LOOW

by Esa Dora

Bridging The Gap To Communicate Abstract Concept of Physics For Visual Learners

Purnama Esa Dora Tedjokoesoemo, S.Sn., M.Sc.

Petra Christian University, Surabaya, Indonesia

Esa Dora is interested in the field of indoor environment quality and wellbeing. Currently she is teaching as a full time lecturer in the Interior Design Department, Petra Christian University.

ABSTRACT

In vitruvius principles, a successful applied design should comply with 3 basic needs. Those are venusity (aesthetic), utilities (function), and firmities (structure). As the bones of the building, structures are often unseen, covered, and considered last by most interior design students. Columns and beams are often taken as a nuisance in creating the perfect canvas of blank space ready to design. Thus, it creates a fragmentation within the building development process to create a well performing building. Conventional approach to deliver the understanding and basics of physics in construction classes had struggled long before google image and pinterest came to flood the students with visual information in decorative manners. The presence of covid 19 then forced the construction teachers to think of appropriate teaching methods to keep increasing interest in learning on this less desirable subject. This study was conducted in a quantitative experimental method in 4 consecutive years of construction and statics class. This study aimed to review different delivery approaches and students' responses resembled through their performance in exam question assessment. The results of the study show that the students get better understanding by carrying out flip class methods because of the flexibility and discussion chances it has offered. However, the presented material should be equipped with graphics to help students to visualize.

Keywords: Flip Class, Experimental, Construction, Statics, Interior Design

INTRODUCTION

Design can be defined as a plan or specification for creating an object, system, activity, or process. The design process is intended to create either a plan, a prototype, a product, or a process. Great design strives to create solutions for people, systems, or physical objects. In the context of a built environment, to create a well performing building, it is necessary for a designer to understand the integration of building systems namely interior, architecture, structure, as well as mechanical and engineering relationship one to another. Marcus Vitruvius Pollio stated that a successful applied design should comply with 3 basic needs. Those are venusity (aesthetic), utilities (function), and firmities (structure) (Vitruvius, 1960, p. 156).

In order to understand the relationship between the four building systems and the Vitruvius principle, interior design students are equipped with Construction and Statics courses in semester 3 along with the first project-based design course. This course will enable students to understand the structure of a building or interior products and how it will respond to forces happening around it. The goal is for students to be able to create realistic designs with the right basic logic of physics, since their design should comply with the basic rules of action and reaction relationship. For years, this course has been given as a supplementary of 2 credits and oftentimes delivered with a theoretical

approach to re-introduce physical principles in the context of built environment, with the hope that the practice and application of the principles can be applied at the design studio for their specific design.

The problem that often occurs in theory-based courses and abstract concepts for design students in general is that they cannot be understood when they have to land the concept to their design, because there is no visualization displayed. Students tend to face difficulties in imagining the concepts of fulcrum, force effect, compression, tension, and stability. Since there are so many students who have difficulty in this course, there are suggestions from generation to generation that semester 3 is a scourge semester because of this course. This course has been considered as a stumbling block because of its nature as an exact subject that is different from most other non-exact courses in this department.

However, structure is the skeleton of a building and products that will enable another building's systems to be attached and function. Therefore, no matter how hard and abstract the concept is, this course should not be missed and must continue to be delivered in a more effective way. This paper reviews 4 strategies of different learning approaches experimented in this course for 4 consecutive years. This research aimed to figure out communication methods and languages that are effective to deliver abstract concepts for visual learners.

METHOD

This research is conducted in a quantitative method with a quasi experimental design approach. This approach was chosen because of the limitations of the researcher to be able to have full control on external variables that will affect the performance of the control variable group during the study. The population of this research is interior design students involved in Construction and Statics class of Interior Design Department, Petra Christian University from the academic year 2018/2019 (control variable), 2019/2020, 2020/2021, and 2021/2022 with an estimate of 120 students per academic year. The sample will take approximately 60 students of each batch (50%) who are randomly selected. The population will be given the same material of study but delivered in different methods of arrangement and tested with different forms of questions and projects.

The hypothesis is project based learning that incorporates cross course assignment does not help to increase student understanding. But simple assignments with simple modeling and visuals will do. In this research there are parameters to be ignored, such as previous GPA, gender, motivation of study, and complexity of their design in

respective designing courses. Some of the parameters that are taken into account will be categorized into the following variables (Noor, 2016, p.48):

- Independent variable

  The independent variable is a variable that affects, or is the cause of a change from the existence of a dependent (bound) variable. In this study, the independent variables are the differences in the flow of material delivery, teaching methods, and types of assignments and tests.

