more members actively browsed the shelves (not simply socializing, drinking coffee, conducting a meeting, etc.). Our observations focused on the following aspects of the patrons' behaviour in the libraries: their interactions with each other (pointing, chatting, standing near / apart, etc.); the browsing or searching strategies they are observed undertaking; how they select a book to read (in the library or to borrow for later reading); how group members distribute themselves in the library and the activities that they pursue (both separately and together); and the perceived goals of the group's visit to the library, as inferred from the group behaviour (e.g., as socialisation opportunities and experiences, locating a book for the group to use, individuals locating books for personal use). Insights from this study about group behaviour in physical libraries suggest design implications for digital libraries. This paper reports on the observational study, and a smaller follow-up study. We then incorporated the insights from both studies into a prototype design that provides support for group use of digital collections.

The remainder of this paper is structured as follows: Section 2 discusses related work in the area of libraries, digital libraries and collaborative information behaviour. In Section 3, we introduce the study methodology that was used for the observations. Results of the study are presented in Section 4, and discussed in Section 5. Section 6 introduces our initial work motivated by the outcomes of this study on designing DL interfaces designed for two or more people. Final conclusions are drawn, and our plans for future work are listed, in Section 7.

2. RELATED WORK
Digital libraries research has a long established interest in collaborative information work [26]. Information search and use remains a complex area for both individuals and groups alike. Fundamental research on information seeking behaviour, reading and group work has repeatedly demonstrated the critical role of the collaborative discovery, selection and reading of texts [16].

Collaboration in Libraries. Collaborative document selection, in either a physical or virtual environment, is not explicitly addressed by current models for collaborative information behaviour [9, 24,5]. Observational studies of the interaction between library staff and patrons has been the primary focus of ethnographic analysis of collaboration within a library setting [17], while we are interested in interactions of patrons with each other. A naturalistic approach has been used for a small number of studies looking at behaviour in public and academic libraries, but an even smaller number have focussed on collaborative browsing or search using these methods. For example, Bohley et al. examined collaborative behaviour when using books [3], without considering book selection. Hinze et al. noted some group interaction during book selection in academic libraries, while predominantly focussing on individual patrons [9]. Timpany et al. observed 40 group patrons in different bookshops [25]. Neither of these studies analysed actions within the groups in depth. Our

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focus aimed to explore the group interactions over the entire time span of the library visit.

Digital Co-reading. Research in digital libraries and human-computer interaction has investigated the design of collaborative reading systems. Collaborative reading between an adult and a child in separate locations has been investigated by Raffle et al [18,19]. A contrasting study by Pearson et al. [16] observed users who were co-located and reading the same document on individual devices. Pearson's observations were similar to those of Cunningham et al. [5] in bookshops, who also observed readers pointing out specific passages to their fellow readers. Again, these studies by Pearson and Raffle focus on joint reading and not on joint decisions making and book selection.

Work teams. The majority of studies involving work teams and how they collaborate have been longitudinal and focussed on information search, information use and sharing of information between group members [20,23]. However, these studies only focus on a fine-grained analysis of the complex behaviours of an individual team.

Children's Book Selection. Examining books during decision making has been the most commonly studied aspect of how children identify books to read. The research focus has been on identification of book elements that influence children's decision-making behaviour. Studies typically involved small numbers of participants (e.g., 9 [10] and 18 participants [21]), which were observed while deciding between a small number of books (e.g., 5 books [8] or 9 books [12]). One of the few available discussions of children's book selection in a substantial book collection [21] focuses on classifying the behaviours of children that physically interact with books on shelves. A second such study of children in bookshops uncovered considerable collaboration in book selection and use (i.e., joint browsing and reading) [4]. Many of these collaborations facilitated joint recreation instead of fulfilling specific information needs.

Social nature of libraries. Libraries have been recognised as a social space for meeting, gathering and socialising, an aspect that is typically underrepresented in Digital Library research [1]. Ackerman identified four contributions of social interaction between (academic) patrons: 1) helps in selecting materials when material is unknown or unfamiliar, 2) informal seeking and sharing of informal (unwritten) information, 3) ad-hoc and contextual information best found face-to-face with colleagues, and 4) provision of a socializing and networking to facilitate collaboration.

Libraries as Third Places. 'Third places' are places of "refuge" [11], which are found outside of home or work [6]. They are places "people can visit regularly and commune with friends, neighbours, co-workers, and even strangers" [14]. We observed that both public and academic libraries constitute 'third places' that are visited not always with the intention of loaning a book [5]: a significant portion of patrons seemed to be 'spending time' rather than actively searching for books together. There is a lack of support for achieving a sense of third place in current DL systems. As well as this, DL systems currently available have non-existent or weak social interaction and collaborative functionality.

3. STUDY METHOD

We here clarify our motivation and research questions, and introduce the setup of our study, undertaken to answer these questions, and to gain further information about patron behaviour in groups.

3.1 Guiding questions

In order to understand how groups are using libraries in a shared manner we identified the following questions, and explored how they might be used to guide our study design:

1. How did participants interact with each other? We observed the ways patrons who visited the library in groups interacted within the group during the book-searching activities. These would be open observations, from which we hoped to be able to classify those interactions, similar to the classification identified in bookshop interactions (e.g., reading aloud, looking over each other's shoulders, pointing to shelved items, chatting), see [5].

2. How do members of groups select books in libraries? We had previously observed how book selection behaviour in libraries differs between individuals [9]. Here we wished to repeat similar observations, but focussing on people in the same groups. We wished to be able to draw a picture of how participants share tasks in order to achieve their searching and browsing objectives.

3. How do groups use the physical spaces in libraries? The physical space within the libraries affords a range of uses, including browsing the collection, book selection, reading, and conversations. We were particularly interested in the positioning of the group members within the space: how they moved through the space, together and separately.

