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THE INFLUENCE OF INTELLIGENCE ON THE LEARNING SUCCESS OF STUDENTS IN THE ARCHITECTURAL ENGINEERING EDUCATION STUDY PROGRAM

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Abstract:

Different levels of intelligence of students in the Architectural Engineering Education Study Program can lead to diverse learning success in Engineering Drawing and Architectural Drawing courses. Intelligence which includes reality ability, flexibility of thinking, abstraction ability, analysis and synthesis ability, and three-dimensional ability or spatial ability is one of the internal factors in achieving learning success in Engineering Drawing and Architectural Drawing courses. The research method used in this study is a correlational method with a quantitative approach and parametric statistical data analysis techniques. The instrument used in this study is the Intelligence Structure Test conducted by the Integrated Services Unit for Counseling Guidance and Career Development Indonesia University of Education (UPT BKPK UPI) to measure student intelligence and documentation of student learning outcomes. The population in this study were students of the Architectural Engineering Education Study Program in the 2022 academic year with a sample of 160 students. The results found in this study include: 1) The average intelligence of students is in the medium category; 2) The average learning success of students in Engineering Drawing and Architectural Drawing courses is in the medium category; and 3) There is a moderate relationship and moderate influence of intelligence on the learning success of Engineering Drawing and Architectural Drawing courses. Overall, the analysis results show that intelligence significantly influences student learning success, with a coefficient of determination of 0.65. This means that 65% of the variation in students' learning success can be explained by their level of intelligence. However, it should be noted that the remaining 35% is influenced by other factors not examined in this study.

Keywords:
Multiple Intelligences; Value of Learning Outcomes; Basic Courses; Spatial Ability

Introduction

Cognitive development is the nature of concept formation, reasoning, planning, and solving problems or complex structures(Demetriou et al., 2018). Cognitive activities include interpreting statements, solving problems, synthesizing information, analyzing complex problems critically(Chusni et al., 2020). Intelligence is part of cognitive development which has the highest mental level(Karpinski et al., 2018). The theory of multiple intelligences has

been influential in the world of modern education and has become a reference for developing learning methods that suit the abilities of each individual(Yavich & Rotnitsky, 2020). Multiple intelligence is a concept for assessing intelligence with several research benchmarks developed by Howard Gardner(Wulansari et al., 2022). Multiple intelligence consists of nine types of intelligence, namely linguistic, logical-mathematical, spatial, kinesthetic-physical, musical, interpersonal, intrapersonal, naturalist, and existential.(Gardner, 1983). Multiple intelligence is a tool for learning, solving problems, and creating new things to help human life(Şener & Çokçalışkan, 2018). As time goes by, the theory of multiple intelligences begins to explore various meaningful thoughts that underlie intelligence as an individual capacity that can influence future achievements.(Moran, 2011). Everyone has intelligence according to their respective fields. However, not many people understand the intelligence they possess, so there are still many people who find it difficult to develop their potential(Mata et al., 2018). The importance of developing one's own potential for each individual is to identify one's strengths and weaknesses so that each individual can determine goals and plans for developing one's potential for life in the future(Caena & Redecker, 2019).

Based on the development of multiple intelligences, Gardner reiterated that intelligence can be focused on certain thoughts, namely: 1) deciding to evaluate oneself based on the scientific discipline one is pursuing; 2) analyze and synthesize information from various references he finds; 3) generate a new idea or concept by expanding or changing objects from a complex domain; 4) respect the differences in opinions of each individual by combining all of the possibilities to form a new conclusion; and 5) emphasizes a person's efforts to develop more creatively which has an impact on the present and future(Gardner, 2007). The five thoughts explained by Gardner can also be expressed through core intelligence attributes which include verbal comprehension, word fluency, number ability, spatial visualization, associative memory, perceptual speed, and reasoning as the basis for measuring intelligence.(Beaujean & Benson, 2019). These intelligence measurement attributes can be carried out through the Intelligence Structure Test which consists of: 1) reality abilities; 2) language skills; 3) flexibility of thinking; 4) abstraction ability; 5) practical calculation skills; 6) theoretical calculation skills; 7) three-dimensional ability or spatial ability; 8) analysis and synthesis skills; and 9) memory(Liepmann, 2007).

