12-2002

Intergenerational partnerships in the design of a digital library of geography examination resources

Yin-Leng THENG

Dion Hoe-Lian GOH
Nanyang Technological University

Ee Peng LIM
Singapore Management University, eplim@smu.edu.sg

Zehua LIU

Natalie Lee-San PANG

See next page for additional authors

DOI: https://doi.org/10.1007/3-540-36227-4_51

Intergenerational Partnerships in the Design of a Digital Library of Geography Examination Resources

Yin-Leng Theng[1], Dion Hoe-Lian Goh[1], Ee-Peng Lim[2],
Zehua Liu[2], Natalie Lee-San Pang[1],
Patricia Bao-Bao Wong[1], and Lian-Heong Chua[1]

[1]Division of Information Studies
School of Communication and Information
Nanyang Technological University (Singapore)
{tyltheng,ashlgoh,nataliepang,patriciawong,clhchua}@ntu.edu.sg

[2]Centre for Advanced Information Systems
School of Computer Engineering
Nanyang Technological University (Singapore)
{aseplim,aszhliu}@ntu.edu.sg

Abstract. This paper describes the engagement of intergenerational partners in the design of a digital library of geographical resources (GeogDL) to help prepare Singapore students for a national examination in geography. GeogDL is built on top of G-Portal, a digital library providing services over geospatial and georeferenced Web content. Scenario-based design and claims analysis were employed as a means of refinement to the initial design of the GeogDL prototype.

1 Introduction

Having completed the first phase of development of GeogDL (digital library of geography examination resources), a study was conducted to engage a group of intergenerational partners involving designers, secondary school students and usability-trained evaluators for the purposes of reinforcing and/or refining the initial design of GeogDL. GeogDL [2] is a Web-based digital library application containing past-year examination questions and solutions, supplemented with additional geographical content.

We wanted to design GeogDL with and for students taking a Singapore national examination in geography (the GCE 'O' level geography examination) with a strong underpinning user-centred design rationale. GeogDL is built above G-Portal [6], a digital library providing services over geospatial and georeferenced Web content.

Beyond summarizing the design of GeogDL, a main contribution of the paper is making explicit the use of Carroll's scenario-based design and claims analysis [1] that inspired recommendations for the refinement of the initial design of GeogDL.

The remainder of this paper describes the study and discusses the implications of the findings in relation to design and implementation issues for GeogDL as well as geospatial digital libraries (DLs) in general.

E.-P. Lim et al. (Eds.): ICADL 2002, LNCS 2555, pp. 427-439, 2002.

2 GeogDL: Design Philosophy and Initial Design Choices

In this section, we briefly revisit our previous work on G-Portal and GeogDL so that their methods and findings can provide a background for the body of this paper and the issues explored within it.

2.1 G-Portal

G-Portal [6] is an on-going DL project at the Centre for Advanced Information Systems in Nanyang Technological University (Singapore). The aims of the project include identification, classification and organization of geospatial and georeferenced content on the Web, and the provision of digital services such as searching and visualization. In addition, authorized users may also contribute resources so that G-Portal becomes a common environment for knowledge sharing. G-Portal resources are defined as Web content, annotations and metadata.

G-Portal also provides a platform for building applications that use geospatial and georeferenced content. This is achieved through *projects* which are user-defined collections of related resources. Resources within projects are further organized into *layers* which allow finer grained organization of content.

2.2 GeogDL

G-Portal is used to build our first DL on geography examination resources (GeogDL). GeogDL [2] is not meant to be a replacement for textbooks and classroom education, but an alternative to printed past-year examination solutions developed to help students revise for their GCE ‘O’ level geography examination.

In GeogDL, past-year examination questions (with their solutions) are created as separate G-Portal projects. Each project consists of Web resources, at least one of which contains the solution to the question. Other resources contain information to related topics and are used as supplementary material for further exploration. Resources may be further organized into layers depending on the needs of the teacher. For example, the solution to an equatorial region question could appear as a resource in a layer while a separate layer might contain supplementary vegetation resources found in equatorial climates.

In the initial version of GeogDL, examination questions are first accessed through the classification interface that organizes questions by year. Upon selection of a question, the associated project, its resources, and the corresponding map are loaded. Currently, resources are divided into three categories: question, solution and supplementary resources, each of which is accessible separately via the classification interface.

