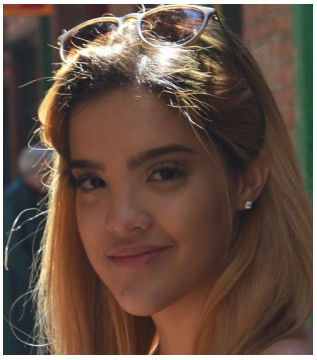

CPSC 444: Evaluation Report

Cecilia Pacheco #43086157 csid:u4q0b

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Collaborative Workspace: The Use of a Common Online Project Space to Improve Organization, and Information Sharing

INTRODUCTION

Collaboration has always been an important element of daily life, as such commonly happens through electronic devices like computers. Group collaboration online has yet to be perfected in its online form. Groups increase in size and file proliferation rises, then the harder it is to keep track of current tasks and files shared amongst users.

In a field study prior to our experiment performed on four university students taking computer science courses, it was perceived that at least in this specific demographic, the students used a conjunction of different information systems to carry out their work, as many used multiple chats to communicate with their colleagues such as Facebook Messenger and Slack, while all of them managed their shared files on Google drive; but would inevitably send important information over their chat channels which would be lost amongst other information as their chats progressed. Also it was noted, that there was a great number of different applications being used both locally and online in which the switch between one application to another was found to be disruptive as cognitively there was a search performed by the user to switch from one application to another, which would interrupt the continuum of the task trying to be completed by the user.

The idea to develop both the field study and experiment arose from several personal experiences related to working in a group collaborative setting with computer work involved that has instigated feelings of frustration and annoyance as the number of file increases, so does the difficulty of search required to switch between open applications and files. Personally, file proliferation increases due to the existence of multiple versions at different online applications as so does the possibility of file duplication both locally as online.

Different studies have been done in HCI regarding digital collaboration as there has been research conducted into how to study the different phenomena in collaboration, like decision-making, documentation, and coordination of resources (Slaterry, 2003). University students' online collaboration has been previously studied through a Likert scale questionnaire, highlighting collaboration practices and satisfaction perception regarding group work (Kirchner & Razmerita, 2015). A study regarding information seeking and sharing in engineering design teams has highlighted that "A common information space is a central element of many collaboration systems in which the common information space consists of a repository with features intended to help teams find, organize, and manage their shared information collaboratively" (Poltrock, Grudin, Dumais, Fidel, Bruce, & Pejtersen,2003), which the common information space between users was the central component for the development of the study in this paper.

The cognitive load theory is utilized in this report to understand the effort placed onto a user's working memory in regards to the completion of a task done under a collaboration

setting that requires the constant switch between different files and applications; and how switching affects adds to the effort placed by the user in order to complete a task.

In the continuation of this report, the description of the experiment is given regarding the goals, methods, problems, and limitations of the experiment conducted; followed by the presentation of the results obtained, discussion and conclusion.

EXPERIMENT INTRODUCTION AND GOALS

The experiment conducted had the purpose to compare two interfaces (modular and desktop) and its components to determine the favorability of the major features (switching applications, opening applications, adding applications) and determine which system demands a lower cognitive load on the user.

METHODS

Participants

Eight university students that are taking or have taken any computer science course were recruited for the experiment through convenience sampling. The participants are the target population at which the prototypes were designed for. In addition, the participants were inexperienced with either prototype model.

Conditions

The experiment makes use of two interfaces that employ different information management metaphors and visual elements. Yet, what they have in common is that they are intended to be shared workspaces that can be edited by the members within a project. Only the chat channels are unique to each user, as their personal chat accounts are supposed to be linked to their account made for each prototype.

Figure A - Modular prototype screenshot

The modular prototype as seen in figure A, has a stack like structure in where projects can be linked to. It allows the user to personalize by adding a variety of apps like files, folders, and chats to their workspace. This bar menu has the purpose to enable quick switching amongst the different elements added by the user. The “Manage Files and Folders” button will take the user to a different view of their current linked files in their workspace and allows users to add, delete and rearrange files into their workspace through the bar menu.

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Figure B - Desktop prototype screenshot

The desktop prototype as seen in figure B, takes onto using the computer desktop format as a metaphor to how the workspace in this prototype works. The files and folders can be added through two separate buttons at the desktop that prompt to pop-ups that allows the user to perform these actions. Files and folders can be placed anywhere in the desktop through drag and drop, as they can also be added to folders, and the contents of a folder can be seen by clicking on a folder. Different files can be minimized to a bar at the bottom, while there is a sidebar where the different chat channels used by a group can be seen and easily opened to see the different chats an individual has within each chat application.

Tasks

The participants were asked to complete a set of tasks that try to simulate to some extent the complexity of tasks in the real world where switching between application is required and access to chats is done constantly. The set of tasks was performed twice by each participant one time for each prototype. The participants were asked to log in into the prototypes and open a code file that had the Monty Hall problem written in c and comment the code. The participants would be interrupted after some seconds into this task, as they had to check their chats and locate a specific chat and follow the instructions given by a person in the chat and then go back into commenting the Monty Hall problem code. This interruption step was repeated twice for each interface as the first chat conversation would prompt the participants to create a new file, then create a new folder ,then add the newly created file into the new folder and then finally open the new file. While the second chat conversation would prompt the participants to search and open for a specific file. In the end, the participants were asked to count the number of files in their workspace.

Design

The experiment makes use of the factorial design as a within-subject experiment design was established given that the goal of the experiment was to examine how the inexperienced participants responded to the two prototypes in comparison. The order in which the prototypes were shown to the participants was mixed as half of the participants saw the modular prototype first, while the other half saw the desktop prototype first in order to

counterbalance any effects on the results that the order in which the prototypes were shown could have had.

Procedure

Each participant was firstly given a debriefing of the purpose of the experiment, then asked to read and sign the consent form. Following up, the participants were asked to fill two Likert scale questions and then read an scenario by the researcher for the completion of the experiments tasks. Subsequently, the participants would read the tasks and perform them while thinking out loud for the first prototype. After the first round of tasks, participants had to fill in a Likert scale questionnaire and an open-ended questionnaire. Then, the participants moved to repeat the same tasks, while thinking out loud for the second prototype, and filled in the same Likert scale questionnaire and open-ended questionnaire but for the second prototype shown. In the end, the researcher conducted a semi-structured interview with the participants.

Apparatus

The experiment was run at different locations at the discretion of each researcher given that the place was quiet and had a table and seats for both the researcher and the participant to use. The researcher's computer was given to the participants to use for the use of the prototypes. While all the questionnaires were administered through paper sheets. While each participant completed the tasks given, the researcher took notes through a paper coding sheet. The interviews were audio recorded by the researcher either using a computer or phone.

Independent and dependent variables

The independent variables are the prototypes, so there are two independent variables that are the modular and desktop prototypes. The dependent variables are the participant's favorability rating and the cognitive load of the user. The participants' favorability rating was measured through the questionnaires using a Likert scale questions (1,2,7,8, as seen in figure C) and open-ended questions in addition to the interview questions. The cognitive load of the participants' was measured through the use of NASA TLX questions (3,4,5,6, as seen in figure C) that were adapted into Likert scale questions in the questionnaire section.

Hypotheses

H0: There is no significant difference between the two prototypes in terms of favorability and cognitive load.

H1: The desktop prototype performs significantly better than the modular prototype in terms of favorability rating.

H2: The modular prototype performs significantly better than the desktop prototype in terms of cognitive load rating.

Hypotheses explanation

Regarding H1, the desktop prototype is expected to perform better in relation to favorability even the familiarity that the participants would have with the mental model of how a computer's desktop system works. Regarding H2, the modular prototype is expected to perform better in relation to cognitive load because its interface is meant to strictly only display in the workspace the current files being worked on, as everything the user would need would be at the sidebar this prototype possesses.

PROBLEMS AND LIMITATIONS

Within the problems encountered in the creation of this experiment was to determine how to measure the performance of the different components of two different prototypes that are quite different on how they operate and look. While it would have been interesting to have measured the user's performance in relation time or to have measured the learnability of the systems it needs to be acknowledged that the collection and the analysis of data needs to be refined through more advanced statistical methods and information collection methods that we did not have time or access to. The tasks given to the participants also do not quite translate to the complexity of different tasks in the real world as it is challenging to replicate collaboration through a prototype that is not fully functional; as the prototypes used for the experiment were medium-fidelity prototypes. Also given that all the participants were inexperienced with the prototypes, the real efficiency of the prototypes' components cannot be measured as the learnability that took place from the participants part affects the results regarding the user's favorability and cognitive load.

QUANTITATIVE RESULTS

The statistics used to evaluate the raw quantitative data of the experiment were the mean, mode, semantic differential and a two one way analysis of variance (ANOVA) procedures. For the ANOVA, the level of significance used was of 0.05.

Questions	**Mean Modular Prototype**	**Mean Desktop Prototype**	**Mode Modular Prototype**	**Mode Desktop Prototype**
1 -Liked to use the interface?	2.875	2.875	3	2
2 -Various features well integrated?	3.25	2.875	3	2
3 -Interface mentally demanding?	2.875	2.875	3	3
4 -Required a lot of effort?	3.25	3	4	3
5 -Difficult to complete task assigned?	3.375	3.25	4	4
6 -Interface irritating, discouraging, annoying, stressful?	3.25	3.375	3	4
7 -Would recommend this interface?	2.875	2.75	2	2
8 -Satisfied with the interface?	3.375	2.875	4	2

Figure C - Means and modes for the questionnaire responses of the Modular and Desktop prototypes

```
$ANOVA
     Effect DFn DFd          F         p p<.05         ges
2 prototype   1   7 0.05511811 0.8211049       0.002053388
```

Figure D - ANOVA result on cognitive load between prototypes

```
$ANOVA
     Effect DFn DFd         F         p p<.05       ges
2 prototype   1   7 0.7974684 0.4015076       0.0355419
```

Figure E - ANOVA result on favorability between prototypes

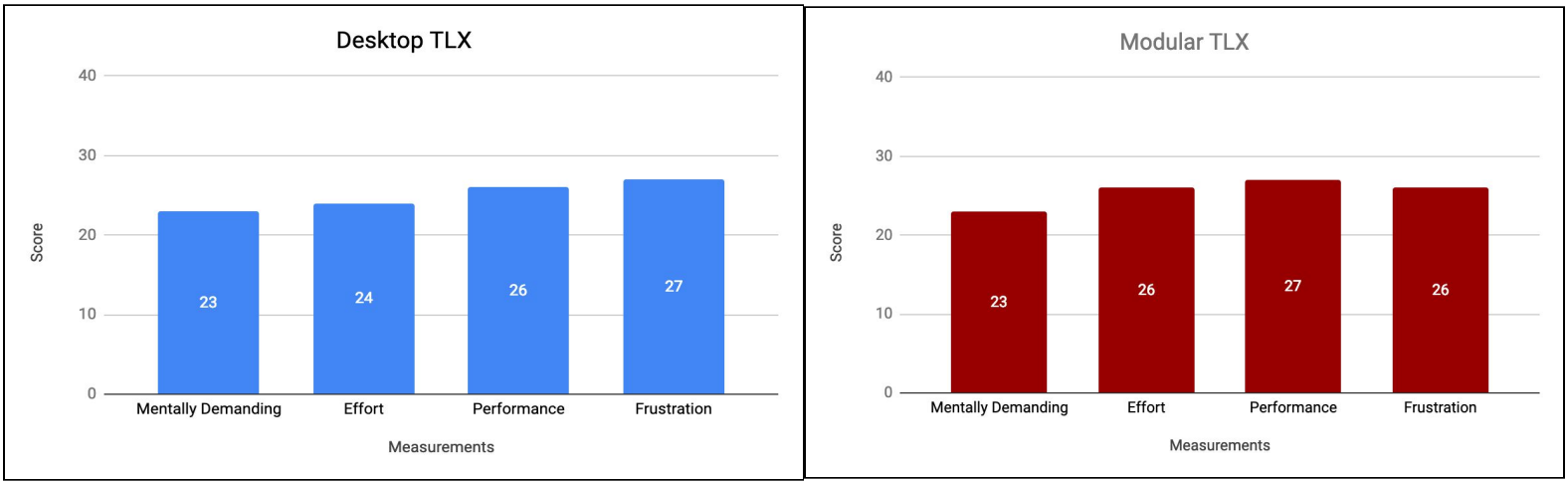

Figure F - Questionnaires' NASA TLX average scores measuring cognitive load in relation to mentally demand, effort, performance, frustration

QUALITATIVE RESULTS

The qualitative data gathered in the experiment for each prototype is made up by the notes taken by the researcher present at each trial, along with open-ended questions of the questionnaire. Comparative qualitative data was gathered through an interview at the end of the experiment.

For the data gathered for the modular prototype, it was documented by two participants that they only knew where to look in the chats the second time around given their first experience within the tasks. In addition, two participants reported that creating a file the second time was easier after doing it for the first time; as four participants in total reported being confused about how to create a file. Two participants had the expectation to be able to drag and drop within the interface and one person had the expectation a modified file would autosave. There was one participant that had to explore the workspace area to acknowledge the presence of the adding file function. Five participants reported that they liked the sidebar feature in the prototype as one participant explicitly said they disliked the way file switching worked with the sidebar. Only one participant said they liked the overall view of the prototype. Six participants complained about having to go to a separate page to deal with the workspace management. One participant suggested that they would like if the integrated window in the workspace could be moved around, as another participant said they would rather have an in-app chat instead of integrating existent chat systems. Some other participant said they would like if they were able to have a change tracker function of all the modifications as another participant said they would like to preview files before opening.

