

Development of a Lesson Plan for Basic Computer Graphics using SketchUp Free at Hiroshima Jogakuin University

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1. Introduction

“The World of Computer Graphics” course is conducted as basic computer graphics (CG) education in the spring semester at Hiroshima Jogakuin University.

Hiroshima Jogakuin University started remote teaching for almost all courses from May 11 in the 2020 spring term at the request of stay-at-home advisories issued by the Japanese government due to the coronavirus disease 2019 (COVID-19) epidemic.

We had to presuppose the possible continuance of COVID-19 and devise a plan to provide online lessons. SketchUp Free^{F1)} (provided by Trimble Inc.) has been adopted for “The World of Computer Graphics” because this software can be used with the cloud anywhere for free. It goes without saying that SketchUp Free compares favorably with Vectorworks,^{F2)} having been used in “The World of Computer Graphics” before. Kouji NAGATANI¹⁾ reported that extremely effective lessons were provided using SketchUp Make 2017 completely via e-learning. In “The World of Computer Graphics”, which consists of 90-minute lessons aimed at beginners in CG modeling, students participate in lecture-based learning for the first 45 minutes of the lesson and then engage in SketchUp Free practice for the last 45 minutes.

Previous studies in CG education have reported on

practical training using SketchUp for architectural students. The present author has conducted lessons using SketchUp Free for beginners, including many students in a non-architectural course, since 2020. In addition, videos made by the author, as well as YouTube videos, were introduced to keep up with the lesson schedule. In the present study, the author gave students SketchUp assignments and conducted a questionnaire survey regarding assignments and CG to discuss the effects of video-assisted assignments and student awareness of CG.

2. Lesson Plan Outline

“The World of Computer Graphics” course is conducted as follows:

1. Guidance
2. Figure perception
SketchUp (introduction)
3. Basic CG knowledge
SketchUp (basic) <https://youtu.be/pv7TrGnZ17w> Getting Started with SketchUp - Part 1
4. Contrast transformation
SketchUp (a house with a chimney) <https://youtu.be/pv7TrGnZ17w> Getting Started with SketchUp - Part 1
5. Affine transformation
SketchUp (a simple table) <https://youtu.be/SuLZYtWJiY8> Sketchup | How To Make A Simple Table

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F1) <https://www.sketchup.com/en/plans-and-pricing/sketchup-free> (last accessed Nov 10, 2024)

F2) Vectorworks Japan Co., Ltd. <https://www.aanda.co.jp/corporate/profile.html> (last accessed Nov 3, 2024)

6. Projective transformation
SketchUp (a glass-top table)
7. Modeling
SketchUp (glass-top table with a curved surface, a slatted bed 1 (legs))
<https://youtu.be/YXcET2wvin0>^{F3)} Essential Bed Frame DIY Tutorial
8. Rendering 1 (wireframe model, constructive solid geometry, Bezier curve and surface)
SketchUp (a slatted bed 1 (frames))
<https://youtu.be/4ZgFE4CU700> How to SketchUp Bed frame | SKETCHUP TUTORIAL
9. Rendering 2 (hidden line removal, hidden surface removal)
SketchUp (a slatted bed 2 (completed version))
10. Rendering 3 (shading)
SketchUp (L-shaped house and presentation)
<https://youtu.be/IMHckAysaSY> Getting Started with SketchUp - Part 2
11. Rendering 4 (texture mapping, volume rendering)
Projection mapping using PowerPoint
12. Computer animation
13. Binarization
SketchUp (a cup with a handle)
<https://youtu.be/Cj3Ev6lqyZQ> Absolute Beginners Lesson to Make a Glass or Cup in Sketchup
<https://youtu.be/7SFff7IhACI> Google Sketchup Tutorial: CUP
<https://youtu.be/MDPPILK9G60> SketchUp ClothWorks Plugin Quick Tip
14. Pattern recognition
SketchUp (donuts on a plate)
15. Wrap-up
Written test
Practical test (a two-tiered birthday cake with dark cherries and candles)

Students watched videos by the author, as well as YouTube videos, before practice to learn the procedure and watched objects being made. The author explained why the skills and methods in the videos were used to build up creativity

because the videos generally proceeded smoothly and instructed viewers about how to make objects.