4. Why do groups visit these libraries? We sought to find out, for example, if patrons were searching for specific books (i.e. books identified before coming to the library or through a library catalogue search or suggested by another person), books for a purpose (i.e. books on a topic or theme for research or personal use), browsing for 'interesting' books without any specific topic in mind, or were they in fact more interested in sharing an experience or spending time together.

3.2 Observation Methodology

The questions and aims (Section 3.1) determined the observation methodology used for our study. For example when aiming to gain insight into patrons' behaviour, we wished to first observe the interactions and actions of patrons in groups. We decided against interviewing groups to further elicit their motivations, as this would have interrupted the flow of their in-library interaction, or might have drawn attention to the actions of the researcher (for outside interviews). As a consequence, the answer to Question 4 can only be speculated about from observing the patrons' activities.

To investigate browser behaviour in a variety of libraries, we conducted anonymous observations at one university library and two public libraries. The three libraries represented different sizes, specialisations and locations, and were all located in Hamilton, New Zealand (the fourth largest city in NZ with approximately 212,000 people). We observed the activities of groups of two or more browsers as they interacted with each other and the books in these libraries.

The criterion for selecting a group for observation was that one or more members actively browsed the shelves (not simply socializing, drinking coffee, conducting a meeting, etc.). Observations occurred in both the fiction and non-fiction sections of the libraries. No children were observed unless they were clearly part of a group that also contained adults. Brief manual

notes were taken in situ, and later expanded and entered into a spreadsheet for analysis. Observations were conducted separately by two of the researchers; they occurred both on weekends and working days, and in the evenings and the afternoons.

We used grounded theory analysis [7] to develop categories describing the observed behaviour, building a rich description of the behaviour 'from the ground up'.

4. RESULTS

We now report on the details of our observations, the resulting data and conclusions drawn from our observations. Section 5 discusses these results in comparison to related work and with regards to implications for digital libraries.

4.1 Participant Groups

Overall we observed 83 groups, 66 in the public libraries, and 17 in the academic library. The public library observations followed 66 groups, totalling 180 people (57 women, 41 men, 44 girls, and 38 boys). These groups, hereafter referred to as G1 to G66, included 12 groups of female-only patrons, 46 groups of male and female patrons, and eight groups of male-only patrons. Group size ranged from two to ten (43 groups of two, 13 of three, 5 of four and 2 of five, 1 of six, 1 of seven, and 1 group of ten). 56 groups consisted of adults and children, and 10 groups were adults only.

In the academic library we observed 17 groups that included a total of 37 people (23 female, 14 male). These groups, hereafter referred to as G67 to G83, comprised of 7 groups of female patrons, 6 groups of male and female patrons, and 4 groups of male patrons. Group size ranged from two to four (15 in groups of two, 1 of three, and 1 of four).

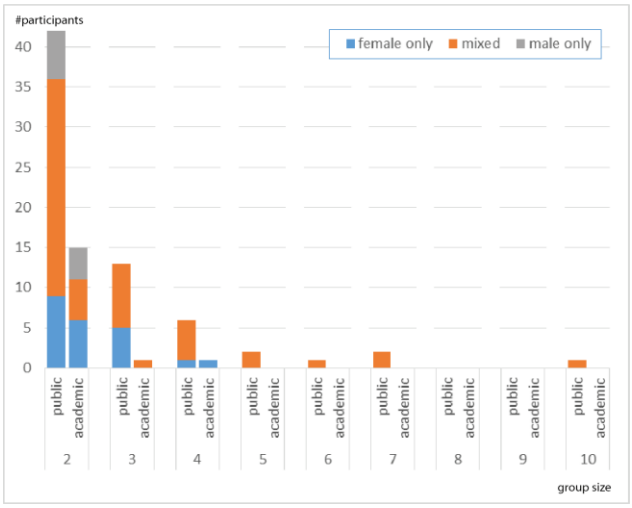

Figure 1: group sizes in library observations

The estimated age of observed adults is shown in Figure 2 and the age of the children observed (in public library only) is shown in Figure 3. The estimated age of observed patrons of the academic library would suggest that all observed patrons were students at undergraduate or graduate level.

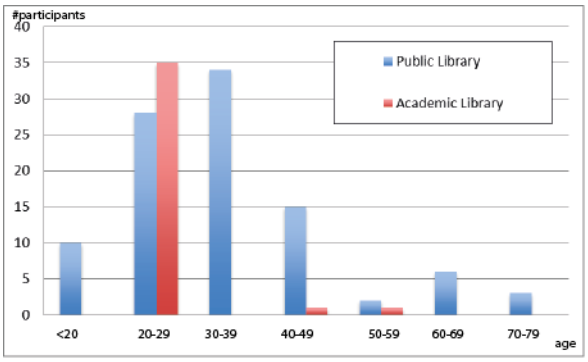

Figure 2. Estimated age of observed adults

In both the public library and the academic library, we observed more female patrons than male patrons. This distribution reflected the patrons visiting the libraries at the time; the researchers did not deliberately skew the choice of groups to include in this study.

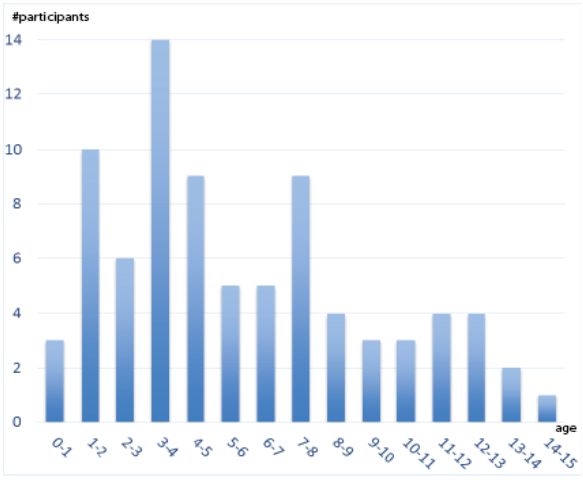

Figure 3. Estimated age of children in public libraries

A total of 101 female visitors (adult and child) and 81 male visitors (adult and child) browsed the public libraries and 23 female and 14 male visitors browsed the academic library. The groups with children may or may not have been families, however for ease of readability of our paper we refer to these adult and child groups as families from this point forward.