For the data gathered for the desktop prototype, it was documented by two participants that they knew where to go for the chats given the notification signifier. Four participants said they needed efficient switching between open files just like a computer's operating system. Two participants did not notice the bottom bar until halfway through the tasks, and one participant did not notice the bottom bar entirely. Two participants commented that they liked the prototype because it looked like a desktop, another participant commented that the model

was simple and not cluttered and some other participant said that as the prototype looked like a desktop it contributed to their learnability of the prototype. Five participants said that the ability to have multiple windows open caused confusion, in addition, four participants said that resizing windows was difficult. One participant said they needed more screen space for the individual windows, as another participant said that overall the application was confusing. Three participants used the minimizing function several times through the tasks. One participant commented on the fact that the file and folder creation was done differently from a computer's desktop model, as some other participant said they liked that the creation of a new file and folder was done differently through buttons. One participant commented they appreciated the drag and drop feature, as another participant said they liked the presence of both the sidebar and bottom bar of the prototype. Another participant said they liked that the files automatically autosaved after editing. The prototype had the presence of some bugs to which one participant said they had trouble with the drag and drop of a file and another participant had trouble scrolling through a file as they could no longer scroll up to close the file. As for suggestions, one person said they liked if they were able to have a global view of all folders and file hierarchy, as another participant said they liked to have keyboard shortcuts integrated into the functioning of the prototype.

For the comparative data between the two prototypes, it was documented that for when participants were asked about which prototype they struggled with the most and why three participants said they struggled the most with the modular prototype, as five participants said they struggled most with the desktop prototype. For the ones that said they struggled most with the modular prototype, three people said that the back and forth was difficult between the workspace and the file and folder manager. One participant said they struggled because they were unfamiliar with the prototype, as they also said it was difficult to navigate the chats given the lack of notifications and highlighted it was difficult to learn how to use the prototype overall. For the participants that said they struggled the most with the desktop prototype, three people said that windows resizing was an issue, one of those participants said that the windows size was an issue because it covered all the workspace. Another participant said they wanted more space for the individual windows. Two participants said that being able to have multiple windows open at the same was no good, as two participants complained about the navigation aspect of the interface. When the participants were asked about what prototype they liked working in the most and why six participants preferred the desktop prototype, while two participants preferred the modular prototype. For the ones that preferred the desktop prototype, three participants said that visually it was better than the modular prototype, one person commented they liked to be able to drag and drop. Three participants said they enjoyed the positive transfer effect from the computer desktop model, another participant said they especially liked the bottom and sidebars. Two participants said would use the prototype is the bugs were fixed. For the participants that said they liked the modular prototype, one participant said they liked that they were able to see all the file options at once, while the other participant said that they liked that they could switch with the sidebar. When the participants were asked about which prototype provided better means to switch between applications, two participants said the desktop prototype was better, while the four participants said the modular prototype was better and two participants said both prototypes switching was similar. For the participants that said the desktop prototype was better, one participant said that given their familiarity with desktops it was easier to switch, while the other participant said switching was made easy by the bottom bar. For the participants that said they liked the modular prototype better, three participants said that switching was better

as the could see all the files and folders at once through the sidebar, while another participant said they liked they could only see one screen at a time. For the participants that the said that switching was comparable amongst the prototypes said that the organizational bars made them equal in this aspect as the modular prototype had a sidebar, while the desktop prototype had a bottom bar and chat sidebar.

INTERPRETATION OF RESULTS

Note: All figures cited that have a number convention can be found at the Appendix A.I.
Given the one-way ANOVA result for the average of the questions regarding cognitive load, it can be said the result is not significant given that the p-value was 0.8211, which is greater than the significance level of 0.05. The same case can be seen in the one-way ANOVA result for the average of the questions regarding favorability as the p-value was .0415, which is greater than the significance level of 0.05. So this means that overall the null hypothesis cannot be rejected in which both prototypes do not have significant difference between their favorability and cognitive load ratings. Also by looking at figure 1.11, it can be seen more than half of the participants reported a neutral level of satisfaction and efficiency with their current online collaboration tools. This trend did not change much when testing the prototypes as in figure C the average score for the questions falls within a 2 - 3 range. Also when looking at the means per question for all the questions in the questionnaire one can notice a pattern as the modular prototype scored higher when presented the first time vs when it was presented second as seen of figure 2.22, while the desktop prototype scored higher when shown second to the modular desktop as seen of figure 2.3. This suggests that having a participant look at both the interfaces hinders the data collected as the responses could clearly be biased for the second interface. When looking at the NASA TLX questions one can observe that for both the modular and desktop prototype the answers were average as seen in figure F, where answers score around an average of 20 points of 40 possible points, yet one must note that the data is slightly skewed to the use of more cognitive load than less, implying that the participants found the prototypes to use slightly more of their cognitive load than the expected average yet not being remarkably significant. When looking at the semantic differential scale for figures 3.1 and 3.3 one can notice that for the first prototypes being either the desktop or modular prototypes when compared to the semantic differential scale of responses for the prototypes shown second, which can be seen in figures 3.2 and 3.4 answers become more one dimensional when answering the questions a second time around through the use of the a second prototype shown. As through the comparison of figures 3.3 and 3.4, which refer specifically to the desktop prototype one can see the variance of responses given when the prototype was shown first vs when it was shown second, where variance diminished drastically into almost one dimension exclusively. What does not seem to changed is the range of responses given by multiple participants that range mostly between 2-4.

Qualitative data suggests that for the desktop prototype participants just enjoyed it because it looked like a desktop while they enjoyed the use of visual aids like notifications, while for the modular prototype participants liked the simplicity of the prototype and the use of the vertical stack bar. Yet, as we listened to participants there are series of improvements to be made as its seems participants had expectations and commented on what they would like to see in the prototypes as overall they would like to see a clean interface look that includes visual aid, also they would like to have a workspace where they can do most of their actions at the home screen as going into other screens seems to come back later seems to be distracting and annoying. Some other more complex suggestions could be explored in the

future after the current functions of each prototype are refined. It also seems that adding a search feature to the prototypes is essential for basic navigation inside the prototypes. Overall, the side bars seemed to be a successful feature in both prototypes as they provided means of organization for the users, users appreciated the drag and drop, and chat notifications features of the desktop prototype, as they also liked that the file and folders could be added through separate buttons that would pop up windows for setting file and folders instead of having the user go to a whole different screen a sit was done in the modular prototype. Yet, participants liked the simplicity of the modular prototype given that only one window file could be opened at once as it keeps a more straightforward approach to organization, as even with the lower bar present for minimization at the desktop prototype users felt that there were too many windows opened at once. It seems that the desktop prototype model would be ideal to kept integrating key aspects of the modular prototype into it.

RELATION TO OTHER WORKS

Even though there have been similar works and research done about online collaboration none of the previous works in literature are similar enough to reflect on the acceptance of the null hypothesis for the experiment as several limitations could have influenced the result.

IMPACT FOR PRACTITIONERS

Given that the null hypothesis was not rejected, if in the future it is actually proven that there is no significant difference between a modular and a desktop workspace, this means that this would give designers more freedom on how to create online collaborative spaces in relation to the two models used. Yet, the study would need to be expanded into looking more specifically to what type of tasks perform better for what prototype for a broader range of users.

LIMITATIONS

Within the limitations of the study that could have affected the results there was a lack of time and resources to get more participants, so there was a small sample pool of eight participants might not be enough to highlight the results as significant. Also, the small sample of participants might potentially display a lack of diversity of the pool as participants were selected through convenience therefore not representing the population overall. Other factors that affected the study was that tasks did not really translate to the real world complexity of online collaborative tasks; threatening the external validity of the experiment, whereas some bugs in the desktop prototype and lagging in the modular prototype could have been potential threats to the internal validity of the experiment. In addition, given the fact that each participant had to see both prototypes might also have affected the results, even when the presentation order was taken into consideration, as there was always the risk for bias regarding the second prototype shown.

FUTURE WORK

If this study were to move forward into a new iteration cycle there are things that could potentially be improved on. As a wider sample size could be used and the study could expanded to compare students with different educational backgrounds and collaboration goals to see if the prototype works for students other than just computer science students. In addition, a future experiment could be done with a between design approach instead of within to eliminate any bias in regards to having participants using more than one prototype. Also, the state of the medium-fidelity used for this experiment would need to be further developed

to eliminate bugs and expand functionality, as the creation of a hybrid prototype could potentially happen after a second iteration and combine the best features for each prototype and analyze at a third iteration if a hybrid model would be more optimized. Further, the collection methods utilized to measure favorability and cognitive load could be improved in accordance with more accurate methods, as people in the experiment tended to answer towards neutral, so maybe the method of information collection used could have been different as to use a semantic scale instead of having used a Likert scale. Moreover, for the next iteration, the pre-experiment questionnaire questions could be more similar to the questions asked at the post-experiment interview for a better comparison between current online collaboration tools to the prototypes in the experiment.

CONCLUSIONS

Even though there were several problems encountered in the experiment, it is important to highlight that there is a need for more research in the area of collaboration in terms of how people use technology to aid in this goal, specifically how information flows gets stored, retrieved, and edited in collaboration.Ho can the existing methods be improved and optimized in terms of efficiency for the needs of users. As technology advances, it seems that the need for collaboration will increase and so will the complexity of the collaboration process, there will be a necessity to further study the user's cognitive load in relation to online collaborative spaces. Even when this study was not able to reject the null hypothesis, it still is a first step in the process of iteration that once we identified the faults for can be greatly improved for a future iteration, as the qualitative data gathered from the participants has opened a conversation of what the user feels it is important important in a shared workspace, which in the end, points towards the aspect of favorability and maybe aid into a new perspective on how to look at the user's cognitive load.

BIBLIOGRAPHY OF CITED REFERENCES:

Kirchner, K., & Razmerita, L. (2015). Collaborative learning in the cloud: A cross-cultural perspective of collaboration. Paper presented at the 333-336. doi:10.1145/2700171.2804452

Poltrock, S., Grudin, J., Dumais, S., Fidel, R., Bruce, H., & Pejtersen, A. (2003). Information seeking and sharing in design teams. Paper presented at the 239-247. doi:10.1145/958160.958198

Slattery, S. (2003). Research methods for revealing patterns of mediation. Paper presented at the 35-38. doi:10.1145/944868.944876

