

# Matrix calculator usability research

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# 1 Introduction

## 1.1 Matrix calculator

The Matrix calculator app was developed by a group of Computer Science students called 'Assert True'. Assert True developed this app for students who want some help with their linear algebra (home)work. This means that students taking Linear Algebra (or a similar subject) can use the Matrix calculator like a pocket calculator.

The app has a calculation option, but it also provides an explanation about matrices and the calculation the app can perform on them. The app can also store matrices in the phone's memory so the user can reuse a matrix or the result from an earlier calculation.

## 1.2 In this report

This is a report written about the previously mentioned app, Matrix calculator. This report contains the results and conclusions of an usability research done on Matrix calculator.

In order to research the usability of Matrix calculator test objectives were set. Test subjects were sought to test the app, guided by scenarios, telling them what was expected of them. These scenarios were developed keeping the most likely uses of the app in mind. For example: the problems set in the first scenario come from the home work of a course like Linear Algebra.

The members of CampGemini were so kind to be the test subjects. They followed a course like Linear Algebra, so they knew about matrices but they hadn't yet followed a follow-up course so they weren't fully educated about matrices.

## 2 Method

### 2.1 Objectives

1. How well is the user able to navigate through the app?
2. How quickly does the user learn to use the app's main functionality?
3. How quickly does the user understand the app's purpose?
4. How helpful are the information buttons?
5. How well can the user use saved matrices?
6. Does the subject find the app to have a clear layout?
7. Would the test subject use the app outside of the test?
8. Are the results given by the app clear and does the user know what to do with them?
9. Does the used input method work correctly?
10. Is the app useful for fast, on the go, calculations?
11. How well is the performance of the app?

### Scenarios

The app has 3 basic uses:

- Inputting matrices and performing calculations with them.
- Saving matrices and the results of calculations.
- Learning about Matrices and possible calculations on them.

So we made 3 scenarios to test these basic uses. (The test subjects were Dutch so they were presented with Dutch versions of these scenarios)

### 2.1.1 Scenario 1:

The test subject uses the app to answer the following questions, and save the result.

$$A = \begin{pmatrix} 1 & 2 & 1 \\ 3 & 3 & 4 \\ 1 & 1 & 2 \end{pmatrix} \quad B = \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix}$$

Calculate  $ABB^T$

Calculate the determinant of  $C = \begin{pmatrix} 1 & 2 & 3 \\ 2 & 0 & 1 \\ 2 & 1 & 1 \end{pmatrix}$

Calculate the inverse of A.

**Tested Objectives in this scenario:**

- 1
- 2
- 6
- 7
- 8
- 9
- 11

### 2.1.2 Scenario 2:

The test subject uses the app to do calculations on previously saved matrices.

**Tested Objectives in this scenario:**

- 1
- 2
- 5
- 6
- 7
- 8
- 10
- 11

### 2.1.3 Scenario 3:

The test subject will learn what Kernel Span is and how this is applicable to matrices. **Tested Objectives in this scenario:**

- ☑ 1
- ☑ 2
- ☑ 3
- ☑ 4
- ☑ 6
- ☑ 7
- ☑ 11

## 2.2 Test subjects

We used three test subjects to test the application and let each subject go through one of the scenarios. The test subjects were 18-20 year old males enrolled at the Radboud university Computer Science study. All test subjects had knowledge about what matrices are and how to do simple calculations on them, but weren't fully educated about everything the app includes and explains. In short, they knew what was expected from them and how the app should work. This made them perfect test subjects, since this is exactly the target audience for the app. The subjects were working at the university and thus in a state in which the target audience would most likely use the app. The test subjects hadn't used or seen the app before and had no pre-knowledge regarding to the app's interface, functions or looks. All they knew was that it was an app in which you can calculate with matrices. They were not given any tips regarding using the app and only helped when the giving objective wasn't clear.

## 2.3 Testing environment

The testing happened in a study area in the university, which is a very likely place in which the target audience would use the app and thus particularly suited as testing environment. If a test subject was required to solve a calculation, it was displayed on a computer screen in front of him, as would also be a likely case for the target audience. There were talking/discussing students in the same room as the test subjects, which would also would

be likely for the target audience. Furthermore the test subjects did not experience any hinder from being observed my the reviewers.