Learning success can be influenced by two factors, namely internal factors and external factors. Intelligence is an internal factor that is more dominant in determining learning success(Yari et al., 2020). The intelligence possessed by architecture students includes reality abilities, flexibility of thinking, abstraction abilities, analysis and synthesis abilities, and three-dimensional abilities or spatial abilities. Reality ability is an ability that refers to the cognitive process of distinguishing experiences produced internally from those felt in the external world(Johnson & Raye, 1981)so that someone who has experience with the object being observed can avoid mistakes that have occurred in order to form a new ideal object(Mammarella et al., 2017).Sastrosasmito (2020)explores the ability of reality to form a new space from architectural observations.

Flexibility of thinking is the diversity of human behavior that is reflected when generating ideas, working and solving problems(Deák, 2000). In the field of architecture, flexibility is used in determining designs to make it easier to achieve functionality(Schneider & Till, 2007).Eissa (2019)found that flexibility of thinking is an important factor in the process of drawing a design.

Abstraction ability is a basis for creating new concepts and objects(Ferrari, 2003). Students in the field of architecture are guided to practice creating design concepts so that abstraction skills can help reduce deficiencies in references by reorganizing the elements they find.(Hershkowitz et al., 2001).Palmiero (2020)found that there is an important relationship

between the ability to abstract and a person's creativity in forming a new structure, essence and definition.

Analysis and synthesis abilities are part of Bloom's taxonomy scheme in the cognitive domain(Fernandes, 1984). Analytical ability is a person's ability to explain the relationship between a combination of elements into a whole(Harsanto, 2005). Synthesis ability is the ability to combine elements logically to form a new structure(Sudijono, 1998).Lopez-Chao and Rodriguez-Grela (2023)explores the importance of analysis and synthesis skills in the process of creating visual interpretation objects in architecture.

Three-dimensional ability or spatial ability is an innate ability to visualize relationships between objects and manipulate mental images in the mind(Elgazzar et al., 2019). This ability is closely related to students in the field of architecture because three-dimensional or spatial abilities are very important in learning related to design(Suh & Cho, 2021). In previous research tooSuh and Cho (2020)found that three-dimensional ability or spatial ability is an important part that influences architectural learning.

First year students in the field of architecture require a high level of adaptation in carrying out drawing assignments in architectural practice courses(Soliman et al., 2019)So students need to develop their potential to face architecture lectures which are different from learning activities in previous secondary education(Saghafi, 2021). The Engineering Drawing and Architectural Drawing courses in the Architectural Engineering Education Study Program are introductory courses that must be taken by first year students as a requirement to take the architecture studio course in the following semester. The varying levels of intelligence of students in the Architectural Engineering Education Study Program can influence various learning successes(Limeri et al., 2020)in the Engineering Drawing and Architectural Drawing courses.Hessary et al. (2020)states that there is an increase in intelligence through the results of architectural design. ThenAl Sayed et al. (2021)states that there is a relationship between increasing intelligence and increasing architectural drawing results and a positive and significant relationship to learning outcomes in technical drawing in the field of architecture.
Based on the background of this problem, the author will discuss the influence of intelligence on learning success which is derived into the formulation of the research statement as follows: How big is the influence of intelligence on learning success in the Engineering Drawing and Architectural Drawing courses?

Methodology – Heading 1 (TNR, 12, Bold, Align Left, Capitalize Each Word)

This research was conducted using a quantitative approach. This research was conducted at the Faculty of Technology and Vocational Education, Indonesian Education University (UPI). The population used in this research were students of the Architectural Engineering Education Study Program for the 2022 academic year. The sample used in this research was 160 people who were divided into two classes, namely 80 Class A students and 80 Class B students. Data collection techniques for measuring intelligence using the Intelligence Structure Test conducted by the UPI Integrated Guidance and Career Development Services Unit (UPT BKPK) and documentation of student grades in the Technical Drawing and Architectural Drawing courses.