APPENDIX A.I

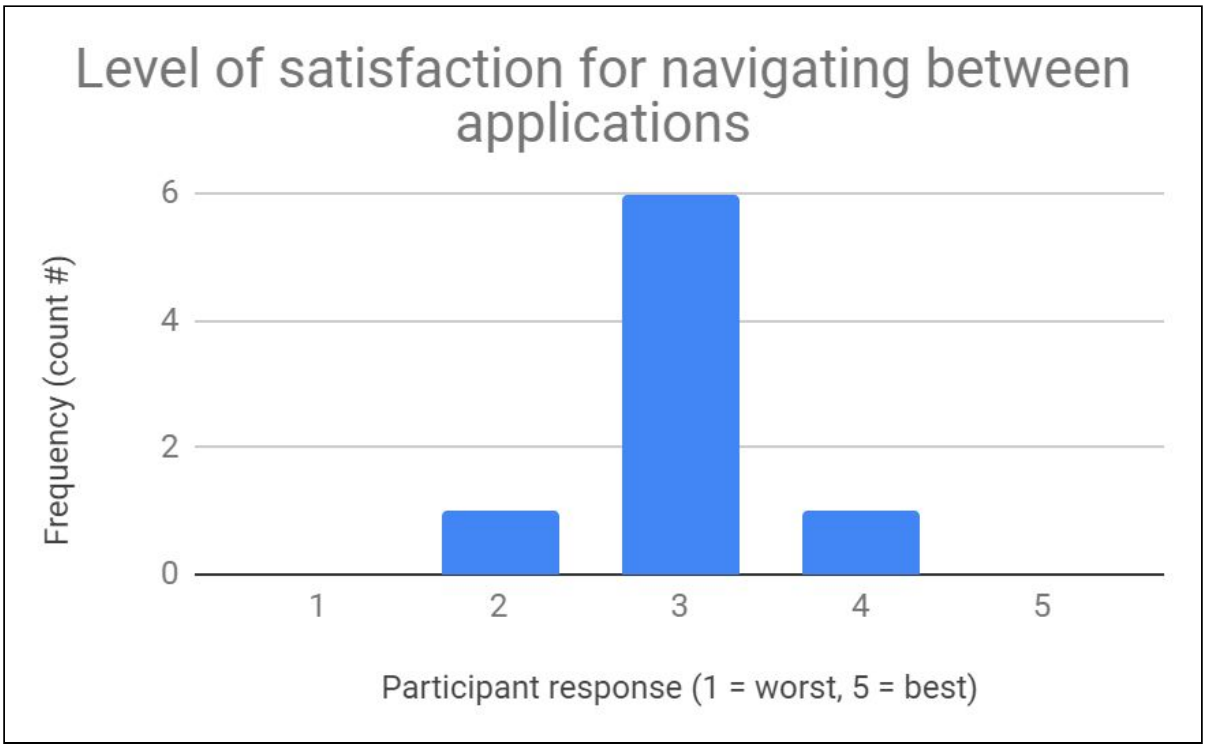

Figure 1.1: Distribution of response to level of satisfaction for navigating

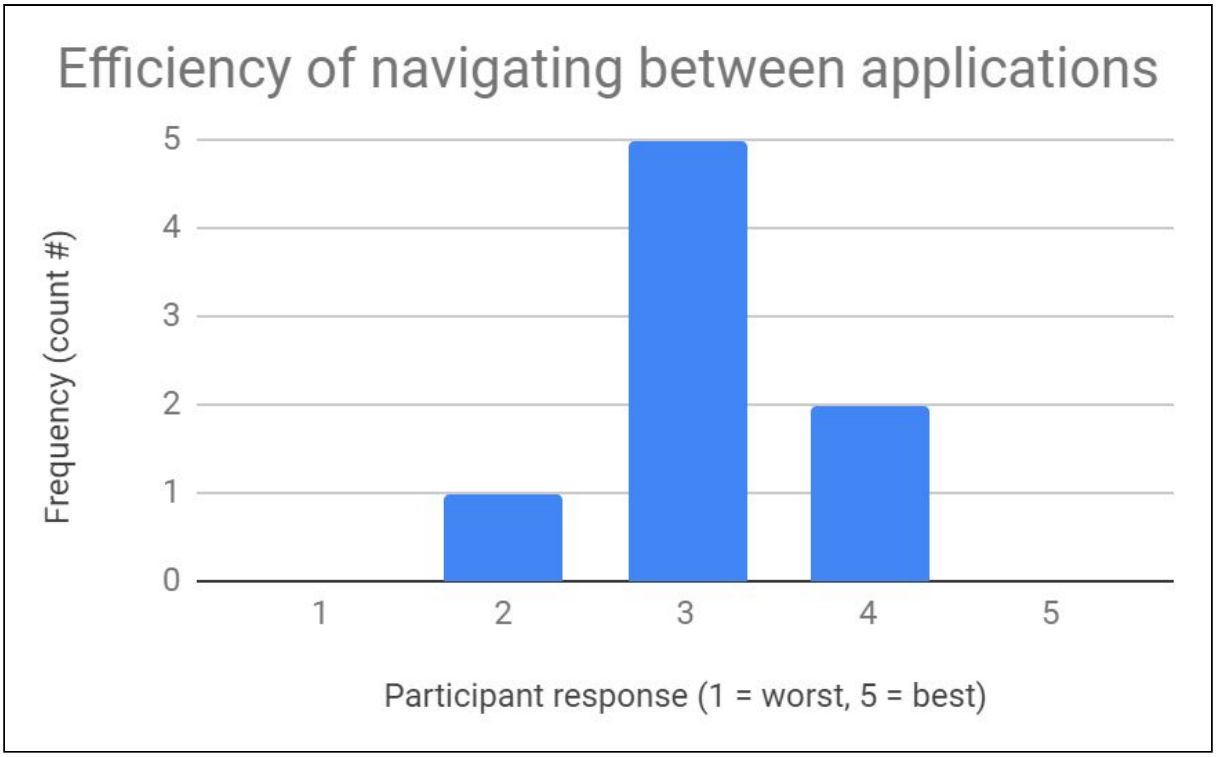

Figure 1.2: Distribution of response to efficiency of navigating

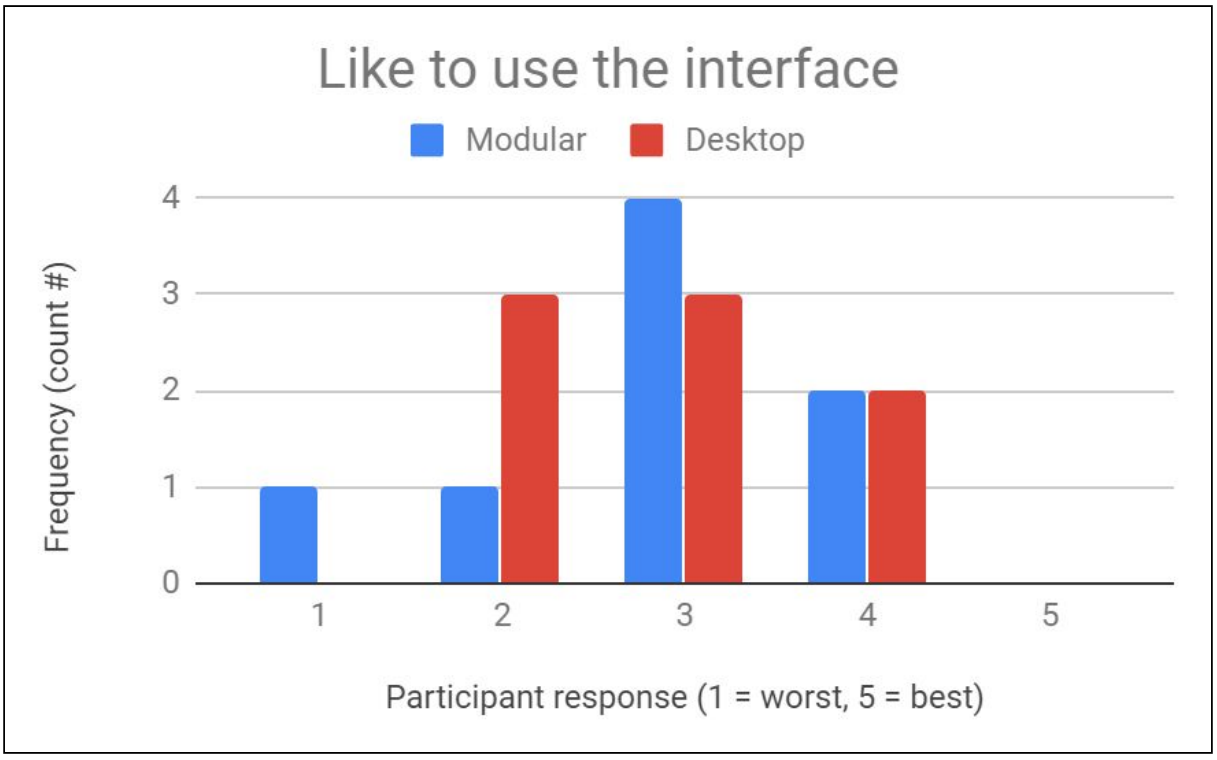

Figure 1.3: Distribution of response to like to use the interface

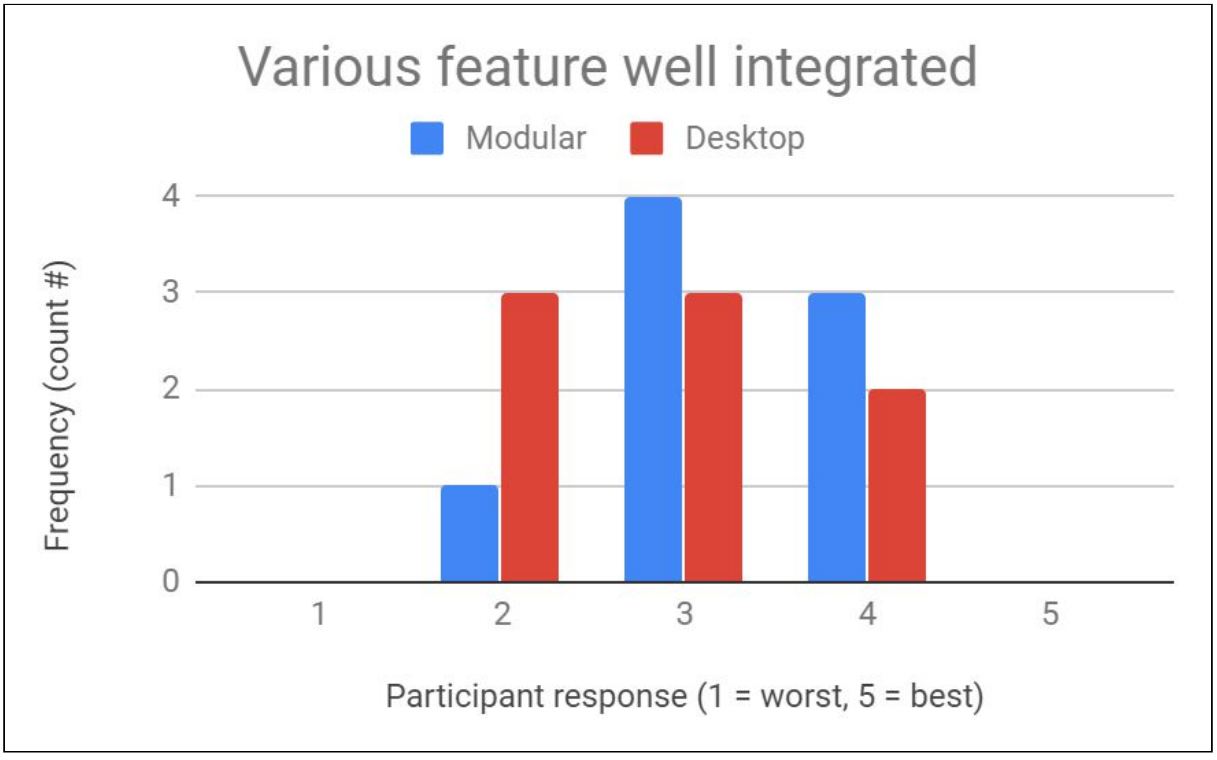

Figure 1.4: Distribution of response to various feature well integrated

