Co-Web: A Tool for Collaborative Web Searching for Pre-Teens and Teens

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Abstract This paper presents a design case of a Rich Internet Application Co-Web: a collaborative work tool for pre-teens and teens to help collect, collaborate, organize and format information from the web for their school projects more holistically by enhancing their in-search and post-search experience. A user-centered design methodology was followed to help identify how teens and pre-teens use search engines and other technology tools in their daily life to collaboratively work on school projects and recognize the key real-world interactions, which help support this activity. This design solution proposes that integrating collaboration with family, friends and visualizing search keeps the user group interested and helps them retain and use the information they seek more cohesively within the existing search paradigms. This paper describes the design methodology, findings from co-design with participants and reflects on designing new web search interfaces that provide tools for collaborating.

Keywords Web search · Collaboration · Teenager · Computer-supported cooperative work

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1 Introduction

Children and young adults are one of the biggest adopters of computers and Internet in India and across the world [1, 2]. The primary use of Internet by secondary and high school children in India is for education and entertainment purposes [3]. Due to increase in exposure to these technologies in schools and classrooms, more and more children are using the Internet and computer based media as primary sources of information for academic related activities [3]. Search engines and online libraries require proper articulation of query, analysis of results to find out the most important result or involve an understanding of abstract concepts which are beyond a child's still- developing skills [4–6] especially in India, where English is not the first language. Searching for information on the web is usually seen as a solitary activity, which often results in incomplete searches, unsatisfactory results and discouraged users [7]. There exists a big need to understand the real-world interactions that children turn to for support in their information seeking activities and to develop applications to support the ecosystem. We conducted interviews with educators, parents and others who frequently observe how children in high schools use computers and Internet for their academic purpose to understand the extent of use and behaviors of the stakeholders. We followed this up with a contextual inquiry with 8 school students and observed them while they carried out a collaborative project in their regular environments. Based on these interviews and observations, we identified several limitations of current collaborative information gathering, search and collaboration practises. Informed by the findings of this formative study, we propose the design of Co-Web, a system for facilitating collaborative Web search among secondary school students working at different locations on a common topic. We provide a detailed overview of the Co-Web system, including a sample usage scenario. We also report some early experiences in co-designing and exploring the design space offered by Co-Web, highlighting on future possibilities. Finally we conclude by highlighting the need of integrating aspects of collaboration and teamwork to support users' desires to engage in active, small-group collaborative searching while finding information on the web.

2 Related Work

Co-Web is built upon several areas of research, including studies of people's information retrieval habits, systems that support synchronous/asynchronous web searching, 'passive' collaboration systems, and systems supporting multi-user searching.

Commercial search engines and Web browsers focus on single-user scenarios [8]. However, there are some systems that enable collaborative work around web searching but most of them focus around co-located collaboration on Web searching like Co-Search, which allows collaborative web search in a co-located

setting, i.e., when several people are gathered around a single computer [8]. Teamsearch supports co-located search of digital photo collections by groups seated around an interactive tabletop display [9]. WebSplitter [10] generates personalized views of Web pages for multiple co-located users based on currently available devices with the users at a given point of time.

There has been some prior work which has explored in way to support remote Collaboration on Web tasks. GroupWeb is a browser that allows group members to visually share and navigate World Wide Web pages in real time using tele-pointers for enacting gestures [11]. Search Together enables groups of remote users to synchronously or asynchronously collaborate when searching the Web [12]. Search Together [12] focuses on supporting collaboration during the process of searching the Web, including formulating queries, exploring search results, and evaluating the information that has been found. S3 allows users to asynchronously share useful sites found during a Web search by representing search results in a persistent file format that can be sent to and augmented by several people [13].

In contrast to these systems, Co-Web's design is specifically contextual to secondary and high school students and it has been designed by keeping their unique needs in mind. It supports two or more synchronous or asynchronous searchers using a variety of Web-based search services, and provides integrated support for information collection, collaboration, assimilation and presentation.

3 Formative Studies

In order to verify the prevalence of collaborative web-based information projects and to understand the needs of the stakeholder, we conducted a series of semi-structured interviews with 10 people who work in settings where computers were used for projects in schools. We interviewed 3 teachers, 2 librarians, 3 mothers and 5 children. The teachers included a primary school teacher teaching in Dahanu, a town in Thane District, India, a primary school teacher teaching in a medium-income public school in Mumbai and a secondary school teacher teaching in Kandivali, a medium-income suburb in Mumbai, India. Of the 2 librarians, one worked in a school library in Mumbai and one worked in a small public library. Of the 2 mothers, one was computer-literate and could guide and assist her children at home, one was non computer-literate and had a computer at home and one was not computer-literate and had children who used it at school. In each interview, a set of open-ended questions were asked which were customized to each individual. The questions were designed to investigate about how high school children searched for information in schools, libraries for school projects, the frequency of collaborative search, participation of each collaborator, the within-group roles that emerge, the type of search tasks, the reservations against use by the parents/teachers, the motivations of searching collaboratively and the physical setup of resources needed.