The classic assumption tests carried out in this research are the normality test and homogeneity test. The data was found to be normally distributed with a significance of > 0.05 through the normality test using Kolmogorov-Smirnov. The data is known to be homogeneous with a significance of > 0.05 through a homogeneity test using the Levene test. Once the data is known to be normally distributed and homogeneous, the data analysis technique used is parametric statistics. Parametric statistics in this research include correlation analysis with Pearson Product Moment, linearity test, linear regression analysis, t test, and coefficient of determination. The flow of this research is depicted with a flowchart in Figure 1.

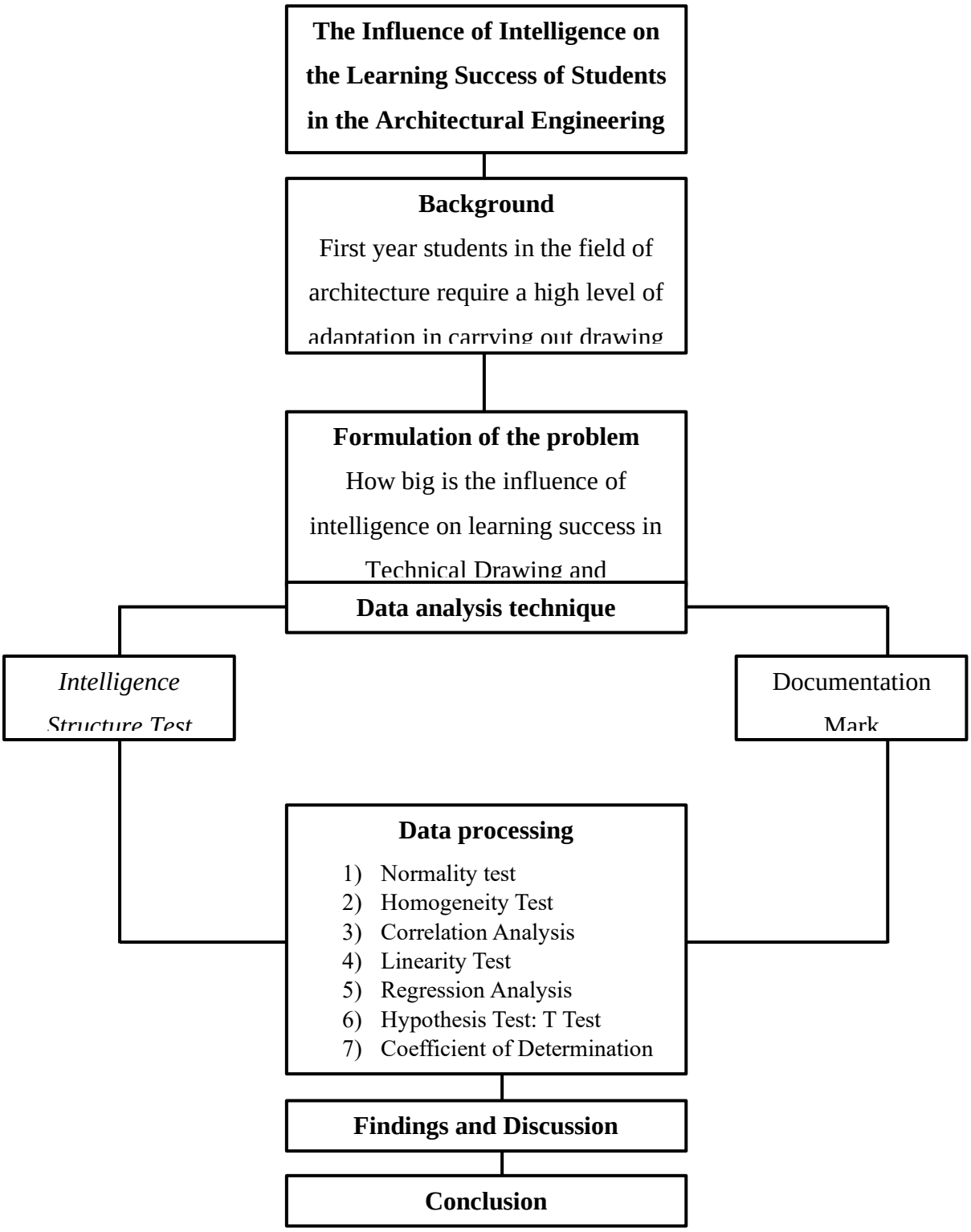

Figure 1. Research Flow

Results and Discussion

1. An Overview of Intelligence

The average intelligence of students in the Architectural Engineering Education Study Program for the 2022 Class A academic year is 72.4, so it can be seen that the average intelligence of Class A students is in the medium category as shown in Table 1.

