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# Interior Design Students' Perception for AutoCAD, SketchUp and Rhinoceros Software Usability

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**Abstract.** Many previous studies regarding CAAD software for design have been developed with reference to how the CAAD software (in this case: AutoCAD, SketchUp and Rhinoceros) will benefit the students while learning to 2D-3D modeling design. The purpose of this study aims to identify the first year students' perspective regarding the 2D-3D modeling software usability. A total of 127 first year interior design students participated in the study. After finishing the course about CAAD software, they completed a survey using System Usability Scale (SUS) and polling method. After that the data was analyzed and measured. Statically, the findings show that there a difference usability between SketchUp – AutoCAD, but not so different between SketchUp – Rhinoceros and AutoCAD – Rhinoceros; secondly SketchUp is less usability than the AutoCAD and Rhinoceros. But using the survey polling, the findings show that most students will be using SketchUp for their 3D modeling design. Possibly not occurring significant result is because: the students may not really understand the System Usability Scale (the greater showed negative usability) and ambiguous perception in the questionnaire statement

**Keywords**: AutoCAD, CAAD, Rhinoceros, SketchUp, System Usability Scale (SUS)

## 1. Introduction

In the past, an interior designer was only using hand sketches and manual three-dimensional models to draw and design. Nowadays, the design can be done faster, both two-dimensional and three-dimensional designs and drawings, using the help of various kinds of computer aided architectural design (CAAD) software. The most popular CAAD Software for 2D and 3D software is Google SketchUp, AutoCAD and Rhinoceros software. Google SketchUp is a program that helps in the concept design stage and is easy to learn. [1] AutoCAD is a program used to draw 2 dimensions and 3 dimensions developed by Autodesk. While Rhinocers is a 3D modelling using NURBS (non-uniform rational B-splines) modelling.

Surveys report that AutoCAD is the dominant software used by designer practices and architecture. Software that is also often used is Google SketchUp [1]. In recent years, Google SketchUp has become popular in academia, practice, and digital design studies. The combination of the two systems is useful for exploration of design [2], because of differences in the nature of the two software programs. Having skills in both software programs, helps students to be critical of which programs are best for certain design tasks and that offer flexibility. [3] Google SketchUp is described as friendly, easy to learn [2]

The Interior Design Study Program of the Petra Christian University under the Faculty of Arts and Design was established in 1998, is one of the leading design study programs in Surabaya, also teaches students to use software technology assistance in designing. This can be seen in the 2016 study program curriculum which has Computer 1 courses since semester 1. This Computer 1 course is a compulsory basic course that is part of the Interior Design study program curriculum. This course is a theory and practice course on skills / 2D drawing skills and digital 3D modeling using design software such as: SketchUp, Rhinoceros and AutoCAD.

The aims for this research is to identify student's perspective regarding the 3D modeling software usability and to identify the dominant software that they will use as the future interior designer. The result of this research will be reference regarding CAAD software usability in fresh year students' perception.

## 2. Literature Study

There are several survey that can be used as an assessing the usability products, From the one to evaluate specific though a wider range of interface types. The System Usability Scale (SUS) is one of the surveys tool that can be used to determine whether some software is useful or difficult to use to the user. Brooke,1996 on Salman stated that the System Usability Scale (SUS) is relatively quick and easy to fill because compos only with ten statements (so the users only need few minutes to fill the survey), the result is in a single score (with ranging from 0 to 100) and easy to understand by a wide range of people. [4] The key is of usability is more to determine wheth the software is useful and the user interfaces (features) are easy to use. [5]. The SUS is contained of ten statements (five po ive statements and five negative statements). Each statement having a five-point scale that ranges from Strongly Disagree to Strongly Agree. The ten statements are:

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.
- I think that I would need the support of a technical person to be able to use this system.
- I found the various functions in this system were well integrated.
- I thought there was too much inconsistency in this System.
- I would imagine that most people would learn to use this System very quickly.
- I found the system very cumbersome to use.
- I felt very confident using the system.
- I needed to learn a lot of things before I could get going with this system.

