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Research paper doi: 10.30822/arteks.v10i1.2841

Evaluating relationships between hand-drawing ability and design performance: Case of Architecture Study Program UGM

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ARTICLE INFO

Article history:
Received November 28, 2023
Received in revised form Oct. 11, 2024
Accepted November 28, 2024
Available online April 01, 2025

Keywords:
Architectural drawing
Architectural education
Design presentation
Design studio
Hand-drawing

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ABSTRACT

The importance of drawing is among the most common discourses in architectural practice and education. Current research investigating the relation between drawing ability and architecture students' study performance give various results, indicating that context plays significant role in determining such relationship. Therefore, using a quantitative manner using comparative measurement of correlations, this study aims to add insights to this issue by exploring the connection between architectural students' drawing ability and the results of stages of design studios wherein one studio emphasizes one facet of design at a time, within the context of undergraduate architecture education at Universitas Gadjah Mada, Yogyakarta, Indonesia. The results reveal that, although the correlations vary throughout phases of the studios, the importance of hand-drawing ability is more prominent at certain studio emphasizing the ability to orchestrate form-space and to present design products by hand-drawing, suggesting the noteworthy role of hand-drawing in both envision and presentation.

Introduction

The role drawing plays in architectural education has long been an interest of researchers. Hand-drawing is regarded as mean for thinking and communicating (Shaikh 2023), strengthening visual memory (Putra et al. 2022), integrating thought, sight, and movement (Gomez-Tone and Raposo Grau 2024), kinesthetic and cognitive (Inoue 2024), sensory, physical, and emotional aspects (Gomes 2022), even reflecting idealism (Lionar 2022). Sketching is also regarded beneficial for investigation, knowledge acquisition, and spatial skill development (Castro et al. 2024), and awakening ideas and expressing design (Budiman, Numan, and Idham 2021). Thus, while computer-aided drawing or virtual reality is encouraged (Fakhry, Kamel, and Abdelaal 2021; Gómez-Tone, et al. 2023; Ummihusna and Zairul 2022), hand-drawing is still considered as basic requirement in architectural education (Tai 2022; Taraszkiewicz 2021).

However, there are various findings regarding the relationship between (hand) drawing ability and study performance of architecture students (Hanafiah and Asharsinyo 2021). Al-Saidi (2020) suggests that drawing ability must be integrated with scientific ability of the students. An experiment by Leandri et al. (2022) using EEG shows that hand-drawing increases brain activity, implying creativity as well. Another experimental study by Budiman (2021) demonstrates positive relationship between drawing ability (sketching) and design performance in terms of. architectonic

aspects (form and space). Furthermore, it has been proved by Kupriyanova (2020) that ability in graphical aspect is related to the creative flexibility. On the other hand, a study by Gawlak, Pruszewicz-Sipińska, and Bonenberg (2021) shows that drawing skill does not necessarily correlate to the performance in the architectural studies. Instead, strong academical background has been proven contributing more.

These varied previous results indicate a gap within the theme of hand-drawing in architectural studio: Those studies were conducted without specifying the *context* of the studios in which the significance of drawing was measured, wherein *context* is understood as the *objectives and focuses* or in other words, aspect(s) of architectural design being emphasized in each studio. Therefore, it may be hypothesized that the relevance of drawing ability is *contextual*. In studios emphasizing certain aspects of architectural design, drawing ability may relate positively to the overall performance; yet in other studios focusing on other aspects, other factors may be more important than drawing ability. Thus, this present study aims to emphasize the importance of context in investigating the relation between drawing ability and performance in design studios of the selected students of undergraduate Architecture Study Program, Department of Architecture and Planning, Universitas Gadjah Mada, Yogyakarta, Indonesia. Therefore, this study is expected to bring more insights on the relation between hand-drawing ability and students' performance in architectural studios.