3. Results and Discussion

A questionnaire survey regarding “The World of Computer Graphics” was conducted on the students using Google Forms. Ten of 11 students responded.

Table 1 shows the results regarding the students’ memorable choices of 25 technical terms in CG. The most frequent choices were pixel (80%) and modeling (80%). The former is a common word used in photographic images, and the latter is frequently used in lessons. Mapping, the third most frequent choice, may have been the result of a lesson on projection mapping. Shading and filtering are assumed to have easily created a picture as CG words in the minds of the students because these terms are used outside of CG, e.g., for makeup and coffee. The

Table 1 Memorable terms in “The World of Computer Graphics” course.

Term	Number
pixel	8
modeling	8
mapping	7
shading	6
filter	5
binarization	5
quantization	4
histogram	4
motion capture	4
sampling	3
projection	3
contrast transformation	3
rendering	3
contrast transformation	2
wireframe model	2
surface model	2
solid model	2
tone curve	2
ambiguous figure	2
optical-illusion figure	2
geometric transformation	1
Bezier curve	1
hidden line removal	1
hidden surface removal	1
pattern recognition	1

F3) The YouTube video shows how to make a self-build slatted bed using timbers.

meaning of binarization may also have been guessed from kanji (Chinese characters). Relatively lower-ranking words required a background in mathematical knowledge. This seemingly led to difficult terms for the students to grasp.

To start with, the author introduced a house with a chimney from YouTube videos as educational materials for beginners. The students created a house apparently similar in size to the sample while looking at a demonstration by the teacher and a YouTube video. The sensorial approach in the YouTube video was supposed to eliminate numerical stress. Additionally, the author explained why the skills and methods were used in the videos to build up creativity because the videos generally proceeded smoothly and instructed viewers on how to make objects.

Table 2 shows the results of a five-item questionnaire survey on the SketchUp assignment after an assignment involving a house with a chimney. The average levels of interest were generally in the vicinity of level four. The average perceived difficulty levels for (a) a glass-top table with a curved surface, (b) a slatted bed, (c) an L-shaped house, and (d) cup with a handle were approximately level three. Demonstrations by the teacher and YouTube videos are considered to be helpful to carry out practice lessons smoothly while maintaining students' interest and moderate difficulty in the four assignments (a)–(d) in the early part of the SketchUp lessons. Samples of the four assignments (a)–(d) are shown in Figure 1. The average perceived difficulty levels for (e) donuts on a plate was higher (3.5) than those for the four assignments from (a) to (d), and the (f) birthday cake assignment had the highest difficulty (4.4) among the others. Students first made a donut-shaped object (Figure 1 (e-1)) based on the demonstration by the teacher; however, they were required to make donuts on a plate by themselves using only a sample image (Figure

1 (e-2)). Some students felt the donuts on a plate assignment was difficult because they levitated donuts on the plate before managing to adjust the position.

In the birthday cake assignment as a practice test, the students were just given text-based instructions to create a birthday cake (a two-tiered structure, decorated with four dark cherries and four candles almost evenly on the lower tier, painted with at least two colors). They used their skills and inventiveness to model a birthday cake. The perceived difficulty of the birthday cake assignment did not lead to a decline in students motivation (3.9).

Figure 2 shows the results of a student's birthday cake assignment. The result was unique because of the well-expressed form of the cherries, candles, and flame. Moreover, the student showed originality by putting a chocolate plate on the cake filling with cream in the middle of each sponge tier. The birthday cake assignment aimed at the following:

1. Visualize freely a rendering image of a birthday cake as an everyday object without a sample model
2. Plan to make the image computer-graphical
3. Model it in accordance with your own plan using SketchUp Free

The creativity of the students was expected to be elevated throughout the above process.

Table 3 shows the students' attitudes at the fifteenth lesson of "The World of Computer Graphics" course. The students worked on the birthday cake assignment enthusiastically. Forty percent of the class felt that they could use SketchUp and attempted to create other objects. Piling up the lessons in the course was presumed to give them confidence. The birthday cake assignment was the most difficult for the students in the course; however, it positively contributed

Table 2 Comparison between the average levels of the six assignments (a) to (f) in "The World of Computer Graphics" course.

