

Jun 2nd, 9:00 AM

## Developing interactive learning environments to promote scaffolding and reflection: A look at the Digital Process Book for design studio education and comparisons to K12 science education applications

Lori Brunner Stone  
*Iowa State University*

Abigail Lundquist  
*Iowa State University*

Stefan Ganchev  
*Iowa State University*

Follow this and additional works at: <https://dl.designresearchsociety.org/learnxdesign>



Part of the [Art and Design Commons](#)

---

### Citation

Brunner Stone, L., Lundquist, A., and Ganchev, S. (2013) Developing interactive learning environments to promote scaffolding and reflection: A look at the Digital Process Book for design studio education and comparisons to K12 science education applications, in Reitan, J.B., Lloyd, P., Bohemia, E., Nielsen, L.M., Digranes, I., & Lutnæs, E. (eds.), *DRS // Cumulus: Design Learning for Tomorrow*, 14-17 May, Oslo, Norway. <https://doi.org/10.21606/learnxdesign.2013.020>

This Research Paper is brought to you for free and open access by the Conference Proceedings at DRS Digital Library. It has been accepted for inclusion in Learn X Design Conferences by an authorized administrator of DRS Digital Library. For more information, please contact [dl@designresearchsociety.org](mailto:dl@designresearchsociety.org).

# Developing interactive learning environments to promote scaffolding and reflection: A look at the *Digital Process Book* for design studio education and comparisons to K12 science education applications

Lori BRUNNER STONE<sup>\*</sup>, Abigail LUNDQUIST and Stefan GANCHEV  
Iowa State University

**Abstract:** *The purpose of this paper is to describe the development and rationale for the design of the Digital Process Book (DPB) learning tool for design education at the University level and discuss the similarities with applications to learning tools in K12 science education. The DPB is an interactive learning environment that is intended to promote reflection throughout a student's design process, as well as integrate important scaffolding elements in the system that supplements the traditional in-person contact between a student and an instructor. It is based on tenets of Cognitive Load Theory, which argues that learners are not able to work to their potential if there are too many elements that they need to process in their working memory. The goal of instructional technologists and instructors is to help students decrease their extraneous cognitive load so students have more cognitive resources to focus on the tasks at hand. Design projects are complex design problems that require a way for students to organize, categorize, and sort the many artifacts and ideations that are produced in their design process. These same goals and needs for university design students are similar to learners in K12 science education.*

**Keywords:** *Design process, instructional technology, human computer interaction, scaffolding, reflective learning, cognitive load theory*

---

\* Corresponding author: Iowa State University | USA | e-mail: lbrun@iastate.edu

## Introduction

Reflection and being a reflective inquirer are important skills for students to master. Students must learn to do more than simply pursue multiple questions in mindless, unclear exploration of sources. This requires new skills to be developed by students; they have to learn the practice of reflective inquiry. Students need to “organize, evaluate, and monitor the progress of an investigation. They need to keep inquiry plans and candidate explanations in mind, systematically interpreting their collected data, periodically reflecting, evaluating their progress, and replanting (Loh, Radinsky, Resier, Edelson & Gomez 1997). They must focus their attention not only the products and results of their work, but also on their inquiry processes. In order to successfully complete an investigation must be reflective inquirers. The purpose of reflective inquiry is to make visible and tangible to others the reasoning and thought processes behind the work being shown. This helps the student and teacher evaluate the processes, improve, and learn from their experiences. Students should reflect on successful outcomes as well as mistakes in order to improve and learn. Having reflective inquiry is parallel to the design rationale in a field such as interior design.

The purpose of this paper is to describe the development and rationale for the design of the *Digital Process Book* (DPB) learning tool for design studio education at the University level and discuss the similarities with applications to learning tools in K12 science education. The DPB is an interactive learning environment that is intended to promote reflection throughout a student’s design process, as well as integrate important scaffolding elements in the system that supplements the traditional in-person contact between a student and an instructor. It is based on tenets of Cognitive Load Theory (Pass, Renkl, & Sweller 2003; 2004), which argues that learners are not able to work to their potential if there are too many elements that they need to process in their working memory. The goal of instructional technologists and instructors is to help students decrease their extraneous cognitive load so students have more cognitive resources to focus on the tasks at hand. Design projects are complex design problems that require a way for students to organize, categorize, and sort the many artifacts and ideations that are produced in their design process. These same goals and needs for university design students are similar to learners in K12 science education.