Methods

This study employs an exploratory correlational statistic. Instead of the more classical approach wherein statistics are utilized for confirming rigorously formulated hypothesis using intricate calculations, this more modern approach places statistics as tools for exploring data using mathematical analyses emphasizing more on the obtainment of new insights (Calkins 2005).

Drawing ability is represented by the grades of architectural drawing course (*Rupa Dasar* or Basic Visuals) in 1st semester. Hand-drawing is practiced through various assignments: freehand sketches vs. technical drawings, observational vs. design, and basic forms vs. hand-rendering. Design performance is represented by the grades of all 8 Studios throughout 8 semesters, both separately and as overall mean values. Each of the Studios emphasizes different aspect(s) of design and presentation mode summarized in table 1. Overall learning performance is represented by the GPAs. The grades were taken from three classes of students under a same curriculum. The dataset consists of 75 students from the class of 2016, 59 students from the class of 2017, and 80 students from the class of 2018, resulting in the total number of 214 students.

The relationship between drawing ability and design performance was measured using correlations, with grades of Basic Visuals as predictor and grades of Design Studios and the GPAs as response variable. Correlational study is limited to reveal only relationships which are not necessarily causal. More technically, correlational analysis only reveals whether or not a change of value in one variable (predictor) is followed by a change of value in other variable (response).

Table 1. The various emphases and mode of products of the design studios

Studio	Emphasis	Modus of product
Design Studio 1	Non-architectural formal-spatial composition	compulsory hand-made 2- and 3-dimensional compositions
Design Studio 2	Architectural formal-spatial composition + simple functions	compulsory hand-drawings and hand-made models
Design Studio 3	Responses to contexts	compulsory hand-drawings and hand-made models
Design Studio 4	Simple buildings	optional hand-drawings and/or optional computer-aided drawings; models (modus is optional)
Design Studio 5	Complex buildings	compulsory computer-aided drawings; models (modus is optional)
Design Studio 6	Thematic projects	optional hand-drawings and/or optional computer-aided drawings; models (modus is optional)
Design Studio 7	Thematic projects	optional hand-drawings and/or optional computer-aided drawings; models (modus is optional)

Studio	Emphasis	Modus of product
Design Studio 8 (Final Project)	Comprehensive design	compulsory hand-drawings and compulsory computer-aided drawings; models (modus is optional)

These variables were classified into four sets: The students of 2016, 2017, 2018, and all students counted as one dataset. In total there were 12 datasets tested for normality. Normal distribution is indicated by the Quantile-Quantile (Q-Q) Plots which show the points falling on or near the reference lines, and by histograms which show the symmetrical bell curve. Instead, in figure 1, the Q-Q Plots show that the points deviate relatively far from the lines; likewise, the histograms show that the data tend to skew to the right. Thus, most of the grades are in non-normal distribution; more students got high grades, fewer got low ones.

Thus, due to the non-normal distribution of the data, in this study the Spearman's Rho (ρ) or Spearman's Rank-Order, which deemed suitable for non-normally distributed continuous data as well as for ordinal data or in short, monotonic ranked data (van den Heuvel and Zhan 2022) was used with the formula:

$$\text{rho } (\rho) = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

wherein:

rho (ρ) Spearman's Rank-Order correlation coefficient, also denoted as rs
n number of paired ranks
n^2 the squared value of the number of paired ranks
d difference between paired ranks
d^2 the squared value of the difference between paired ranks
$\sum d^2$ the sum of the squared value of the difference between paired ranks

The value of the correlation always falls between 1 (maximum positive relationship) and -1 (maximum negative relationship), with 0 representing no correlation. Calculations were made for 2016, 2017, and 2018 classes as well as these three batches combined, in which grades of the Basic Visuals course were compared to the various 8 Design Studios, the average (mean) values of all Design Studios, and the GPAs, resulting in 40 calculations.

Results and discussion

The correlation coefficient may be interpreted Leclezio et al. (2015), adapted from Dance and Reidy (2004) as presented in table 2.