Table 1. Criteria for Trends in Class A Intelligence Results

Criteria	Category
X ≥ 91	Very high
79 ≤ X < 91	Tall
66 ≤ X < 91	Currently
66 ≤ X < 54	Low
X < 54	Very low

Source: Researcher, 2023

The average intelligence of students in the Architectural Engineering Education Study Program for the 2022 Class B academic year is 70.8, so it can be seen that the average intelligence of Class B students is in the medium category as shown in Table 2.

Table 2. Criteria for Trends in Class B Intelligence Results

Criteria	Category
X ≥ 87	Very high
76 ≤ X < 87	Tall
65 ≤ X < 87	Currently
65 ≤ X < 54	Low
X < 54	Very low

Source: Researcher, 2023

The intelligence results of students in the Architectural Engineering Education Study Program for the 2022 academic year include reality abilities, flexibility of thinking, abstraction abilities, analysis and synthesis abilities, and three-dimensional abilities. A depiction of the five intelligence indicators possessed by students of the Architectural Engineering Education Study Program for the 2022 academic year is presented in diagram form in Figure 1.

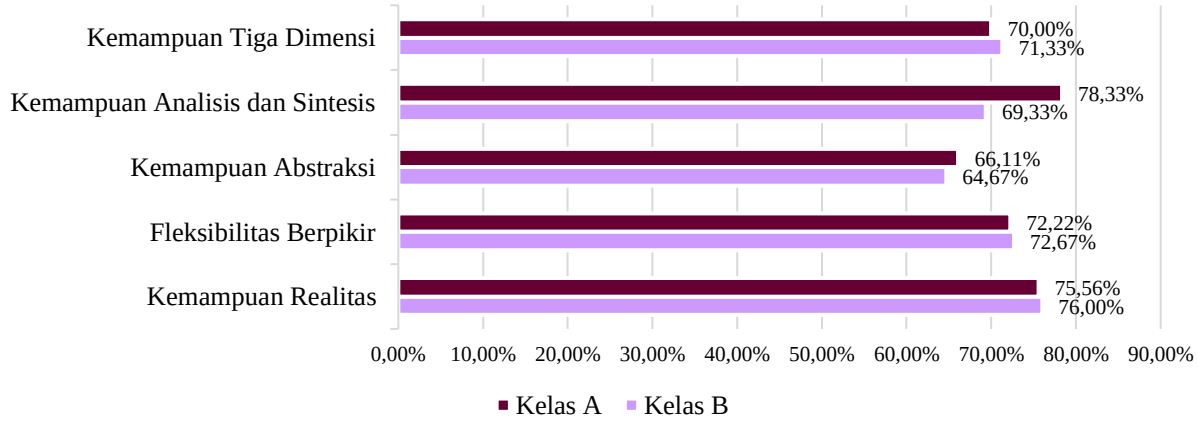

Figure 2. Obtained Intelligence Indicator Diagram
(Source: Researcher Analysis, 2023)

The percentage of Class A students is more dominant in analytical skills and Class B students are more dominant in reality skills. Analysis and synthesis abilities can be influenced by the student's level of knowledge in exploring architectural knowledge and the student's level of understanding of the information provided from classroom learning so that this helps students to think more creatively in producing a good and correct architectural product. Students in the Architectural Engineering Education Study Program for the 2022 academic year are new students, but Class A students have the ability to understand better through analysis and synthesis exercises to produce architectural products through learning and guidance from educators.

Reality abilities can be influenced by students' experiences in observing architectural forms in the real world so that Class B students who are more dominant in reality abilities can visualize better in forming a good and correct architectural product. Students' experience of

architectural forms can help students assess objects whose elements need to be increased or reduced.