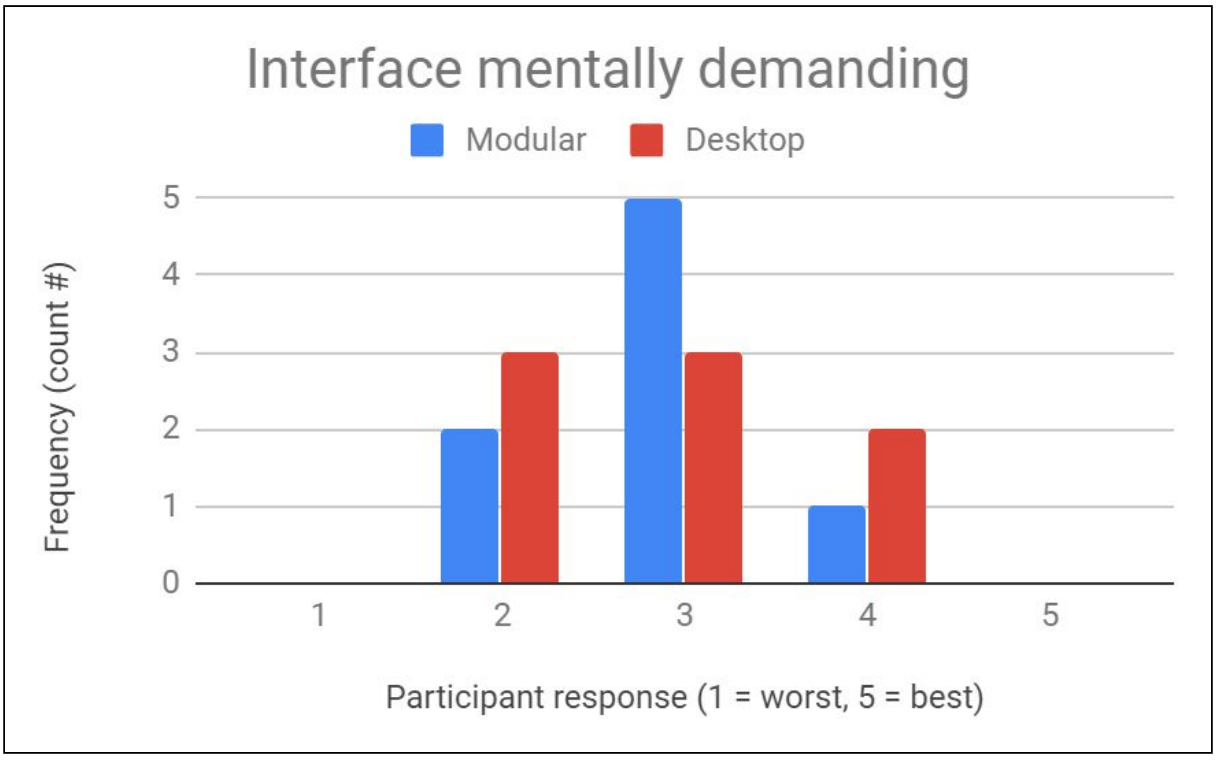

Figure 1.5: Distribution of response to interface mentally demanding

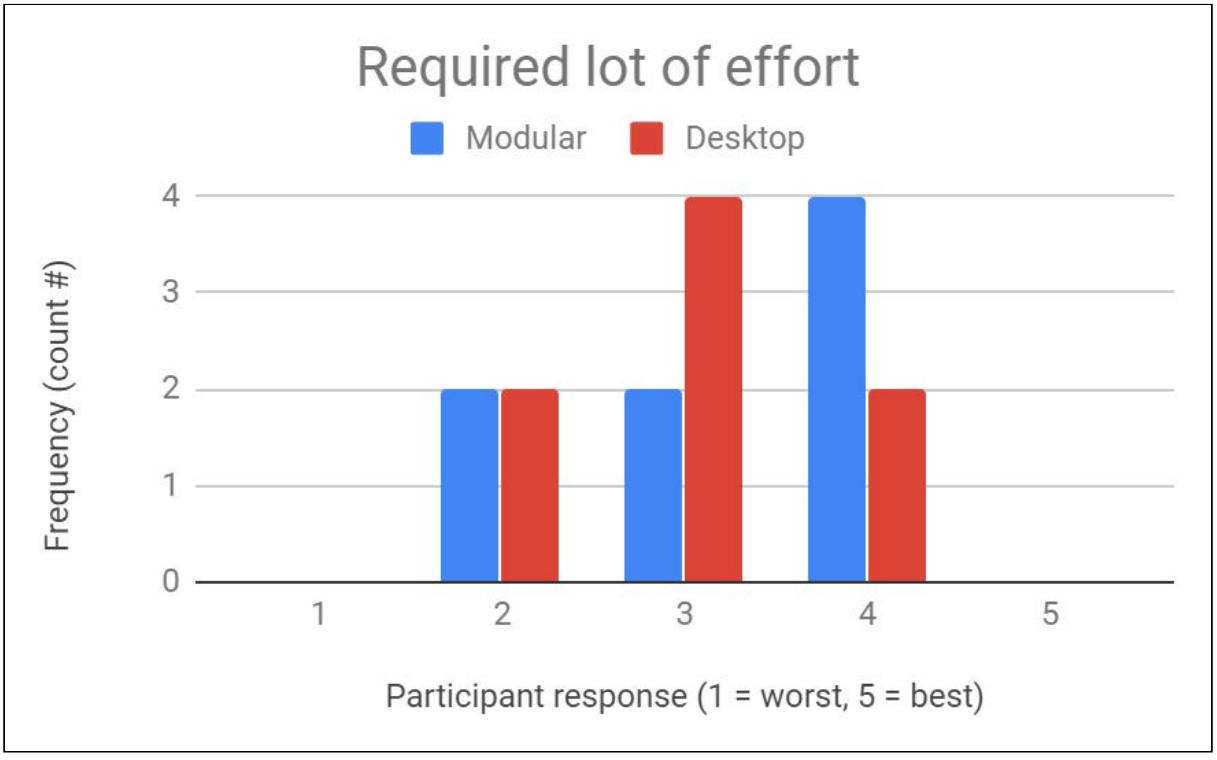

Figure 1.6: Distribution of response to required a lot of effort

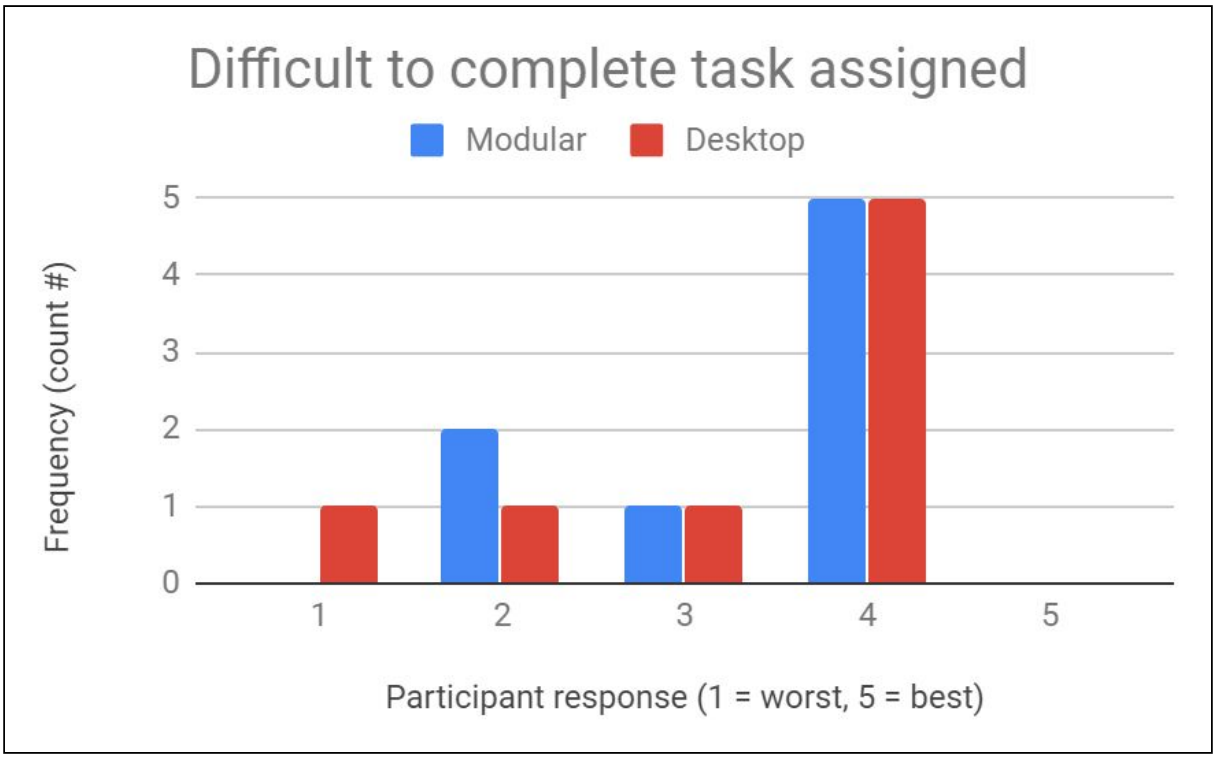

Figure 1.7: Distribution of response to difficult to complete task assigned

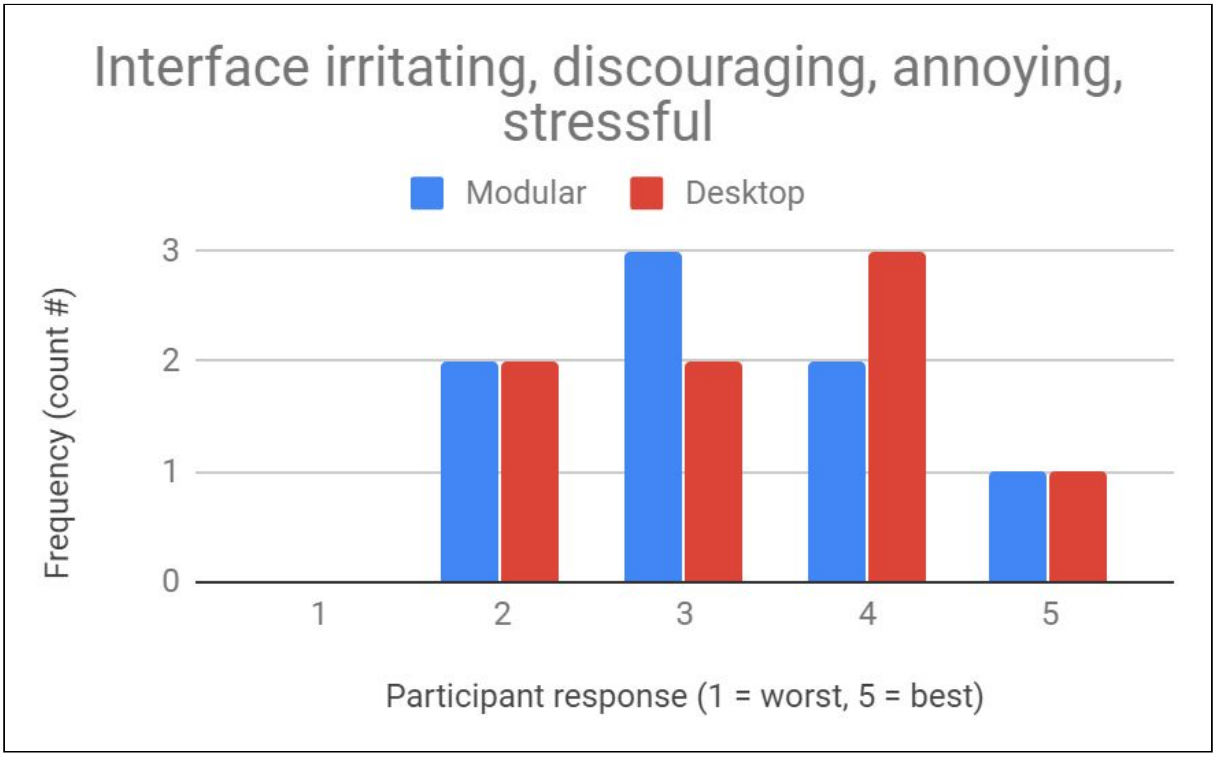

Figure 1.8: Distribution of response to interface irritating, discouraging...

