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Applying Computer Graphic Design Software in a Computer-Assisted Instruction Teaching Model of Makeup Design

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Abstract: Methods for teaching contemporary makeup design involve drawing on paper, which requires considerable time and is difficult to edit. To change the makeup color, one must redraw their entire makeup design again, which is both inefficient and not environmentally friendly. Furthermore, design drawings are difficult to preserve. However, computer graphic design has not been used in the teaching of makeup design drawing; instead, learners rely on knowledge from professors and the experience they accumulate through practicing drawing on paper. Computer graphic design software allows users to experiment with various color designs, lines, and shading options before finalizing their makeup design. Thus, this study sought to employ such technology to improve upon conventional hand drawing practice techniques. The experiment was divided into a preliminary experiment and main experiment, where a two-stage questionnaire was conducted. In the preliminary experiment, the researchers compared the time required to complete the hand-drawn and computer-drawn makeup designs. The results revealed that the hand-drawn designs required almost double time than computer-drawn designs to complete. Additionally, time-lapse photography was taken during the computer drawing process; the photos were used to explain—to participants in a digital drawing group in the main experiment—the digital drawing makeup design procedures and the required operation time. The first stage of the main experiment comprised a brush selection experiment. The participants, 39 students from a cosmetology department, completed a Likert-scale questionnaire. They also performed item analysis to discuss and select drawing tools from a graphic design software, which met the requirements for makeup design pertaining to the eyebrow, eyeshadow, eyeliner, blush, nose contour, and lips. The software allowed the students to experiment with different colors in their design and immediately displays the results. In the second stage, an experiment on optimizing brush arrangements was performed by 10 experts, all of whom were teachers from the department of cosmetology, had at least 5 years of teaching experience, and had obtained a Level B (advanced level) Beauty Technician Certificate. Data from a Likert-scale questionnaire were analyzed and narrative analysis was conducted to determine the rating and evaluation priorities for standards pertaining to the eyebrows, eyeshadow, eyeliners, blush, nose contour, and lips. The requirement for design symmetry was achieved by using the mirror function of the software. This function was useful: it enabled students to complete their makeup design in approximately half the time. This study transformed the conventional learning method through interdisciplinary integration, established novel and innovative teaching models, and provides crucial insights into future research on improving teaching practice.

Keywords: makeup design; computer-assisted instruction (CAI); facial symmetry

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1. Introduction

The COVID-19 pandemic has forced universities to teach remotely. However, makeup design is generally taught through a mentorship system, with hand drawing and the use of cosmetics being fundamental components of instruction. In such a model, students must redraw their entire design if they make a mistake or wish to change something. As of the time of writing, digital teaching methods have yet to be applied in the teaching of makeup design. This may be due to design software having too many types of tools, overly complex functions, or functions that are unsuited to makeup design. These disadvantages may result in the user being unsure of which function to use. Table 1 presents the standards for evaluating makeup design, with respect to technique, in the Republic of China examination for the Level B Beauty Technician Certificate. Most techniques covered by these standards require a symmetrical design that maintains the overall balance and beauty of the face, reflecting the importance of symmetry [1]. Level B and C licensed Beauty Technician Certificate is a requirement for being a professional makeup artist in Taiwan. The contents of the examination for such certification require techniques from paper drawings to real makeup. Hand-drawn training stage is basic and preliminary in terms of the technical difficulty in the learning process, beginner's makeup training starts from the symmetry of makeup, and the makeup symmetry is also one of the primary requirements of the Level C (elementary level) Beauty Technician Certificate. When the learners are proficient and advanced to secondary level B training, there will be makeup design hand drawing and real person makeup training. So at this stage the learners target their learning on makeup design drawing.

Table 1. Standards for evaluating makeup design from the Republic of China examination for the Level B (advanced level) Technician for Beauty Certificate.

Face Part	Technique	Description
Eyebrows	Suitable shape of eyebrows; even eyebrow coloring	Modified according to the face shape. The shape, angle, thickness, and length of the eyebrows are symmetrical, and the eyebrow coloring is even and natural.
Eyeshadow	Symmetrical eye shape; layered and naturally colored	Symmetrical and modified according to the eye shape. The eyeshadow is cleanly applied, and its color is layered and natural.
Eyeliners	Suitable shape of eyeliners; smooth and symmetrical eyelines	Uniform and of suitable shape. The eyelines are smooth, symmetrical, and even.
Nose contour	Suitable for the face shape and is symmetrical; natural and three-dimensional	Modified according to the face shape and helps define the nose shape. The contour is smooth, natural, and makes the nose more three-dimensional.
Blush	Correct positioning and symmetry of blush; evenly and naturally colored	Symmetrical and modified according to the face shape. Uniform and naturally colored, and a nonapparent blush/non-blush boundary.
Lips	Suitable for the face shape and is symmetrical; evenly and naturally colored	Symmetrical and modified according to the face shape. Uniform and naturally colored.