4 User Study

We recruited 8 students and the children were observed in their natural settings to perform pre-defined search tasks on their computers. The studies were conducted in two phases:

In phase 1, Participants were asked to 'think aloud' during the task and tell the researchers about any issues or problems they faced. The participants were also encouraged to avail the help of other people in case of difficulties to observe how they traditionally completed tasks, which they could not do independently. Finally, we conducted semi-structured interviews with participants after they had completed the task.

In phase 2, the same 8 students were divided into 2 groups and were asked to do a project on 'Surface Tension', which was a topic from their curriculum but had not been covered by the teachers yet. The project was to be submitted within five days and the final deliverable was a MS Power-point presentation, which is the most common form of presenting content in most schools (as conveyed to us by the participants in formative study). The participants were all acquainted with each other. They all had previously used internet and computers for school projects but had not used online collaborative tools. Each group member had a computer connected to the Internet and they were free to use other standard software like the Microsoft Office suite as well as well as take notes.

During both phases, we observed the participants' search strategies, usage of tools, and creation of any electronic and non-electronic artifacts during the search. Also, we saved all the information found by participants during the task and the phase 1 individual searching was video recorded. This two-phase study design gave us a chance to observe information gathering not only during synchronous collaboration but also when collaboration was asynchronous. We analyzed the data using affinity mapping and looked for themes related to how group members understood the information (e.g., websites) found during the task as well as information related to division of labor, group members' task strategies, and task state.

5 Insights

The formative study revealed several themes regarding the challenges of finding information and collaborative Web search for students, teachers and the parents.

Prevalence of internet based information gathering: The librarians and parents both reported that students frequently perform online searching for their project purposes. Teachers pointed out that it is also mentioned in the teacher's curriculum to encourage students to find additional information on the internet after a lesson is taught in class to arouse their curiosity to know things and break beyond the information provided in textbooks. Librarians mentioned that due to lack of books

in the library about specific topics taught in classroom, children often use the library computer which has access to internet and try finding relevant books and in turn ask the librarian to order these books for their school library. Students and teachers both mentioned that more and more classroom assignments related to exploring subjects and making presentations were expected to be done on the computer.

Participation and enthusiasm in group projects: Teachers also stated that collaborative activities in classroom prove to be very helpful for the students. Students also enjoy it as they like to work and play together. Parents and children also reported that the energy levels of the children would peak up during collaborative and group projects if they had selected the group themselves. Children would see it more as a fun activity compared to usual homework. Also, competing with other groups in the class would make them do little more than required at times, to prove themselves as the best group. There were reservations about the lack of visibility of individual contribution in group projects. If a member was not working, the entire group had to suffer. The intent of the project was clearly defined to the users as to try and explore the subject and gain more information apart from what is currently there in the textbook to get a better understanding of the subject, but it was observed that for some of participants, working on the project merely was a task completion activity and due to which the motivation and enthusiasm in other participants got affected. The initial division was soon forgotten and work was done on an on-need basis. The work kept shuffling between the members of the group as per need.

Locations of computer use: The librarians stated that they rarely saw students in her library using computers in isolation. Librarian also reported that students would use the computer lab for collaborative tasks during free periods, as that would require discussion, which would not be possible in a library atmosphere. Parents and students reported that although most of the first sessions would start with a physical meeting with all the teammates either in school or some collaborators house, most of the other coordination would happen over telephonic conversations. While students preferred working in a co-location setting, day-to-day logistics issues prevented them from physically meeting teammates and do group project.

Resolution of breakdowns: The librarians stated that students of secondary school often come with problems that they are unable to find information of particular topics on the Internet and need guidance on how to frame the query to get relevant information. One parent reported that her son's online searches are mediated either by his father or elder brother as he generally needs help as he is unable to find information by himself. The help provided is typically guiding the search by making query suggestions (verbally) or navigation suggestions (by pointing). In the individual task, 6 out of the 8 users gave up when they could not locate the desired information. Students reported that they gave up more easily when they were working alone on a project. They had to either wait to ask a family member or request help from a class-mate. In collaborative tasks, it was easier as everyone was working on the same project so they did not face any hesitation.