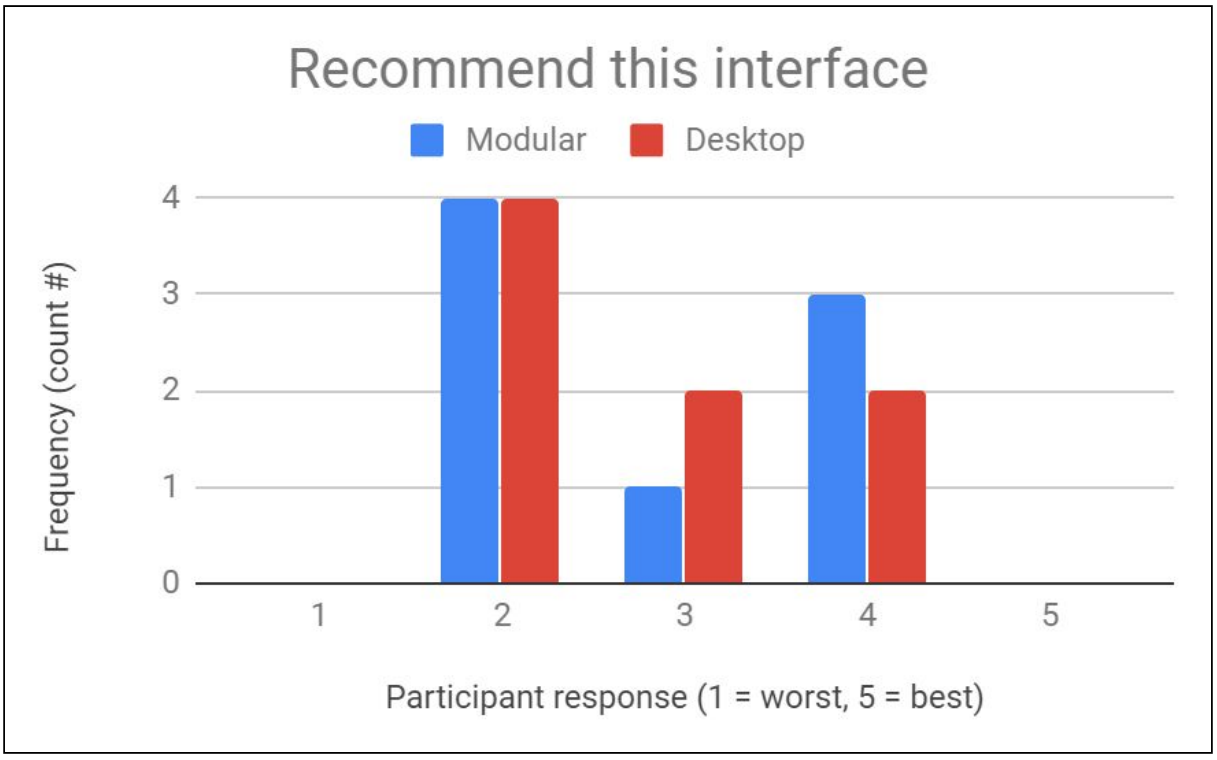

Figure 1.9: Distribution of response to recommend this interface

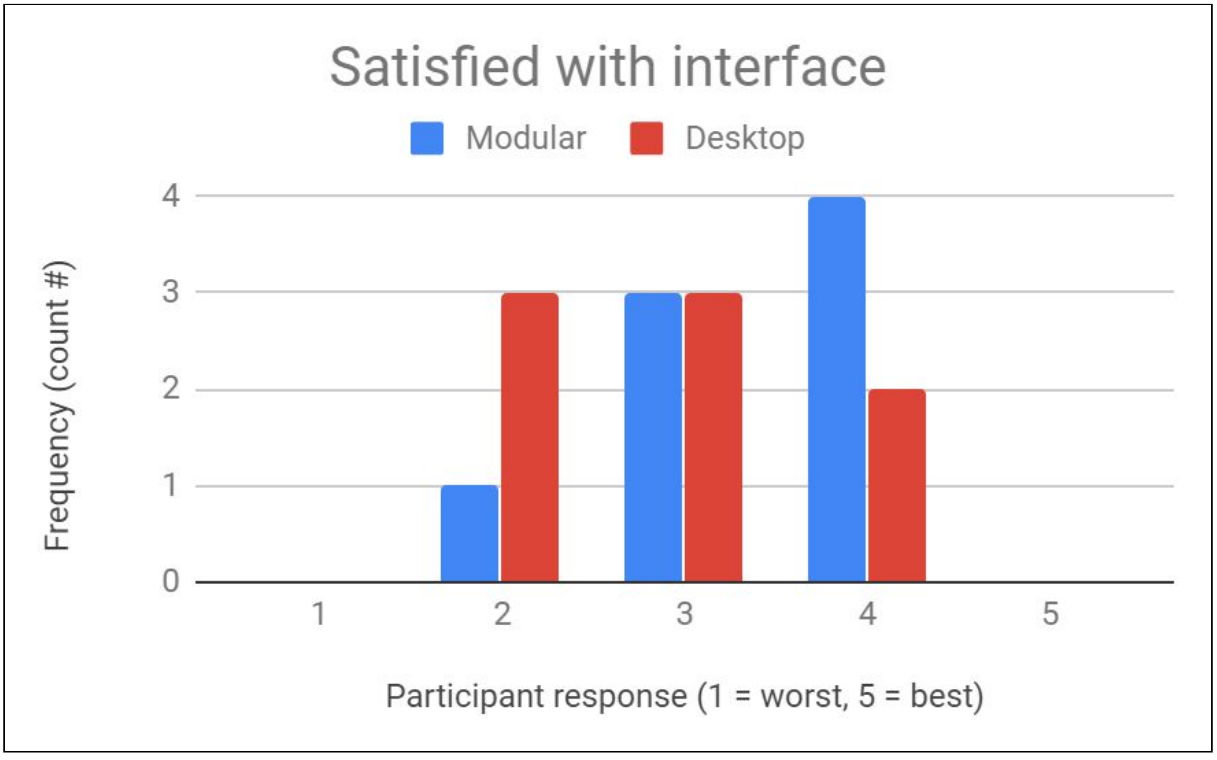

Figure 1.10: Distribution of response to satisfied with interface

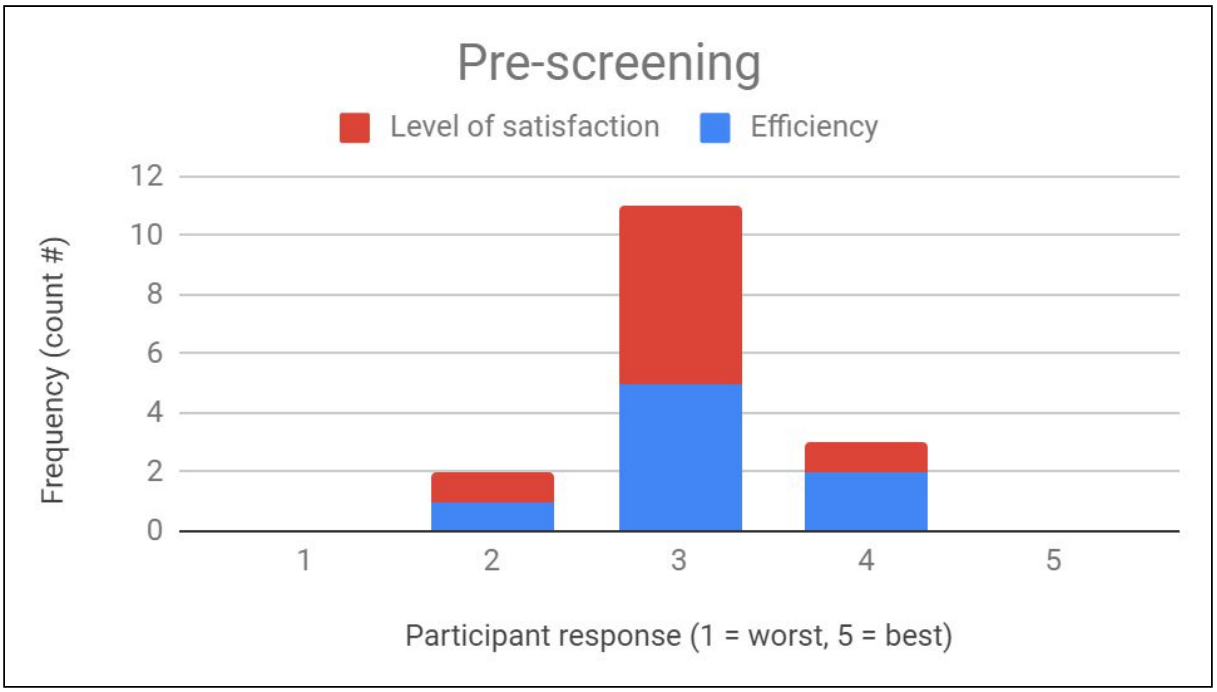

Figure 1.11 Distribution of all pre-screening questionnaire answers

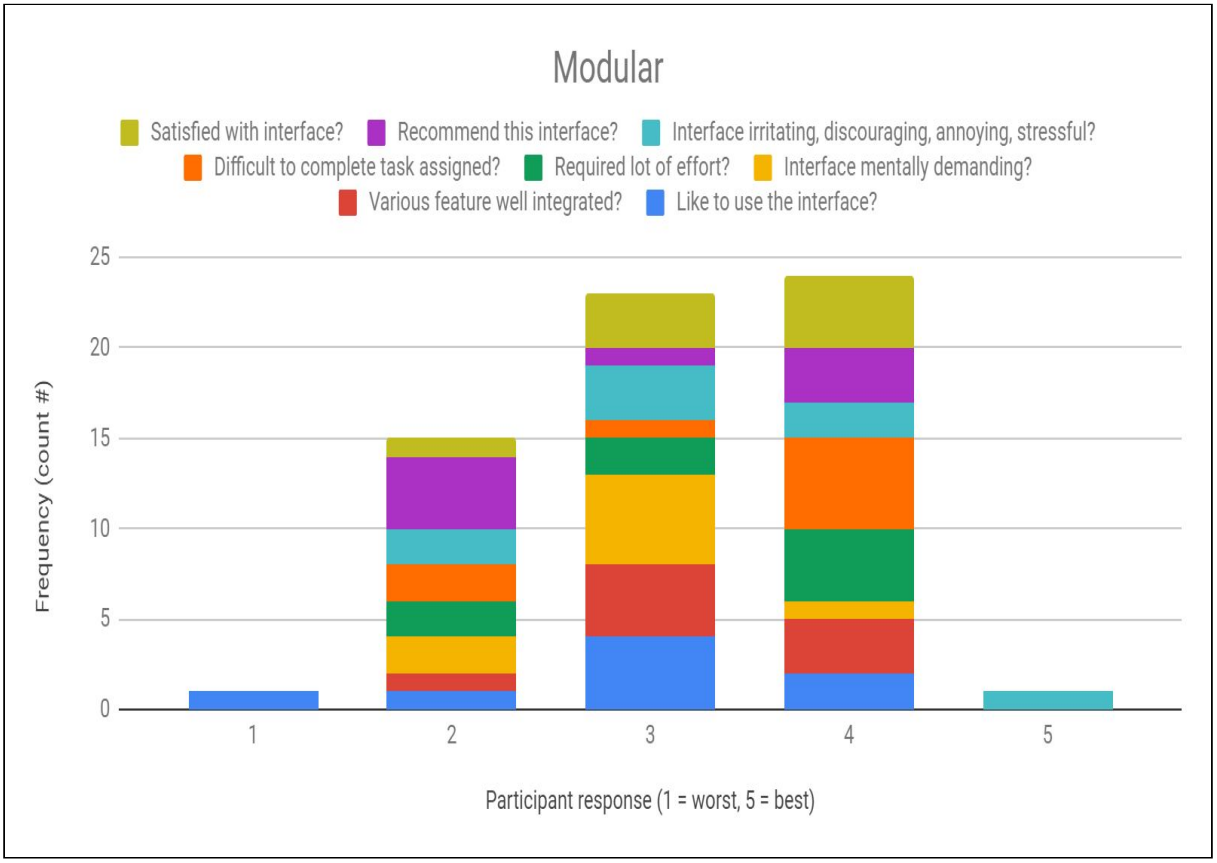

Figure 1.12 Distribution of all questions about the modular prototype

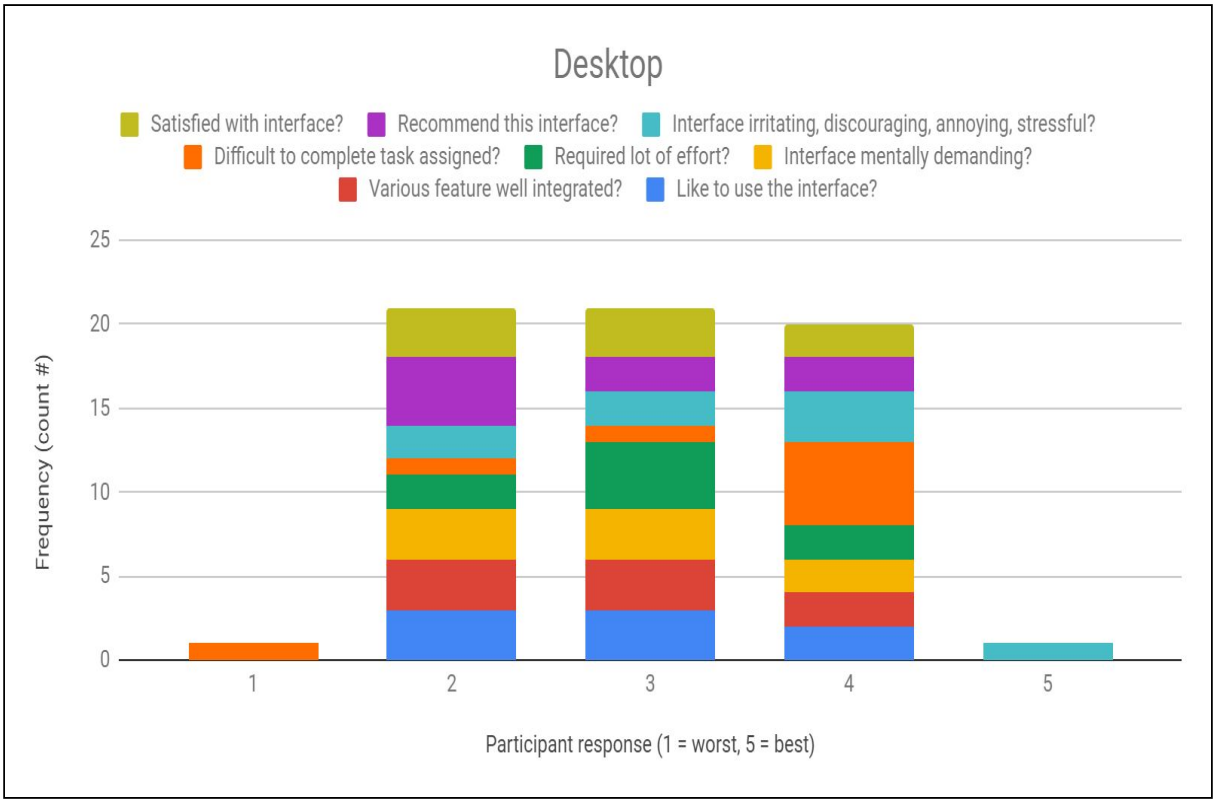

Figure 1.13 Distribution of all questions about the desktop prototype