## **2.4 Data gathering and documentation**

The test subjects experiencing the set out scenarios were filmed from beginning to the end, with the focus on the usage of the app. The test subjects were asked to speak out their opinion about the app and anything they were thinking regarding the app during the use of it. The video of the subjects included sound so the voice of the subjects was also recorded. These videos were later used to review and look at the behavior of test subjects while using the app in the particular scenario. One tester was making sure the test subject was constantly speaking out their thoughts by asking what was going on once in a while. Another tester made notes as to the behavior of the test subject which might not show on the video, or could be misinterpreted without certain context not captured in the video. This tester also noted what the final result was the scenario resulted with and whether or not this was the anticipated result. And finally the app was used on the phone of one of the testers, so if any data remained in the app after the scenario, this could also be looked at.

### 3 Results

The first test person tried to do a matrix multiplication. After this multiplication he had to compute the inverse and the determinant of the result of the matrix multiplication. He started filling in the two matrices. This went pretty well, but it did not go very fast. While filling in the matrices the test person said: "Ik kan de cijfers niet zien op het moment dat ik de matrix invul" (I cant see the numbers when i try to fill the matrix) and "Het toetsenbord switcht iedere keer naar letters als ik een nieuw getal in wil vullen" (The keypad changes to letters every time i try to fill in a new number). Eventually it took the test person about four minutes to do one matrix multiplication. It was very easy for the test person to save the result of the computation. The test person was not really impressed by the app, because he had to save every new matrix he just made before he could use them. The computations went a lot faster when the test person could use the saved matrices for new computations. In the beginning the test person had trouble finding everything he needed in the app and how he had to use the app, but after a while he learned how to use the app. The test person understood the functionality of the app pretty fast, because the app is based on one particular functionality.

The second test person had to use the saved results to make new computations. The test person immediately went to the tab with the saved matrices. He tried to tab on one of the saved matrices to start a computation. This failed, because you can only start computations from the computations tab and not from the matrix tab. This mistake will only be made once by a user, because after that, the user knows that a computation can only be made from the computation tab and not from the matrix tab and he/she will never make that mistake again. After going the wrong way the test person found the right tab to start his computation. When the test person tried to select matrices for his computation he said: "dit is wel irritant" (this is quite annoying). He probably said this because when you tab on a matrix to select it, it will get a number next to it. This number is 1 or 2 and stand for first selected matrix and second selected matrix. When you select two matrices and you want to deselect the second matrix and you tab on the second matrix, the first matrix will be deselected and the second matrix will be selected double. So when you want to deselect your second matrix, you have to tab on that matrix three times and then tab on the first matrix. This test person also managed to save the results of the computations fast and correctly.



The third test person had to read the info button of the kernel computation. After that he had to compute the kernel of a self-made matrix. First he quickly read the info, and started a kernel computation. The test person did not manage to make a good computation, because he tried to use already saved matrices he did not need for his computation. The test person read the information again because the computation went wrong. After that he tried to do a kernel computation again, but he accidentally tabbed on inverse computation. After saying "ik snap er niks van" (i dont get it) a few times the test person gave up without finishing the computation. This person also complained about the fact he couldnt see the numbers correctly.

In the end all three test persons found it very useful that they could switch from saved matrices to computations and back. Those two tabs were not very clear at the beginning, because then you do not have any saved matrices yet and you do not know what you can do with that tab.

## 4 Conclusion

Regarding the basic functionality of the app: from the results it is clear that the testers had few issues navigating through the app. Some things can be a little counterintuitive here and there like not being able to directly do actions with saved matrices. In most cases, the test subjects managed to quickly get the hang of the app, although one of our test subjects had some major issues with it, so it may still need some more improvement. Furthermore, the test subject had no issue understanding the apps purpose. This is not very surprising, considering most users who would download this app would already have some experience with matrices.

Regarding the specialized functionality of the app (matrix calculations): input of matrices seemed quite slow, making the app not all too useful for quick calculations, although it is quick when the user needs to execute several different calculations with the same matrices. Matrices can easily be saved and saved matrices can quite easily be reused. That being said, there appears to be some slight issues with the input method, as numbers dont always appear on the correct location.

## 5 Discussion

The research went well. The tests were recorded so we could review them later on, which we did. If there is a next time we might try to get some more test persons so we will have more data to base our conclusions on. Since we are not really sure whether we can conclude that a third of the future users will have major issues getting the hang of the app or this test subject was the only one.

We could have tried to stimulate our test subjects to talk a bit more. We also should have made it a bit more clear to the first test subject what was expected of him. He said that he had finished multiple times, while we wanted him to test something more. But on the whole the testing went well, and we think we researched the usability of Matrix calculator quite well.