Abstraction ability is the lowest ability for both Class A and Class B students. This can happen because students in the Architectural Engineering Education Study Program for the 2022 academic year are new students who are not yet familiar with the concept creation process. This can affect student performance in facing architecture studio courses in the following semester. Abstraction skills can be improved through practicing creating concepts using visual aids such as sketches(Goldschmidt, 2011)and avoid using photos as a reference in creating concepts because photo sources only provide little information(Cheng et al., 2014)so this does not provide a stimulant for students to think creatively.

2. Description of Success in Learning Technical Drawing Courses

The average learning success of Class A students of the Architectural Engineering Education Study Program for the 2022 academic year in the Engineering Drawing course is 84.1, so it can be seen that the average learning success of Class A students in the Technical Drawing course is in the medium category as shown in Table 3.

Table 3. Criteria for Trends in Class A Technical Drawing Learning Outcomes

Criteria	Category
$X \geq 93$	Very high
$87 \leq X < 93$	Tall
$81 \leq X < 93$	Currently
$81 \leq X < 75$	Low
$X < 75$	Very low

Source: Researcher, 2023

The average learning success of students in the Architectural Engineering Education Study Program for the 2022 academic year Class B in the Engineering Drawing course is 79.7 so it can be seen that the average learning success of Class B students in the Engineering Drawing course is in the medium category as shown in Table 4.

Table 4. Criteria for Trends in Class B Engineering Drawing Learning Results

Criteria	Category
$X \geq 94$	Very high
$84 \leq X < 94$	Tall
$75 \leq X < 94$	Currently
$75 \leq X < 65$	Low
$X < 65$	Very low

Source: Researcher, 2023

The successful learning results of students in the Architectural Engineering Education Study Program for the 2022 academic year in the Engineering Drawing course include 13 drawing assignments. A depiction of the scores for the 13 drawing assignments obtained by students of the Architectural Engineering Education Study Program for the 2022 academic year in the Engineering Drawing course is presented in diagram form in Figure 2.