In the past, CAAD was once viewed as a replacement for production drafting work. Now CAAD has being utilized in interior design studios from the earliest stages of conceptual design as an iterative tool through the 3D modelling and a true BIM software [1]. To determine the usability of Computer Aided Architectural Design software (CAAD) by first year students, there were three software that were used: AutoCAD, SketchUp and Rhinoceros. This three software were introduced in semester 1 in Computer 1 courses. As part of the core curriculum, in Computer 1 courses, students were taught to develop their knowledge and digital 2D-3D modelling drawing skills. Students attempted to learn and practice about 2D Digital drawing using AutoCAD, then they were introduced new ways of discovering 3D modelling and orthographic views using SketchUp and Rhinoceros software.

AutoCAD is a commercial computer-aided design (CAD) and drafting software application. AutoCAD were developed and marketed by Autodesk. AutoCAD is usually used by industries, architects, project managers, engineers, interior designer, graphic designers, and many other professionals. AutoCAD were introduced first in Computer 1 courses because this software was capable of producing precise drawings with a minimum effort, especially in 2D modeling.

SketchUp is a dynamic software program that is used to quickly compile, modify, and construct 3D modeling image. SketchUp software were developed and marketed by Google and Trimble Inc. This software usually used in the fields of architecture, design and engineering. SketchUp were introduced second in Computer 1 courses because easy to use and can be used to teach and learn 3D space geometry concepts.

Rhinoceros is a commercial 3D computer graphics and computer-aided design (CAD). Rhinoceros or Rhino were developed by Robert McNeel & Associates. Rhinoceros geometry is based on NURBS mathematical model (NURBS or non-uniform rational B-splines are mathematical representations that can accurately model any shape from a simple 2-D line, circle, arc, or box to the most complex 3-D free-form organic surface or solid) (see Figure 3). Rhinoceros were introduced last in Computer 1 courses. [6]

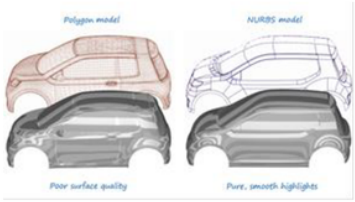



**Figure 3.** Difference between Polygon Model and NURBS Model.

## 3. Research Methodology

It is within this context that this study approached by Interior Design department – Petra Christian University, requesting feedback on the current usability software in interior design education. This was accomplished through the distribution of an electronic survey (managed by Google Form) using SUS (System Usability Scale) technic. The survey was distributed in December 2018.

### *3.1. Participants*

The study was conducted in Interior Design course especially Computer 1 course in Semester 1. Among 145 students enrolled in the Computer 1 course (class A = 74 students, class B = 71 students), 127 of them participated in this research (87.58%). The age of participants ranged from 18 to 20. The majority participants were female.

### *3.2. The Course Schedule*

The Computer 1 course is a 2 credits course, was held once a week for 4 h per meeting (Schedule for class A: Wednesday 13.30-17.30; Schedule for class B: Thursday 13.30-17.30) in 1st semester 2018/2019. The first five weeks will be AutoCAD course, then continue with SketchUp course and Rhinoceros course (see Table 1)

**Table 1.** Detailed Schedule for Computer 1 Course

| Week | Date | Detailed Schedule | Lecturer |
|---|---|---|---|
| 1 | 15.08.2018 | Introduction – Pengenalan Mata Kuliah Komputer 1 | Sherly de Yong |
| 2 | OFF | OFF: Eid Al-Adha | - |
| 3 | 29.08.2018 | AutpCAD Pengenalan AutoCad (User Interface) + Toolbar Draw | Purnama Esa Dora |
| 4 | 05.09.2018 | AutoCAD: Toolbar Modify; Window Selection, Crossing Selection | Purnama Esa Dora |
| 5 | 12.09.2018 | AutoCAD: Block, Refedit Toolbar Layers; Toolbar Properties | Purnama Esa Dora |