Table 2. Interpretation of Spearman's rank-order (ρ) correlation coefficient

Spearman's rank-order (r_s)	Correlation
≥0.70	Very strong relationship
0.40–0.69	Strong relationship
0.30–0.39	Moderate relationship
0.20–0.29	Weak relationship
0.01–0.19	No/negligible relationship

Source: Leclezio et al. (2015), adapted from Dance and Reidy (2004)

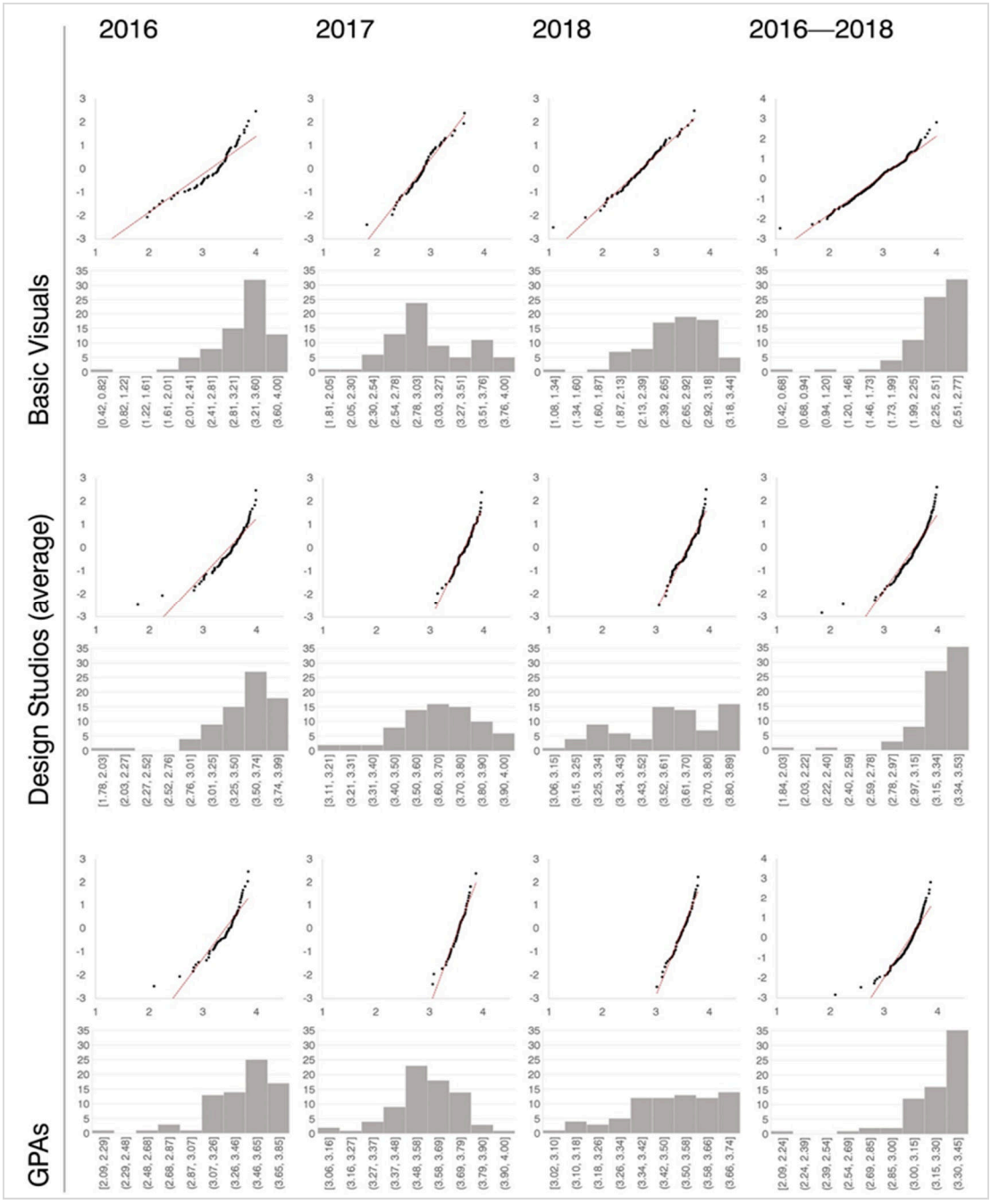

Figure 1. Graphical normality tests for the data in the forms of Q-Q plots and histograms