According to the source of Workforce Development Agency, Ministry of Labor, the C-level certificate test started since 1992 and B-level certificate test started since 1996. It has been nearly 30 years that paper makeup training remained unchanged. It is the time now the education model must have an evolution and break through therefore we want to study and construct a set of teaching model advancing with the time, with the science and technology of modern world. At present, there is not yet any relevant research and

beauty education training to take such an approach. Accordingly, the mirror function in computer drawing software is indispensable to makeup design instruction. In addition, the selection of a suitable brush for drawing and the optimization of brush arrangements saves the time required for optimizing design time and provides designers with a more aesthetically pleasing optimization, a key concern in digitized makeup design instruction. Psychological and medical studies have identified facial averageness and symmetry as crucial factors that make a face more attractive; specifically, a face becomes attractive when it represents the average of a population and exhibits a high level of symmetry [2,3]. The argument that facial averageness and symmetry increase attractiveness is supported by the research findings of evolutionary biology that facial symmetry has a positive effect on attractiveness [4]. Many studies have found a positive association between facial symmetry and attractiveness, and exploring the connection between facial symmetry and facial attractiveness has long been an interest of researchers [5–7]. The overall facial image is important, but what are the important factors affecting the facial image, and the relevant studies, as literatures echo the importance of features comparing [8–14].

The rapid development of our information society has made computers indispensable. Computer-assisted instruction (CAI) has been applied in scholarship for many years; it has influenced the conventional teaching ecosystem of schools. As a new education medium, CAI has been used to provide hands-on practice, training, tutorials, and simulations and have prompted teachers to redevise new teaching goals and teaching models [15]. Hemmerla proposed that computer technology provides various types of teaching methods and can greatly improve learning outcomes, constituting an inevitable wave of the future [16]. Science education and corporations have actively devoted their efforts to developing CAI. Studies have indicated that compared with conventional teaching methods, CAI teaching methods can yield significantly better learning outcomes [17,18]. Computer design software provides designers with novel and effective methods to create and express themselves [19,20]. Slavin and Lake revealed that CAI had the greatest influence on improving teaching methods, such as in cooperative learning, course management and incentive planning, and additional counseling programs. CAI can be applied to conventional teaching methods to add new teaching content, create new teaching methods, improve conventional teaching methods, and enable teachers to adjust the teaching content through various methods to satisfy the student's individual demands and assist students in exercising their potential through diverse learning [21]. Matthews compiled data from the Educational Resources Information Center and from hundreds of studies on the reasons why computers must be applied and integrated to art education. The researcher concluded that CAI should be applied in art education primarily because it allows learners to make an unlimited number of trials, corrections, and revisions to their projects [22]. Regarding the commercial applications of computer drawing software, software firms have established makeup systems that offer a graphic user interface with a color palette and virtual drawing tools. Users can choose from diverse colors and textures, select and apply their desired density [23,24], and receive makeup suggestions and examples [25,26]. Most functions in computer drawing software are designed to enhance learning outcomes. Such software also enable graduates to directly connect with industry with regard to the commercial function of innovative makeup designs, helping them better adapt to their new role as an industry professional. The existing challenges in makeup teaching are as follows: (1) The conventional teaching model; (2) the inefficiency, high paper consumption, and environmental unfriendliness involved in the redrawing of makeup designs whenever a change is needed in the color design; (3) difficult filing of hand-drawn makeup designs; and (4) lack of interdisciplinary coordination between the makeup and computer professions. To address these challenges, developing a graphic design tool to improve the teaching model of makeup design drawing is of considerable importance (Figure 1). When computer drawing is applied in the CAI of makeup design, students can instantly see their revision of lines and layers and change colors in the design. Furthermore, the mirror function enables students to quickly complete designs that require symmetry. Digital designs are also portable, and

sending them to others online for discussion and revision is convenient. During distant teaching, instructors can use them to teach various techniques and demonstrate practical examples. The present study investigated the problems experienced when computer drawing techniques were applied in the CAI of makeup design. Statistical analysis was performed in SPSS on Likert-scale questionnaire data to determine how users ranked drawing tools according to their strokes. Through this finding, the researchers constructed a tool database for use in a professional makeup design software as part of CAI. This stage of research focused on computer drawing brush screening and evaluation, the next stage will have the expected value survey and pre-assessment of the computer drawing teaching effectiveness. The final stage will apply the three-dimensional 3D charts and VR simulation test, the ultimate goal is to accomplish the complete set of digital makeup teaching model. This study aimed to discuss the development potential of using a computer drawing makeup design software for CAI and to explore the problems encountered in conventional teaching methods of makeup design. The researchers analyzed the feasibility of applying computer drawing tools in makeup design to improve teaching and learning.