### *Interactive Learning Environments*

Interactive learning environments are an important part of human computer interaction. They allow users to intimately interact with their computer and the computer provides learning opportunities as well guidance to the user. Interactive learning environments have become a necessity as many modern-day classrooms support more numerous students than ever before. While the increased number of students is undoubtedly a positive outcome, having so many students does not allow a teacher time to have a personal and calibrated exchange with every student about learning progress and guidance (Rogoff, 1990). This has led to the advent of computer learning tools in which support for student learners is provided through software that individuals can then interact with. The use of such software tools in learning can be challenging because in order for them to be effective, they need to be dynamic and able to adapt to different learners and learning styles while still maintaining their original purpose and programming.

Interactive learning environments have a wide range of applications in the classroom and need to be accessible to both student learners and teachers for very different reasons. The teacher is responsible for the content of the material to be learned by students. Their role is one of a knowledge facilitator who has the necessary skills and strategies to teach. They should help to motivate student learners with support that can take a variety of forms such as providing hints, showing examples, and emphasizing the most important features of a task in order to help students reflect on the material (Puntambekar, 2003). The role of the student is to be engaging in their investigations and learning applicable skills, but most importantly they need to be reflecting on the material presented. Software tools developed for educational purposes are in key in this because they make tangible the invisible processes of reflection that students should experience.

The learning benefits of interactive learning environments are substantial because of the new opportunities they provide. As a digital tool, they can help the student learner to manage a design investigation by preventing cognitive overload. They can aid students in coordinating data, text, images, and annotations to be used in projects. Additionally, the option to have multiple users accessing a project is a possibility that allows for group projects that have a single repository for all information pertaining to the investigation. Many of the new software programs that have been developed in the last fifteen years provide support for students in a manner similar to a teacher. They can prompt students to reflect being learned and on material being discovered. Furthermore, they can offer hints and clues about what actions to take next and help students to organize material so that it accurately depicts the internal processes being undergone. With the help of these educational software programs, students learn to become reflective inquirers and the importance of documenting the evolution of their design. This is done so that the otherwise intangible procedure can be visible to all.

The accurate and complete depiction of the design process is essential to both teachers and students. For teachers, being able to see the methods used by students is critical in understanding how student's designs came about and the steps taken to achieve the final result. The teacher can then help the student to analyze the methodology and determine its effectiveness in producing the desired design solution. However, the end result should be reviewed as only one component of the design process and the student should still be expected to present their processes in a clear and organized fashion. The teacher and student should collaboratively discuss possible unrealized design solutions and reflections made by the student. Students need to come to the realization that detailed documentation of the design process is the only way in which they can produce better designs. Open discussion of the process between peers and student to teacher will help students to analyze their design methods and become better designers.

### *Scaffolding*

Working by themselves, it is difficult for students to learn detailed design processes and create designs that are innovative and accurate. They rely on teachers to provide direction and instruction in order to accomplish tasks that would normally be beyond their reach. This is called scaffolding and is defined by Wood, Bruner, and Ross (1976) as an adult controlling those elements of the task that are essentially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence. Vygotsky originally developed the concept of scaffolding (1976), where he advocated that every child has a zone of

proximal development in which tasks may be too difficult to complete by themselves, but with the aid of another knowledgeable person with can learn how to successfully complete the task.

The knowledgeable individual, referred to as the expert, uses scaffolding to help the learner understand the task and methodologies for completion by structuring or arranging the task in such a way that a learner can execute it with success (McLeod, 2010). Support for the novice learner is essential and Wood et al. documents six types that an expert for can provide: first, a learner's interest must be obtained, second, the teacher needs to reduce the degrees of freedom by breaking the task down into smaller components, third, the teacher has the responsibility to maintain direction and keep the learner goal-orientated, fourth, critical task features should be highlighted and emphasized for the novice learner, fifth, frustration of the learner needs to be controlled, and sixth, the teacher should be able to identify and demonstrate ideal solution paths for the learner (Wood, Bruner & Ross, 1976).