4.2 Visit durations

Where possible, we observed patrons from their entry to the library to their exit. When this was not possible we identified groups who were already present in the library and observed them through to the point at which they completed their visit and left (with or without books). The duration of the observations in public libraries varied from 4 to 180 minutes, with a mean of 26 minutes. The duration of the observations in academic libraries varied from 2 to 29 minutes, with a mean of 11 minutes.

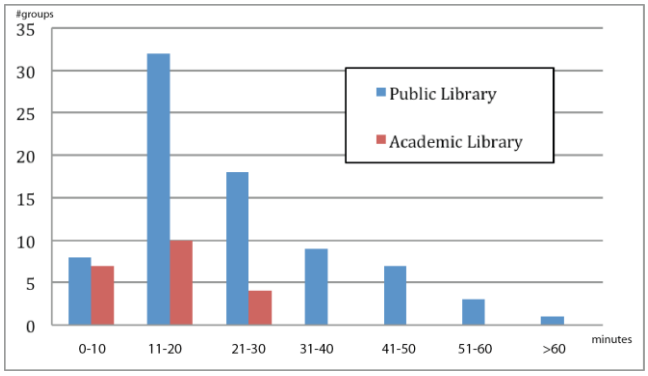

Figure 4. Length of observations (in minutes)

4.3 Interaction Behaviour of group members

Here we describe the interactions between the observed patrons in the libraries (see Figure 5).

Groups in the academic library were most commonly observed communicating about what they were doing, and reporting and questioning each other about their progress. We also regularly observed group members pointing to books and book content during a shared search. Overall, we note that there is more interaction between members of a group in the academic library than group members in the public library. In the public library, the main interaction in groups was browsing and searching together. Overall, group members in the public library interacted less with each other.

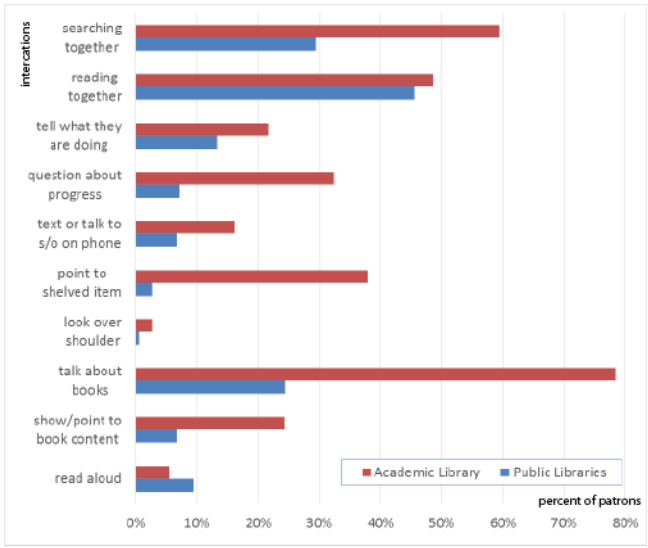

Figure 5. Interactions in patron groups (percentage of observed patrons in each location)

Searching together in the academic library can be exemplified through group G67:

> They arrive with their assignment sheet, and start by searching the catalogue. The woman reads from the assignment paper and the man used the keyboard. They go together to the shelves, pointed to books, half pulled books (to see more of the cover), and discuss the suitability. They both look at the shelves from some distance, discuss, and go back to the catalogue. They again read the assignment sheet together, talked while standing next to the catalogue. Again, he types on the keyboard while she looks over his shoulder at the screen … and the paper. They go back to the shelves […], both looking for the book number. He pulls a book out, shows it to her, they talk and seem to have found what they were looking for. They talk for a bit longer and then leave the library without any books.

The interaction seemed focussed on the task of finding material for the assignment, we observed very little "spending time" if at all. A common interaction of searching together in a public library is illustrated by group G40:

> While mum uses the computer catalogue the 12-year-old girl assists the 6-year-old girl to find books in the children's section. Without success they move to mum who is still working at the computer. They briefly chat and the two girls return to the stacks. The older girl browses novels while the younger one plays, they then move together to the DVD's and CD's. They then again move to the books where older shows younger one a book before the two girls search separate sections for more books. Mum finishes on the catalogue, glances towards the girls and then moves to the adult fiction section.

The interactions between the girls seemed to be predominantly related to "spending time together", while mum might have been more focussed on finding a particular book.

We noted considerable book-oriented conversations and gesturing in the academic library. Patrons were chatting, talking about the books, searching together and pointing to the shelves. We also see academic visitors reading together and telling what they are doing as part of their time searching for books. Discussions about books in the public library were quite different: For example, we overheard in group G54 a 3-year-old remarking that "this [book] is for a baby" and mum observing "you already have this one [book] at home". In group G48, the grandfather asks "do you like this one?" showing the cover; in G8 a 16-year-old was heard to say "mum said to get chapter books". In the academic library, conversations were around the topic of the book or the topic of the particular assignment that the browsers were working to answer, whereas in the public library book-related conversations were less focussed and more playful.