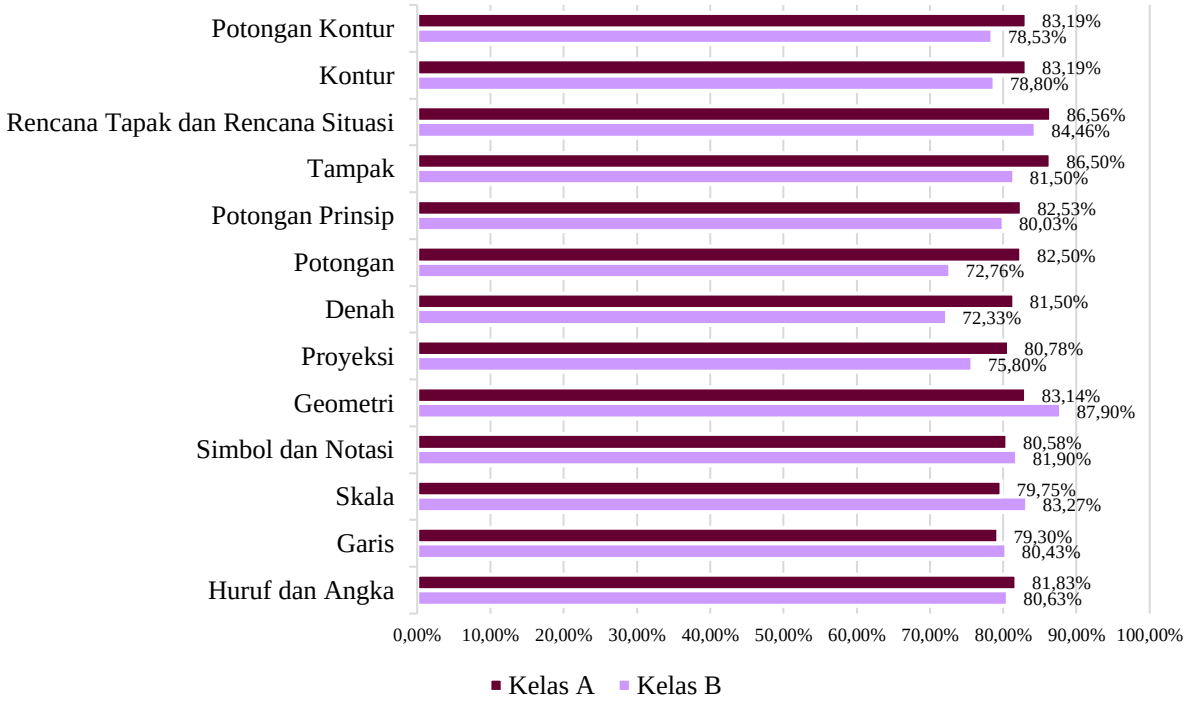

Figure 3. Diagram of the Engineering Drawing Course Assignments Obtained
(Source: Researcher Analysis, 2023)

The percentage of Class A students is superior in the task of Drawing Site Plans and Situation Plans which can be influenced by students' quicker level of understanding in re-drawing the form of site plans and situation plans in accordance with the directions given. This assignment can help students to take studio courses in the following semester which emphasize being able to make site plans and situation plans according to considerations between indoor and outdoor spaces. However, Class A students were lower on the Line Drawing task. Lines are the main component in technical drawing. This can be influenced by the varying levels of adaptation of new students in drawing lines of various types and varying thicknesses, so this needs to be improved again through practice in order to be able to apply lines to architectural products properly and correctly.

The percentage of Class B students who are superior in the Geometry Drawing task can be influenced by the level of understanding of students who find it easier to re-describe geometric shapes that are often found in daily activities. However, Class B students were lower on the Plan Drawing task. The floor plan is the most important part of engineering drawing because all the information related to architectural buildings is contained in the floor plan. This can affect student performance in facing studio courses in the following semester because students are emphasized to be able to make plans well and correctly.

3. Description of the Success of the Architectural Drawing Course

The average learning success of Class A students of the Architectural Engineering Education Study Program for the 2022 academic year in the Architectural Drawing course is 88.9, so it can be seen that the average learning success of Class A students in the Architectural Drawing course is in the medium category as shown in Table 5.

Table 5. Criteria for Trends in Class A Architectural Drawing Learning Results

Criteria	Category
X ≥ 98	Very high
92 ≤ X < 98	Tall
86 ≤ X < 98	Currently
86 ≤ X < 79	Low
X < 79	Very low

Source: Researcher, 2023

The average learning success of students in the Architectural Engineering Education Study Program for the 2022 academic year Class B in the Architectural Drawing course is 82.0 so it can be seen that the average learning success of Class B students in the Architectural Drawing course is in the medium category as shown in Table 6.

Table 6. Criteria for Trends in Class B Architectural Drawing Learning Results

Criteria	Category
X ≥ 92	Very high
85 ≤ X < 92	Tall
79 ≤ X < 92	Currently
79 ≤ X < 72	Low
X < 72	Very low

Source: Researcher, 2023

The successful learning results of students in the Architectural Engineering Education Study Program for the 2022 academic year in the Architectural Drawing course include a pre-test, 16 assignments, mid-semester exam (UTS), and final semester exam (UAS). A depiction of the grades obtained by students of the Architectural Engineering Education Study Program for the 2022 academic year in the Architectural Drawing course is presented in diagram form in Figure 3.