Minimal Sense-making: During collaborative Web searches, the interviewees reported that students would divide the projects in multiple tasks and choose these tasks as per their skill sets and facilities available with each one of them. There would be students who would be good at making presentations and finally after all the other collaborators have gathered information, one student would compile all of it into a beautiful looking presentation. In some cases, the presentation would be divided into stages and each one would contribute some slides.

Lack of Awareness of Search Engines and Boolean searches: The problem seen with students searching for information on the web was that Children are poor at representing their needs in form of a query. Most of the children found it difficult to articulate what they were looking for. On the other hand, search engines are poor at responding to vague queries. They were not aware of the various techniques and tricks available to articulate their query in a search engine friendly manner for the best results.

Minimal Awareness: In the collaborative task, there were communication problems observed among the users as they were not at the same pace. Most of the things were communicated over telephonic conversations. There were misunderstandings among the team mates as they couldn't see each other's screen and visualizing what exactly is being viewed by the teammate became difficult.

Plethora of programs: Users generally coordinated and worked using a multitude of different programs/websites for different tasks. e.g.: MS-Word for editing content, Skype, Instant Messengers for co-ordination with other team mates, PowerPoint for formatting and presenting content etc. The users kept switching between multiple applications which were pointed out by users as being irritating and distracting. Most of the files were shared over email or instant messenger file transfers which added to their confusion and a lot of time was spent on keeping track of different files spread over different locations on the computer. A lack of version control also ensured that mismatches in data crept up especially when the data was being assimilated for presentation.

Video as a distraction: Users generally got distracted while using video chat of instant messengers. Due to poor broadband speeds, video generally did not stream well and much time was spent in trying to fix it.

Parental Control: Parents often enforced a time-limit of anywhere between 45 min to 2 h for a single session. Parents often could not identify whether the computer was being used for casual purposes or for project work.

6 Design Goals

It was quite clear from the user studies and interviews that collaboration on projects remotely was quite prevalent. Also, students collaborating on finding information together had the potential to improve search experiences and outcomes even within the existing search paradigm. Since these activities are not supported by current paradigms, people were employing workarounds and multiple applications to

communicate and coordinate. It was postulated that systems and tools were designed to support such user behavior will benefit students and help them. With the above considerations in mind, the envisioned design goals of Co-Web were as follows:

- To create a collaborative environment to reduce redundancy and repetition in search queries thereby increasing productivity.
- To provide tools to save/search results and create new visualizations of search results to elicit more user involvement in the information search rather than it just being a mechanical activity.
- To provide a sense of comfort and reinforce user confidence in completing a search by turning it into a group activity yet not a competitive one.
- To help users articulate their queries better by incorporating advanced search techniques in a visual manner.
- To ensure that users complete their search activities with higher confidence/correctness by involving family, friends and teachers in the search activity.

7 Co-Web

Based on our investigations of students' collaborative search practises and needs, Co-Web is designed to enable either synchronous or asynchronous remote collaboration between students. The application is a RIA (rich internet application), which ensures that the reach of the internet can be leveraged with a compelling user interface. In the next section, we shall illustrate the experience of using Co-Web by describing its features. In the most basic Co-Search usage scenario, a group of students can login to the application and run an instance of co-web on their individual computers. They can collaboratively search information and collect relevant pieces of information in the shared space. Each user is represented by a unique color and icon. Every piece of collected information displays the identity of the person who created it. Audio and text chat functionality is in-built so that participants can collaborate. Special search categories like Encyclopedia and summary search are integrated so that participants can find relevant information quickly. Related search and Boolean operations are also included. Basic text editing tools are also integrated so that basic formatting and presentation can be done in the application itself. The application has a separate interface for the teachers where they can have an overview of the project.

7.1 Features

The first screen is sectioned into three main sections:

- Start individual search (Fig. 1a)
- Start collaborative search (Fig. 1b)
- Continue an ongoing project (Fig. 1c)

Clicking Collaborative search on (Fig. 1b) takes the user to the screen (Fig. 2) where he/she can choose to either browse through previous projects (Fig. 2a) or start a new project (Fig. 2b). The user can choose to invite friends, family and other people from his contacts to join the session, merely by dragging and dropping the contacts (Fig. 2c) on the project book (Fig. 2b). (In case of a group project, the friends added to the project become the collaborators).

Dynamic Cloud and Booleans: A tag cloud (Fig. 3a) displays a network of words related to the inputted query word. On clicking a related search terms from the interactive cloud, a Boolean operator 'AND (+)' (Fig. 3b) is added along with the initial query term to narrow down search and get more accurate results to help ease the problem of articulating search queries for the best results.