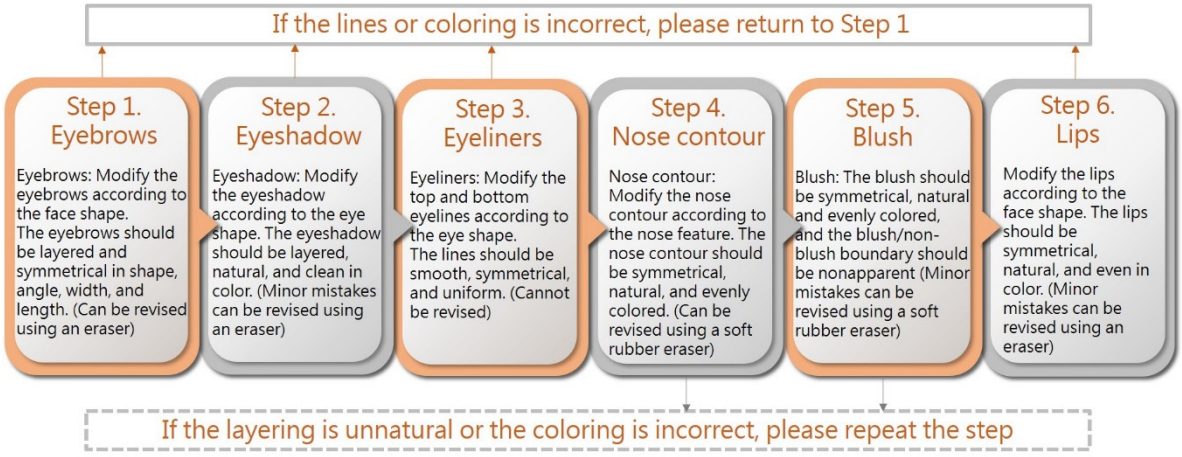


Figure 1. Teaching procedures and requirements in conventional makeup design teaching.

2. Related Works

2.1. Computer-Based Tools in Makeup Design

Drawing makeup designs is a skill required of learners in a makeup course. The conventional teaching model for makeup design drawing involves mostly hand-drawing techniques. The use of computer tools is not prevalent in the makeup profession. However, the makeup industry has a demonstrable need to upgrade; therefore, in response to this need, an interdisciplinary approach combining computer technology and makeup teaching should be adopted. The use of computer technology in education, which can elevate learners' professional knowledge, is crucial to technologically upgrading the makeup industry. The traditional teaching method is hand-drawing teaching, both the teaching process and learning need a long time. The use of computer drawing teaching is absolutely more beneficial than traditional teaching in the further digital application level. After training, perhaps it feels natural that the computer drawing must be relatively fast, but the details of the requirements and practices are very important in the teaching process, and in fact the computer-aided will have more teaching benefits than hand-drawn, such as hand-drawn paper drawing exercises cannot show three-dimensional makeup, but with computer aided, the three-dimensional part of the training can be presented in teaching process. As a result of that, students will have much better three-dimensional sense of space.

In addition to the presence of the outdated teaching model and difficulties in filing of makeup designs, challenges are involved in changing makeup color and design in

hand-drawing practice. Therefore, determining how computer tools can be applied in the cosmetics profession was the crucial problem addressed in this study.

2.2. Establishing Computer Drawing Tools with Suitable Strokes for Makeup Designs

Graphic design software packages that produce strokes include Photoshop, InDesign, Illustrator, and Painter. The present study employed Painter software, the drawing logic of which is more suitable for makeup design and for makeup teaching and drawing. Furthermore, Painter features a realistic and natural brush stroke. Additionally, the software features digital copying and drawing functions to simulate natural effects. Designers can draw using simulated watercolors, oil painting, and chalk as materials to complete their digital design. By using a digital tablet, teachers can teach the various applications of each brush type according to the curriculum and also present various design materials and practices that otherwise cannot be done under conventional teaching methods. This enables students to better understand what is being taught. In the present study, teachers used Corel Painter to authentically present the effects of Western drawing media [27]. Currently, Painter has developed into an expansive toolbox providing a wide variety of presentation media. Designers can use the drawing function to present their unique innovations as media to express their passion for life [28,29]. However, before using the Painter brush simulation, students must familiarize themselves with the brush techniques in the learning process; test, compile, and adjust the parameters; and undergo training to become skilled in controlling the brush and become familiar with the feeling of drawing in the software. Painter use textures represent brush stroke. However, specific media usage with textures is not an easy task, and many designers need to adjust sensible parameters [30]. While the brush is being dragged and before it is released, then accumulate the stroke into a separate overlay texture. When the mouse is released, this overlay is blended with the image below in a process called merging. Merging follows the standard compositing rules [31]. Image editors often provide multiple parameters to customize the brush tool: diameter, hardness, opacity, flow [32].

