# Education and Design: Using Human-Computer Interaction Case Studies to Learn

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## ABSTRACT
As computers become increasingly integral to daily life there is a need for computer scientists to focus on the user. This, in part, entails developing applications that have interfaces that are well designed. It is therefore important that computer science students gain formal education in design methodology. The best way to teach design is debatable, but one teaching tool gaining popularity in the field of Human Computer Interaction (HCI) is the use of case studies. We aim to increase the usefulness of the case study as a tool to teach design methodology. A case study is a collection of artifacts and data used to communicate a story. In the field of HCI cases communicate how a designer accomplished designing a certain aspect or, in some cases, the entirety of a design. Case studies are inherent flexibility and can be presented in a variety of ways. We explore if by altering presentation we can enhance the usability of the case study and better communicate the encapsulated design methodology to the student; thus, can we enhance design learning. We make use of ordering effect in our attempt to achieve these ends and to shed light on the effect of online presentation on education.

## Categories and Subject Descriptors
D.2.2 [**Software Engineering**]: Design Tools and Techniques – *User Interfaces, Evolutionary Prototyping*

## General Terms
Design, Human Factors

## Keywords
Human-computer interaction, case studies, scenario based Design, Information Design

## 1. INTRODUCTION
There is an increasing body of research that suggests the order in which documents are presented in a document library affects a user's perceived relevance of the documents. As a digital case study is essentially a document library, there is reason to suspect we may be able emphasize or deemphasize the importance of artifacts included in a case study by altering the order in which these artifacts are presented. The ability to augment the relevance of an individual artifact, or type of artifact, is interesting as by doing so we may be able to alter the user's perception of an entire case.

Using case studies as teaching tools is popular in a number of fields including law, business [4], and medicine [2]. The use of a case study commonly serves the purpose of introducing a student to a problem solving method that is not easily communicated in a standard text or is unique to a specific problem or circumstance. Case studies benefit from common language and story which tend to leave a more lasting impression than the technical jargon presented in a standard college text. The vividness of the data and artifacts, and their relation to the story, and each other, additionally aids in making the pieces of a case study easier for a student to digest.

A case study gains quite a bit of its usefulness by having a form that is flexible and by leaving most of the details to the author. Cases can vary widely in content and presentation. In spite of this, within a field, there are typically a set of artifacts that are common to the majority of case studies. For example in the field of medicine a "description of symptoms" could be called a common artifact. In an interface design case intended to communicate Scenario Based Design methodology, scenarios and claims, serve as common artifacts.

In the past a case study may be provided simply as a stack of stapled papers. With the proliferation of the internet case studies are increasingly being digitized allowing them to exploit the benefits common to this format. As there is an increasing trend towards digitalization all case studies used in our research are of this nature.

Making use of ordering effect and the fact that a digital case study is essentially a digital library we theorize that by varying the order, in which common artifacts in a case are arranged, and swaying a user's perceived relevance of an artifact, we can shift perception of the case as a whole. Our goal is to see if we are able to find an ordering that best allows a student to collect, retain, and then reapply information they garnered from the case study. The ultimate goal is to increase the usefulness of the case study as a tool to teach the methodology of design.

## 2. BACKGROUND AND RELATED WORK
In the field of Human Computer Interaction case studies often exhibit an actor, or actors, utilizing a specific design methodology to achieve a final design One such design methodology that has been successfully coupled with case studies is Scenario Based Design (SBD) [4, 5].

Scenario Based Design is a user centric design methodology that utilizes short stories, called "scenarios." Scenarios are stories that illustrate how an end user may interact with an interface. Features of the interface described in the scenario, along with the pros and cons of this interface feature form a "claim." Scenarios and claims form the backbone of SBD.

The interrelated nature of a set of claims to a scenario allows for simple and convenient way to navigate artifacts in a digital case study. It is easy to imagine reading a scenario and then wanting to see the corresponding claims. Coupling SBD and case studies is especially convenient, as SBD case studies have proven useful in the education of HCI students. [5, 7] and further work has been undertaken to compile a library of cases rooted in SBD [6, 8].