An essential element of scaffolding is the process of internalization that learners undergo as they master the material and complete the task successfully (Vygotsky, 1978). The process of internalization should result in an understanding not just of the specific task at hand, but should be able to be generalized to other similar tasks. This is an important step for the student as it means that they are moving towards independence and have achieved mastery of the task. At this point, the teacher should begin to offer less support as there is a transfer of responsibility from the expert teacher to the novice learner. This concept is known as fading and is an essential part of successful scaffolding.

The purpose of fading is to help the learners further internalize the material they are learning and to have them take control of their learning processes. This concept is fairly simple for a person to implement, but represents a challenge when it comes to interactive learning environments. Software programs often begin by offering a multitude of hints and prompts to students in order to help them adjust, learn how to reflect, and accomplish tasks successfully. Then, as students begin to master the process of investigation, they can choose to ignore the hints or tell the computer not to offer them anymore. However, if they continually neglect certain aspects of the task the computer program will start to prompt students again. The other potential complication with this method is that students are often unaware what level of support they need in order to be successful at task completion. Other programs allow the teacher to control how many hints and prompts are given to students and support is faded out in this way such that as students' progress and master increasingly difficult tasks, they are weaned off of support offered by the software program. In order to have successful fading of support a calibrated understanding of each student's level of knowledgeable and ability is necessary.

Achieving scaffolding in interactive learning environments represents a challenge because it needs to offer calibrated support for the individual learner, fade the support out at the appropriate time, and maintain its functionality as a workspace for the investigative process. Additionally, a delicate balance needs to be struck between allowing individual learners the freedom to be creative and express their innovativeness while preserving function and guiding the learner through the process of design and reflective inquiry. Most programs begin by allowing the user very little control and offering plenty of support through hints and prompts as learners are still trying to master basic concepts and need help with most aspects of the investigation and are prone to forgetting elements of the design process when not reminded. As the

learner progresses and masters more concepts and performs the process correctly support begins to fade out as fewer hints and prompts are offered, provided that the learner does not regress and begin forgetting to reflect or answer questions relevant to the task. When the learner has mastered a task, they are allowed more freedom to adjust and control settings within the program. This represents the transfer of responsibility from the program acting as teacher to the student learner who is no longer a novice. At this point, the student should have internalized the necessary processes and will reflect and critique their own designs and methods.

## **The *Digital Process Book* Learning Tool**

Studio experiences are central to design education, particularly at the higher education level. These experiences are concentrated on teaching students a design process. Through long-term projects lasting between four to sixteen weeks in duration, students are encouraged to explore, to try several ideations, to provide research that substantiates their decision-making, to analyze their design alternatives, and to develop innovative, original solutions to complex problems. These projects culminate in a final design (a product, a solution), and a compilation of their process in the form of a process book. This process book includes representations of all of the activities that occur and the artifacts that are constructed as a student completes a design project. It allows the instructor, external reviewers, and others to see the process a student goes through to complete a project. Schenk (2007) describes this process work in the graphic design context as “job bags,” where this material, for the most part, provides the “drawn record” of the design process.

Unfortunately, a shortcoming of existing paper-based process books (Appendix A) is that they are a linear compilation of the design process that do not offer the structure or framework that beginning design students need (Brunner, 2008). In essence, they are a black box in which the student stores the remnants of the project. These students are required to manage a large amount of information in design projects, which places a heavy burden on a student’s cognitive load. Cognitive load is a construct that represents the cognitive resources that performing a particular task imposes on one’s limited cognitive system (Pass, Renkl, & Sweller, 2003). Students are not able to direct all of their creative abilities towards a design project when they must allocate a substantial portion of their cognitive resources organizing and making meaning of the complex design problem. The process book, however, has the potential to be more than simply a receptacle of students’ artifacts of a given project. This was the impetus for developing the DPB.