To achieve strokes resembling eyebrow, eyeshadow, eyeliner, nose contour, blush, and lips makeup, this study selected Painter's different drawing tools for computer-based graphic designs, thereby providing new insights into the teaching of makeup design drawing. Therefore, the production of makeup strokes using computer software for makeup designs was expectable.

2.3. Computer Use in Makeup Design

This study evaluated the feasibility of using computer graphic design tools to draw makeup designs to provide a reference for such tool use in makeup design drawing. A computer drawing tool database was established to serve as a reference with which to solve problems in makeup design drawing caused by conventional hand-drawing techniques for makeup design. The requirement for design symmetry was achieved by using the mirror function of the computer software. The mirror function is efficient, enabling students to complete their makeup within half the required time. Computer tools were used to construct a new teaching model and thus to transform the conventional teaching methods of makeup design drawing. The efficacy of using computer tools for makeup design was tested in a model and need to be confirmed.

3. Methods

The experiment comprised three stages, namely the preliminary experiment, stage one of the main experiment, and stage two of the main experiment. The preliminary experiment tested and compared the required time for participants to complete their makeup designs using conventional hand drawing techniques versus digital drawing techniques. Time-lapse photography was taken during the digital drawing process to illustrate the framework of the digital drawing process to participants in the digital drawing group in the subsequent stage of the experiment. The main experiment was divided into two stages. In the first stage

of the main experiment, a brush selection questionnaire was administered to 39 participants who were asked to rate these drawings of makeup design on a 7-point Likert scale and identical to the test sample by using the computer drawing tools. This research aimed to compare the teaching models for students in the department of Applied Cosmetology, so the background of the 39 participants is mainly for students with makeup experience who have been trained and have a preliminary level C Beauty Technician Certificate, rather than according to the demographic proportions. The statistics data show that an average of about 2200 new students each year entering various technical colleges and universities to study in the cosmetics makeup department in the past three years [33]. There are a total of 73 sophomores, of whom only 39 have level C licensed Beauty Technician Certificates participated in this study, so the 39 people in this study represent a 100% proportion of level C licensed Beauty Technician Certificate students to participate in teaching experiments.

The data on the items were analyzed to determine which brush was suitable. In the second stage of the main experiment, an experiment on optimizing brush arrangements was performed in which design drawings were evaluated by 10 experts in terms of the quality of the makeup design strokes. The brush arrangements were subsequently determined based on the results. The purpose of this study was to improve on the conventional hand-drawing-based teaching of makeup design. A makeup design template from the national examination for the Level B Technician for Beauty Certificate was used as the test sample and evaluation standards [1].

3.1. Preliminary Experiment

The preliminary experiment compared the time required for students to complete a makeup design using conventional hand drawing versus digital drawing methods. Furthermore, time-lapse photography was taken on the strokes performed using various brushes in the digital drawing process to explain the framework of the digital drawing process and the required design time to participants in the digital drawing group of the subsequent stage of the experiment. The results revealed that the hand-drawn and computer-drawn designs required 19 min 38 s and 11 min 45 s to complete.

3.1.1. Participant

Participants of the preliminary experiment were college students from the department of applied cosmetology, were 20 years old, had acquired the Level C (elementary level) Beauty Technician Certificate by the Ministry of Labor of the Republic of China (ROC), and had learned to design using the Painter software for one and a half years. The participants were familiar with operating the computer drawing tool, have completed various practices in drawing and makeup design, and have underwent an eye examination to ensure that no participant was colorblind or had hypochromatopsia.

3.1.2. Experimental Procedure

In the experiment performed to compare hand-drawn versus computer-drawn makeup designs, the participants participated in two sessions of design drawing with a 3-week gap in between. This was to prevent the learning effect. During the computer drawing process, time-lapse photography was recorded to provide an observable example for subsequent participants in the digital drawing group.

3.2. Stage One: Brush Selection Experiment

The number of brushes provided by the Painter software differ for each part of the face. The software provides 23, 23, 24, 23, 13, and 23 choices in the initial selection of brushes for drawing the eyebrows, eyeshadow, eyeliners, nose contour, blush, and lips, respectively. A questionnaire survey was conducted to select brushes with higher ratings and that were suited for drawing in each part of the design.