| | | | |
|---|---|---|---|
| 6 | 19.09.2018 | AutoCAD: Dimension; (Design Center)<br>Teaser for Advance AutoCAD: Construction Drawing, 3D Modelling AutoCad, 3dMax Rendering | Purnama Esa Dora |
| 7 | 26.09.2018 | SketchUp – Introduction *(Introduction, SketchUp Concept & User Interface)*<br>SketchUp Tools (part 1) *(Principal Tool, Drawing Tool, Modification Tool)* | Sherly de Yong |
| 8 | 03.10.2018 | SketchUp Tools (part 2) (*Construction Tool, Camera Tool, Walkthrough Tool*) | Sherly de Yong |
| 9-10 | UTS<br>UTS | U T S | |
| 11 | 24.10.2018 | SketchUp *Model Settings; Input - Output (Model-Material Browser and Entitiles, Import-Export 2D-3D Graphics)* | Sherly de Yong |
| 12 | 31.10.2018 | *Sketchup Extensions + Teaser for Advance Sketchup Extensions (3D Warehouse, Extension; Teaser Extension (Parametric Design using flowify and voronoi)* | Sherly de Yong |
| 13 | 07.11.2018 | *Rhinoceros – Introduction & User Interface* | Bramasta P. Redyantanu |
| 14 | 14.11.2018 | Rhinoceros – Introduction & User Interface | Bramasta P. Redyantanu |
| 15 | 21.11.2018 | Rhinoceros: Create Surfaces from Curves | Bramasta P. Redyantanu |
| 16 | 28.11.2018 | *Rhinoceros: Edit Surfaces from Curves* | Bramasta P. Redyantanu |
| 17 | 05.12.2018 | Rhinoceros: Organize, Render and Annotation + Teaser for Advance Rhinoceros | Bramasta P. Redyantanu |
| 18 | UAS | U A S | |

*3.3. Instrument*

There were two instruments used in this study. The first instrument is for gathering the information regarding the usability of the software. The instrument was adopted using the System Usability Scale (SUS). Usability is a technique used to evaluate products / design by testing them directly on users. The SUS is contained of ten statements (five positive statements and five negative statements). Each statement having a five-point scale that ranges from Strongly Disagree to Strongly Agree. The sample adapted SUS instrument can be seen in Table 2. This SUS instrument were applied in three software (AutoCAD, SketchUp and Rhinoceros) [5]

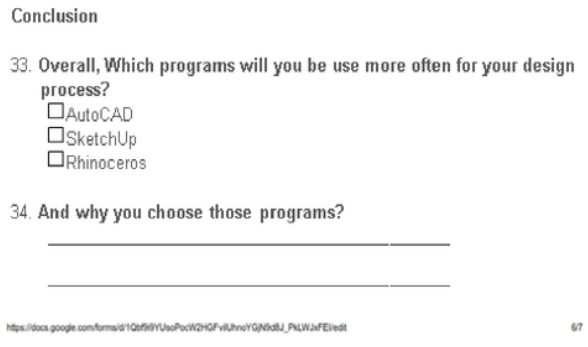
**Table 2** The Sample of Adapted System Usability Scale (SUS) for AutoCAD Program

| Original SUS Question | Adapted SUS Question | Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| I think that I would like to use this system frequently. | I think I would like to use this **Program AutoCAD** frequently. | | | | | |
| I found the system unnecessarily complex. | I found the **Program AutoCAD less** complex. | | | | | |
| I thought the system was easy to use. | I thought the **Program AutoCAD** was easy to use. | | | | | |
| I think that I would need the support of a | I think that I would need the support of a technical | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| technical person to be able to use this system. | person / **tutor** to be able to use this **Program AutoCAD**. | | | | | |
| I found the various functions in this system were well integrated. | I found the various functions in this **Program AutoCAD** were well integrated. | | | | | |
| I thought there was too much inconsistency in this System. | I thought there was too much inconsistency in this **Program AutoCAD**. | | | | | |
| I would imagine that most people would learn to use this System very quickly. | I would imagine that most people would learn to use this **Program AutoCAD** very quickly. | | | | | |
| I found the system very cumbersome to use. | I found the **Program AutoCAD** very cumbersome to use. | | | | | |
| I felt very confident using the system. | I felt very confident using the **Program AutoCAD**. | | | | | |
| I needed to learn a lot of things before I could get going with this system. | I needed to learn a lot of things before I could get going with this **Program AutoCAD**. | | | | | |