3 Scenario-Based Design and Claims Analysis

Our study was inspired by Carroll's work on the task-artifact cycle, user-centred strategies such as scenario-based design and claims analysis [1].

The task-artifact cycle explains why design is never completely "done". At the start of any software development, tasks help articulate requirements to build artifacts, but designed artifacts create possibilities (and limitations) that redefine tasks. Hence, managing the task-artifact cycle is not a linear endeavour with starting and ending points [1]. There will always be a further development, a subsequent version, a redesign, a new technology development context. The design scenarios at one point in time are the requirements scenarios at the next point in time. Carroll [1] stresses the importance of maintaining a continuous focus on situations of and consequences for human work and activity to promote learning about the structure and dynamics of problem domains, thus seeing usage situations from different perspectives, and managing tradeoffs to reach usable and effective design outcomes.

Claims analysis was later developed by Carroll [1] to enlarge the scope and ambition of scenario-based design approach to provide for more detailed and focused reasoning. Norman's influential model of interaction [7] is used as a framework in claims analysis for questioning the user's stages of action when interacting with a system in terms of goals, planning, execution, interpretation and evaluation.

3.1 Experimental Protocol

We engaged a group of intergenerational partners involving secondary school students, designers and usability-trained evaluators. The concept of intergenerational partnership, in which design partners of varying ages, needs, expectations and experience negotiate design decisions, is especially crucial in systems designed for children and teenagers [e.g. 3; 9; etc.]. One of the challenges of this kind of partnership is for children/teenager users to trust adult designers to listen to their contributions. Druin et. al. [3] found that this kind of idea-elaboration process takes time to develop, but they found it to be extremely important to work towards in a design partnership [3], and hence towards a better design that would cater to the needs of the prospective children/teenager users.

Brainstorming session among usability-trained evaluators and designers
Four usability-trained evaluators were involved in the study. Two of the evaluators were Masters of Information Studies students at Nanyang Technological University (NTU, Singapore) who had completed a course on Human-Computer Interaction (HCI) with a working knowledge on scenario-based design and claims analysis. The other two evaluators were lecturers at NTU who taught HCI and Systems Analysis/Design respectively. Since there is little literature available on the practicalities of applying claims analysis to evaluate and improve the usability of DLs [5], the evaluators met for a brainstorming session prior to the sessions with the student design partners to make concrete and agree upon the procedures in carrying out claims analysis [1].

Identifying possible goals or scenarios of use of GeogDL

To situate claims analysis within the context of use, the session began with the evaluators identifying the possible goals or scenarios of use prospective users might have when using GeogDL.

Ellington et. al. [4] propose four basic factors to match the natural learning processes of humans, and thus ensure the successful learning experiences of learners by: (F1) making learners *want to learn*; (F2) incorporating sufficient activities to help learners experience *learning by doing*; (F3) providing sufficient channels of *feedback* to learners; and (F4) enabling learners to *digest and relate* what they have learned to the real world.

Since the main goal of GeogDL is to help students prepare or revise for the GCE 'O' level geography examination, the following sub-goals were postulated to provide the possible scenarios of use with the inclusion of the four basic factors proposed by Ellington et. al. [4] for successful learning experiences of learners:

- *Goal #1: Practice/revision* on multiple-choice (MCQs), short structured and essay-type questions. Model answers and hints to tackle these questions should also be provided (applying F2). Feedback should be provided (applying F3).
- *Goal #2: Trends analysis*. The idea is to give information on when and what questions are being asked over the years. This would help students identify trends in the types of questions asked and the topics covered. This may increase their motivation to want to learn (applying F1).
- *Goal #3: Mock exam*. This would help students better manage their time in answering questions. To make it fun, a scoring system could be incorporated for MCQs (applying F4), while hints/model answers could be provided for structured and essay questions (applying F3).
- *Goal #4: Related links and resources*. This could include related topics, teachers' recommendations, etc., thus showing relationships of concepts, and linking concepts to the real world (applying F4).