The observation that many patrons of the public library are "spending time" is also supported by the number of children playing or the groups that were noted to not interact with books at all. In 24 of the 56 family groups, children spent some time playing, sometimes with items from the library (pillows, rocking horse, ball, puzzle, books, paper and scissors), sometimes with items they brought along (mobile phones and iPads). Two groups were observed spending 21 minutes (G32) and 5 minutes (G40), respectively, on playing with the rocking horse, the puzzle, the pillows, without anyone in the group ever looking at or interacting with the books. In other cases, it was only the children who didn't interact with the books, while the adults searched the stacks or catalogue. In some cases it seemed that the library provided a place to meet with other adults in an environment that would offer some distraction or entertainment to the children. Some parents appeared to be accompanying children who needed or wanted books, yet the parents were observed to be merely waiting for their children to finish their task (e.g., G16: child browses for books while parent waits, and G23 grandmother watched children browsing for books).

Four observed groups arrived for specifically-booked internet hours (but neither G29, G30 nor G42 could find a free computer and needed to wait or come back later). However, most groups observed did interact with the books, often making decisions about books to take home (more about this in Section 4.6). None

of the groups observed in the academic library seemed to just "spend some time", though some people were observed talking or checking notes on their mobile phone or computer.

4.4 Book selection

Figure 6 shows which information patrons used to make book decisions and how many patrons issued books to take home. Most likely the lower numbers for the public library mainly reflect that only a fraction of the patrons was actively engaged with the books. The 'specials' refer to specially announced bestsellers and returns that are available on separate shelves (similar shelves do exist in the academic library but no groups were observed perusing those).

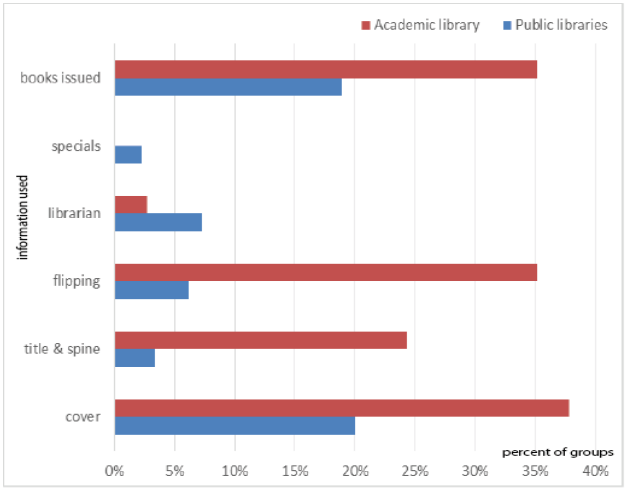

Figure 6. Information used for Book decisions

The use of title and spine information was predominantly observed after patrons had used the electronic catalogue and were then directly searching for a book by catalogue number. 36 of the 82 children in our study were seen to make decisions based solely on the cover of a book. Book selection based solely on the cover was only noted three times in the academic library and not observed for any of the adults in the public library.

Most of the patrons of the public libraries visited in groups with children (56 of 66). The visits observed appeared very social or recreational in nature.

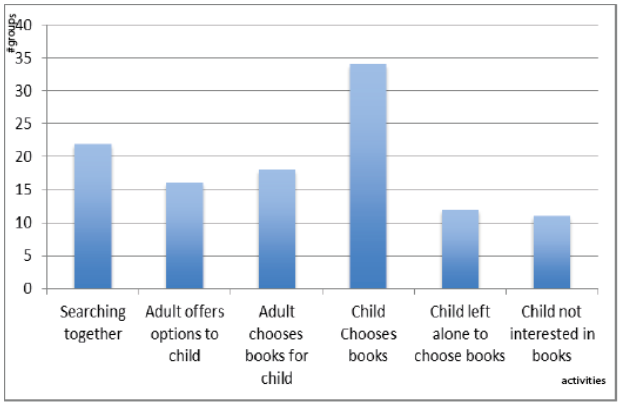

Figure 7. Observed book decision making (in overall 56 groups with children in public libraries)

Figure 7 explores in more detail the decision making processes observed in the 56 groups with children in the public libraries. In many cases, the children depended on their parent's guidance (through joint search in the stack or library), but we observed that in 34 groups the children chose their own books. We observed how some parents offered suggestions and options for their children to assist them in decision making, while other children were left alone to interact with shelves and select their own books. 18 adults decided to select and choose books for the children instead of the child selecting books themselves. Naturally, the very young children, often those 1-3 years old, were often much more enthusiastic about playing and enjoying these public places, and several of them appeared uninterested in books or selecting books at all.

4.5 Use of library spaces for reading

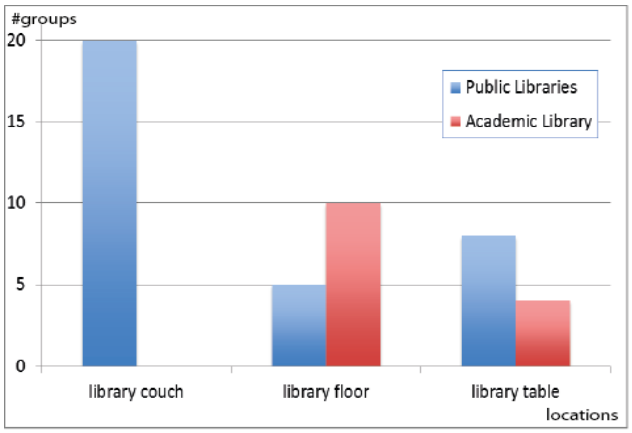

Figure 8. Library spaces used for reading (#groups)

Figure 8 shows which places the observed groups used to read books together. In the academic library this was typically done quietly, while in the public library it was either quiet, or, more often, an adult reading to one or more children aloud.