The next step is the participant will have ranked each of the 10 templates questions above, from scale 1 to 5, based on their level of agreement. After they fill the scale, we can calculate the answer from the participant. The first rule is for each of the odd numbered questions (question 1,3,5,7, and 9 considered as positive statement), we subtract 1 from the score (for example, the participant scale is 5 for question no 1, then the final score will be 5-1 = 4). The second rule is for each of the even numbered questions (question 2,4,6,8, and 10 considered as negative statement), subtract their value from 5. score (for example, the participant scale is 3 for question no 2, then the final score will be 5-3 = 2). The next step is to take these new values which you have found, and add up the total score, after that multiply the total score by 2.5. The result of all these SUS score calculations is that our score out of 100.

The second instrument, is by doing the survey polling. In this polling, the same student will be asked regarding the possibility about programs that they will be use more often for their design process later. They can choose more than 1 programs between three program AutoCAD, SketchUp and Rhinoceros. (see Figure 5)


Conclusion

33. Overall, Which programs will you be use more often for your design process?
- ☐ AutoCAD
- ☐ SketchUp
- ☐ Rhinoceros

34. And why you choose those programs?

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_____

https://docs.google.com/forms/d/1Qbf9i9YUsoPocW2HGFvilUhnoYGjN9dBJ_PkLWJxFEl/edit 6/7

**Figure 5.** Polling Questionnaire.

## 4. Discussion and Results

In this study, we wanted to identify the first year students' perspective regarding the 2D-3D modelling software usability using SUS (System Usability Scale) method. The result from the participant can be seen in the chart below. For AutoCAD Program, the mean score for SUS question number 1=4.18, 2=3.62, 3=3.72, 4=2.88, 5=3.94, 6=4.05, 7=3.48, 8=2.36, 9=3.41, 10=2.51. While the mean score for SketchUp Program is 1=3.85, 2=3.56, 3=3.74, 4=2.83, 5=3.74, 6=3.84, 7=3.53, 8=2.40, 9=3.39, 10=2.76. The mean score for Rhinoceros Program is 1=3.77, 2=3.72, 3=3.91, 4=2.89, 5=3.99, 6=3.99, 7=3.62, 8=2.33, 9=3.55, 10=2.77 The next step is calculating the participants' values based on regulation on SUS Score Calculation method (done in Microsoft excel program) (see Table 3)

**Table 3** The System Usability Scale (SUS) Final Score for AutoCAD, SketchUp and Rhino Program

| | | Modified SUS Question | Mean of Score | SUS Calculation Score | SUS Final Score (x 2.5) |
|---|---|---|---|---|---|
| AutoCAD | 1 | I think I would like to use this Program AutoCAD frequently. | 4.19 | 3.19 | 7.97 |
| | 2 | I found the Program AutoCAD less complex. | 3.62 | 1.38 | 3.44 |
| | 3 | I thought the Program AutoCAD was easy to use. | 3.72 | 2.72 | 6.81 |
| | 4 | I think that I would need the support of a technical person / tutor to be able to use this Program AutoCAD. | 2.88 | 2.12 | 5.30 |
| | 5 | I found the various functions in this Program AutoCAD were well integrated. | 3.94 | 2.94 | 7.36 |
| | 6 | I thought there was too much inconsistency in this Program AutoCAD. | 4.06 | 0.94 | 2.36 |
| | 7 | I would imagine that most people would learn to use this Program AutoCAD very quickly. | 3.49 | 2.49 | 6.22 |
| | 8 | I found the Program AutoCAD very cumbersome to use. | 2.35 | 2.65 | 6.63 |
| | 9 | I felt very confident using the Program AutoCAD. | 3.42 | 2.42 | 6.04 |
| | 10 | I needed to learn a lot of things before I could get going with this Program AutoCAD. | 2.52 | 2.48 | 6.20 |
| | | **Total Score** | | | **58.35** |
| SketchUp | 1 | I think I would like to use this Program SketchUp frequently. | 3.85 | 2.85 | 7.13 |
| | 2 | I found the Program SketchUp less complex. | 3.69 | 1.31 | 3.29 |
| | 3 | I thought the Program SketchUp was easy to use. | 3.75 | 2.75 | 6.87 |
| | 4 | I think that I would need the support of a technical person / tutor to be able to use this Program SketchUp. | 2.83 | 2.17 | 5.41 |
| | 5 | I found the various functions in this Program SketchUp were well integrated. | 3.75 | 2.75 | 6.87 |
| | 6 | I thought there was too much inconsistency in this Program SketchUp. | 3.84 | 1.16 | 2.89 |
| | 7 | I would imagine that most people would learn to use this Program SketchUp very quickly. | 3.54 | 2.54 | 6.34 |
| | 8 | I found the Program SketchUp very | 2.41 | 2.59 | 6.48 |