To protect against potential distortion of the scenarios, the above four sub-goals or scenarios of use were validated with the two designers of GeogDL. Designer 1 was in charge of the architecture of G-Portal; while Designer 2 was in charge of populating GeogDL with geography examination resources.

At the time of carrying out this study, only Goals #1 and #2 were implemented. Goals #3 and #4 are currently being implemented. Therefore, for the purpose of this study, we were only interested to examine GeogDL in terms of Goals #1 and #2. In identifying the scenarios of use with good coverage and minimal bias, we made use of the participatory design approach where prospective users were involved as design partners.

Modifying questions as used in Claims Analysis

Space constraints, however, do not permit us to write in detail the changes made to the questions tailored for the specific goals. Based on the four goals identified, the evaluators modified the original nineteen questions formulated by Carroll [1] so as to "speak the students' language" and to make them more relevant to the specific goals in question. For example, the original question "How does the artifact evoke goals in the user?" was modified to reflect Goal #2 (Trends analysis), and was changed to

"How does the system (screen) help you to decide what to do to analyse trends or spot questions?"

Sessions with student design partners

A group of eight secondary students (ages between 13 – 15 years old), consisting of four boys and four girls, were invited as design partners. The purpose of the session was to reinforce the initial design and/or gain insights from what the student design partners said they wanted or what they wanted, as a means of refinement of the initial design. The session with the four girls was held in the morning while the session with the four boys in the afternoon, each lasting approximately two hours. Every student was assigned to one usability evaluator, and they were asked to carry out claims analysis on either Goals #1 or #2.

The session was divided into three parts. Part 1 began with getting to know the students in terms of their experience with Web-based interface, searching/browsing skills and study habits. The interview session ended with a discussion on the possible scenarios of use for students preparing for the GCE 'O' level geography examination. Part 1 lasted approximately forty-five minutes. The evaluators stepped through GeogDL with the students responding to the stages of actions when interacting with GeogDL in Part 2 of the session. They were asked to identify the positive outcomes as well as negative consequences of the features provided in GeogDL in supporting either Goals #1 or #2. Part 2 also lasted approximately forty-five minutes. In Part 3, all four students together with the four evaluators congregated for a focus group discussion. The purpose was to confirm and/or refine the four goals identified by the evaluators described earlier, and brainstorm, if any, other goals that students might have when preparing/revising for GCE 'O' level geography examination.

3.2 Findings and Analyses

3.2.1 Profiles, Study Habits, and Scenarios of Use

Students' Profiles

Our student design partners came from a local secondary school in Singapore and would form a representative sample of prospective users, according to a secondary school teacher who was also one of the evaluators involved in this study.

We wanted to capture students' profiles to help us understand, for example, not only what they said they liked about a certain feature, but also why they said they liked it. Studies have shown users' backgrounds in terms of their experience with Web-based interface and searching/browsing skills might affect their acceptance of a system [5]. Since GeogDL aims to provide users with a successful learning experience, an understanding of the subjects' study habits, in particular, examination techniques adopted would also be useful.

Boys

The boys (denoted as S1 to S4) were between 13 – 14 years old, and were generally more confident Web users compared to the girls. They rated themselves as intermediate to advanced users spending a considerable amount of time everyday on the Web, ranging between two to six hours, playing games, emailing or chatting with friends. Except for S2, all believed that their searching/browsing skills commensurate with their usage of the Web. S2, though a self-believed advanced Web user, thought of himself a novice in searching/browsing on the Web. The boys rated themselves as novice or intermediate in terms of library searching/browsing skills.

Girls
Although the girls were one year older than the boys, they were comparatively less confident Web users. The reason, according to a teacher of the school, was that the girls did not have the benefits of being introduced to simple HTML/XML programming in the revised lower secondary curriculum. The girls (denoted as S5 – S8) rated themselves as novice or intermediate users of the Web. They used the Web mainly for emailing or chatting with friends. Except S5 who rated herself "intermediate", the rest of the girls rated themselves novices and commented that their searching/browsing skills were "poor". Similar to the boys, library searching/ browsing skills were not good, ranging from novice to intermediate.

Study Habits
In general, the students were less motivated to explore beyond what was required of the syllabus. All the students relied heavily on textbooks, exam questions with model answers, teachers' worksheets and notes taken during lessons to prepare for exams. In particular for geography, atlases and maps were constantly referred to.