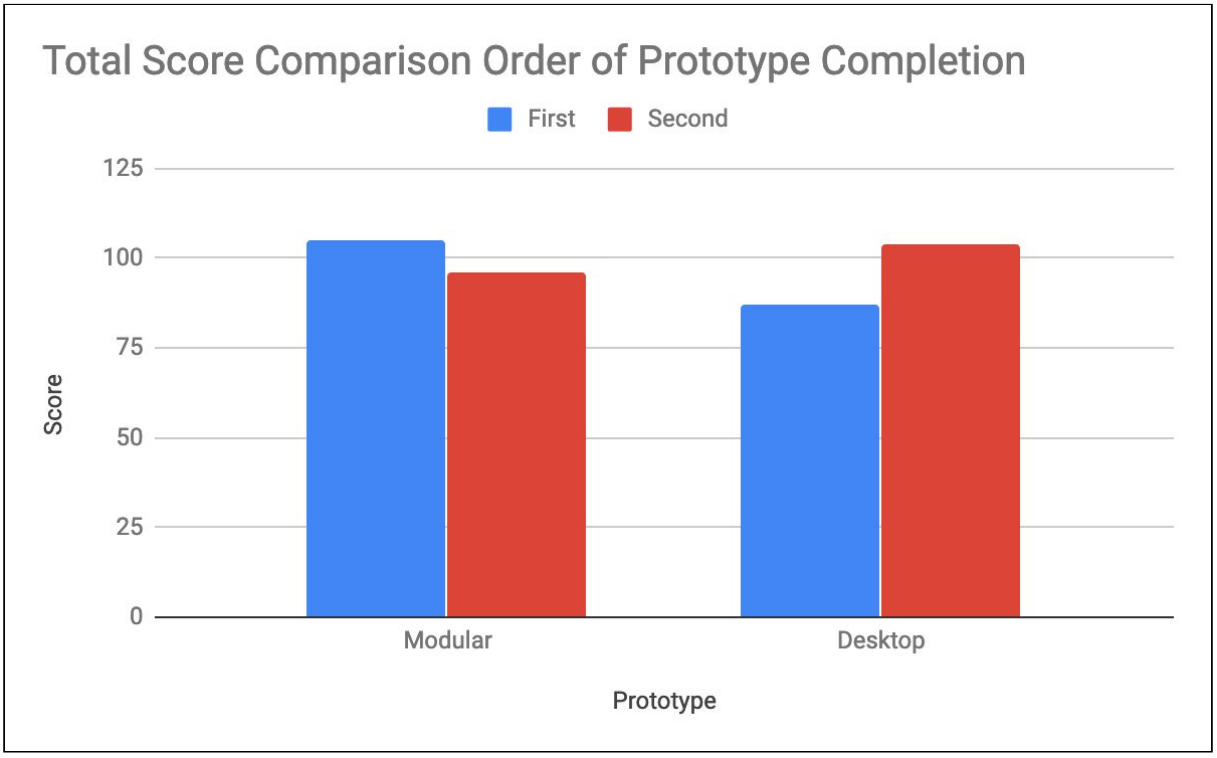

Figure 2.1: Total Score for prototypes when they were done first or second

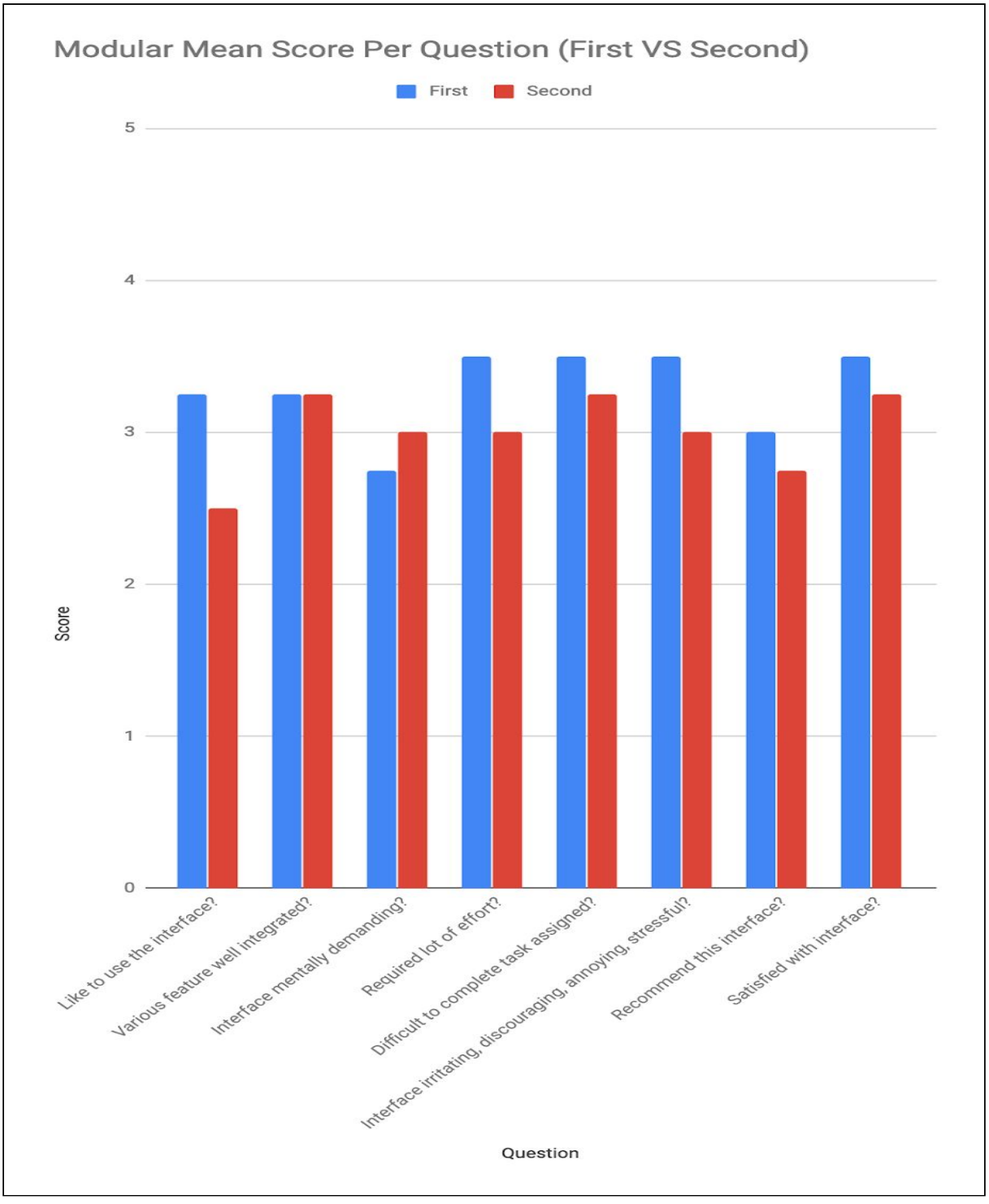

Figure 2.2: Mean score for each question from the Modular prototype, comparing whether it was used first or second by participant to complete assigned tasks

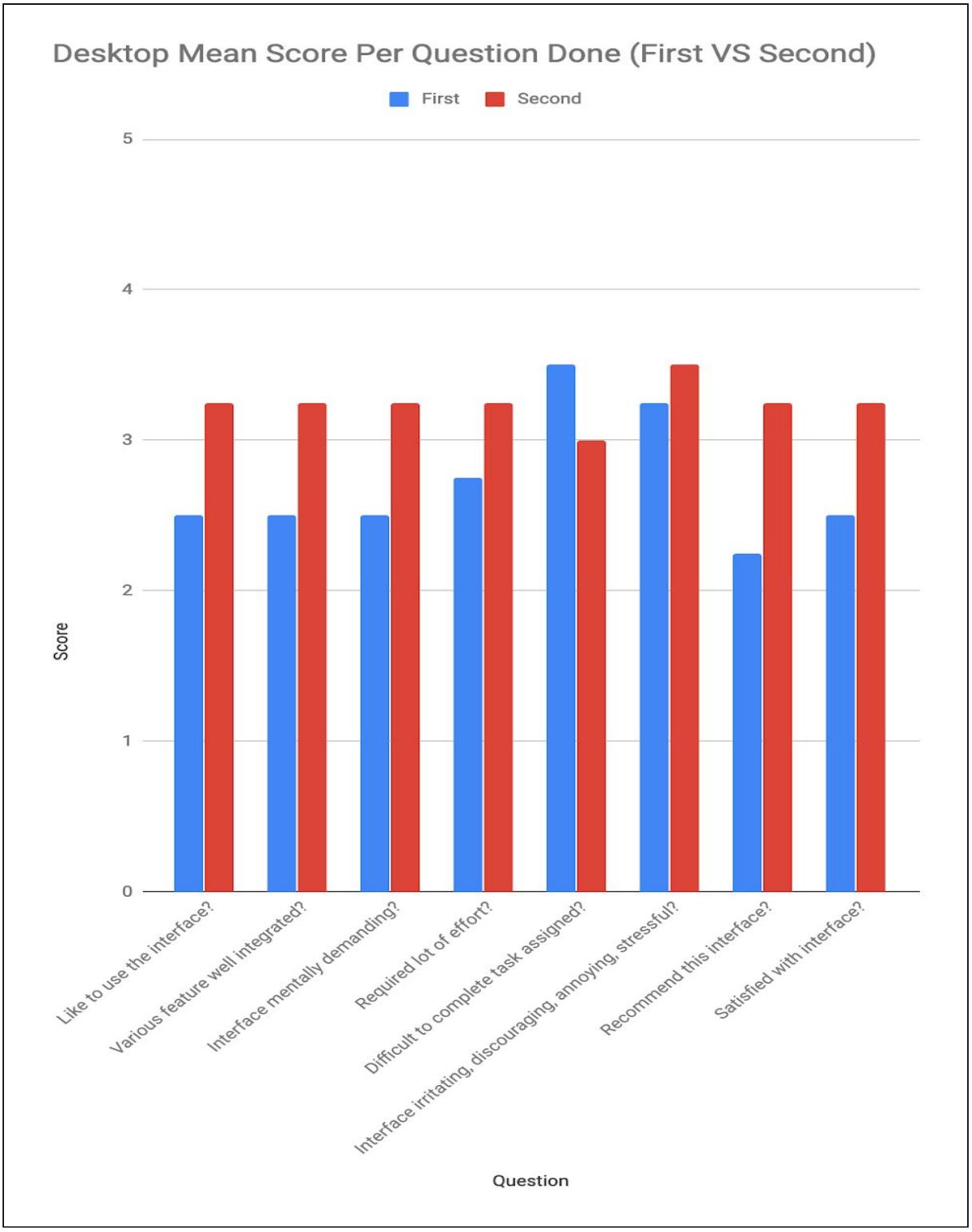

Figure 2.3: Mean score for each question from the Desktop prototype, comparing whether it was used first or second by participant to complete assigned tasks