3.2.1. Participants

Given the prospective application of the study results in professional makeup courses in undergraduate beauty programs, this study recruited students from the department of applied cosmetology at a college as the research participants. In the first stage of the experiment, 39 participants were invited, aged between 18 and 20 years, had been granted the Level C (elementary level) Technician for Beauty Certificate by the Ministry of Labor of the Republic of China (ROC).

3.2.2. Experimental Procedure

In the first stage (Figure 2), 39 participants were repeatedly asked to replicate the makeup design used in the ROC national examination for the Level B Technician for Beauty Certificate for 2 months by introducing Painter drawing tools as a medium paint flow; as the aim was to determine the drawing tools that produce a makeup design for each part of the face similar to the design in a hand-drawn version. Each participant was asked to answer the questionnaire, which had items rated on a 7-point Likert scale. Subsequent item analysis was performed on the questionnaire data to eliminate brushes with lower ratings and to determine the optimal brush for drawing each part in the makeup design. The makeup for each face part by separately applying a single stroke (original texture of the stroke), two strokes (texture of overlaid strokes), and multiple strokes (demonstration of chroma created by the multiple overlaid strokes) using the appropriate drawing tool for each face part. The optimal stroke results, determined jointly by the 39 participants, were used as the sample in the subsequent expert assessment questionnaire survey.

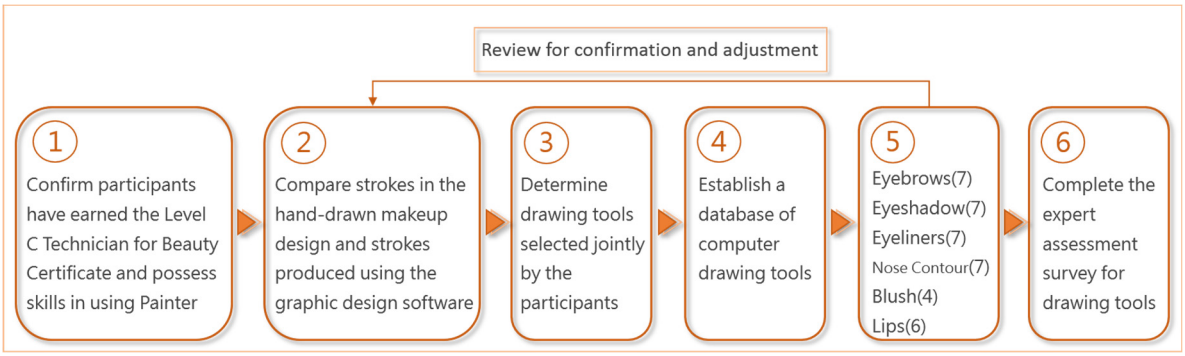


Figure 2. Procedure and steps for producing the experimental makeup design sample using graphic design software.

3.2.3. Samples of the Experiment

In the first stage of the experiment, drawing tools in Painter that produce strokes similar to those in hand-drawn makeup design were determined (Table 1). The stage one result presents the drawing tools and the makeup results completed using the corresponding tools. In the second stage, the effects of applying from one to multiple strokes as well as the completed makeup result of each face part produced by the appropriate drawing tool were used as the experimental sample for the questionnaire survey.

3.3. Stage Two: Optimizing the Ranking of Brushes for Computer Drawing

3.3.1. Participants

In the second stage, 10 experts were recruited to conduct an expert assessment questionnaire survey. These experts were professional teachers who had been granted the Level B (advanced level) Technician for Beauty Certificate by the Ministry of Labor (ROC) and had been teaching makeup for 5 consecutive years or longer.

3.3.2. Experimental Procedure

The second stage (Figure 3) involved the following. (1) We designed the expert assessment questionnaire survey regarding the drawing tools. (2) In the expert assessment survey, the 10 experts were asked to compare the stroke results in the makeup of each face part completed with the drawing tools selected by the 39 participants and rate each result according to its resemblance to the stroke in the corresponding part of the hand-drawn makeup design. The questionnaire was rated on a 7-point Likert scale, where a high score indicated a high level of resemblance. Face-part-specific assessment survey (pretest): The face-part-specific assessment survey began with the eyebrows and then considered the eyeshadow, eyeliners, nose contour, blush, lips. The experts ranked the strokes according to their resemblance to the hand-drawn strokes in the makeup design. (3) Prevention of afterimage interference: After the assessment for each face part ended, the experts were asked to look at a green Bristol board for 1 min to give their eyes a rest; this prevented interference from the afterimage of the previous assessment and reduced the mental workload of the experts. (4) The pretest was followed by a 60-min break before the posttest began. (5) Face-part-specific survey (posttest): the order of the face-part-specific assessments in the pretest was reversed in the posttest. The experts were asked to rank the strokes according to their resemblance to those in the hand-drawn makeup design. (6) After each face-part-specific assessment ended, the experts were asked to look at a green Bristol board for 1 min to give their eyes a rest; this prevented interference from the afterimage of the previous assessment and reduced the mental workload of the experts.