- Dependent variable

  The dependent variable is defined as a variable that is influenced by the presence of an independent variable. In this study, the dependent variable is the graph of the general grade description and the accuracy of application and analysis on final project assignments.

- Control variable/ control group

  Control variables are variables that can be controlled. In this study the control variable is the class of 2018/2019 that still uses the conventional approach to be compared with other samples that get changes in the independent variables.

LITERATURE REVIEWS

Learning Theory

Learning is a process to attain measurable and persisting change of performance. Therefore, by going through a learning process, learners are expected to come up with modified knowledge, skills, and abilities. Learning is continuous and is continuously built on the prior knowledge that the learner has intellectually developed based on their physical capacity. Even with the same input, the success of learning will be different. Human behavior depends not only on the external environment, but also on the cognitive process itself (Kurt, 2021).

Learning requires differentiated guidance and different levels of support. Since each learner has their own prior knowledge, the instructor or teachers must always deal with the learner's complexity and processing level. Different strategies are needed to achieve different learning goals (Kurt, 2021). There are 3 major camps of learning theories, that each of these has their own traits and superiority (Newby, 2017):

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- Behaviorism: it equates learning with changes in the form or frequency of observable performance. Learning is achieved when an appropriate response is given after the presentation of a particular environmental stimulus. Behaviorists view learners' mental structure as a black box that retains inputs from environment stimulation and will show when needed in an observable behavior.

- Cognitivism: It focuses on conceptualizing the student's learning process, and sees how information is received, organized, stored, and retrieved by the mind. Learning is not about what the learner does, rather than what the learner knows and how to learn it. Knowledge acquisition is described as a mental activity with internal coding and structuring by the learner. Learners are considered to be very actively involved in the learning process.

- Constructivism: it equates learning with creating meaning from experience. Constructivism crosses both categories by emphasizing the interaction between these two variables. Constructivists are mind-independent and do not share the belief that knowledge can be "mapped" to learners with cognitivists and activists. People create meaning instead of acquiring it. Learners do not transfer knowledge from the outside world to their memory. Rather, they build a personal interpretation of the world based on individual experience and interaction.

Information Processing Theory

Learning objectives are an important element in making a course learning instruction and modules. It helps to set the alignment of goals and the type of assessment for each type of assignment. Bloom has categorized the cognitive areas of learning into 6 different levels based on their complexity and abundance. This framework is important in designing a learning experience as it helps instructors identify, classify, and outline what students are expected to learn in the course.
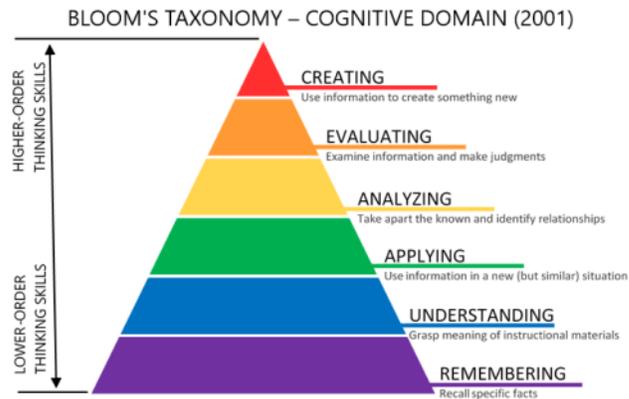
Figure 1. Bloom's Taxonomy

(Source: Karthwohl, 2002 in University of Florida, n.d)

Humans are active learners in a sense that they never stop learning by actively processing the information they receive from their senses. In information processing theory, the information that learners absorb is first easily stored as sensory memory. Then they are moved to short-term memory or working memory. It is then they either will be forgotten or transferred to long-term memory as a semantic memory (concepts and general information), procedural memory (process), and/or images. It is important that information is transferred from short-term memory to long-term memory for learning to take place. This is because short-term memory can be overloaded with more than seven pieces of information at a time.
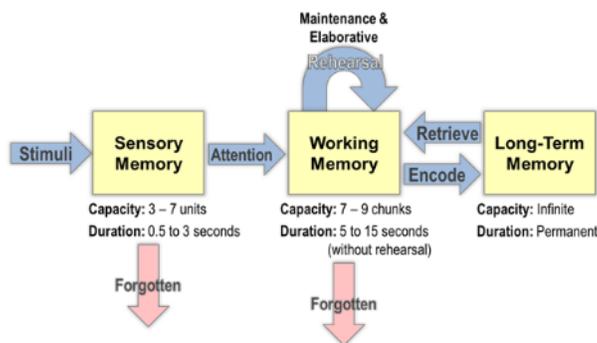