The correlation coefficients are shown up to 2 decimals (Cole 2015) and presented in table 3. Since this study utilizes descriptive instead of inferential statistics, the results are given without the p-values. According to table 2, the results in table 3 may be interpreted in table 4. Due to the chronological nature of the Design Studios, the correlations may also be interpreted visually in the form of line graph (figure 2), with the addition of two dot plots indicating how the Basic Visuals course related to the average results of the Studios and the GPAs.

Table 3. Spearman's rank-order (ρ) correlation coefficients between basic visuals course grades and design studios as well as GPAs

Class	Spearman's rank-order (ρ) correlation coefficients between basic visuals and various design studio grades								Correlations between basic visuals grades and mean values of all studios	Correlations between basic visuals grades and GPAs
	Studio 1	Studio 2	Studio 3	Studio 4	Studio 5	Studio 6	Studio 7	Studio 8 final project		
2016	0.37	0.62	0.57	0.45	0.44	0.36	0.41	0.61	0.57	0.75
2017	0.40	0.51	0.44	0.48	0.16	0.25	0.24	0.24	0.47	0.51
2018	0.49	0.61	0.56	0.46	0.38	0.38	0.26	0.36	0.64	0.70
2016—2018	0.41	0.56	0.49	0.47	0.26	0.17	0.16	0.23	0.46	0.54

Table 4. Strength of relationships between basic visuals course grades and design studios as well as GPAs

Class	Relationship between basic visuals and various design studio grades								Relationship between basic visuals grades and mean values of all studios	Relationship between basic visuals grades and GPAs
	Studio 1	Studio 2	Studio 3	Studio 4	Studio 5	Studio 6	Studio 7	Studio 8 final project		
2016	Moderate	Strong	Strong	Strong	Strong	Moderate	Strong	Strong	Strong	Very Str.
2017	Moderate	Strong	Strong	Strong	Negligible	Weak	Weak	Weak	Strong	Strong
2018	Strong	Strong	Strong	Strong	Moderate	Moderate	Weak	Moderate	Strong	Strong
2016-2018	Strong	Strong	Strong	Strong	Weak	Negligible	Negligible	Weak	Strong	Strong