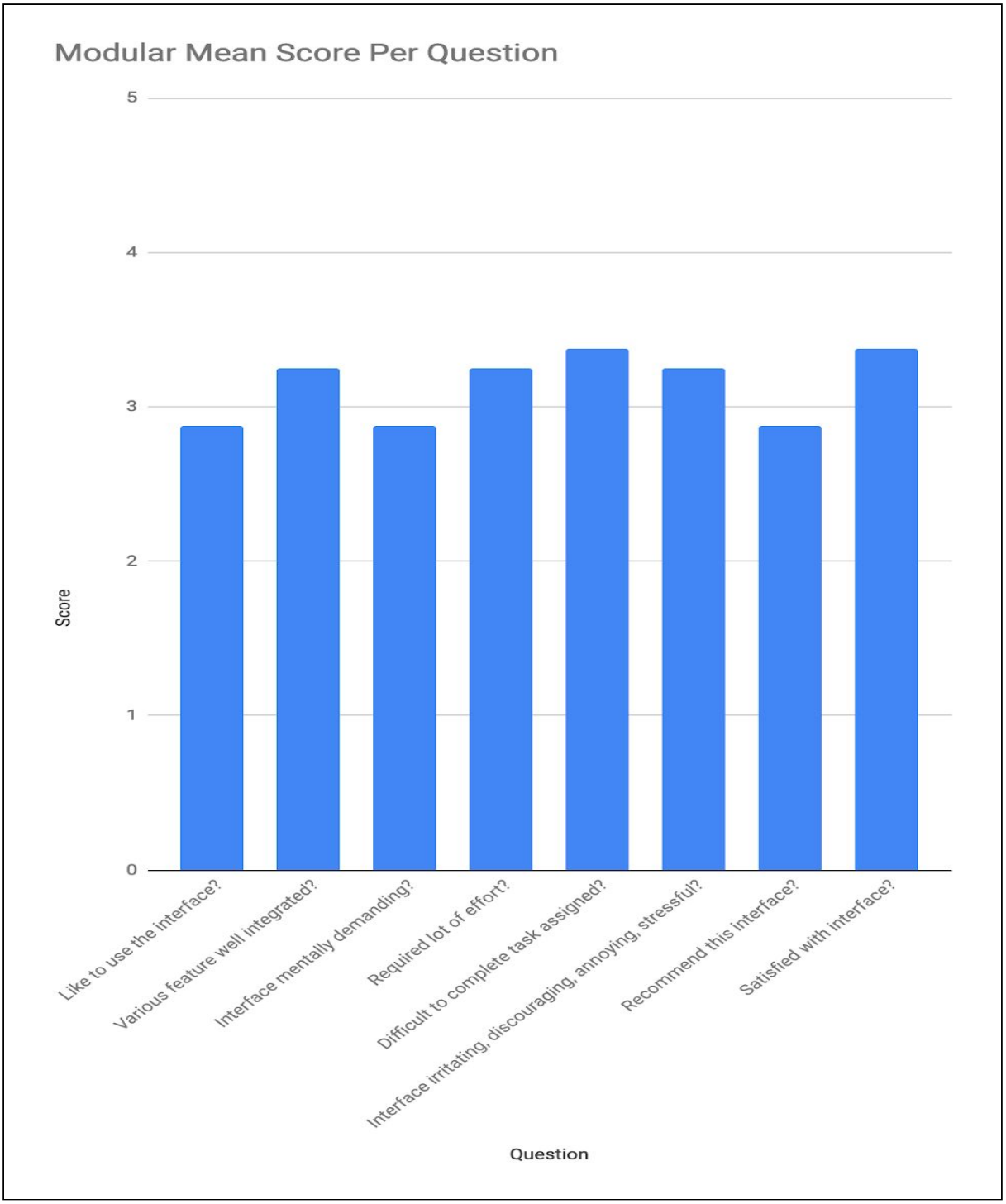

Figure 2.4: Total mean score for each question from the Modular prototype

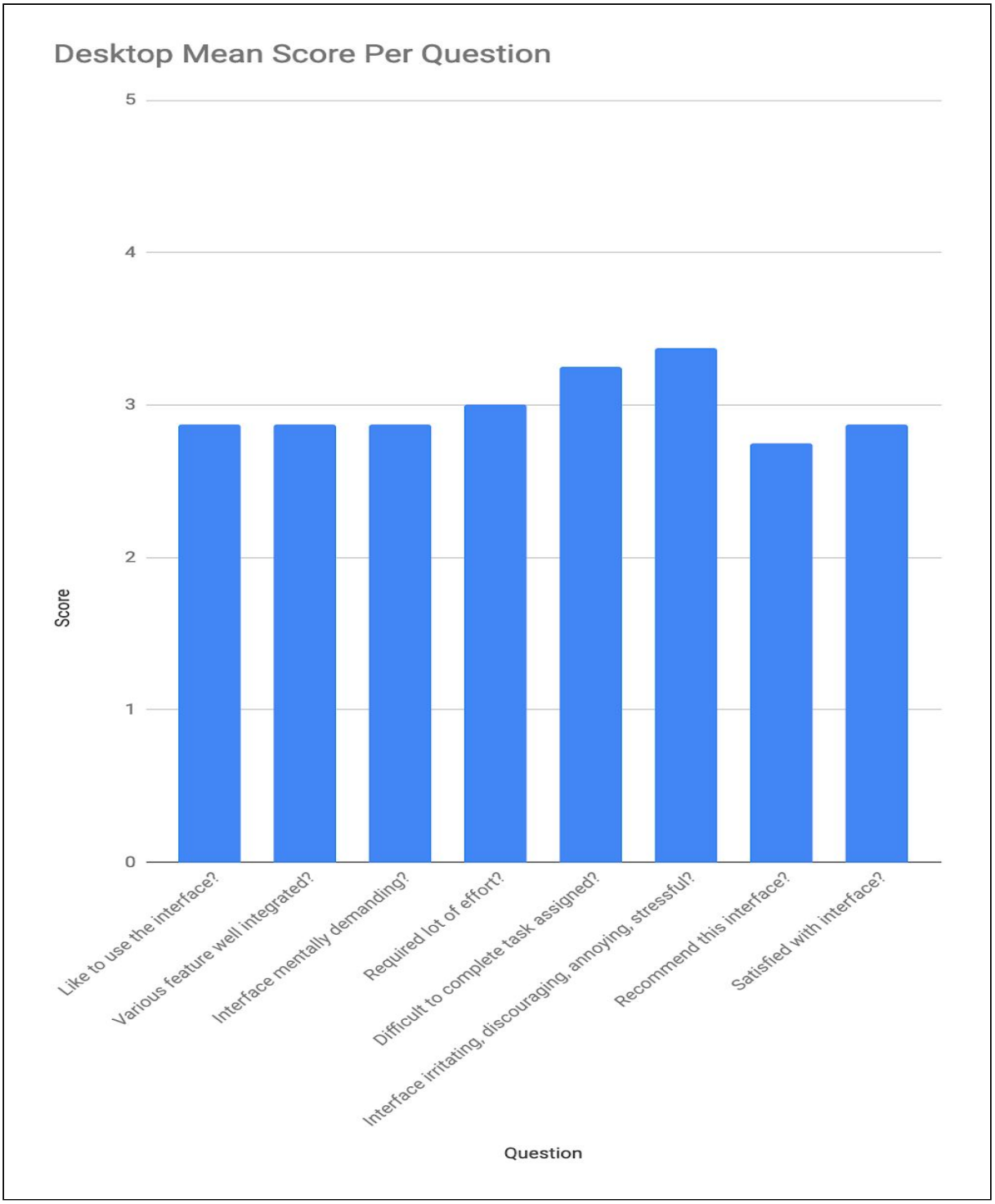

Figure 2.5: Total mean score for each question from the Desktop prototype

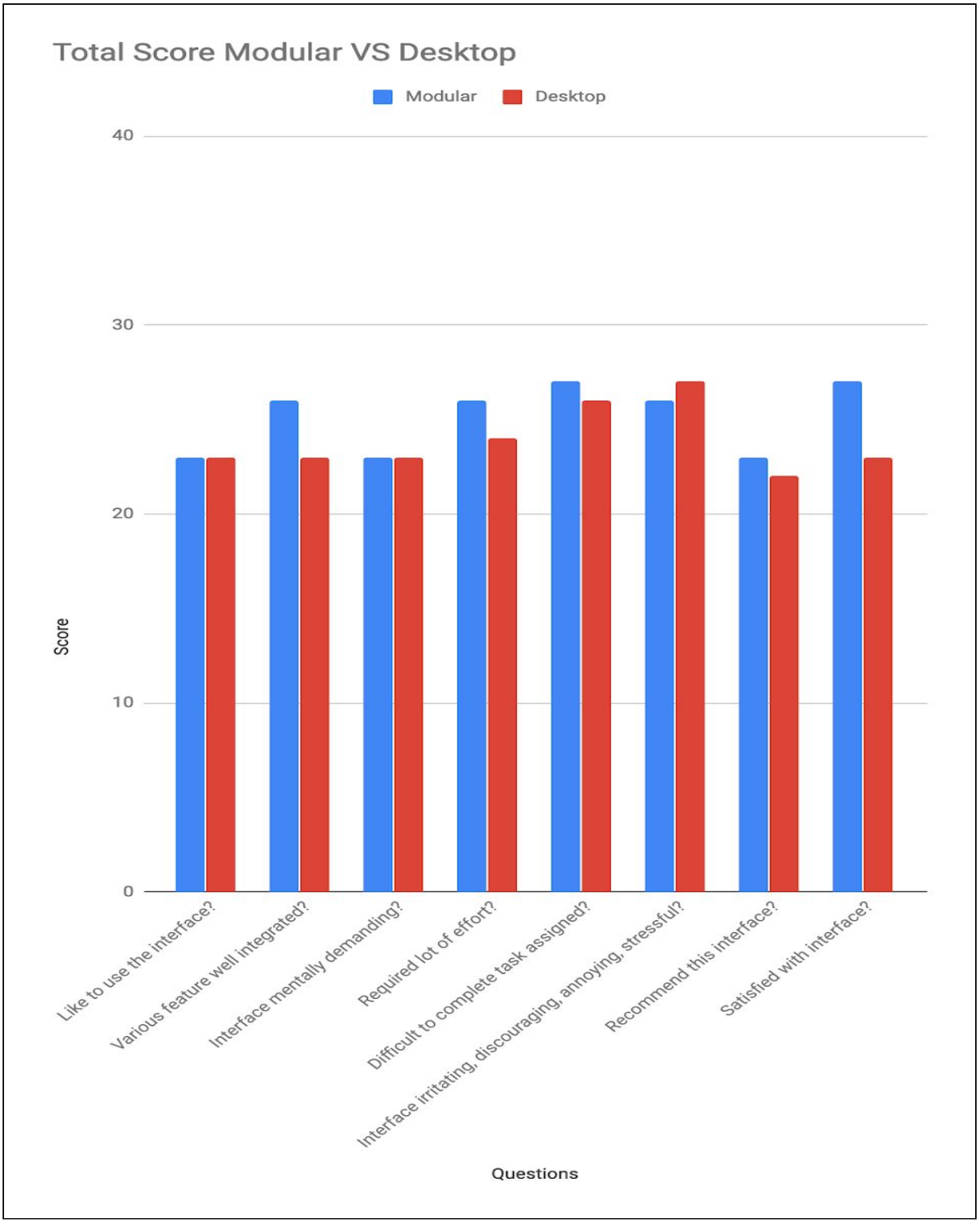

Figure 2.6: Total mean score for each question, comparing Modular and Desktop prototypes

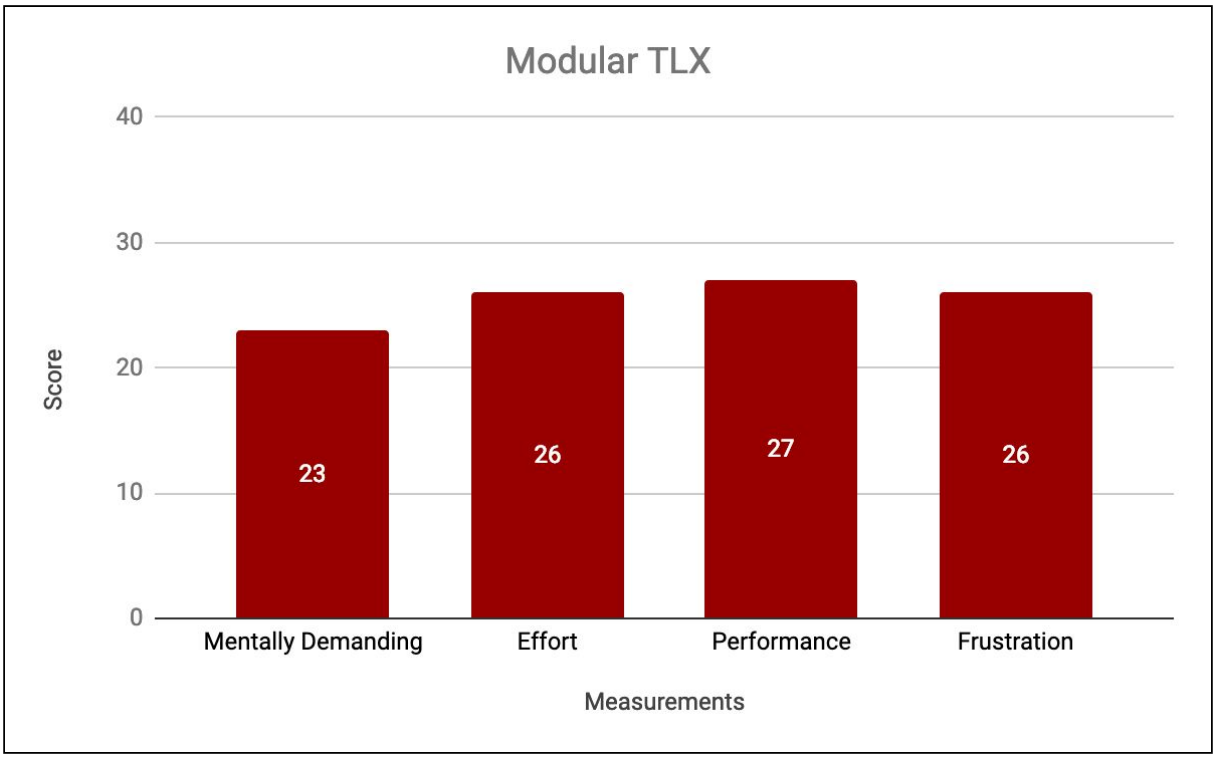

Figure 2.7: Score for Modular prototype from NASA TLX measurements we found important in our experiment

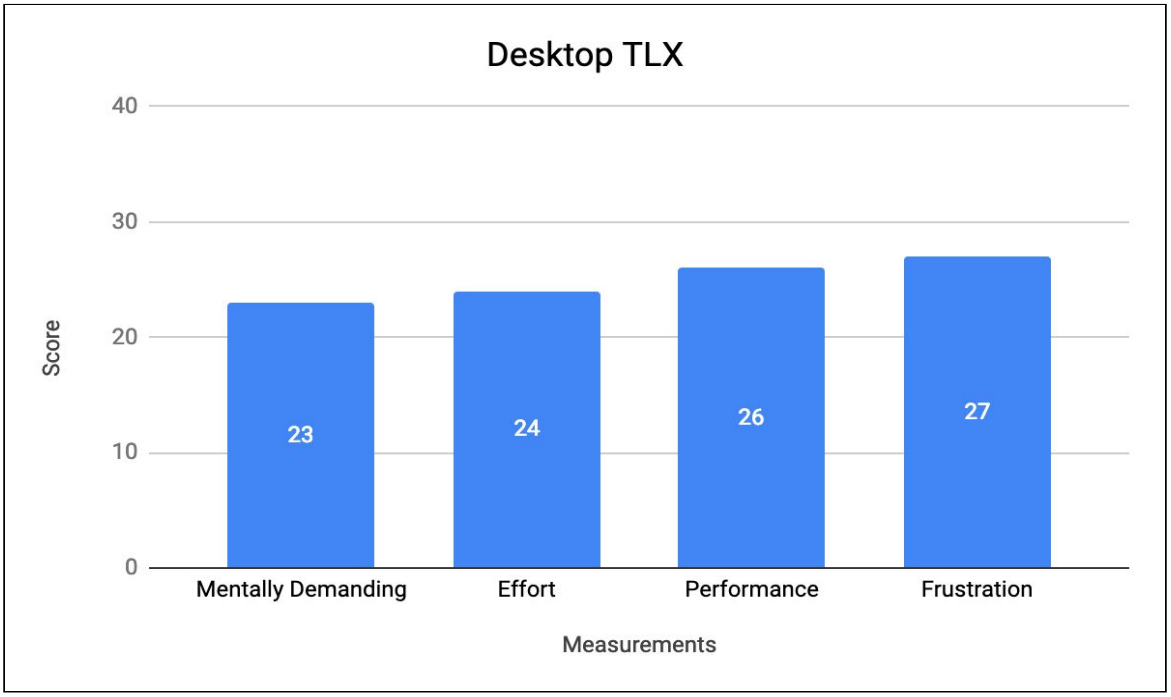

Figure 2.8: Score for Desktop prototype from NASA TLX measurements we found important in our experiment