Scenarios of Use
Enumerating typical and critical use scenarios characterizes the scope of an artifact's actual use or the anticipated use of an artifact still in design [1]. The students reinforced the relevance of the four goals identified by the evaluators to achieve the main goal of preparing/revising for GCE 'O' level geography examination. As suggested in Carroll's task-artifact cycle hypothesis, the GeogDL artifact also provided a platform for students to add on/modify the goals of GeogDL. Because the scenarios provided a working representation for exploring and altering the design, the students also saw GeogDL not only as an examination resource DL, but also as an interactive teaching aid.

3.2.2 Stages of Actions and Design Consequences
Since we were interested in how users complete a task successfully, we made use of the method "questioning stages of actions" to elicit claims about the design of GeogDL. In this method, theories of human activity were thought to be effective in facilitating systematic questioning. Based on Norman's execution-evaluation cycle, Carroll [1] developed a set of questions as a heuristic for comprehensively interrogating the tradeoffs implicit in scenarios. We modified the original set of questions designed by Carroll [1] to make them specific to the goals in question and also in simpler English so that the student designers could understand the questions.

Capturing and analyzing students' responses
The students performed iterative walkthroughs of the system together with the respective evaluators to achieve Goals #1 or #2. This was done by questioning stages of actions in Norman's execution-evaluation model of task completion broadly divided into these three phases [1]:

- *Before executing an action.* This phase intends to prompt claims on the design before users perform an action. Two stages of users' actions that address formation of goals (Stage 1a) and planning (Stage 1b) are involved. A total of seven questions were used to prompt claims.
- *When executing an action.* This phase (Stage 2) obtains claims by questioning users on how well the system helps them to perform the action. We used two questions instead of the original three in Carroll's set because we felt that one of the questions was redundant.
- *After executing an action.* Two stages (Stage 3a and 3b) prompt users to interpret system's response and evaluate the system's effectiveness in helping to complete a goal. We appended to the original list questions that address also Nielsen's well-established design heuristics. A total of twelve questions were asked.

For each scenario of use, evaluators helped the students to step through the above five stages by framing their goals (Goals #1 or #2 in our study), taking action, interpreting the consequences of their actions, and evaluating action consequences with respect to the instigating goals.

Owing to space constraints, we are not able to show all eight students' responses to the twenty-one questions for all the five stages. As an illustration, Table 1 shows S6's comments in response to the three questions asked in the Goal Stage (Stage 1a) for Goal #2 (Trends analysis). Columns 2 and 3 record S6's claims highlighting positive consequences or negative consequences/risks respectively. The rest of the students' responses were constructed in this manner.

Table 1. Stage 1a (Goal Stage): Student S6's for Goal #2 – Trends Analysis

Stage	Positive Consequences	Negative Consequences
Stage 1a: Goal Stage Questions to prompt: 1. How does the system (screen) help you to decide what to do? 2. How does the system (screen) help you to want to analyse trends or spot questions? 3. How does the system (screen) suggest that spotting questions is: - simple or difficult? - appropriate or inappropriate?	Comments: Statement on the occurrence of the question in the past years helps me to get a vague idea of the question's frequency. Compliance - Feature: Linking of related concepts	Comments: No references to the map. Violation - Feature: Linking of related concepts Comments: I have no idea how to use statement of occurrence to spot question. Violation - Feature: Match between system and real world Comments: Too many windows opened which causes confusion. Violation - Feature: Minimalist design

Table 2. Desirable – Features with Positive Consequences

No.	Features	Positive Consequences							
		Boys				Girls			
		S1	S2	S3	S4	S5	S6	S7	S8
1	Diagnosis and recovery from errors	Not applicable since students did not encounter errors in their interactions.							
2	Visibility of systems status	1a	1a	1b, 2	3a	2, 3a	2		
3	Match between system and real world				3a	3a			
4	Control and freedom for users	1a, 1b	1a, 1b						
5	Consistency and standards			3a			3a		
6	Recognition rather than recall	3a		1b	1b				
7	Flexibility and efficiency of use		3a		1b, 2, 3a			2	2
8	Minimalist design								
9	Speak the users' language			3a		1a	3b		
10	Help and documentation						3b		
11	Provide shortcuts								
12	Links to related concepts					1a, 3a	1a		