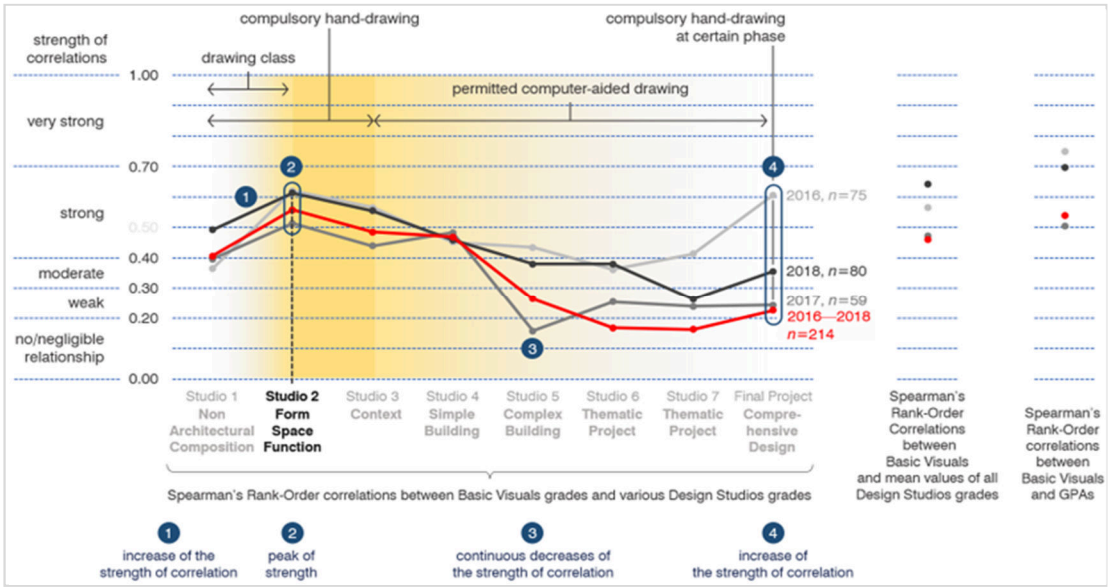

Figure 2. Correlations between basic visuals and various design studio grades, average (mean) values of the studios, and the GPAs, presented in comparative, chronological, and contextual manner

While all 8 calculations involving the average *results* of all the Design Studios as well as the GPAs show strong and very strong positive correlations, of all the total of 32 correlations involving the Design Studios separately, 17 correlations (53%) indicate strong positive relationships, while 15 correlations (47%) indicate moderate, weak, and negligible ones. No negative correlation found. This variety of strength is interesting and offer potentials for further investigation. For example, the four values between the Basic Visual Course and the 5th Design Studio are dispersed across four different levels: strong, moderate, weak, and negligible. Such is also the case of the final project, in which the values encompass strong, moderate, and weak levels. It is possible that this variety is due to the different natures of the classes and/or the Studios, as will be described afterwards.

Nevertheless, instead of the values *per se*, perhaps it would be more insightful to note the *pattern(s)* formed by the values. With some exceptions, it is prominent that the four lines on the graph follow one certain pattern: 1) an increase of the strength of correlation from 1st Design Studio to the 2nd Design Studio, 2) a peak of strength at 2nd Design Studio, 3) continuous decreases after 2nd Design Studio, and 4) an increase at the Final Project. This pattern may be interpreted by considering two possible factors: the difference in terms of mode for presenting design products and the difference in terms of the emphasis of each design studio.

Hand-drawing as mode for presenting design products

The two points in the general pattern depicting the two highest values of correlation are 2nd and 3rd Design Studio, which are two of the first three Studios during which the computer was forbidden and hand-drawing was compulsory.

It should be noted that the 1st Design Studio is unique in terms of this discussion. First, the 1st Design Studio was conducted in parallel to the Basic Visuals course. Thus, it is likely that during this time the students' hand-drawing abilities were still at the formative phase, in contrast to the 2nd Design Studio during which the students' hand-drawing abilities were considerably ready to be utilized. Second, the curricula implemented upon the classes subjected to this study emphasized the use of maquettes/models (both 2- and 3-dimensions) and minimize the use of drawings.

On the 4th Design Studio and afterwards, hand-drawing was not compulsory, and the use of computer was permitted; this coincides with the continuous decreases of the correlations. Finally, a certain phase within the process of the Final Project Design Transformation required compulsory hand-drawing and forbid computers; this concurs with the increases of correlations at the end of the pattern.

This interpretation implies that, within the context of this study, the relationship may be understood in terms of the hand-drawing's role as *the means to present the design product*, more than its role as *the means to enhance design process*. The relatively high correlations between the results of Basic Visuals course and the results of 2nd and 3rd Design Studios then may be understood by considering the compulsory hand-drawings as design product for these two studios; since the quality of the presentation was among the components of the assessment, hand-drawing ability *in terms of presenting design products* contributed significantly in determining the results of the 2nd and 3rd Design Studios. In contrast, from the 4th Design Studio and afterwards, presentation of the products relied more on computer-aided drawings. This explains the decreases of correlation, with an increase at the end indicating the requirement of hand-drawing as the compulsory means to present design products at the phase of Design Transformation within the Final Project series.