Encyclopedia and Project Search categories: Two new categories of 'Encyclopedia' (Fig. 4) and 'Project search' (Fig. 4d) have been created especially considering the search requirements of the user group: 'Encyclopedia' category returns results of the search term from a set of pre-selected online encyclopedias. It was noticed during the user studies that people were not using other encyclopedias for content and defaulting to Wikipedia since it was the only encyclopedia they had used regularly and were aware of. However, there was a latent aspiration to use information from other resources. 'Project' category summarizes different categories (Fig. 4a, b, c) of information traditionally related to an academic project (namely encyclopedia, experiments, diagrams, videos, definition, images) on a

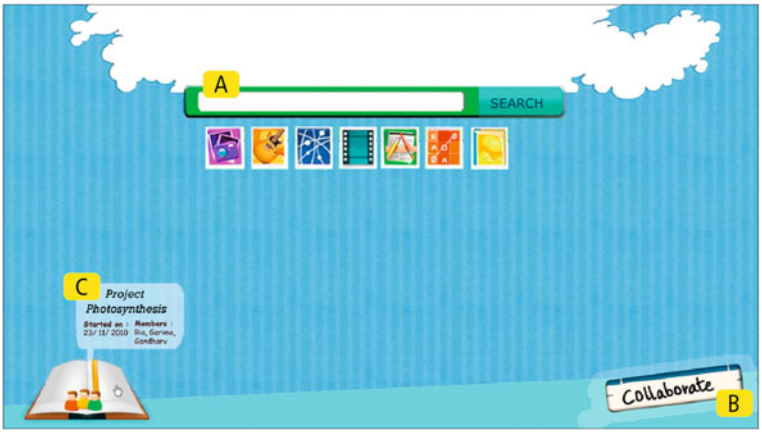

Fig. 1 First screen

Fig. 2 Project view

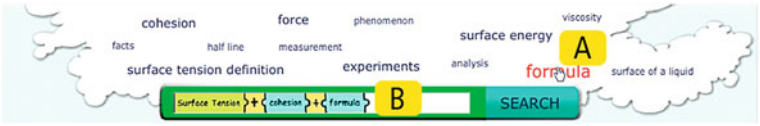

Fig. 3 Related query terms

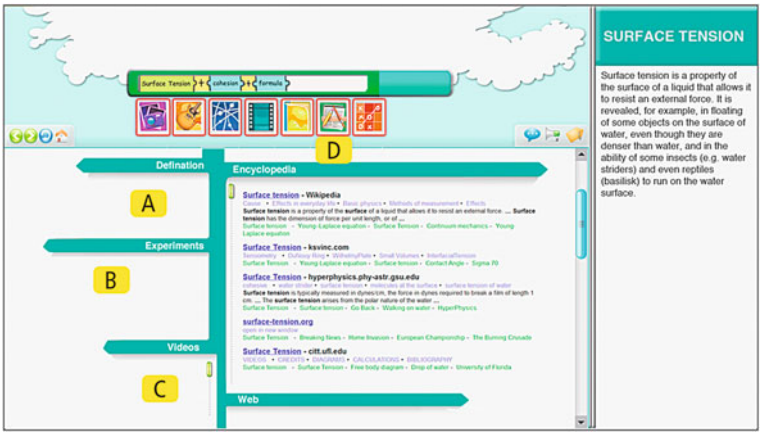

Fig. 4 Project search category visualization

single screen. Clicking the button (Fig. 4d) fires multiple queries to get all project related information at one go and it's visualized in a common space. Users don't have to keep swapping between different categories every time while searching for information and can access it from a common screen.

Fig. 5 Project tools for documentation

Shared Space: (Figure 5d) The application provides a shared space for all the team members to keep dumping all data collected by them. This data can be viewed by all the collaborators and anyone who has been invited to join the session. The icon (Fig. 5c) of members who dumped the data is shown to avoid confusion and for further referencing. Also, the application gives the users an indication when the collaborators join/leave (Fig. 5b) the session by showing their icon in the shared space.

Collapsible and flexible space: The shared space is a flexible space, which can be adjusted to any size to avoid using too much space while searching. During the search activity the shared space can be collapsed and while editing the content it can be expanded into full screen. This provides a common ground between the users to carry out discussions, view, share and comment (Fig. 5d) on the data being accumulated by team members. Users can collectively take a decision on what can be finally chosen for the final presentation. Changes made by the group members are reflected in real time. Discussion and expressing view-point leaves a scope for reflection—a vital component of learning.