Table 3. Undesirable - Features with negative consequences

No.	Features	Negative Consequences							
		Boys						Girls	
		S1	S2	S3	S4	S5	S6	S7	S8
1	Diagnosis and recovery from errors	Not applicable since students did not enter errors in their interactions.							
2	Visibility of systems status	1b	1b		3b	2, 3b		1a	1a
3	Match between system and real world			3b	1a, 3a	1b, 3b	1a		
4	Control and freedom for users	1a	1a						
5	Consistency and standards			3a, 3b	3a, 3b	3a, 3b	3a, 3b		
6	Recognition rather than recall			3b		3b	3b		
7	Flexibility and efficiency of use	1a	1a	1a, 2, 3b	1a, 1b, 2, 3a, 3b	1a, 1b, 3b	2	1a, 1b, 2b, 3b	1a, 1b, 2b, 3b
8	Minimalist design			1a, 1b	1a, 3b	1b, 3b	1a	1a	1a
9	Speak the users' language	1b	1b		1a, 1b, 3b	3a, 3b	1b	1b	1b
10	Help and documentation			2, 3b	3b	3b	2		
11	Provide shortcuts	1b		2, 3b	3b	3b	3b		
12	Links to related concepts		1b	3a, 3b	1a, 1b, 3a, 3b	1a, 1b, 3a, 3b	1a, 3a		

Analyzing design consequences

Since students' comments were made in response to the design of GeogDL where the method of operation was not fully predictable, and where the students were not completely novices in the use of Web-based interactive systems, we turned to the following well-accepted design heuristics to categorize students' comments [e.g. 8; etc.]. We made these assumptions: students' comments with positive consequences suggest compliance with the design heuristics (see Table 1, Column 2); while comments with negative consequences/risks indicate violation of design heuristics (see Table 1, Column 3).

By categorizing all eight students' comments in this manner, a list of claims with positive outcomes in relation to design heuristics was generated (see Table 2). Table 3 shows combined students' comments on the negative consequences/risks violating design heuristics, obtained from similar tables like Table 1. Unless properly dealt with, negative consequences/risks could potentially affect usability of a system [1]. Section 4 discusses recommendations made to GeogDL to eliminate or at least alleviate the negative consequences or risks imposed by these current features that might hinder the completion of Goals #1 and 2.

4 From Analysis to Refinement

In this section, we identified areas for refinement grouped according to violations against the following design heuristics (see Table 3):

1. *Diagnosis and recovery from error.*
   <u>Students' Comments:</u> No comments from students since we did not encounter errors. Comments such as "don't know what to do or how to proceed" were common.
   <u>Recommendations:</u> An examination of GeogDL showed that no error messages were provided. Error messages should be clear, indicating precisely the problem, and constructively suggesting a solution.
2. *Visibility of system status.*
   <u>Students' Comments</u>: "I'm not sure if I have completed my goal"; etc.
   <u>Recommendations:</u> The system should always keep users informed of what is going on through appropriate feedback within reasonable time. The student was not sure whether she had already accomplished the goal. She expected something different and not just a question with a phrase to signify the types of questions asked.
3. *Match between system and real world.*
   <u>Students' Comments:</u> "I'm not sure what to do"; "lack of a legend on the map, which failed to provide linkages to topics"; "mouse-over text is also missing to provide context to potential mouse clicks"; etc.
   <u>Recommendations:</u> Follow real-world conventions, making information appear in a natural and logical order. Instead of a map-based interface only, a list of questions could be created also as a point of access to GeogDL. The map should not be the main window. There could be graphical representations of occurrences of questions, and information should be organized by topics. A legend should be provided on the map.
4. *Control and freedom for users.*
   <u>Students' Comments:</u> "Lack of a clear map between different features in the system (e.g. questions and relationship to map)"; "don't know how to exit"; etc.

Recommendations: Users often choose system functions by mistake and will. They need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Perhaps an explorer-like presentation to organize different information and content could be implemented in GeogDL. Users would be familiar with its use, and also be able to tell at a glance, the relationships between different functions in GeogDL.