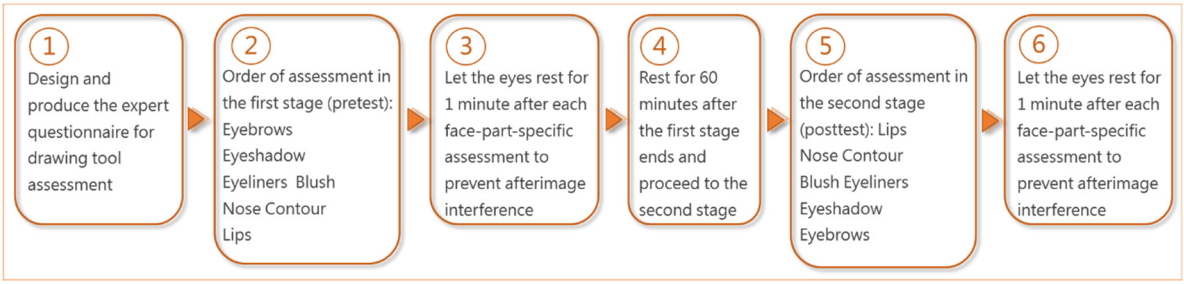


Figure 3. Procedure and steps of expert assessment survey.

3.3.3. Samples of the Experiment

The brushes selected from the previous experimental stage were used according to the evaluation standards of the Level B Technician for Beauty Certificate (Table 1) to draw makeup on the makeup design template from the national examination for the Level B Technician for Beauty Certificate as the test sample. The experts then rated the brushes based on the requirements in the evaluation standard for each test sample (Table 2).

Table 2. Criteria for selecting the appropriate painter strokes for each face part.

Face Part	Criteria for Selecting the Appropriate Painter Strokes
Eyebrows	Light spray and uniform finish; symmetrical; helps the eyebrows stand out
Eyeshadow	Uniform; transparent; exhibits symmetry; helps define the eye sockets
Nose contour	Modifies the nose shape according to the face shape; has a powdery and sprayed finish; exhibits local symmetry; helps the nose stand out
Eyeliners	Suitable, single line drawn along the end of the eyelashes, symmetrical, and having smooth lines
Blush	Uniform, transparent, and layered; symmetrical; a nonapparent blush/non-blush boundary
Lips	Uniform; natural; layered; color-saturated; symmetrical lines; rich in color

4. Results and Discussion

4.1. Drawing Tool Comparison

The 39 participants compared and selected appropriate Painter drawing tools according to the selection criteria for each face part in the makeup design. By rated drawing tools that were included in the database, it was determined that the selected Painter drawing tools for each face part conformed to the criteria of a uniform, transparent, and natural layered finish. In particular, the finer spray, digital airbrush, digital soft flat airbrush, digital soft flow airbrush, digital soft velocity airbrush, fine detail air, and soft airbrush tools all met the criteria for eyebrows, eyeshadow, and nose contour. According to the results, the spray tools were suitable for creating a layered finish; these spray tools, with their shared characteristics of a light spray and powdery layered finish and local symmetry, produced suitable strokes for the 4 of the 6 face part. Item analysis was performed on the questionnaire rating results of the first stage of the experiment, in which the elimination criteria of the observed data were used to determine which items to delete. Specifically, items were eliminated if their mean < 5.4, standard deviation (SD) < 0.7, skewness > 0, corrected item total correlation > 0.3, factor loading < 0.55, t < 0.05, Pearson correlation > 0.3, and total deviation $\geq$ 3. Items with a total devaluation of three or higher were screened and eliminated, and brushes demonstrating favorable computer makeup drawing performance were retained. Tables 3 and 4 revealed that after screening 23 types of brushes for makeup design pertaining to the eyebrows, eyeshadow, and nose contour, only 7 remained. Additionally, out of 24, 13, and 23 types of brushes for makeup design pertaining to the eyeliners, blush, and lips, only 7, 4, and 6 remained, respectively. Table 5 revealed the questionnaire was stable and reliable, having a Cronbach's α of 0.926. After the first stage of screening, only brushes that demonstrated satisfactory performance in computer makeup drawing remained (as displayed in Figure 4). Subsequently, the second stage of the experiment—ranking the ratings of each brush—was conducted.

Table 3. Painter drawing tools for the eyebrows makeup design.