| | | | | | |
|---|---|---|---|---|---|
| | | cumbersome to use. | | | |
| | 9 | I felt very confident using the Program SketchUp. | 3.39 | 2.39 | 5.98 |
| | 10 | I needed to learn a lot of things before I could get going with this Program SketchUp. | 2.76 | 2.24 | 5.59 |
| | | **Total Score** | | | **56.85** |
| Rhinoceros | 1 | I think I would like to use this Program Rhinoceros frequently. | 3.78 | 2.78 | 6.95 |
| | 2 | I found the Program Rhinoceros less complex. | 3.72 | 1.28 | 3.19 |
| | 3 | I thought the Program Rhinoceros was easy to use. | 3.91 | 2.91 | 7.28 |
| | 4 | I think that I would need the support of a technical person / tutor to be able to use this Program Rhinoceros. | 2.90 | 2.10 | 5.26 |
| | 5 | I found the various functions in this Program Rhinoceros were well integrated. | 3.99 | 2.99 | 7.48 |
| | 6 | I thought there was too much inconsistency in this Program Rhinoceros. | 3.99 | 1.01 | 2.52 |
| | 7 | I would imagine that most people would learn to use this Program Rhinoceros very quickly. | 3.63 | 2.63 | 6.57 |
| | 8 | I found the Program Rhinoceros very cumbersome to use. | 2.33 | 2.67 | 6.67 |
| | 9 | I felt very confident using the Program Rhinoceros. | 3.55 | 2.55 | 6.38 |
| | 10 | I needed to learn a lot of things before I could get going with this Program Rhinoceros. | 2.78 | 2.22 | 5.55 |
| | | **Total Score** | | | **57.85** |

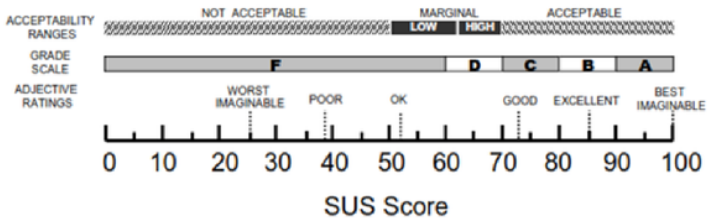


**Figure 6.** Adjective Rating Scale for SUS Score

The result is as can be seen in table 6, where the AutoCAD is 58.35, SketchUp 56.85 and Rhinoceros is 57.85. The next step is comparing the result with the grade scale (see figure 4.1) [4]. There are three ways that will be used to determine score: using acceptability range, grade scale and adjective ratings. [7]. For the acceptability range, there will be 3 categories: not acceptable, marginal and acceptable. For the grade scale, there will be 6 scale: A, B, C, D, E, and F. While the adjective ratings, there will be 6 ratings: worst imaginable, poor, Acceptable, good, excellent and best imaginable. Based on the SUS score (AutoCAD is 58.35, SketchUp is 56.85 and Rhinoceros is 57.85), the acceptability range for the three programs are Low Marginal, the grade scale are grade E and the

adjective ratings are ACCEPTABLE. Based on the score from the first year students, they find that the AutoCAD is the most usability, second is the Rhinoceros and third is SketchUp.