Furthermore, this interpretation concurs with the nature of the Basic Visual course. The lesson plan focused more on drawings based on observations of existing objects and various techniques of hand-rendering. Form-drawing for non-existing objects is in relatively much lesser portion. Thus, it may be said that the Basic Visual course developed hand-drawing ability in terms of *presenting* instead of *generating* design.

Hand-drawing as mode for enhancing (certain emphases of) design process

Another interpretation focuses on the certain aspects characterizing each Design Studio. It is prominent that in general the 2nd Design Studio is the one correlating strongest with the results of the Basic Visual course; this Studio focused on the *ability to generate formal-spatial composition within architectural scope* and basic simple functions. Compared to other Studios, the focus of 2nd Design Studio was certainly more closely related to the *activity* of (hand) drawing. Aspects

such as context (3rd Design Studio) or systems in complex buildings (5th Design Studio) were indeed not handled by drawing; however, the process of *generating formal-spatial composition* certainly involves and is affected by the activity of drawing. This concurs with (Budiman 2021): that the activity of drawing by hand supports and enhances design process in generating *architectonic compositions*, or form and space. It is also important to note that *spatial ability*, which plays significant role in generating such formal-spatial compositions, has been proven as positively correlated with creativity (Suh and Cho 2020), thus regarded as valid predictor for the performance in studio (Elgazzar, Helmy, and Ibrahim 2019).

Therefore, there also exists possibility that the ability to hand-draw also contributed to design process, in particular in the 2nd Design Studio, in which the focus is the quality of formal-spatial composition. This suggests that composing design requires coordination between motoric activity and cognitive process. As the focus and assessment components were expanded including other aspects, the correlations between hand-drawing ability and performance in designing seemed to decrease.

Hand-drawing ability and communicative capacity in general

Finally, despite the highly varied values of correlation calculated separately for each studio, correlations between drawing ability and the *average* results of all the studios as well as the GPAs show strong and very strong positive relationships. This explanation implies that 1) students with high cognitive capability may possess both good drawing ability and good communicative ability; and 2) good communicative ability may result in higher GPA, since most courses in architectural education demand good communication of the students, be it their theoretical knowledge or their design.

Conclusions

This study is an attempt utilizing quantitative and statistical methods to investigate the notions about possible relationships between hand-drawing ability and performance in designing within the context of the architectural education conducted at the undergraduate Architecture Program Study, Department of Architecture and Planning, Universitas Gadjah Mada, classes 2016–2018. The results indicate that the strength of the correlations varies throughout the chronological Design Studios, with the importance of hand-drawing ability is in general most prominent at 2nd Design Studio. This variation can be attributed to two possible explanations. First, this Studio focused on the architectonic aspects of architectural design that is, formal-spatial composition which relied on hand-drawing in its envisioning process. Second, this Studio also relied on compulsory hand-drawing in presenting the design products.

These findings suggest that hand-drawing is indeed significant for the process for architecture education within the context of this study, in terms of both *design process* and *design products*. However, it should be noted that this significance is limited to the early Design Studio(s); results show that the hand-drawing ability seems to relate less to more advanced Studios. It may be explained by the less demand of hand-drawing product in these higher Studios and more usage of computer. Still, although the final products of the higher Studios are digitally-made, it should be possible to demand for hand-drawing in earlier conceptual process. This issue may be investigated in future studies.

Acknowledgments

This study was conducted with the support of the 2023 Grant for Laboratory Research, Department of Architecture and Planning, Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia.

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Author(s) contribution

Mario Lodeweik Lionar contributes to data analysis and completion of the manuscript.

Labdo Pranowo contributes to the provision of the basic data used in the study.

Kadek Indira Diah Kardina contributes to the provision and analysis of the literature.

Harry Kurniawan contributes to the technical aspects of the study's completion.

Diajeng Dwi Putri contributes to supervision of the study and completion of manuscript.

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