Figure 2. Information Processing Model

(Source: University of South Australia, n.d)

Learning Styles

As individuals are unique, each person will have a preferred learning style that is superior to each individual. Learning styles are a way for different students to learn. Learning style refers to a person's preferred way of absorbing, processing, understanding, and retaining information. One of the most popular theories to date is the VARK model. This model identifies four types of learners: visual, auditory, kinesthetic, and literacy. Most people are a combination of these four styles, but often they have a dominant learning style. Each of these styles has a complementary teaching method.
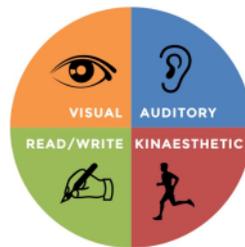

Figure 3. The VARK Learning Style Model

Apart from specific learning styles, each of us also inherit specific mind styles of information processing. Gregorc's learning styles are a way of breaking the mind's ability to perceive and process information. He divides the groups based on perceptual quality (concrete and abstract) and ordering ability (sequential and random). The four distinct categories are concrete sequential, concrete random, abstract sequential, and abstract random (SUNY Cortland, n.d).
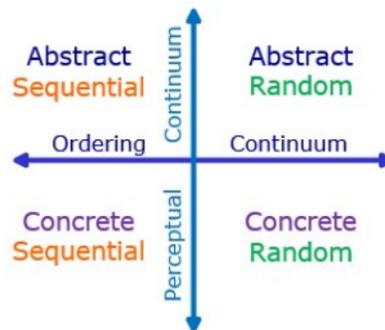

Figure 4. The Gregorc Mind Style Model

(Source: The Peak Performance Center, 2017)

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FINDINGS AND DISCUSSION

Learners Analysis and Course Profile

The research subject for this study is the sophomores of interior design students from Petra Christian University. They are divided into 2 majors as "Interior Design and Styling" and "Interior Design Product". Generally, the students possess strong drafting skills and if given a drafting task, the quality of their drawings would be expected to satisfy most real-world clients. Their spatial logic and reasoning are also notable; given a spatial problem where the solution is one of efficiency, the students would be expected to arrive at a fairly satisfying answer. According to Piaget's levels of cognitive development, our learners are at the formal operational level. This is typical of later adolescence and adulthood, and they have the ability to work with abstract concepts (Cherry, 2020). The learner's level of visual literacy should be considered high. Due to their background in design, most students can be expected to correctly interpret any reasonable graphic or diagram presented to them. The learners are dominated by Abstract Random and Concrete Sequential based on Gregorc learning styles who prefer a logical and hands-on learning style and a combination of experimental, imaginative, and people-oriented learning styles. However, these traits are not exclusive, and in fact all four Gregorc learning styles have a significant presence.

The Construction and Statics course is an exact subject which studies the application of basic physics of stability and rigidity in the context of interior design and furniture design approach. This course is mandatory for sophomores in their third semester which is taken together with the first design course. The course aims to enable learners to achieve the "applying" stage according to Bloom Taxonomy. Up to the year of academic 2019/2020, this course is delivered in 2 different subjects namely "Construction" and "Statics". Previously, these 2 courses were delivered in pure physics only, but in the year academic 2019/2020, it is experimented to have both synchronized and contextualized to their design course theme. From the year academic 2020/2021, both courses are combined as "Construction and Interior Detail" courses, but in this paper we will have it called "Construction and Statics" to avoid bias in subject goals.

Development of Media, Material Flow, and Assignment Type

Considering the learners profile, the course has been adjusted and shifted from all pure physics to project based contextual to their ongoing design studio to enhance the logical and experimental learning experience. Due to

limitations of credits, which affects the amount of workload, this course was unable to make use of the wood laboratory and prototype making. Thus, these experiments will be synchronized with the design studio with 8 credits load and the Construction and Statics will focus more on foundation and analysis.