5. *Consistency and standards*.
   Students' Comments: "Links are not designed using Web formats"
   Recommendations: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform convention. Recommend that GeogDL be designed using the standards of the Web – as it is perceived by the users that GeogDL is a Web-based system (using Internet Explorer to access the system). Icons and taxonomy used should also be that of the Microsoft Windows environment to increase acceptance and familiarity.
6. *Recognition rather than recall*.
   Students' Comments: "I don't know how to start using GeogDL"; etc.
   Recommendations: Make objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. Students were unable to identify with the newness of the geospatial-like interface in GeogDL. Perhaps a virtual tour of the system would be useful, which can also be supported with careful implementation and training.
7. *Flexibility and efficiency of use*.
   Students' Comments: "There is a lack of instructions and explanatory notes to help me to navigate"; "No indication that it is the final screen. Found the question window by mistake"; "Overlapping windows causes confusion"; etc.
   Recommendations: Help could be provided to users by giving instructions and explanatory notes. GeogDL should also provide feedback to users when the final screen has been reached by providing 'previous' or 'next' buttons. Re-design interface such that windows are neatly arranged to make GeogDL more efficient and flexible to use. Fig. 1 is a recommendation for a revised interface to GeogDL by tiling the windows neatly, and also making the map-based and classification interfaces prominent as equal points of access to GeogDL. Accelerators, unseen by the novice users, may often speed up the interaction for expert users to cater systems to both inexperienced and experienced users.
8. *Minimalist design*.
   Students' Comments: "Too many windows opened, causes confusion"; etc.
   Recommendations: Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility. Improve the design by integrating certain functions together in one window. Please see Fig. 1 for a recommended revised interface to GeogDL.
9. *Speak the user's language*.
   Students' Comments: "I don't understand what windows 'layers' do"; etc.
   Recommendations: System should speak the user's language with words, phrases and concepts familiar to the user, rather than using system-oriented terms. Use "legend" instead since this term is familiar to geography students used to reading maps and atlas.

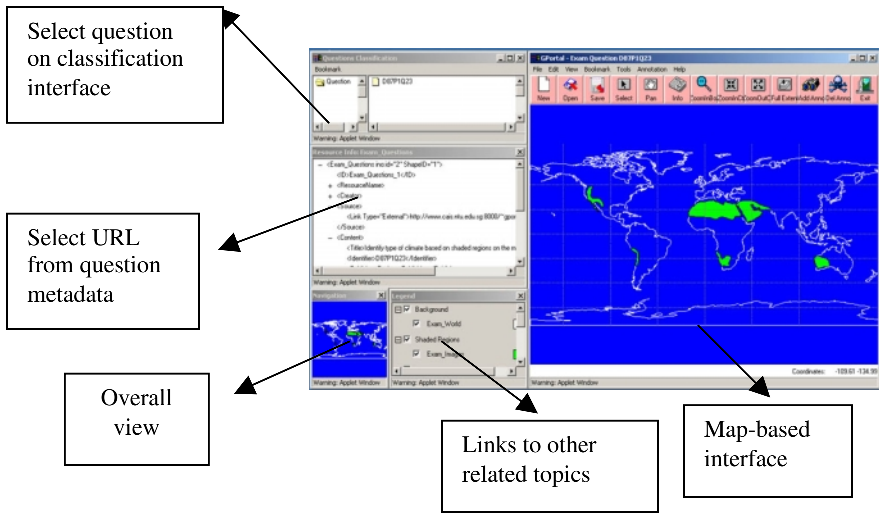

Fig. 1. One of the recommendations for improving the interface addressing the violations against design heuristics "flexibility and efficiency of use" & "minimalist design"