### ***Goals of the Digital Process Book (DPB)***

The main goal of the DPB is to function as a learning tool that complements studio-based activities, while enhancing the student’s design thinking, including reflective thinking. See Appendix B for a screen shot of the home page. It is envisioned to capture the spontaneous actions of manual sketching and diagramming, while assisting the student in compiling, managing, and encoding information, so the collection of information is translated into a successful solution. It shall facilitate increased communication between student and instructor, as well as providing a venue for student-to-student commenting and feedback. The DPB shall also allow inclusion of computer drawing files from programs such as AutoCAD and Revit, as well as integrate

the many diverse forms of data that a design process embodies, such as text documents, tables, matrices, photographs, and audio and video.

The goals and requirements for the prototype included: 1) develop quick and easy ways to add and post images, diagrams, sketches and notes to a project page, 2) devise an easy and intuitive way of adding and reading comments related to a process book page, 3) integrate a file management system, 4) enable private and public access of process books for instructor progress tracking or employer review, 5) develop deadline and important dates tracking, using calendar and task functions, 6) devise a simple, internal drawing function that incorporates a set of common drawing features, 7) incorporate an embedded self-reflection function or journal into the system, 8) integrate an evaluation component for individual drawings and images, 9) enable users to print a report of DPB pages for archival, review, and portfolio purposes, and 10) to integrate an explicit design process paradigm into the system so learners become more aware of the activities that are associated with a particular design phase, as well as to scaffold these expert processes of chunking and sorting relevant information into a meaningful whole.

Two rounds of high fidelity prototypes have been conducted, along with usability testing and surveying of university design students (Brunner Stone et al 2012). The DPB research group has also created an advisory board to provide feedback and suggestions for the system development.

### *Important Features and Functions of the DPB Prototype*

The many important features and functions of the DPB are also common in digital learning tools for K12 science education—namely the *Progress Portfolio*. While developed initially several years ago (Loh et al 1997), the Progress Portfolio possesses several commonalities with the DPB for university design students, who are working with the complexities of ill-defined problems and the output and organization of all of the artifacts that are typically produced in a design project. We discuss the similarities with these two digital learning tools by feature and function, and then the connection to reflective thinking and scaffolding. This comparison highlights the universal aspects of the DPB to other learning environments and users, not just to design students and adult learners. We begin by briefly presenting an overview of the *Process Portfolio* highlights.

#### THE PROGRESS PORTFOLIO

The Progress Portfolio (PP) is a workspace for K12 science students, where they can keep track of a multitude of sources and make notes about sources and the analyses generated. The students can manage these sources and analyses and they can communicate with others about their projects. The PP works in union with and incorporates other useful tools such as data visualization software and digital libraries. These aid the student in generating and analyzing the data. This is a tool that is meant for incorporation into all aspects of the investigative process and helps learners to document all aspects of the investigation including questions, pictures, documents, annotations, various revisions, and presentations of material. The PP is designed to make the intangible aspects of the investigative process into visible objects that are meant to be “worked with, discussed, presented, and revised, allowing students to tell the story of their investigation and reflect on their inquiry process” (Loh et al., 1997).

#### PAGES

The central feature of the DPB (Appendix C) and the PP are pages. This is where students can place images and objects, as well as receive comments from their peers and instructors about certain contents on these pages. These comments are page specific and are not linked to an individual object, which is discussed next. The page in the DPB is supposed to replicate the form of the paper-based process book, for a more nature way of going about their design process. Many times it is important to place several objects on a page for a more meaningful chunk of information the students are creating, expressing, or researching. This is too limiting if students are only able to view objects individually. The pages act as a series of workspaces or ideas that can easily be reflected and acted upon. The underlying structure of the DPB is a database that links objects to pages (if the student decides to place this object on a given page). An object can be placed on more than one page if a student wishes. Each page is associated with a certain design phase; there is typically five to seven phases in a given design paradigm, and this is set up by the design instructor prior to the start of the project. It is important to provide some scaffolding of these design phases into the DPB system, as this has been a weakness in novice designers processes.