Due to pandemic, the in class experiments experienced a change in the delivery method, from the conventional face-to-face form and since 2020/2021 it has changed into online classes. The change in the class model turned out to provide a change in the type of media that was more effective as delivering material. In the conventional model before pandemic, in class quiz, mini assignments, and discussion occupy the top 3 methods that are more effective according to students. On the other hand, flip classes that provide video to rewatch with pictures in slides and provide verbal explanation in live and non live sessions became the top 3 in online classes after the covid 19 breakout. The limitation of physical meeting somehow also influences changes in random student type learning patterns to become more independent learners.
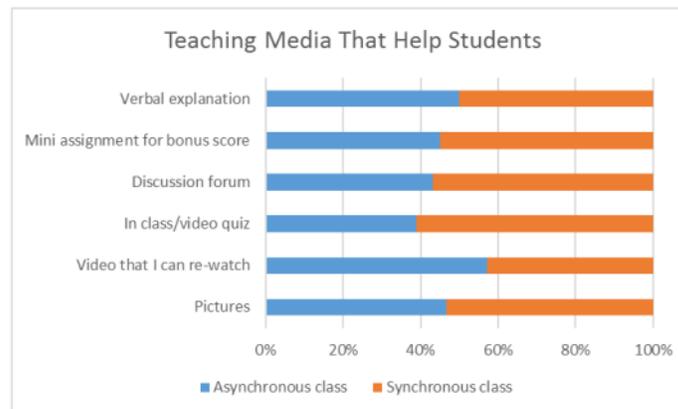

Figure 5. Media and Delivery Method

The material flow changes significantly in the academic year 2020/2021. In previous years, no explanation to explain the relation of this course to the history of design (so that this course became easily forgotten and seems not connected) and concepts were delivered at the beginning of the semester before the mid exam to provide foundation in understanding terms and movements. After the mid exam, material will be continued with application of those concepts in interior context and case studies. Whereas in 2020/2021, the applications in interior context were given

at the beginning of the semester then continued with showing how those applications actually relevant to the physics concepts.
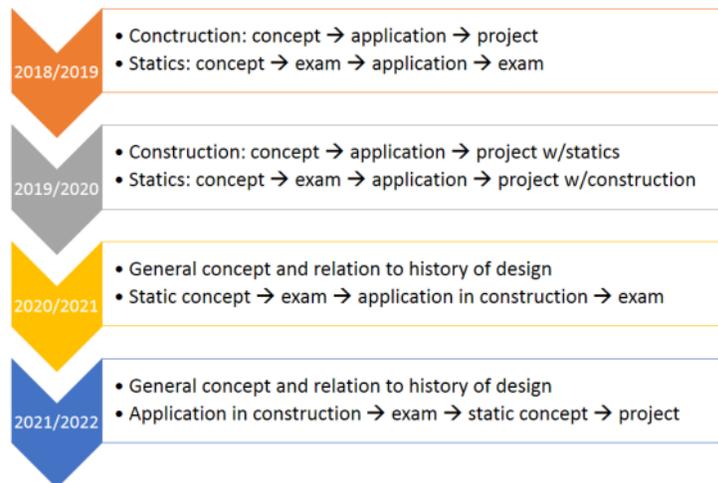

Figure 6. Development of Material Flow

The assignments change for each academic year to figure out the best synchronization with the design course. The details are as follows:

- In 2018/2019, the final project was to enable students to break down existing furniture and redraw the construction and as built drawing. Students were mostly enjoying the learning process and able to understand the construction and details, however, they were limited to built up knock down furniture only. The students lacked understanding in interior elements joints especially those in major of interior design and styling.

- In 2019/2020, the final project was to analyze individual project construction and statics performance according to their project prototype in the design course. The students generally performed moderately. They were generally able to explain the construction well but most of them were not able to explain how the static concept worked in their specific design. In the type of assignments, students from the major of interior design products did not perform well due to their nature of design studio assignments that were still in the topic of decorative furniture. Although in figure 7 it shows higher graphs, it was because of more student body by that academic year.