The public library offered a couch, which was used by many groups with children (almost half the groups in the public libraries used the couch for reading). They flipped through books and read stories aloud. Many parents were observed sitting on the couch reading with their children, while a number sat on a library table next to the bookshelves so they were able to pull books while they were sitting. For families with children who were very young (1 or 2 years old) the floor seemed a common choice in order to let their children play while the parents read stories. This low seated position also allowed children to be able to pull books from book bins (floor bin shelving system which often houses picture books at a level easy for children to rummage). Note that reading stories together did not mean that the books were then issued; reading in the library may have been a way to triage the books for the families, or simply a way to spend time interacting and learning.

The academic library did not offer couches, and had few tables that could be sat around (as opposed to workstations and long benches for individual working). The tables in the academic library were also further away from the shelves than in the public libraries. Some groups, such as G75, wished to use a table but could not find a free one.

10 of 17 observed groups in the academic library used the floor for reading (compared to 5 of 66 in the public library). The library floor was used in the academic library for triaging and browsing low shelves. 4 of these 10 academic library groups who sat on the

floor together shared multiple books, using the floor as a spatial layout and to triage books collaboratively.

4.6 Reasons for visiting

Figure 9 summarises our observations regarding the purpose of the library visits, which we derived from observing family conversations, body language, the use of notes and tools that participants brought to the library, and activities groups undertook in the library.

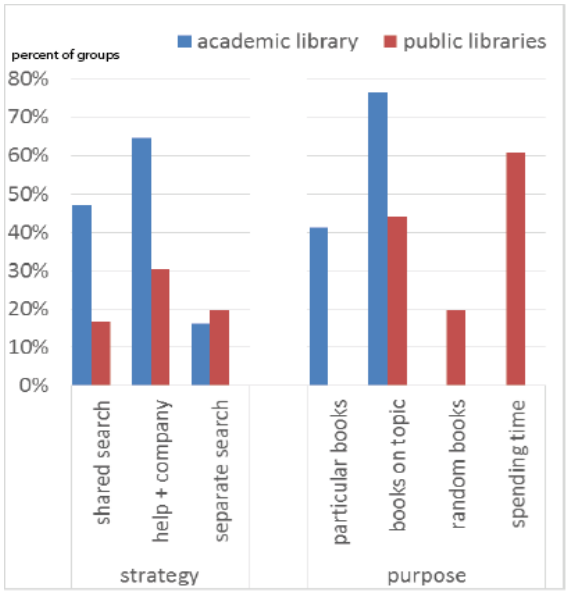

Figure 9. Purpose of visit and observed strategy on book finding (% of groups)

When looking for books, groups either came to search for books together, to assist someone who is looking for books, or they had separate search interests. They came to find particular books (often using the catalogue to find them), books on a certain topic (e.g., group G47 searches for books about basketball, and G9 searches for books about ballet), or browsed to randomly find books of interest. A number of groups came to spend some time, with hardly any reference to the books.

Even though we previously observed people browsing for "interesting" books in the academic library while being on their own [9], this was not observed for groups of patrons in the academic library. When we compare the purposes of the visitors in the two library spaces, we see that patrons of the academic library seem more goal oriented and appeared to be searching for a particular book or with a particular topic in mind. Group members were likely to be assisting each other in the search process in the academic library. For example, in G81:

> Two friends visit the library. One of them goes directly to the required section and walks from the beginning of the section to the end, looking at the eye level of the shelf without touching or pulling out any book. Then he stops and takes one book and put it in his hand without having flipped or read it. After that, he goes to talk with his friend and assist him to find his required books by looking at his mobile and searching on the shelves. During this process, he finds a book for himself and takes it without flipping through it. He leaves the library with two books.

On the other hand, in the public library, spending time, looking for interesting books on known topics or even just a random book were more likely to occur. One such instance of a family spending time together is G55:

> The 12-year-old girl flips through books, handing a book to mum while the 3-year-old girl plays on the large pillows. Mum sits on the sofa holding the older girl's book while the two girls play together on the pillows. The older girls sits with mum, who is reading the book to her. Once finished, mum asks her to get a few more books to read while mum pulls three books, opens them and places them on the floor for the younger one to flip through. After reading a further two books that the older girl selected, mum chooses two more books, shows them to the older girl who selects third book all of which are issued before the family leaves.

Even though in this case (G55), some books were issued, book selection with the goal of identifying books to take home was not a significant task in either academic or public libraries. Only 30% of the visitors (13 of 37 visitors at the university library and 52 of 180 at the public libraries) issued a book during their library visit and 15% (12 of 180) of the visitors issued an audio book (all at the public library and all were members of family groups). Overall, 18 groups took home books, 11 took books only, 6 took audio books only, one group took both book and audio books. 34 books and 9 audiobooks were taken overall. None of the patrons observed explored the eBooks offered by the academic and public libraries or took home one of the available eBook readers available at the public libraries.

5. DISCUSSION

As discussed in the introduction and related work of this paper, research rarely considers the book selection process for individuals or groups and thus we discuss here the implications of our observations in physical libraries. This study observed group interaction behaviour in academic and public libraries. We sought to determine if and how the physical environment affected the participants' actions. After analysing the data, we now wish to go beyond the initial research questions that guided our study methodology. We will first describe our observations using the two classifications of social interaction behaviour and search interaction behaviour.

Search. We observed that some interactions within academic and public library differed in nature and context. Others were observed in both contexts, such as showing and discussing books, reading and searching together, and chatting. In public libraries the search task was often conducted side-by-side and collaboratively, while in the academic library search was done either together, separately (individuals search and report back), or one searcher was accompanied by helping friends. Public library patrons often seemed to desire to find an interesting book, rather than one on a specific topic. Collaborative searching and browsing involved moving between different sections of the library to examine the book, and talk at the same time.