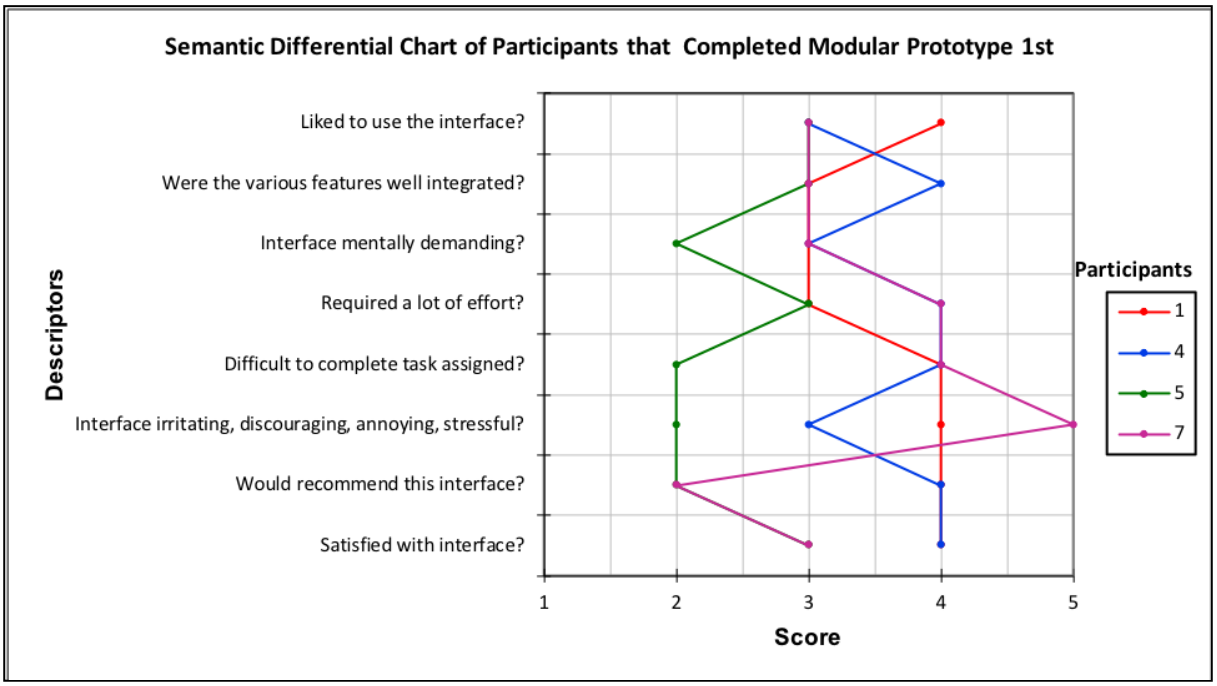

Figure 3.1: Semantic Differential Chart of Likert Scale questionnaire score responses per participant that completed Modular prototype 1st

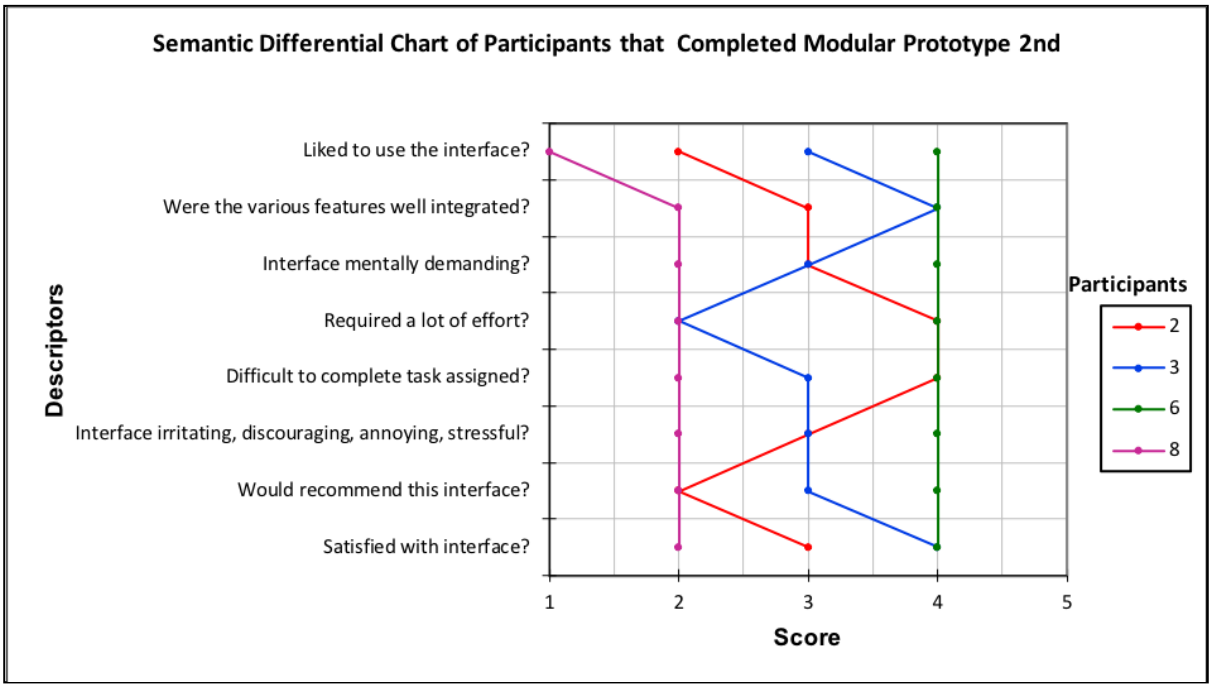

Figure 3.2: Semantic Differential Chart of Likert Scale questionnaire score responses per participant that completed Modular prototype 2nd

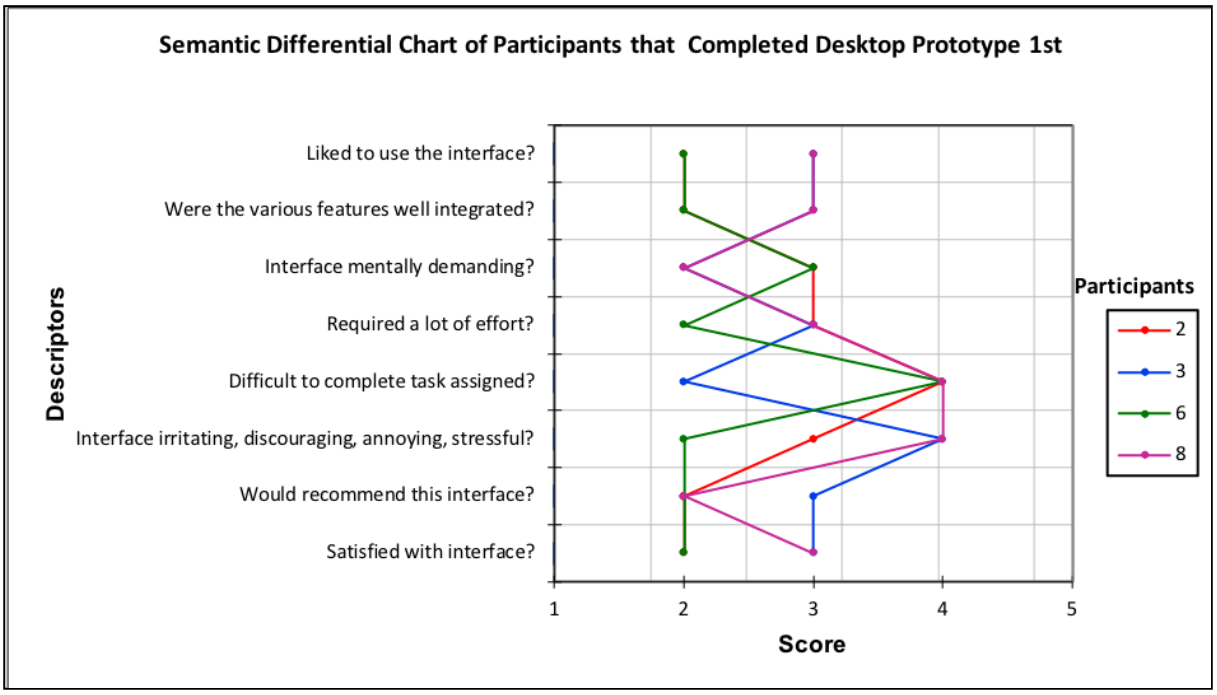

Figure 3.3: Semantic Differential Chart of Likert Scale questionnaire score responses per participant that completed Desktop prototype 1st

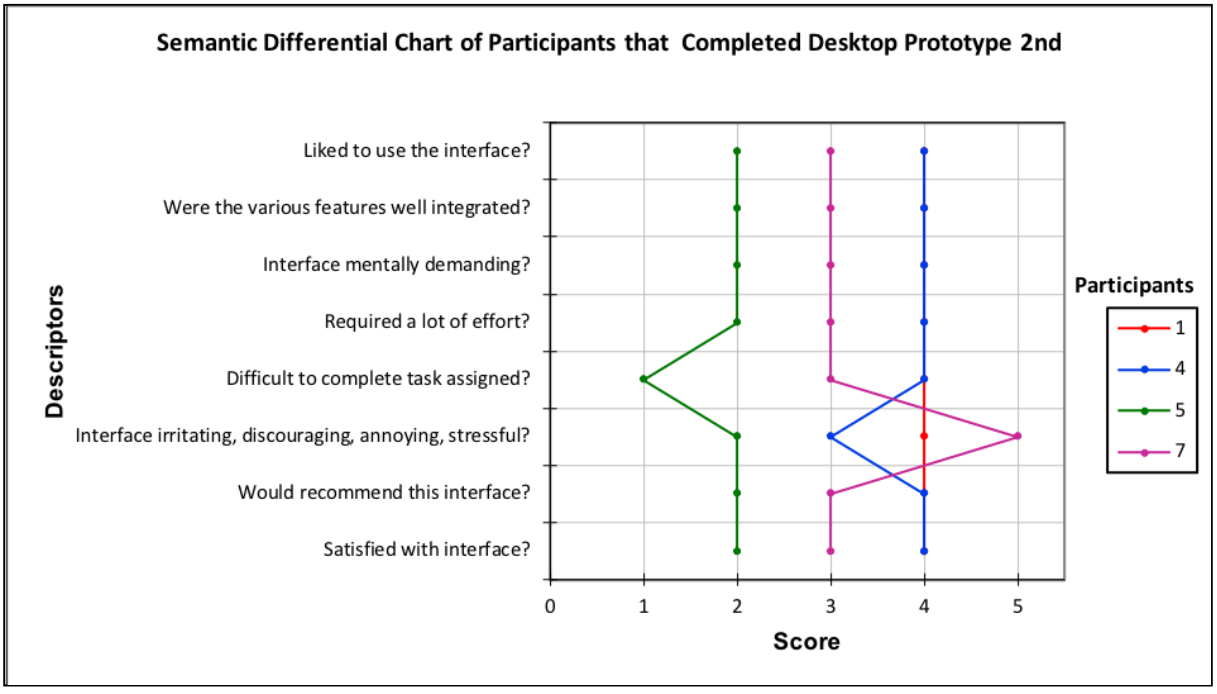

Figure 3.4: Semantic Differential Chart of Likert Scale questionnaire score responses per participant that completed Desktop prototype 2nd

participantData | main.R

Source on Save | Run | Source

```
1  library(ez)
2
3  participantData <- read.csv(file="quantitative_data_analysis.csv", header=T, sep=",");
4
5  #make sure R recognizes our image sizes as factors
6  #participantData$prototype <- ordered(participantData$prototype)
7
8
9  anovaResult <- ezANOVA(
10   data=participantData,
11   dv=favourability_response,
12   wid=pid,
13   within=prototype
14 )
15
16 print(anovaResult)
17
```

Figure 4.1: Code for generating ANOVA data on overall positivity score

```
>
> print(anovaResult)
$ANOVA
     Effect DFn DFd         F         p p<.05         ges
2 prototype   1   7 0.3022453 0.5995716       0.01388889

>
```

Figure 4.2: Generated positivity ANOVA results

```
library(ez)

participantData <- read.csv(file="quantitative_data_analysis_goals.csv", header=T, sep=",");

anovaResult <- ezANOVA(
  data=participantData,
  dv=cognitive_load_average,
  wid=pid,
  within=prototype
)

print(anovaResult)
```

Figure 4.3: Code for generating ANOVA data on cognitive load

```
> print(anovaResult)
$ANOVA
     Effect DFn DFd          F         p p<.05         ges
2 prototype   1   7 0.05511811 0.8211049       0.002053388
```

Figure 4.4: Generated cognitive load ANOVA results

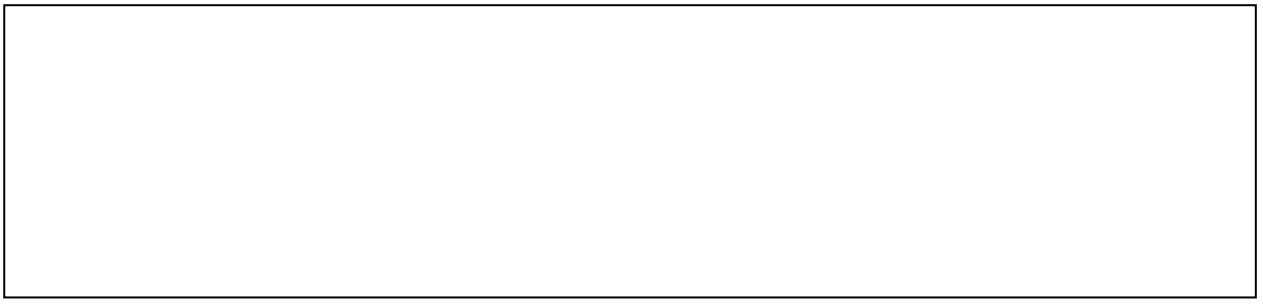

Figure 4.5: Code for generating ANOVA data on favorability

```
> print(anovaResult)
$ANOVA
     Effect DFn DFd         F         p p<.05       ges
2 prototype   1   7 0.7974684 0.4015076       0.0355419

>
```

Figure 4.6: Generated favorability ANOVA results