- In 2020/2021, the first batch of online classes were begin. In this academic year, the idea of assignment is to give proper basic understanding and models for both majors and can be done individually due to limitations in early pandemic. So, this batch's project was given as an individual practice assignment with dedicated questions. The type of project was given the right or wrong type of answer. Students perform well within the limits of being able to work on the questions given but when given an open ended question referring to their ability to make construction drawings in the design studio, the students did not show the appropriate quality.

- In 2021/2022, the class was still in online mode. To ensure students can repeat the material that had been given previously, then the class in this batch was made in the flip class model. In this batch, the visualization was made rather superior by using augmented reality (AR) for their final project presentation. The question was made basic and not related to their design studio to give fair learning for both majors. However, the question was made for an open ended type. The assignments were made mixed as they needed to explain the concept, give actual examples to explain how the concept works, and provide visualization both in technical drawing and 3d AR models to avoid misinterpretation because they can easily rotate the model to review all angles. Students were pretty overwhelmed with the new presentation method to learn. However, they showed excitement, sharper analysis, and better solutions in the open ended question. Unfortunately, the applications to their respective design in design course were still lacking of excellence but showed a better foundation of concept and spatial visualization.

The class general performance was gained through the central LMS (sim.petra.ac.id) to retrieve the recapitulation of scores and grading. For the academic year 2019/2020 and 2018/2019, the graph in figure 7 shows the average of both courses which combined in 2020/2021. The graph shows normal grade distribution in the academic year 2018/2019, 2019/2020, and 2021/2022. Both 2018/2019 and 2019/2020 had a gap of learning experience and relevance to one of each major. However, hands-on and project based learning are favorable and bring higher attention to learners. Then this approach was taken to practice in academic year 2021/2022 but with defined open ended questions to enable the project based learning and bridging the gap between both majors. In this year, the material deliveries were also given in different flows. The changes gave better intro and made students better prepare with visualization before given the conceptual approach.
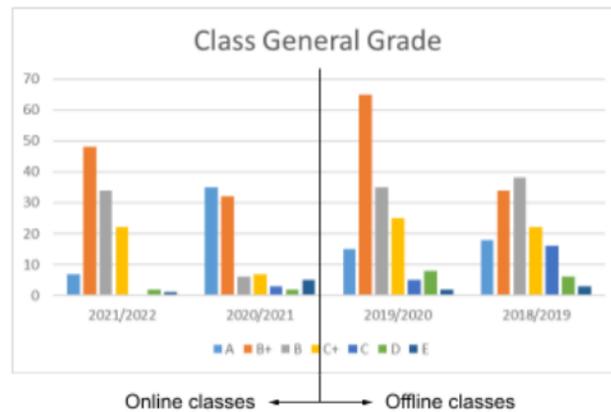
Figure 7. Class General Grade In 4 Consecutive Years

CONCLUSION

In order to gain spatial logic and foundation of stability and rigidity, as well as to understand the relationship between building systems, interior design students are equipped with Construction and Statics courses in semester 3 along with the first project-based design course. The synchronization of practice between the theoretical approach and practice in both courses will enable students to understand the structure of a building or interior products and how it will respond to forces happening around it. The interior students of Petra Chrstian University are dominated by visual learners with Abstract Random and Concrete Sequential learning styles based on Gregorc's learning styles who prefer a logical and hands-on learning style and a combination of experimental, imaginative, and people-oriented learning styles. Since 2020/2021, the classes were delivered online due to the pandemic. This shifting of methods made different media which is considered efficient by students. Flip classes that provide video to rewatch with pictures in slides and provide verbal explanation in live and non live sessions became the top 3 in online classes after the covid 19 breakout. The limitation of physical meeting influences changes in random student type learning patterns to become more independent learners. The material flows that explain the relation of this course to other courses create connectivity to gain students attention and a sense of importance. The flow of materials that began by the applications of construction in interior context then continued with showing how those applications actually relevant to the physics concepts made a better intro and made students better prepare with visualization before given the conceptual approach. By making use of various visualization techniques and rotable models, it helps learners to avoid misinterpretation. The approaches made by the end of academic year 2021/2022

can not be judged as the most efficient in achieving the goal of "applying" according to Bloom taxonomy because learners were still facing difficulties in the applications to their respective design in the design course, even though they showed a better foundation of concept and spatial visualization. There are still rooms for improvement and further research is still needed to evaluate the delivery methods and types of assignments that are truly efficient in bridging the gap of understanding and applying the abstract concept of physics for design students.

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