Eyebrows	Mean	SD	Skewness	Corrected Item Total Correlation	Factor Loading	*t*	Pearson	Total Deviation
Finer Spray	5.49	1.30	−1.92	0.24	0.06	0.15	0.14	1
Digital Airbrush	5.41	1.27	−2.14	0.02	0.03	0.13	−0.01.	1
Digital Soft Flat Airbrush	6.05	0.79	−3.43	−0.02	0.00	0.45	0.17	1
Digital Soft Flow Airbrush	5.49	0.64	−0.89	−0.08	0.00	0.81	−0.08	2
Digital Soft VelocityAirbrush	4.85	1.37	−0.55	−0.12	0.03	0.30	−0.12	2
Fine detail Airbrush	6.44	0.75	−2.49	0.04	0.03	0.23	0.07	1
Soft Airbrush	5.5	0.64	−0.57	0.21	0.01	0.22	0.23	1

Note: significance (two-tailed p < 0.05).

Table 4. Painter drawing tools for the eyeliners makeup design.

Eyeliners	Mean	SD	Skewness	Corrected Item Total Correlation	Factor Loading	*t*	Pearson	Total Deviation
2B Pencil	6.67	0.87	−4.36	−0.57	0.53	0.15	−0.30	1
Color Pencil	6.44	0.75	−2.49	−0.36	0.19	0.30	−0.404 *	1
Mechanical Pencil	6.46	0.72	−1.42	−0.39	0.25	0.25	−0.17	1
Simulated 2B Pencil	6.10	0.97	−3.89	−0.04	0.00	0.33	0.11	1

Table 4. *Cont.*

Eyeliners	Mean	SD	Skewness	Corrected Item Total Correlation	Factor Loading	*t*	Pearson	Total Deviation
Simulated 2H Pencil	5.85	1.53	−2.56	−0.36	0.34	0.25	−0.675 **	1
Simulated Sharp Color Pencil	5.46	1.60	−2.07	−0.25	0.16	0.91	−0.496 **	1
Sharp Pencil	6.41	1.12	−2.69	−0.25	0.33	0.44	−0.403 *	1

Note: significance (two-tailed $p < 0.05$), * (**) correlation significant at the 5% (1%) level.

Table 5. Reliability statistics.

Cronbach's α	Standardized Cronbach's α	Items
0.926	0.910	129

Figure 4. Performance of brushes suitable for computer makeup drawing design from the brush screening experiment.

4.2. Analysis Results for Drawing Tools

4.2.1. Eyebrows

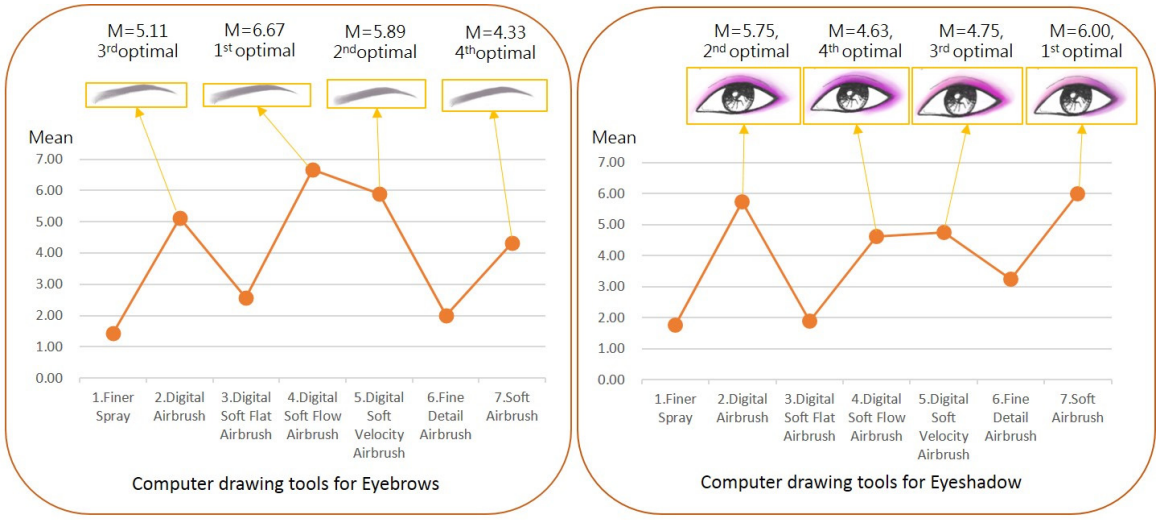
Based on the strokes produced by the seven drawing tools selected by the participants for eyebrows, this study developed a stroke assessment survey and administered it to 10 experts, who were asked to rank the drawing tools' strokes by rating the strokes from 1 to 7 in a pretest and posttest. Specifically, 7 was assigned to the best stroke and 1 to the poorest performing stroke. SPSS was used to determine the test–retest reliability by using the Pearson correlation coefficient. The results of nine experts reached the significance level ($p < 0.05$), which indicated reliability of the nine experts' assessments (Table 6).