Secondly, the participants were also requested to give feedback through survey polling regarding the regarding the possibility about programs that they will be use more often for their design process later. The survey produced 127 responses (which the participants can voted more than one choice). From the polling question, 52% preferred AutoCAD, 60.6% preferred SketchUp and 39.4% preferred Rhinoceros. (see Figure 7). Between those polling question, there are several participants that voted more than one.


**Figure 7.** Program Polling From the Students

Beside the polling question, the participants were also requested to fill the reason about their vote. The reason from some participants who voted AutoCAD software were because AutoCAD is more detail, more consistent, more accurate, most widely used especially for detailed 2D modeling. Some participants who voted SketchUp, found out that SketchUp is easier to use, more attractive, more realistic and more practical for 3D modeling. Rhinoceros has more features and lighter because of its NURBS-based 3D modeling. Some who voted AutoCAD and Rhinoceros because AutoCAD and Rhinoceros has similar user interface. Some who voted AutoCAD and SketchUp because these two program are relevant and usually an interior designer use both of these programs. Some who voted SketchUp and Rhinoceros because they could immediately create a 3D modeling. Some who voted all the program because they found out the difference usability among these 3 programs such as using AutoCAD to create 2D layout as a floor plan, then modeling it 3d using SketchUp, then create the product in 3D using Rhinoceros. (see Table 4)

**Table 4** Participants' Opinion Regarding Prefered Programs

| Programs | Students ID | Why you prefered those programs? |
|---|---|---|
| AutoCAD | xxxxx016 | Because it's more accustomed to using the program |
| | xxxxx023 | More detailed and more consistent with distance |
| | xxxxx033 | More detail, precision, complete and clearer use. |
| | xxxxx089 | Because it's easier to use and the shape can be applied through two dimensions first |
| | xxxxx058 | Because it is more accurate and easy to use |

| | | |
|---|---|---|
| **SketchUp** | xxxxx123 | Simpler and easier to operate |
| | xxxxx014 | in my opinion besides being easy to learn, Sketchup programs are among the most efficient programs |
| | xxxxx127 | Because it is more attractive, in 3D and colored, so it's easier for me to imagine my design. |
| | xxxxx065 | Because its use is easier, and usually people use it more often in designing plans |
| | xxxxx036 | Because in my opinion, SketchUp is the lightest in operating on a laptop and the software is relatively small compared to other 3D modeling software. SketchUp is also the easiest to learn. There is also a filling of the furniture that can be downloaded and used directly on our design. Its use is practical and not too time consuming. |
| | xxxxx077 | because SketchUp is easier and more practical to use, and the results generated from the sketchUp program are very good |
| | xxxxx146 | because in my opinion sketchup is easier to use. |
| | xxxxx154 | I think sketchup is the most realistic to use in terms of what I need and is easier than others |
| **Rhinoceros** | xxxxx009 | Because the results of the use of rhinoceros are good and compared to other programs, the rhinoceros is more visible and will be easier. |
| | xxxxx160 | Because it is better and has many features |
| | xxxxx143 | Simple and easier |
| | xxxxx083 | Because Nurbs-based 3D modeling results are more concise and easy to use |
| **AutoCAD & Rhinoceros** | xxxxx139 | because in both programs the command can be typed without having to remember which icon, and especially on the autocad background screen so that my eyes are not too painful when using it too long. |
| | xxxxx024 | because the usage that I understand is better and both are not much different in terms of the user interface |
| | xxxxx031 | In my opinion, when compared to the Sketch Up program, the Auto Cad program is easier to use, because the operation of Auto Cad is not complex and coherent or not random so it does not make me confused. The results are neat and detailed. I also chose Rhinoceros because Rhinoceros can produce cool, detailed product designs, smooth results and the program is also quite easy to use |
| | xxxxx041 | easier to learn, the commands are quite similar |
| **AutoCAD & SketchUp** | xxxxx110 | because in my opinion the autocad and sketchup programs are relevant for use in interior design study programs |
| | xxxxx053 | Because both can be more detailed in the arrangement of space and not just interior products. |
| | xxxxx098 | From the material I got, I was more comfortable using autocad and sketchup. And the application is more suitable for me to use in the future in my lecture on Interior Design |
| | xxxxx136 | The programs that I will use more frequently are AutoCad and Skecthup because as interior design students we have to master both programs to realize the design that will be made |
| **SketchUp & Rhinoceros** | xxxxx052 | because sketchup is in the three-dimensional form of making space, Rhinoceros has an easy to use because it can be seen from all sides, compared to AutoCAD which only has two dimensions |
| | xxxxx025 | in my opinion the Sketchup and Rhinoceros programs are more realistic and easier to understand because of some tools. And in my opinion the program is more often used in interior designer work because it is easier to see according to customer / client desires, and more realistic. |
| | xxxxx076 | Because it is quite easy and for the future semester will often use the program |