However, in the academic library, groups searching separately were often difficult to identify. Only after a group member had conducted a shelf search and reported back to a team or partner at a working space away from the stacks were those groups identified. Thus these particular groups were not fully observed and we feel they are underreported in this paper.

Adults in both public and academic libraries selected books based on metadata including spine, book title, online catalogue, and back of book, in addition to the cover. The observations made here are in keeping with those from observing single users academic libraries [9].

	location	device	time	library equivalent	eReader equivalent	current DL support
1	shared	shared	same	collaborative or assisted search/browsing [as observed]	co-reading using same device together	restricted to one person interacting with the DL at a time, limited collaboration (assisted search/browsing: one person interacts and one keeps company or comments)
2	shared	separate	same	search/browsing in different locations in the same library (collaborative or individual) [as observed]	co-reading using different devices, e.g., [Pearson et al]	separate interactions, sharing of search results not supported
3	shared	shared	other	reserve books to be picked up later by other person, or taking out same book and seeing annotations in the book	example: parents pre-select books for children to read later	not supported
4	shared	separate	other	n/a (patrons frequenting the same library at different times)	n/a	not supported, only when shared login (example: select books for child and send the selection to the child)
5	separate	shared	same	n/a (talking about a book on the phone)	n/a	not supported in DL, possible via screensharing in skype
6	separate	separate	same	n/a for groups (patrons frequent different libraries)	n/a	standard scenario (individual user), no group commmunication supported
7	separate	shared	other	n/a (talking about same book)	n/a	standard scenario (individual user), no group commmunication supported
8	separate	separate	other	n/a for groups	n/a	standard scenario (individual user), no group commmunication supported

Figure 10: Comparison of affordances of physical library to digital library

Social. The public library was heavily frequented by families and other visitors with the apparent purpose of "spending time", where searches, if executed at all, were done in an informal and casual manner. Like the bookshop patrons observed by Cunningham et al. [5], patrons seemed to treat the libraries as social spaces or third places. As observed in bookshops, many patrons of the public library engaged in casual browsing, not aiming for accuracy or efficiency in their book selection, but for enjoyment of the experience. They engaged in social interaction, searched collaboratively, held discussions, gave advice and feedback on the books. Patrons were observed to have conversations within their groups, and with strangers. Other actions included reading aloud to (children) members of the groups, and texting or talking to someone on a telephone.

However, while public libraries seemed to serve the purpose of being social in nature, there was still significant use of these public libraries for book selection and book borrowing. On the other hand, the academic library patrons' actions seemed much more related to books than to social interaction. Social interaction activities—such as looking over each other's shoulders, texting or talking to someone on a telephone and questioning about progress—were not as significant in the academic library.

Children in libraries. The public library organizes activities for children from time to time. Some of the observed family groups clearly knew about these events before entering the library. Often parents participated together with their children in playing games and singing, while also socialising. Children were regularly observed to be playing with pillows, balls, rocking horses; books were pulled from book bins for inspection and play. Many parents chose books for their children first then searched for their own books. This seemed to serve the purpose of entertaining the children to create some time for the parent's own task. Other interactions observed parents guiding their children on how to choose (age) appropriate books. Children were found to make decisions predominantly based on book covers, some also used known authors or characters. This observation is similar to that made by Cunningham [4].

Group selection of books. Searching for books in a group was observed to be done in a shared, separate or assistive manner. Even if searching is done separately, group members often report back to the groups how they are doing. Children were often assisted in a similar way, with parents, other adults or siblings acting as a "search partner". In both the public and academic library, suggestions were observed to include verbal commentary, pointing and passing of books.

Implications for Digital Libraries. The group selection process described above is currently not supported in either library catalogues nor in digital libraries or eReaders. Co-reading, e.g., [16], addresses collaboration once joint reading has commenced, but the prior decision process is unaffected. This indicates a need for ways to communicate, highlight, point and pass documents in a DL. This observation is also supported by Cunningham et al.'s observation in bookshops [5], where similar interactions during book selection were observed. In an ongoing study of current eReader interfaces, we noted a similar requirement for additional information during book selection.

Limitations. We note that the number of patrons observed in the public libraries was much greater than those in the academic library, and that the public library also included a large proportion of groups with adult & children group members.

While we visited the academic library on numerous occasions for significant periods of time, we found that groups of patrons were found significantly less often compared to the public libraries surveyed. Often individuals would search for books in the academic library and return to a group setting to discuss the find rather than multiple members of a team searching together. This might indicate that social use of a library for search and selection is much more necessary for public libraries than academic libraries and that we must therefore develop these public digital libraries for social and collaborative use before we do so for academic digital libraries. However, the type of collaborative behaviour noted in the academic library suggests that while collaborative selection was not central to the process, co-reading and collaborative triage, document and content selection and shared use was a requirement of a digital library system in an academic context.

6. Affordances of DL's for groups

In our related study of bookshops [5] we identified a range of affordances of bookshops for group use that were not presently matched in DLs (e.g., talking, pointing, showing, look over shoulder). We have now found strong similarities in our observations of groups in libraries. In our previous work, we did not address how to provide solutions for the problems identified. Here we report on initial research into possible solutions that are presently being investigated.

6.1 Physical libraries vs digital libraries

In comparing the group situations to the context of digital libraries, we note the following variations: different to physical libraries and bookshops with their synchronous interactions of shared location and same time, DL have the potential to support a variety of usage situations: of shared/separate physical location, shared/separate screen or eReader, and same/different time.

Figure 10 shows a table with a comparison between these eight usage situations from the digital realm with the equivalent scenarios found in the physical library. While Situation 1 represents physical co-reading, Situations 2 and 6 have been addressed in literature on digital co-reading, e.g., [16]. Situations 1 and 2 most resemble typical library interactions as identified in our study (Section 4 and 5 of this paper), while all other situation are only available via eBooks.