#### OBJECTS

Objects in the DPB can be a wide range of items including images either downloaded from the Internet or images created by the student. Photos, diagrams, tables, and videos, as well as sketches that are scanned and saved as image files are examples of objects in the DPB system. This is similar to the PP, but would probably have less scanned sketches from the student. Objects are an important connection between the DPB and paper-based process books. Anything that a student could possibly create on a paper can be uploaded into the DPB system as an object and then later placed on a page.

An important feature about an object in the DPB is that students can annotate these images with comments and also assign ratings (Appendix C) to these. This is an important reflection component of this system as it creates an easy way for students to go back to created objects, think about them, and then determine if this object is a 'good', 'neutral', or 'bad' iteration of an idea. This quick visualization self-assessment is important, as students are encouraged to produce several ideas, concepts, and/or sketches as part of their design process. These embedded rating functions are what instructors consistently prompt or ask students in the studio learning environments. Thus, the rating function is another example of scaffolding incorporated into the DPB.

#### TEMPLATES

Templates are currently incorporated into the DPB during the final phase of the design process, where they are developing layouts of their final presentation boards. Design students in such fields as interior design or architecture may not have the experience or skills of creative effective layouts. Thus, several presentation board templates are available to students so they can just drag and drop completed drawings and images to placeholders in these template pages. There are also text boxes for prompting students to correctly title and label each of these presentation elements. This is another example of a scaffold built into the DPB. Also, as students progress through the different studio levels, they may not need such explicit templates and scaffold so these may be less prominent or even eliminated from the upper level studios as needed. This is an example of scaffold fading in the DPB system.

In the PP system, students, designers of the software, and instructors can create templates that might best accommodate the specific needs of the project. When instructors create templates, they can add prompts to force students to reflect and record observation about objects.

#### ANNOTATIONS

Annotations in the DPB and PP are very important for reflection. There is an option on each page for students, students' peers, and instructors to input comments about content on the page (Appendix C). On a more intimate level, the student designer and owner of the project can make annotations about an object as well. Prompting students to annotate their work in their paper process books has been a difficult endeavour, so a built-in mechanism for students to easily input some reflective thought is a crucial aspect in the DPB system. It acts as a reflective and scaffold feature in the DPB. The comments feature is intended to be more public or produced externally from another student or the instructor. The annotations are designed to be more internal and reflective for the student designer.

In the PP system, these annotations are visually displayed as "sticky notes" to resemble the physical function of a paper based process. These notes are also designed with a color-coded scheme for easier categorization of different aspects of a project as well.

#### LIBRARIES

In the DPB, the built-in sketch pad includes libraries of common shapes to quickly select and use to create an object. Lines (free-hand, straight, arrows), rectangles, circles, and textboxes are used extensively to construct diagrams, flow-charts, and schematic drawings in the design process. While there are many external digital software programs that are stand alone sketch pads, the DPB researchers believed that an internal sketch pad was important for seamless process work, helping to reduce the extraneous cognitive load imposed upon a design student. In addition to the library components of the sketch pad, the DPB is planned to incorporate "worked examples" relevant to the specific project scope. These examples (imported into the students' library) is another instance where scaffolding aspects are integrated into the system design. While students could easily access these examples from external Internet searches and course textbooks, it is the direct access to these specific examples in the library that help to reduce a student's extraneous cognitive load while designing. These examples could be more apparent in lower level studios and then decrease as the student becomes more knowledgeable about such examples and concepts.

#### TEXT FIELDS

The DPB includes a journal type feature in which longer entries may be made concerning the progress through the project and any ideas or concerns that a student has about their work. Journaling is a common way in which instructors can encourage students to reflect on their work, but many times a separate journal becomes secondary or cumbersome for students to actually complete. An area within the DPB system, and even prompts for asking them to record daily journal entries are included in the DPB interface. Mechanisms can also be built into the DPB that would require a student to provide a journal entry each day or on a frequently designated basis.

#### PROMPTS

Prompts are an important feature in both the DPB and PP, as they are excellent ways in which to scaffold an instructor's guidance or an expert's process. The DPB is beginning to incorporate several system wide prompts to assist the students in their work. As the DPB is in its second round of prototyping, an increasing amount of prompts will be added to the system over time, as the researchers continue with the usability testing and implementation into the classroom settings for study and refinement. Mouse-over areas of informational text, and areas to include basic definitions for the design student are planned in future prototypes.