	(a) Glass-top table with a curved surface	(b) Slatted bed	(c) L-shaped house and presentation	(d) Cup with a handle	(e) Donuts on a plate	(f) Two-tiered birthday cake	Average level of (a)–(f)
Interest	4.1	4.2	3.8	3.7	3.9	3.9	3.9
Difficulty	2.9	3.3	2.8	3.0	3.5	4.4	3.3

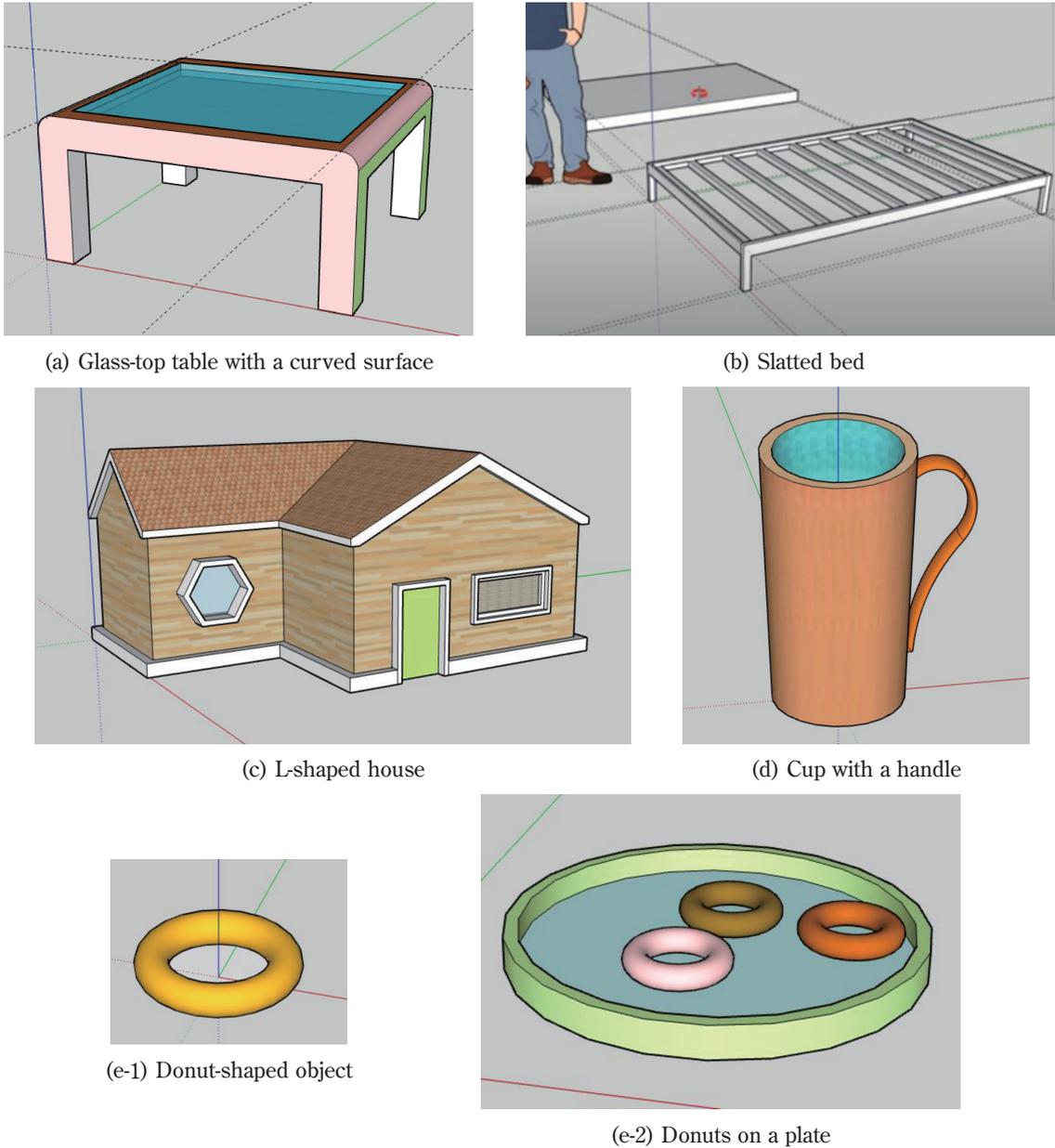


Figure 1 Samples of assignments using SketchUp Free. (a), (b), (c), (d), and (e) are based on YouTube videos shown in section 2. (a) is also based on the procedure by Obra Club²⁾.