Timeline: The timeline option in the project tools (Fig. 5c) shows a replay of how the shared document has been edited from the start. This is a valuable aid to view the chronological progression of the actions of all group members in editing the information gathered during the entire search session. This can be valuable aid to recognizing dead-ends, reorganizing and adopting a different search strategy also prevents redundancy.

Integrated chat: (Figure 5a) The application helps the team to communicate by integrating a text and audio chat feature in the application. This is to ensure that searching and discussing information can happen simultaneously. A combination of a singular shared space and audio/text chat helps a lot in preventing miscommunication.

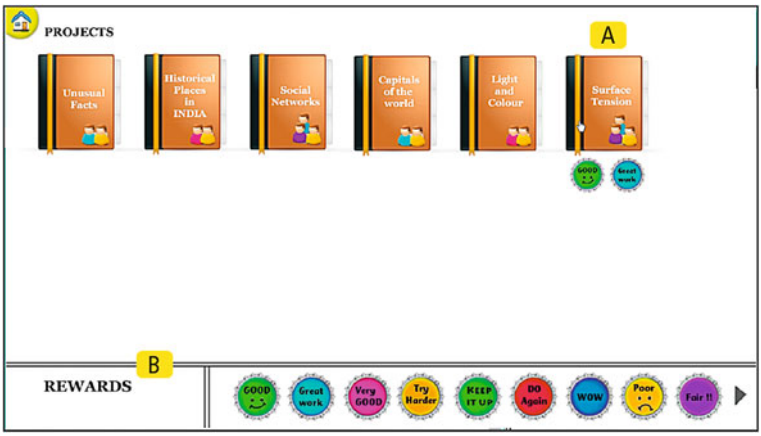

Fig. 6 Project tools for documentation

Project Tools: (Figure 5c) The application provides basic editing tools in the shared space, so that a rich documentation of the project can be completed in the application itself. The final edited summary can also be exported into different file formats.

The application has a separate interface (Fig. 6) for the teachers (to make sure they are not directly involved) where they can view, comment, suggest corrections and reward (Fig. 6b) the projects to encourage the team.

8 Co-Designing and Experiencing Co-Web

A high-fidelity prototype created in Action script and deployed as an AIR application was used to evoke the participation of multiple students working on finding information for a common project. A group of students and teachers were asked to try out the sketch and then discuss the possibilities that opened up during the sketch. The students believed that the overall idea of carrying out informational searches in a common space was helpful but stressed the need of more ways to simplify articulation search queries. Features visualizing search (timeline, shared space, dynamic tag cloud) were among the most highly rated aspects of the prototype. Users expressed a desire to directly print the edited summaries and use it in their project scrapbooks. This suggests that providing rich documentation/post searching experiences is an important aspect of supporting collaborative Web search and is something that the users enjoy and cherish. Teachers expressed the view that it would not be comfortable for them to add any person to the project (esp. family members of students) and also wondered if there was enough sense-making of the data that was would be collected by the students using this application. One student expressed that she could use this to even do collaborative

searches with her siblings and use it to teach her mom who did not know how to use internet search. Thereby in addition to evaluating the specific features of the sketch, the process facilitated a move forward in co-articulating what it means to design and use digital technology to facilitate collaborative information searching in everyday life.

9 Future Work and Possibilities

Technologically, the first step would be to develop a completely working application which is tested with a bunch of students on a real project. This will be taken to the homes and schools of users to discuss the design space of possibilities. Future efforts should be taken in the direction of increasing sense-making of the information collected collaboratively by the participants. It may also be interesting to expand the formation of search queries through different Boolean operators apart from 'AND' and also visualizing other advances search techniques in an intuitive and usable manner. Therefore, future research plans include not only further evaluation of Co-Web interface, but further development of the interface to support various collaborative scenarios, increasing leaning and ensuring better search articulation.

10 Future Work and Possibilities

In the above sections, we detailed how the design space offered by collaboration in online searches and information retrieval in secondary school students was explored. We further detailed the interviews and user studies carried out to flesh out this design space and how Co-Web emerged out of the pain-points and opportunities presented by the design space. We finally conclude by reflecting on the contributions of the paper: firstly, providing a high-fidelity prototype in the form of Co-Web and secondly this initial exploration opening up and adding to the emerging design space of collaborative web searches and information gathering online for children.

As described above, the design of Co-Web evolved from user studies and interviews to early software manifestation in a co-design setting where the students and teachers evaluated the ideas and specific features as the process moved forward. Adding to this, the process was set in the actual site of their individual homes of the students, thereby brining forward more direct and relevant evaluation of the concept. We end by discussing the future directions and the possibilities that emerge out of this exploration and the direction further research can take for creating unique collaborative interfaces used by children for better information retrieval.

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