10. *Help and documentation.*
    Students' Comments: "There is a lack of help and documentation"; etc.
    Recommendations: Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large. A virtual tour of the whole system could aid users' exploration and familiarization with the system. Help mascot, as suggested by the students, could monitor and guide users' actions.
11. *Provide shortcuts.*
    Students' Comments: "No shortcuts available for more experienced users"; etc.
    Recommendations: The features that make a system easy to learn such as verbose dialogues and few entry fields on display are often cumbersome to experienced users. Clever shortcuts, unseen by novice users, may often be included in a system such that the system caters to both experienced and inexperienced users. Shortcut buttons/quick jump menu could be designed for experienced users.
12. *Links to related concepts.*
    Students' Comments: "No references are made to the map"; "Climate identification on map is not related to similar topics, questions, and has no references to links"; "No other links from the questions exist, to also prompt for further exploration"; etc.
    Recommendations: To help users achieve a successful learning experience, not only should information appear in a natural and logical order, inter-connectivity between concepts should also be captured. Perhaps there should be links and references to the map. The map interface should also tell users 'where' they are. This is to allow users to see in an organized fashion the organization and taxonomy of GeogDL map. A suggested list of related links from each section for

further exploration by users could be created. Also, links should be provided to the model solutions of questions, and to tips from teachers in answering such questions/similar questions; etc.

5 Conclusions and On-Going Work

This paper described the engagement of intergenerational partners and the novel use of scenario-based design and claims analysis as a means of refinement to the initial design of the GeogDL prototype. The study also showed that through a process of aggregation, a team of eight design partners could produce a comprehensive, rich set of data, of which we presented only some of the findings in this paper.

This is on-going work for us. The initial work has created useful findings to refine the initial design of the GeogDL prototype. It will be interesting to repeat this work with other age groups and control for factors such as Web skills, gender and study habits/preferences.

Compared to other forms of usability evaluation, say heuristic evaluation, claims analysis is powerful and more strongly theory-based. In our study, we showed how usability problems could be detected by analyzing claims made by users stepping through stages of actions in Norman's execution-evaluation cycle model of task completion. Claims sharpen the understanding of relationships that may only be suggested by the scenarios themselves [1], highlighting just how GeogDL in use affords actions, suggests explanations, signals progress and highlights problems for refinement. Unlike other usability evaluations, claims analysis situated in the context of use together with the emphasis to generate likely scenarios, make evaluators focus not only on problems but also on solutions.

However, Carroll's claims analysis is not intuitive to use since the questions to prompt claims are quite difficult to understand, and using it well requires a competent level of "craft skills". More can be done to make scenario-based design and claims analysis practical and easy to use.

Acknowledgements. The authors would like to thank the students from Yio Chu Kang Secondary School for their participation and ideas. The project is partially supported by the SingAREN 21 research grant M48020004.

References

1. Carroll, J.: Making use: Scenario-based Design of Human-Computer Interactions. The MIT Press. (2000).
2. Chua, L.H., Goh, D., Lim, E.P., Liu, Z., Ang, R. A Digital Library For Geography Examination Resources. Proceedings of the Second ACM+IEEE Joint Conference on Digital Libraries, pp. 115-116. (2002).
3. Druin, A., Bederson, B., Hourcade, J.P., Sherman, L., Revelle, G., Platner, M., and Wong, S.: Designing a Digital Library for Young Children : An Intergenerational Partnership. Proceedings of First ACM/IEEE-CS Joint Conference on Digital Libraries. pp. 398 – 405. (2001).

4. Ellington, H., Percival, F. and Race, P.: Handbook of Educational Technology. Kogan Page. (1995).
5. Keith, S., Blandford, A., Fields, B. and Theng, Y.L.: An Investigation into the Application of Claims Analysis to Evaluate Usability of a Digital Library Interface. Accepted for Workshop on "Usability of Digital Libraries" in the Second ACM+IEEE Joint Conference on Digital Libraries (Portland, Oregon, July 2002).
6. Lim, E.P., Goh, D., Liu, Z., Ng, W.K., Khoo, C., Higgins, S.E. G-Portal: A Map-based Digital Library for Distributed Geospatial and Georeferenced Resources. Proceedings of the Second ACM+IEEE Joint Conference on Digital Libraries. pp. 351-358. (2002).
7. Norman, D.: The Psychology of Everyday Things. Basic Books. (1988).
8. Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S. and Carey, T.: Human-Computer Interaction. Addison-Wesley. (1994).
9. Theng, Y.L., Mohd-Nasir, N., Buchanan, G., Fields, B., Thimbleby, H. and Cassidy, N.: Dynamic Digital Libraries for Children. Proceedings of First ACM/IEEE-CS Joint Conference on Digital Libraries. pp. 406 – 415. (2001).