to student attitude because 60 percent of the class commented that CG was difficult and 90 percent became interested in attaining CG skills. It is likely that they may crave CG skills when they experience difficulty in creating a desired result.

Students of 90 percents in the class took interested in the skills of CG, however, students of 30 percent took interested in theoretical knowledge of CG. Regarding this issue, it may suggest the need for improvements, in that some theoretical knowledge is explained in relation to SketchUp tools (e.g., sweep representation and the follow

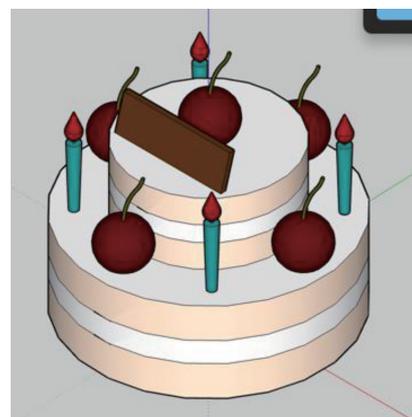


Figure 2 Results of a student's birthday cake assignment (used with permission of the student).

Table 3 Student attitudes at the fifteenth lesson of “The World of Computer Graphics” course.

Get interested in theoretical knowledge	Get interested in skills	As difficult as I thought	I feel like I can do SketchUp.	I want to make something using CG software.	I want to try the CG engineer certification test.
3	9	6	4	4	2

me tool, projective transformation and the scenes tool). According to the students’ comments, some students felt that every lesson was interesting, and some students wanted to make cars, animals, and playground equipment. A lesson plan using the above subjects seemed to make CG more appealing.

4. Summary

The author introduced SketchUp Free in 45-minute practical lessons with videos on YouTube and videos made by the author in “The World of Computer Graphics” course and additionally provided comments on the technical ingenuities in the videos to develop creativity in CG modeling. The videos were useful for providing CG lessons for beginners smoothly. A questionnaire survey was also conducted on students regarding the six SketchUp assignments and students’ comments about CG.

In the beginning of the SketchUp Free lessons, students made objects not by a designated size, but by an apparently similar size to the samples shown by the teacher, which led them to be free from numerical calculations. Therefore, they perceived the modeling as not being very difficult. Subsequently, students made objects (slatted bed, cup with a handle, and donuts on a plate) according to a designated size. Finally, they created a birthday cake without videos

or a sample. The assignments (a glass-top table with a curved surface, a slatted bed, a cup with a handle, and a birthday cake) were perceived as being more difficult (higher than level 3) than the other objects; however, the students became interested in CG modeling through the SketchUp lessons.

Further studies should focus on arousing student interest in the theoretical knowledge of CG as well as skills from the perspective of CG education. The development of a lesson connecting skills to theoretical knowledge is planned for the future to foster interest in both the skills and theories of CG.

Acknowledgements

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[研究ノート]

広島女学院大学における SketchUp Free を利用した CG 基礎教育のための授業計画の展開

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要 旨

広島女学院大学においてコロナ禍の2020年より無料のクラウド版3D CADソフトのSketchUpFreeを利用して、「CGの世界」の授業を行っている。45分の講義，45分の実習という中で，動画を利用して効率的な授業を計画した。課題の難易度と興味度などをこのコース終了後に学生にアンケートで回答してもらい，その結果を分析した。難易度が高くても，身近なものをテーマとし，見本を提示しないことで学生の創意工夫の促すことが分かった。しかしながら，講義でのCGの理論的知識への関心を上げるにはさらなる改善が必要である。