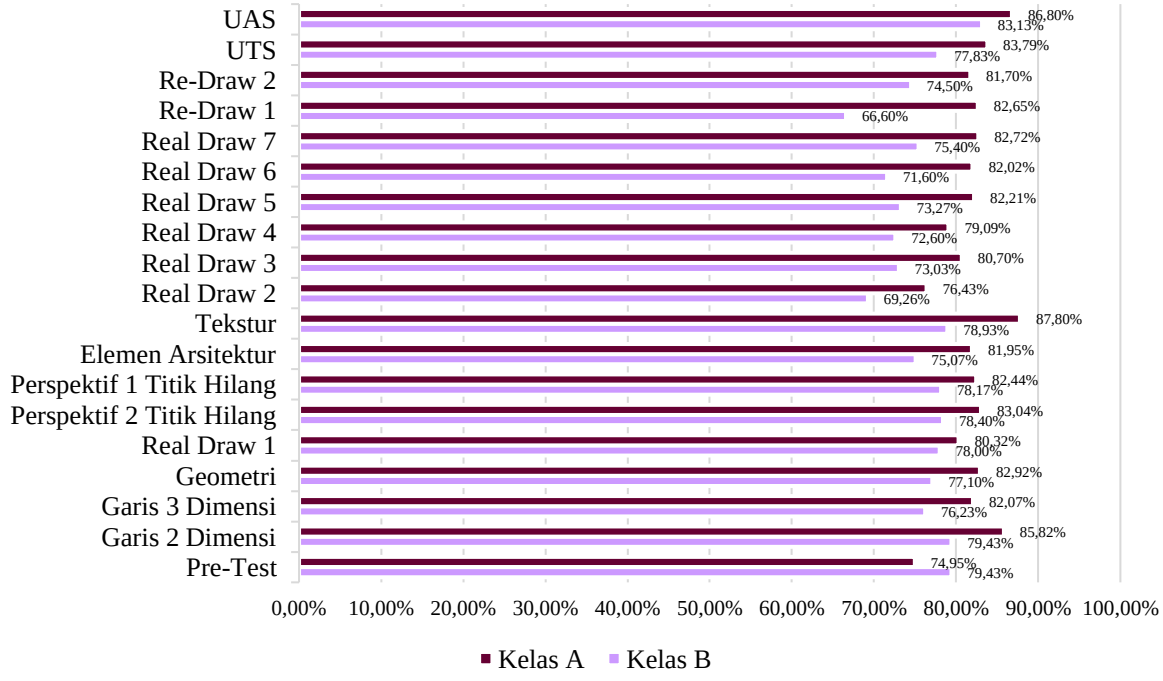

Figure 4. Diagram of the Architectural Drawing Course Assignments Obtained
(Source: Researcher Analysis, 2023)

The percentage of Class A students who are superior in the Texture Drawing task can be influenced by students' preferences in choosing textures to depict that are in accordance with the students' abilities so that this stimulates students to express the results of their observations on the texture of the object being observed. However, Class A students were lower on the pre-

test. The pre-test was carried out as a tool to measure students' drawing abilities before being trained to draw architectural products, namely sketches. This can be influenced by the diversity of students' drawing abilities, so students need to practice a lot to produce interesting and informative architectural drawings.

The percentage of Class B students is superior in the final semester exam (UAS) which can be influenced by the condition of students who have been well trained while doing assignments in the Architectural Drawing course so that on average Class B students get a higher score compared to the assignments given previously. . This can also be influenced by the school background of students in Class B which has a higher number of Vocational High School (SMK) graduates with a percentage of 16.7% compared to Class A with a percentage of 5.6% so that students who graduate from Vocational Schools in Class B can help other students improve. Their learning outcomes through drawing experience are superior to those of high school (SMA) graduate students. However, Class B students were lower on the Re-draw 1 task. This task directs students to redraw a multi-storey building to train students in drawing a building where the object will be seen and depicted directly using freehand techniques. The freehand technique requires a fairly high level of drawing ability, so students who are new to freehand architectural drawing certainly need practice first.

4. The Influence of Intelligence on Learning Success in Engineering Drawing Courses

Based on the correlation analysis that has been carried out, the correlation value (r) is 0.468, which means that there is a moderate level of relationship between intelligence and learning success in the Engineering Drawing course and a significance value of 0.000 (sig. < 0.05) which means that there is significant relationship between intelligence and learning success in Engineering Drawing courses. Then, this relationship is said to be positive and unidirectional so that it can be seen that the higher the intelligence, the higher the student's learning success in the Engineering Drawing course.

From the results of simple linear regression analysis, a constant of 71.599 was obtained and the regression coefficient had a positive value, namely 0.146, resulting in the equation Y = 71.599 + 0.146 Technicals will rise by 0.146. Then, as a form of in-depth research, the researcher carried out multiple regression analysis on the five intelligence indicators to find the indicators that had the most influence on student learning success in the Engineering Drawing course. From the results of the multiple regression analysis, it can be seen that reality abilities have a greater influence on learning success in the Engineering Drawing course with a coefficient value of 0.229 which is higher than other abilities.