Synchronous and asynchronous interaction is supported by a number of systems, see Figure 11, which support different types of collections (general, eBooks, and digital table-top artefacts) and interactions (voice, text, and video). We evaluated systems according to their support for action awareness (knowing what the group member is doing), shared navigation (in eBook collections), and shared navigation within documents.

Systems	Collection type	Communication			Action awareness	Shared navigation in collection	Shared navigation in document	Evaluation subject
		Voice chat	Text chat	Video conf.				
Search Together[13]	general	-	+	-	+	+	-	+/-
CoSense [16]	general	-	+	-	+	+	-	-
Coagmento	general	-	+	-	+	+	+	+
Mixed-Presence Tabletop [26]	digital artefacts	+	-	-	+	+	n/a	-
CoSearch [2]	general	-	-	-	-/+	+	-	+
Goodreads	eBooks	-	-	-	-/+	+	-	+
LibraryThing	eBooks	-	-	-	-/+	+	-	+
BuddyBooks	eBooks	-	-	-	-	-	+	-
Kindle	eBooks	-	-	-	+	-	+	+
Mendeley	eBooks	-	-	-	-	-	+	+

Figure 11: affordances of a range of known digital systems[1]

6.2 Small scale user study

We explored the supported interactions for their suitability for digital library interactions (Scenario 1 from Figure 10). This small study observed both document selection and document use by non-colocated users. Eight groups of two participants (Groups A to H) situated in two separate rooms were asked to browse together the same pre-collected documents in the Greenstone digital library to identify the following sets of documents:

1. documents that match a given topic based on title
2. documents that match a given topic based on content
3. documents that best represent a given viewpoint (depending on content of documents)

Participants' interactions were recorded and feedback sought through post-study interviews. The participants (10 male and 6 female students) were allowed to use any communication medium they wished, bar visiting each other. None of the participants used their own mobile phones. Overall, two groups used audio chat via skype, 3 groups used video conferencing, 2 used text chat and one used video & shared screens.

[1] www.coagmento.org, www.goodreads.com, www.librarything.com, www.mendeley.com

Observations. Some participants were found to use the Greenstone search function to identify the collection, and the Firefox search to highlight keywords in the list of documents within the Greenstone collection. Five used the "highlight one by one", whereas three used the "highlight all keywords" option. We observed the groups to encounter a number of problems.

Spelling. Finding an agreed spelling of keywords was problematic as well as detecting the problem, see example from group C:

> C2: "what word(s) did you put?", C1: "you may have spelled it wrong", C2 (reads the word), C1: "what are you looking for?", C2: "what words should I put?" C1: "it is <repeats word>", C2 "yeah" (reformulates search query)

The example shows that C2 input all of the given keywords in Firefox and failed to match them with webpage content, while C1 put in the right words and did not know what C2's query was. To avoid this problem, participant D2 of group D was trying to share the query, but their partner D1 was busy browsing the collection and missed the communication.

Referencing within collection. When participants tried to direct their partner to the same reference in the collection, they used different techniques for solving the problem. Participants who used audio (landlines, videoconferencing and audio calling through Skype) aimed to identify the document reference by first reading the title aloud and, if that failed, by counting the lines on screen to direct each other. Participants communicating via chat (groups G and H), used copy-and-paste to exchange information.

Referencing within documents. Participants used page numbers, paragraph numbers, line number and content referencing (e.g., "below the table", or "The paragraph that starts 'Asynchronous is'"). The example from group D illustrates the problem:

> D2: "I found one and I think it is a good one [read the title]", D1: "Ok where?" D2: [Counts the lines], D1: [Moves the cursor when hears the count], D2: "It is number fifteen from the top" [read the title aloud], D1: "yup yup"

Different document types. Most participants were using PDF documents, while in group B, one participant opened a PDF while the other read the HTML version of the document. In group G, the same case did not cause any problems as they used text-based communication. Users were observed to be lost several times while moving between webpage tabs for the Greenstone collection and each of the opened documents, see example from group C.

> C1: "You find it!!" (sic) C2: "Ok, I think I found a [document]". C1: "How did you find it?" C2: "I opened the articles from the top, third one" C1: "From the top?" {Viewing the result in the Greenstone tab}, C2: "You can click on the icon and open the file" {participants do not notice that two icons are offered for opening the file either in HTML or PDF}, C1: [move from section to section] {lost track}, C2: "Oh no, no, it is the third one; where are you?" C1: {reads titles}, C2: "Ok, Ok probably you are on different pages"

None of these problems were encountered by the one group using screen sharing, however, this group spent some time initially talking about technical issues (e.g. how can I share my screen?).

Feedback. From the post-study interviews, we conclude that the groups using audio-chatting were most frustrated about their interaction and quickly lost motivation. The group using shared screen felt motivated throughout, and was overall more positive than any other group (video, text, or audio).