There is a significant amount of debate, however, as to which artifacts should be included in a SBD case study beyond scenarios and claims. While scenarios and claims may support an overview of the design, alone they can fall short of illustrating an entire design. Regardless of which other artifacts are to be included though, it is indisputable that scenarios and claims are the essential artifacts if a case is to exhibit the SBD methodology.

In our study we attempt to vary presentation of a case study to the ends of best communicating design methodology and enhancing general usability of the case study. One way to vary presentation would be to change the order in which artifacts are presented to the user within a case study. It has been shown that the presentation of documents in a document library can result in emphasizing or deemphasizing the worth of included documents [3]. Furthermore, it has been show that significant ordering effect is present when a user is presented between 15-30 documents but tends to dissipate when more than 75 documents [1]. A case study may very well be in the 15-30 document range and thus ordering effect could potentially occur within a case study. It may be possible to present artifacts in a specific order and skew perception of relevance, potentially affecting comprehension of the case study and the ability of the user to retrieve information

## 3. Experiment

### *3.1.1 Experimental Design*

Our hypothesis was that by varying the artifact type that served as the basis of navigation within a case study we would observe differing levels of usability and comprehension of key Scenario Based Design concepts. To address this hypothesis three groups of participants were assembled (n=48). Participants were all undergraduate students currently enrolled in a Computer Science class. Participants were not allowed to have already completed the undergraduate Introduction to Human Computer Interaction class as this would give them a significant advantage in completing the activities. Participants were broken up randomly into 3 groups. A participant was assigned to a group based on a random number generated by the survey application when they began their session. This unfortunately resulted in groups of varying sizes; in spite of this, random assignment was maintained and our data should not be adversely effected.

Each of the three groups of participants were presented a set of case studies with a unique navigation style. Group 1 was presented case studies with a claim centric case study design; a design in which they were initially provided a claim set and from this claim set were able to navigate to related scenarios. Group 2 was presented case studies with a scenario centric design; a design in which the participants were provided a set of scenarios and could navigate from this set of scenarios to related claims. Group 3 was presented a relational map (web) in which the title of the claims and scenarios were presented in randomly dispersed blocks with lines linking related scenarios and claims; this method of navigation was designed to give no emphasis to claims or scenarios and to serve as the control.