Testing the hypothesis with the t test obtained the calculation results, namely t count = 4.236 > t table = 1.66901. The results of this calculation mean that there is a positive and significant influence of intelligence on student learning success in the Engineering Drawing course. The results of calculating the coefficient of determination show that the coefficient of determination is 21.9%, meaning that intelligence has a moderate influence on learning success in the Engineering Drawing course. These results are in line with research conducted by(Hessari et al., 2020)which states that intelligence has a positive and significant relationship to learning outcomes in technical drawing in the field of architecture.

5. The Influence of Intelligence on Learning Success in Architectural Drawing Courses

Based on the correlation analysis that has been carried out, the correlation value (r) is 0.328, which means that there is a low level of relationship between intelligence and learning success in the Architectural Drawing course and a significance value of 0.007 (sig. < 0.05) which means that there is significant relationship between intelligence and success in studying Architectural Drawing courses. Then, this relationship is said to be positive and unidirectional

so that it can be seen that the higher the intelligence, the higher the student's learning success in the Architectural Drawing course.

From the results of simple linear regression analysis, a constant of 71.136 was obtained and the regression coefficient had a positive value, namely 0.204, resulting in the equation Y = 71.136 + 0.204 Architecture will increase by 0.204. Then, as a form of in-depth research, the researcher carried out multiple regression analysis on the five intelligence indicators to find the indicators that had the most influence on student learning success in the Architectural Drawing course. From the results of the multiple regression analysis, it can be seen that analysis and synthesis skills have a greater influence on learning success in the Engineering Drawing course with a coefficient value of 0.595 which is higher than other abilities.

Testing the hypothesis with the t test obtained the calculation results, namely t count = 2.778 > t table = 1.66901. The results of this calculation mean that there is a positive and significant influence of intelligence on student learning success in the Architectural Drawing course. The results of calculating the coefficient of determination show that the coefficient of determination is 10.8%, meaning that intelligence has a low influence on learning success in the Architectural Drawing course. These results are in line with research conducted by(Al Sayed et al., 2021)which states that there is a relationship between increased intelligence and increased architectural drawing results.

CONCLUSION

Based on research results, the average intelligence of students in the Architectural Engineering Education Study Program for the 2022 academic year, which includes reality abilities, flexibility of thinking, abstraction abilities, analysis and synthesis abilities, and three-dimensional abilities, is in the medium category with reality abilities and analytical abilities more dominant. and synthesis and lower on abstraction abilities. Then, the average learning success of students in the Architectural Engineering Education Study Program for the 2022 academic year in the Engineering Drawing and Architectural Drawing courses is in the medium category. In the Engineering Drawing course, Class A students were superior in the task of Drawing Site Plans and Situation Plans and lower in the task of Drawing Lines. Meanwhile, Class B students were superior in the Geometry Drawing task and lower in the Plan Drawing task. In the Architectural Drawing course, Class A students were superior in the Texture Drawing task and lower in the pre-test. Meanwhile, Class B students were superior in the final semester exam (UAS) and lower in the Re-draw 1 assignment.

The magnitude of the influence and relationship of intelligence on student learning success in the Engineering Drawing course is in the medium category with reality ability being the indicator that has the most influence on learning success in the Engineering Drawing course. Meanwhile, the magnitude of the influence and relationship of intelligence on student learning success in the Architectural Drawing course is in the low category with analysis and synthesis skills being the indicators that have the most influence on learning success in the Architectural Drawing course. This shows that intelligence has a positive and significant influence on student learning success in both Engineering Drawing courses and Architectural Drawing courses.

However, there are still many supporting factors that can be measured to see the influence of intelligence on student learning success. So based on these conclusions, researchers recommend conducting a deeper study and measuring other factors such as student background and learning methods for Engineering Drawing and Architectural Drawing courses or other practical courses. Researchers also recommend that educators help improve students' abstraction skills by directing students to learn to practice constructing concepts by making abstract visual aids such as sketches from each reference element they have found so that from the results of these sketches they can produce a new form that fits the characteristics. the student.

THANK-YOU NOTE

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