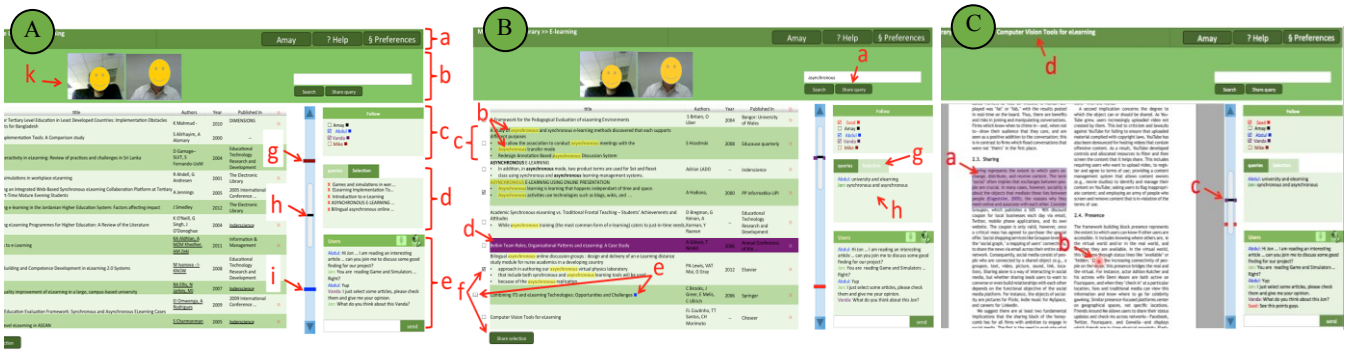

Figure 12: Interface Prototype for Co-browsing

6.3 Initial Prototype

From our user study reported in Section 6.2, we derived the following requirements for a co-browsing interface:

(1) awareness of group participants,
(2) group communication,
(3) selective sharing, and
(4) referencing awareness.

Figure 12 shows our initial interface prototype that addresses these requirements via video (see k on screen A), chat (see e on screen A), a multi-user scroll-bar pointer (see g, h & i on screen A), a tele-pointer (see d in screen B), and in-document pointers for areas (see b in screen C) and paragraphs (see a in screen C).

The interface prototype was evaluated in a small user study with five participants to gather initial feedback on our concept. They were given tasks for Situations 2 and 6 (Section 6.1), and asked to think aloud as they were interacting with the interface. The tasks were mimicking the user interactions from our previous evaluation (e.g., directing a group partner to a document collection, selecting a document, discussing its suitability, etc).

From the participant feedback, we conclude that the prototype sufficiently addresses the Requirements 1, 2 and 4 (Section 6.3). However, participants identified some *privacy issues* that fall under Requirement 3 (selective sharing). They found that sharing and awareness is easy, but the options for selective sharing, and control and awareness of who is following one's interactions are not clear enough. They reported to be sufficiently aware of who is following which of their activities. They requested a "private" option that stops selected group members from following their activities on selected documents, and also interface elements for private queries, and private references.

Furthermore, they identified as a potential problem the long-term *awareness of changes* (when not interacting synchronously). For example, deleting selected references by a group member might impact on the other members of the group. They requested a notification feature, in case new references are added, or current references are removed, by other group members.

We conclude that an interface for asynchronous co-browsing needs to take into account insights from Computer–Supported Cooperative Work (CSCW) research.

7. CONCLUSIONS

Our group is engaged in ongoing research into the behaviour of patrons of bookshops, libraries and digital libraries. This paper explores interactions within 66 groups of patrons of public libraries, and 17 groups of patrons of academic libraries (overall 83 groups with 213 participants). Based on the insights gained from our observations, we identified requirements for co-browsing in digital libraries. We explored these requirements in a user study in synchronous co-browsing with eight participant groups. We developed an initial interface prototype, which was evaluated with five users, leading to identification of privacy issues and questions of long-term awareness in asynchronous interaction in digital libraries.

Implications for Digital Libraries: We believe the findings of this study will serve a variety of researchers and designers in moving forward with DL design and development. From our findings of visitors to physical libraries we observed a range of behaviours that require better support in DL that house eBook collections. Public and academic libraries clearly serve different modes of interaction and visit purposes. We see in our study patrons with specific research tasks using the academic library while patrons in public libraries often entered with less precise goals in hand. An academic library should thus support targeted, known product search and retrieval while a public library might also serve browsing and exploratory search.

We also noted a very different sample of visitors to the two spaces suggesting that digital library equivalents would benefit design and consideration for these differing audiences. Visual design features of the academic library will of course be such that a tertiary age audience will appreciate the aesthetics and by all means have this not interrupt their known search goals. This differing from a public library, likely with a target market of children and parents using the environment together. We see this as an important observation of our study. We do not believe that children's DL are necessarily the sole outcome of this, nor are adults DL. Instead, we propose a need for DL's that are suitable for shared use by parent and child. With this in mind, digital libraries for the public library must be friendly, approachable and allow for use and enjoyment by both the adult and the child, individually, and collaboratively. Public digital libraries also require the ability for the parent and child to share their finds and offer suggestions. Parents were noted to show books to their children and choose books for their children, while children were also noted choosing books with parents and on their own.

Our small scale study identified four requirements of DL to afford similar experiences to physical libraries. These requirements are (1) awareness of group participants, (2) group communication, (3) selective sharing, and (4) referencing awareness. Supporting synchronous verbal and non-verbal communication in DL's will assist in the book selection process for purchasers and lenders alike. Purchasers may require synchronous communication for social benefit while lenders may require synchronous or

asynchronous communication for ratification and confirmation purposes during information searching and browsing problems. Our prototype sought to address the first stages of study development to test interfaces for support of these requirements. Results of this initial study indicate ethical considerations related to awareness and change logging are central to the needs of the students who participated in this study.

This study has been an examination of a largely unstudied aspect of peoples' collaborative information behaviour of synchronous co-browsing across different environments. The study of collaborative interactions in both physical and digital library environments has allowed for insightful comparisons to be made with implications for the development of DL tools. Two distinct relationships were observed: collaboration of equals (peers) and parent-child collaboration. These two social collaboration relationships are very different in nature and might therefore need different tools. Based on our comparisons and observations there are four requirements for successful collaboration within DLs; participant awareness, group communication, selection sharing and referencing awareness. Providing these functionalities for collaborative information search would enable DLs to better support purposeful collaborative behaviours.

Future work: The next steps in our research are an extension of the co-browsing prototype and an extensive user evaluation in real-world settings of different a/synchronous situations.

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