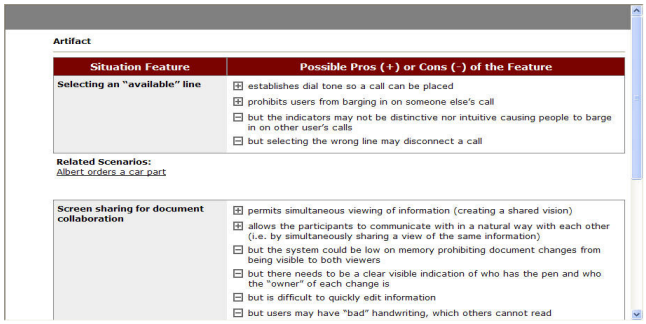


**Figure 1. Claim centric design screenshot.**

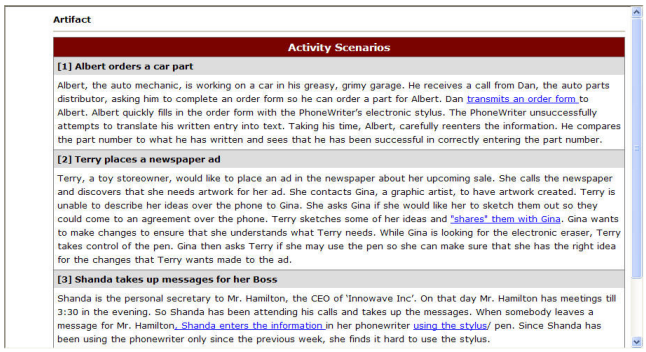


**Figure 2. Scenario centric design screenshot.**

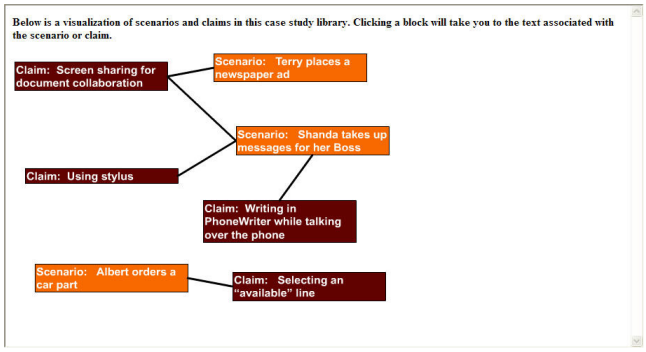


**Figure 3. Relational map design screenshot.**

Scenarios and claims were chosen as the sole artifacts to use in the case studies the participants explored. This was done for two

reasons. Firstly, as discussed in the Background, if case studies are demonstrating the SBD, claims and scenarios are artifacts that will be common to all such cases. Secondly a set of scenarios and a claim set are invariably coupled thus providing a means to navigate back and forth between scenarios and claims.

Each case study used in the study was put together in digital form using HTML and PHP, the relational map navigation method additionally made use of Flash. Each participant group explored their corresponding design on a computer. The activities participants completed using these case studies were also in a digital form.

We aimed to measure two attributes using the varied case study designs. First was usability and second was participant comprehension. We did this through providing each group three activities; the activities provided to each group were identical. The activities involved exploring and answering questions about three separate case studies.

The first activity was comprised of a set of questions designed to address usability. We aimed to determine whether participants could quickly and accurately collect basic information from each case study they were provided. Participants answered a series of short questions about basic information included in the cases. The questions were answered in sequence; once an answer was submitted it could not be returned to. This allowed for collection of both response and completion time. The questions drew upon information contained in claim sets and scenarios equally as not to give favor to one case study presentation method. Questions in Activity 1 were broken up into three subsections based on the case they correspond to.

The second set of questions aimed to gauge comprehension and retention of the information explored by each participant in Activity 1. Users were once again presented with a series of questions but were now disallowed from navigating the case studies they previously had access to in Activity 1. Questions in Activity 2 were broken up into three subsections based on the case they correspond to. The order of the subsection and the cases they correspond to were the same as in Activity 1.

The final task the participants performed was writing a claim set and a short scenario. The claim set and scenario that each individual wrote was related to the Garden.com case study. This study was the longest and most filled out case study of the three used throughout the activities. The participants were asked to write claims for 2 features that they thought should be included in the design. The participant was then asked to write a short scenario incorporating these claims.

The scenario was evaluated on the following criteria:

**Table 1. Elements of a scenario. (Adapted from [6, 7].)**

| Element | Definition |
|---|---|
| Setting | Situational details that motivate or explain goals, actions, and reactions and actor(s) |
| Actors | Human(s) interacting with the computer interface or other setting elements |
| Task Goals | Affects on the situation that motivate actions carried out by actors |
| Plans | Mental activity directed at converting a goal into behavior |
| Evaluations | Mental activity directed at interpreting the features of the situation |
| Actions | Observable behavior |
| Events | External actions or reactions produced by the computer or other features of the setting |
| Plot | Arrangement of incidence to convey the story |

**Table 2. Characteristics of a scenario. (Adapted from [5, 10].)**

| Characteristic | Definition |
|---|---|
| Succinctness | The ability to convey the right amount of information about the elements. |
| Concreteness | The ability to be firm in the details about the elements. |
| Flexibility | The ability to leave future adaptation about the elements |
| Coherence | Logical flow and aesthetic consistency |
| Promote Work Orientation | Enables all stakeholders to understand the design at any point in the design process. |

The claims were evaluated on the following criteria:

**Table 3. Characteristics of a claimset. (Adapted from [6, 7].)**

| |
|---|
| **1.** The claim feature should provide a description of the psychological effects that are caused by the UI feature in a particular context. |
| **2.** Care must be taken not to state the obvious in upsides/downsides. State upsides/downsides so that they provide novel knowledge. |
| **3.** Care should be taken not to refer to system specific functionality. Do not over-specify a claim. |
| **Meta.** The scenario must depict how the claim as a whole and its upsides/downsides come into play within a usage context using a narrative. |

Each of the scenario and claim feature was evaluated on a 1-10 scale with 10 being a high score. The Meta feature was likewise scored on a scale of 1-10 and was an evaluation of how well the user synergizing of scenario and claims. The scenarios and claims were evalued by two experts in Scenario-Based Design.

### *3.1.2 Results*

#### *3.1.2.1 Usability Question Set*

For the usability question set the null hypothesis was disproved. That is, there was a statistical difference between the groups.

**Table 4. Single factor ANOVA for Activity 1 Scores.**

| | Scenario Centric | Claim Centric | Relational Map |
|---|---|---|---|
| n | 11 | 17 | 20 |
| Average Combined Score | 7.86454 | 6.588235 | 8.125 |
| Variance | 2.099359 | 2.476103 | .830409 |

There was significant difference between the relational map and the scenario and claim centric designs. Participants using the claim centric design performed significantly worse then the control and scenario centric design. Using a single factor ANOVA a p-value was found to be .033215 between groups. A two tail t-test between claim and scenario centric designs produces a p-value of .03345.

Based on our data for time measurements we could not disprove the null hypothesis of there being a difference in the time required to complete Activity 1.

**Table 5. Single factor ANOVA for Activity 1 Times**.

| | Scenario Centric | Claim Centric | Web Design |
|---|---|---|---|
| n | 11 | 17 | 20 |
| Average Time to complete Activity (hrs) | .440253 | .520588 | .399722 |
| Variance | .040256 | .041162 | .01796 |

Using a single factor ANOVA we found a p-value of .124336 with the relational map group performing best on average. A two tail t-test between the combined claim and scenario centric designs and the web design produces a p-value of 0.072937; as this is very close to being statistically significant additional trials may reveal that the relational map presentation resulted in a faster completion time over the other methods.

### *3.1.2.2 Retention Question Set*

**Table 6. Single factor ANOVA for Activity 2.**

| | Scenario Centric | Claim Centric | Relationa l Map |
|---|---|---|---|
| n | 11 | 17 | 20 |
| Average Time to complete Activity (hrs) | 6 | 5.852941 | 5.5 |
| Variance | 1.05 | .742647 | 2.526316 |

With the data collected we are not able to disprove our null hypothesis. For Activity 2 presentation method did not have a statistically significantly affect on scores for the set of questions. We found a p-value of .514081. Running a two tailed t-test between the claim and scenario centric designs we found p=.697791.

### *3.1.2.3 Scenarios and Claims.*

**Table 7. Scores by Presentation Method.**

| | Scenario Centric | Claim Centric | Relationl Map |
|---|---|---|---|
| n | 11 | 17 | 20 |
| Claim Totals Average | 15.13636 | 15.61765 | 14.625 |
| Scenario Totals Average | 75.77273 | 74.32353 | 82.05 |
| Combined Totals Average | 95.59091 | 94.14706 | 101.9 |
| Combined Totals Variance | 894.9909 | 974.5864 | 893.7263 |

We were unable to disprove our null hypothesis. We found no significant difference in a participants ability to write their own claims and scenario as a result of presentation order of artifacts. For the total combined score we showed a p-value of .717843. For only the scenario scores a p-value of .635723 was found and for only the claim set scores a p-value of .876377 was found. When ANOVAs were run with individual raters: rater 1, for claims p=.901602 and scenarios p=.82679; rater 2, for claims p=852858 and p=.715815.