The PP software helps to prompt students to reflect about material they are working on or have recently added. In addition, it may offer hints directing students to reflect specifically on a question or counter point. The instructor may add prompts when they design a template so that these prompts are structured to fit the project and emphasize material the instructor finds to be of importance.

#### CLUSTERS

Clusters may be defined as ways to group individual pages of a student's project. In the DPB, these clusters represent the different design phases of a project. Thus, at any given time of a life of a project, a student can visualize the pages that are associated with a particular design phase. The PP system uses a similar type of cluster, but these clusters are not pre-determined but are more content-driven and project specific.

#### PRESENTATIONS

Presentations as defined in the DPB include a series of pages that can be added to a portfolio or PDF file. In design projects, being able to highlight and communicate a student's process is important to the instructor, student, and future employers. The presentation function in the DPB allows students to select certain pages to include in this file, or include all pages created during the project. The process is easily archived for several communication purposes that a student may find useful in their education goals (getting a job, reflecting on past projects, etc). Thus, the DPB acts as a process portfolio for the student after the completion of a project.

The PP offers a presentation tool, which allows a student to quickly create a 'PowerPoint' featuring slides from the various pages and clusters they collected throughout the investigation. Thus, the DPB and PP have similar presentation features embedded within the given systems.

#### TASK MANAGEMENT

The DPB is currently adding task management features to the system, the first priority being a task list generated by a student and associated due dates. A more elaborate calendar feature is planned for the next round of prototypes of the DPB. It is intended that both students and instructors will be able to add critical deadlines to the designated project. Again, there are many external task management software programs readily available now, but an internal, simple task management system will help with the reduction of extraneous cognitive load stressors of the student.

The PP does not offer a calendar or task management system, but instead relies upon the instructor to offer verbal guidance as to what needs to be done. This may be because of the level of the student learner, and the difference in skill levels between K12 and university level students. As adult learners and persons more responsible for

making their own priorities and deadlines, the task management system may be more natural for these students at the university level.

## Significance

Design studio experiences rely heavily on the one-on-one interaction between faculty and student, but the current students in the 21st century have many digital tools and new ways of communicating with others as well as themselves. These students demand immediate feedback, try to multi-task between several different priorities at once, and have access to a breadth of information from the Internet that was not available to the design student twenty years ago. These changes are both challenges and opportunities in instructional practices and strategies at the university level. One opportunity for design instructors and instructional technologists is to think and devise innovative ways for students to process the abundance of information they are introduced to in a given design project. The DPB is focused on assisting in this purpose. It is also important to note that these functions and goals of this system has many universal qualities, in that most of the DPB goals and features are also important to other educational contexts and levels, such as K12 science education. As the development of the DPB prototypes continue, we find more useful connections between other disciplines and its uses. Thus, the DPB is transformative across discipline and age group borders.

## References

- Brunner, L.A. (2008). "An analysis of the 'process book' as a means of capturing interior design students' design process." Paper presented at the *2008 International Conference of the Interior Design Educators Council (IDEC)*, March 3-9, 2008, Montreal, Canada.
- Loh, B., Radinsky, J., Reiser, B.J., Gomez, L.M., Edelson, D.C., & Russell, E., (1997). "The Progress Portfolio: Promoting reflective inquiry in complex investigation environments". *Proceedings of Computer Supported Collaborative Learning 1997*. Ontario, Canada.
- McLeod, S.A. (2010). "Zone of proximal development," retrieved October 1, 2012, <http://www.simplypsychology.org/Zone-of-Proximal-Development.html>.
- Pass, F., Renkl, A., and Sweller, J. (2004). "Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture". *Instructional Science*, 32, 1-8.
- Pass, F., Renkl, A., and Sweller, J. (2003). "Cognitive load theory and instructional design: Recent developments". *Educational Psychologist*, 38, 1-4.
- Puntambekar, S. (2003). "Scaffolding," retrieved on October 1, 2012, [www.education.com/reference/article/article/scaffolding/](http://www.education.com/reference/article/article/scaffolding/)
- Rogoff, B., (1990). *Apprenticeship in thinking: Cognitive development in sociocultural activity*. New York: Oxford University Press.
- Schenk, P. (2007). "Developing a taxonomy on drawing for design." In proceedings of the International Association of Societies of Design Research. Hong Kong Polytechnic University, November 12-15, 2007.
- Stone, L.B., Ganchev, S., Lundquist, A. (2012). "High Fidelity Prototype of the Digital Process Book Learning Tool for Design Students in Higher Education: Design and Usability Results." Paper accepted to *ELearn 2012 World Conference on E-Learning in*