| | | |
|---|---|---|
| **AutoCAD, Rhinoceros & SketchUp** | xxxxx157 | I chose all three because they were important to use to design. Also I don't think it would be more practical if all three were used in designing later. Like the floor plan can use AutoCad. |
| | xxxxx007 | I will use all three because each application has its own advantages in making a 3d modeling that will help me in the future. |

## 5. Conclusion

Based on the result and discussion above, the finding for are:

- On the SUS Score, AutoCAD program is 58.35, SketchUp program is 56.85 and Rhinoceros is 57.85, the acceptability range for the three programs are Low Marginal, the grade scale are grade E and the adjective ratings are ACCEPTABLE for first year students who just learn about CAAD. Based on the score, students find that the AutoCAD is the most usability, second is the Rhinoceros and third is SketchUp
- On the survey polling regarding which software that the students will be used in the future, majority students preferred SketchUp (by 60.6%), then AutoCAD (by52%) and Rhinoceros (by 39.4%). But based on students' opinion, each program has their own strength and usability. Such as AutoCAD is better for 2D modeling, SketchUp is more flexible and easy to use for a 3D modeling and Rhinoceros is for creating a 3D product based on NURBS system.
- Based on the SUS survey, these three programs are acceptable to used especially AutoCAD software but on the polling site, the students will prefer to use SketchUp more often rather than the other software. The reason is because they can straight away see the image of the 3D space design in 3D modelling by using SketchUp, therefore most of them voted for SketchUp program. But AutoCAD is more usability (based on SUS) because more neat and detailed especially while doing 2D modelling such as layouts and the program show more complete icons that can be used while doing modelling, while SketchUp did not show complete icons.


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## References


[1] Salman, H.S., Laing, R. & Conniff, A. (2014) The impact of computer aided architectural design programs on conceptual design in an educational context. *Design Studies*, 35(4), p.412-439.

[2] Zuo, Q., Leonard W., and Malonebeach E.E., (2010), Integrating performance-based design in beginning interior design education: an interactive dialog between the built environment and its context. *Design Studies*, 31(3), pp. 268-287

[3] Al-Qawasmi, J., (2005). Digital media in architectural design education: reflections on the e-studio pedagogy, *Art, Design & Communication in Higher Education* 4(3), pp. 205–222

[6] Bangor, A., Staff, T., Kortum, P., & Miller, J. (2009). Determining What Individual SUS Scores Mean. *Journal of Usability Studies*, 4(3), 114–123. https://doi.org/66.39.39.113

[5] Nielsen, J., (2012) *Usability 101: Introduction to Usability.*, http://www.nngroup.com/articles/usability-101-introduction-to-usability/ Accessed on 10 December 2018.

[4] McNeel, R. (2013). *Rhinoceros 5 User ' s Guide*. http://docs.McNeel.com/rhino/6/usersguide/en-us/windows_pdf_user_s_guide.pdf Accessed on 10 December 2018

[7] Knight M., Dacceptableonal W., Brown A., and Hannibal C., (2005) Contemporary Digital Techniques in the Early Stages of Design, *Proceedings of the 11th International Conference on Computer Aided Architectural Design Futures* Vienna (Austria) 20–22 June 2005, pp. 165-174.

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