### *3.1.2.4 Discussion.*

The study results suggest that the order in which artifacts were presented did not have a significant impact on a participants' score for Activity 2. Activity 2 contained questions designed to measure comprehension and retention of information. Presentation of the case study may have had little effect as a result of participants reading the entire case study in Activity 1. The intention of Activity 1 was to encourage the user to exploit the uniqueness of the navigation method provided to complete the activity as quickly as possible. If enough people approached Activity 1 by simply reading the case study in full, navigation method would likely have little impact on retention.

Likewise, presentation method did not translate into a participant's ability to grasp key SBD concepts and then translate them into their own scenarios and claims in Activity 3. There are two reasons we hypothesize this might be. Firstly the case studies presented were limited to a single scenario and a single claim set, a more thorough and in depth case study may have exposed more of the underlying components of Scenario Based Design. Secondly, it is possible that the amount of time each participant was able to spend with the claims and scenarios was simply too limited to expect the participants to fully grasp "important" aspects of Scenario Based Design. Remember, the case studies were only available to explore while answering questions in Activity 1. Most participants only spent about 30 minutes looking at the case studies and even then had the additional distraction of having to complete tasks. There may not have been enough time for a student to study and analyze.

The one area we did find significant results was in Activity 1. Users had significantly lower scores using a claim centric design as compared to the scenario centric design or relational map navigation method. This may be because claims are less familiar to a user lacking experience in HCI than scenarios. A scenario in essence is a story, something most people are familiar with navigating from a very young age. However navigating a claim set may initially confuse a participant and serve as a poor base to explore the case study. The relational map, in spite of also having a design that may initially be unfamiliar to the user, also outperformed the claim centric design considerably. This may be because the map design had indicative labels, often containing key words included in the question. For example, if a question was asked about the scenario involving George, all the participant had to do was click on the label with George in the title and (s)he would end up in roughly the right place.

Although we could not disprove our null hypothesis for the time it took to complete Activity 1 we did find a very low p-value when comparing completion time between participants given the claim or scenario centric designs versus the relational map design. The relational map may have had an advantage as the labeling provided an obvious way to jump to relevant information quickly. With additional trials it is likely we could prove that the relational map navigation method is significantly better.

## 4. FUTURE WORK

The affects of ordering scenarios and claims in different ways was investigated, but there a number of other types of artifacts that can regularly be found in a design case study. Perhaps one of these other artifacts has an affect on usability or usefulness of the case study if presented to the student in a certain order in relation to certain other artifacts.

Likewise our presentation of claims and scenarios was basic to say the least. The relational map was able to illustrate the entwined nature of claims and scenarios but there are a variety of other potential ways to present artifacts in a case study that may increase its usefulness as a teaching tool for design. One idea might be to present the artifacts on a timeline to illustrate the temporal nature of design.

We additionally need to look at the effects of a case study's design on student comprehension over a longer timeframe than a single session. Expecting participants to internalize the deeper concepts of Scenario Based Design may simply not be possible in an hour and that is why we are not able to find any difference between navigation methods. Perhaps, over the long term one design does significantly outperform others. It would be interesting to see if repeatedly exposing participants to a given design would produce significant results.

## 5. CONCLUSION

We need to further explore whether or not presentation order of key artifacts in a case study affects a student's ability to retrieve information and ascertain key SBD concepts. From our results it does seems safe to conclude that presenting a student with limited knowledge of HCI an unfamiliar artifact, such as a claim, to navigate a case study can adversely affect the ability of the student to find information within the case study. Additionally there may be a relationship between design presented and ability to quickly navigate to information in a case study, though additional trials are needed to determine whether this is indeed true.

The order information is presented and its presumed relevance by a user has been showed repeatedly to correlate. We need to explore and experiment further to determine if it is possible to use this phenomenon to emphasize elements of a case study that will in turn increase comprehension and usability of the entire case study.

## 6. ABOUT THE AUTHORS

Gregory Smith is a Computer Science and Mathematics undergraduate at Virginia Tech. Laurian C. Vega is a Computer Science Ph.D. candidate at Virginia Tech. D. Scott McCrickard is a Professor at Virginia Tech.

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