*Developing interactive learning environments to promote scaffolding and reflection*

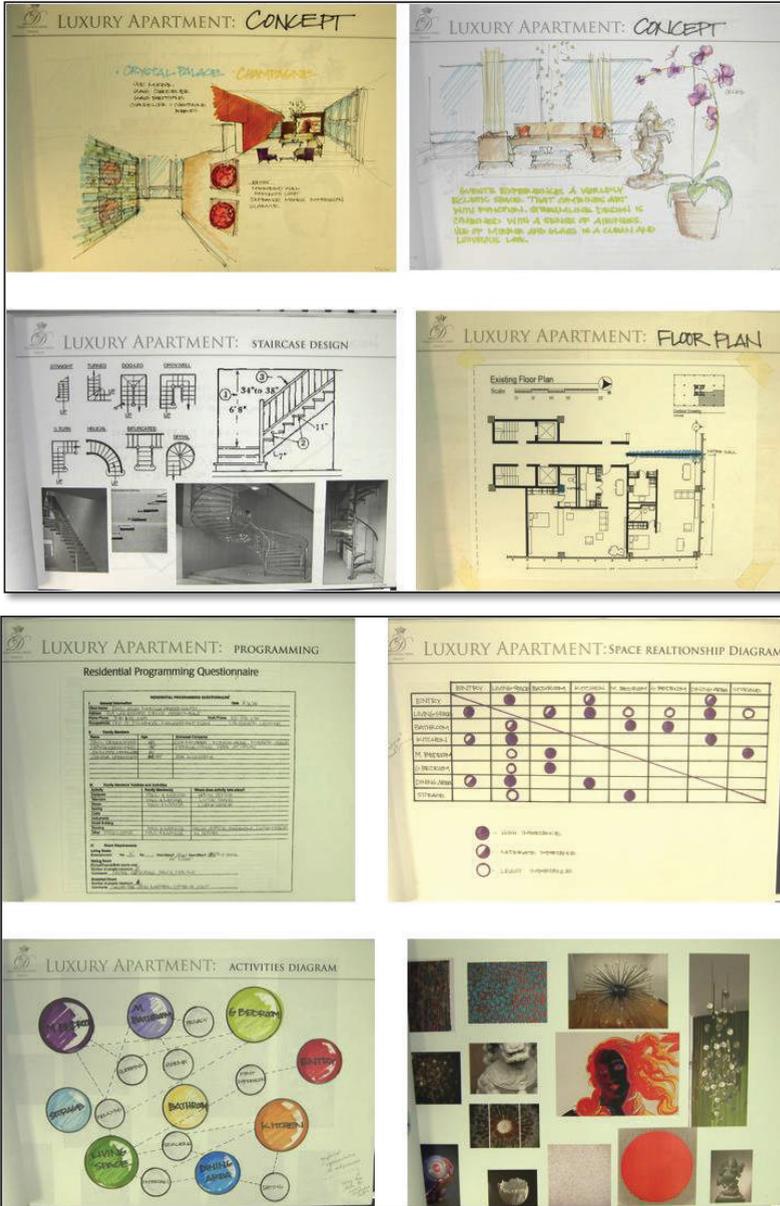
*Corporate, Government, Healthcare & Higher Education*, October 9-12, 2012,  
Montreal, Canada.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wood, D., Bruner, J.S., and Ross, G. (1976). "The role of tutoring in problem solving".  
*Journal of Child Psychology & Psychiatry & Allied Disciplines*. 17(2), 89-100.

# Appendix A

Example of Paper Process Book Pages



## Appendix B

### Home Screen of the DPB

The screenshot shows the home screen of the DPB system. At the top left is a star icon followed by the text "Logotype". At the top right, it says "Welcome, John Davis! (logout)".

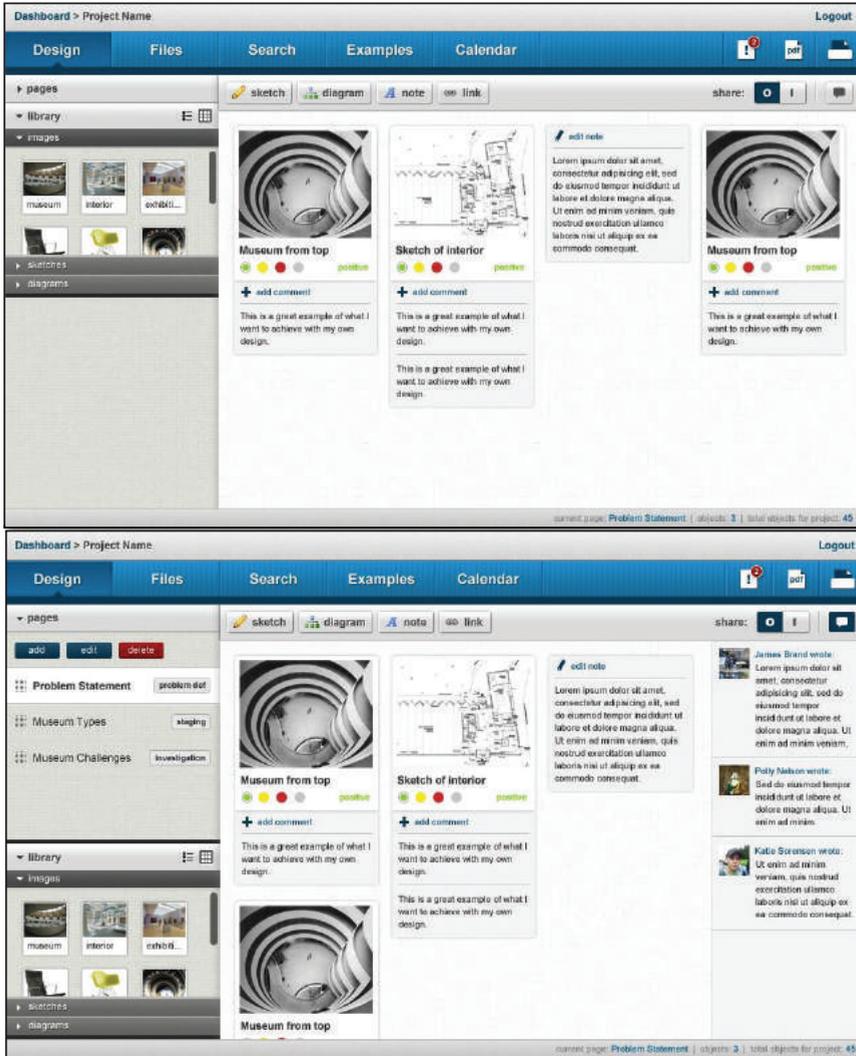
The main content is divided into three sections:

- Projects:** A list of four projects, each with a name, an "info" icon, and a "report" icon. A "New" button is located at the top right of this section.
- Recent Activity:** A list of three activity items, each with a green checkmark icon, a description, and a timestamp (e.g., "2 hours ago").
- Essential Tasks:** A list of three tasks, each with a checkbox and a description.

Home screen where students can either open a new or existing project in their DPB system, view essential tasks that they have created in the past, or view recent activity that they or others have completed that are associated with the student's DPB project.

## Appendix C

### Screens of the DPB



*These screens show a DPB page, objects, annotations, comments from other students, rating options for objects, an internal library, and main menu features of the system. The objects can be moved around the page window in any fashion the student desires. Each page includes a unique ID created by the system, and a place for the student to add a title for each page.*