Table 6. Test–retest reliability analysis for eyebrows drawing tools.

Eyebrows Stroke Survey	EP [a] 1	EP [a] 2	EP [a] 3	EP [a] 4	EP [a] 5	EP [a] 6	EP [a] 7	EP [a] 8	EP [a] 9	EP [a] 10
Pearson correlation coefficient	1.000 **	0.964 **	0.286	0.929 **	0.857 *	0.821 *	0.964 **	0.964 **	1.000 **	0.964 **
Significance (two-tailed $p < 0.05$)	0.000	0.000	0.535	0.003	0.014	0.023	0.000	0.000	0.000	0.000

Note: * (**) Correlation significant at the 5% (1%) level, [a] expert, EP.

The nine experts' assessments were subsequently subjected to the Kendall's coefficient of concordance (Kendall's W) test to determine whether their assessments were consistent. The descriptive statistics (number of experts, mean, SD, minimum, and maximum) were used to identify the optimal drawing tool. The rank list had shown below (Figure 5a).



(**a**) (**b**)

Figure 5. The optimal drawing tools rank list of computer drawing tools for (**a**) eyebrows and (**b**) eyeshadow.

Consistency analysis results: The Kendall's W was 0.880 and reached the significance level ($X^2 = 47.524$, $p < 0.001$); therefore, the nine experts' assessments were consistent.

Determination of the optimal drawing tool: Of all strokes produced by the seven drawing tools for eyebrows, the digital soft flow airbrush received the highest score (mean = 6.67; SD = 0.707) and was determined by the experts to be the optimal drawing tool for eyebrows (Table 7).

Table 7. Consistency analysis of drawing tool assessment and ratings of drawing tools for eyebrows.

Descriptive Statistics					
Eyebrows Stroke Statistics	**Number**	**Mean**	**SD**	**Minimum**	**Maximum**
1 Finer Spray	9	1.44	0.726	1	3
2 Digital Airbrush	9	5.11	0.782	4	6
3 Digital Soft Flat Airbrush	9	2.56	0.527	2	3
4 Digital Soft Flow Airbrush	9	6.67	0.707	5	7
5 Digital Soft Velocity Airbrush	9	5.89	0.782	5	7
6 Fine Detail Airbrush	9	2.00	0.866	1	3
7 Soft Airbrush	9	4.33	0.707	4	6
Test Statistics					
Number			9		
Kendall's W			0.880		
Chi-square			47.524		
Degree of freedom			6		
Asymptotic significance			0.000		

Kendall's coefficient of concordance.

4.2.2. Eyeshadow

On the basis of the seven drawing tools selected by the 39 participants for eyeshadow, this study designed a stroke assessment survey and administered it to 10 experts, who were asked to rank the strokes by rating each stroke from 1 to 7, with 7 and 1 indicating the most and least favorable strokes, respectively. A test–retest reliability analysis was performed using SPSS to obtain the Pearson correlation coefficient between the pretest and posttest. Eight experts reached the significance level ($p < 0.05$), which indicated that their assessments were reliable (Table 8). The assessments of the eight experts were then subjected to the Kendall's W test to obtain the level of consistency among their assessments. Descriptive statistics (number of experts, mean, SD, minimum, and maximum) were used to determine the optimal drawing tool. According to the consistency analysis result, the Kendall's W was 0.648 and reached the significance level ($X^2 = 31.125$, $p < 0.001$), showing a consistency among the eight experts' assessments. Of all strokes produced by the seven drawing tools, Soft Airbrush had the highest rating (mean = 6.00; SD = 0.756) and was identified by the experts as the optimal drawing tool for eyeshadow (Figure 5b), and the rank list had shown below (Table 9).

Table 8. Test–retest reliability analysis for eyeshadow drawing tools.

Eyeshadow Stroke Survey	**EP [a] 1**	**EP [a] 2**	**EP [a] 3**	**EP [a] 4**	**EP [a] 5**	**EP [a] 6**	**EP [a] 7**	**EP [a] 8**	**EP [a] 9**	**EP [a] 10**
Pearson correlation coefficient	0.964 **	0.857 *	0.429	0.964 **	0.679	0.893 **	0.964 **	0.964 **	0.964 **	0.964 **
Significance (two-tailed $p < 0.05$)	0.000	0.014	0.337	0.000	0.094	0.007	0.000	0.000	0.000	0.000

Note: * (**) correlation significant at the 5% (1%) level, [a] expert, EP.

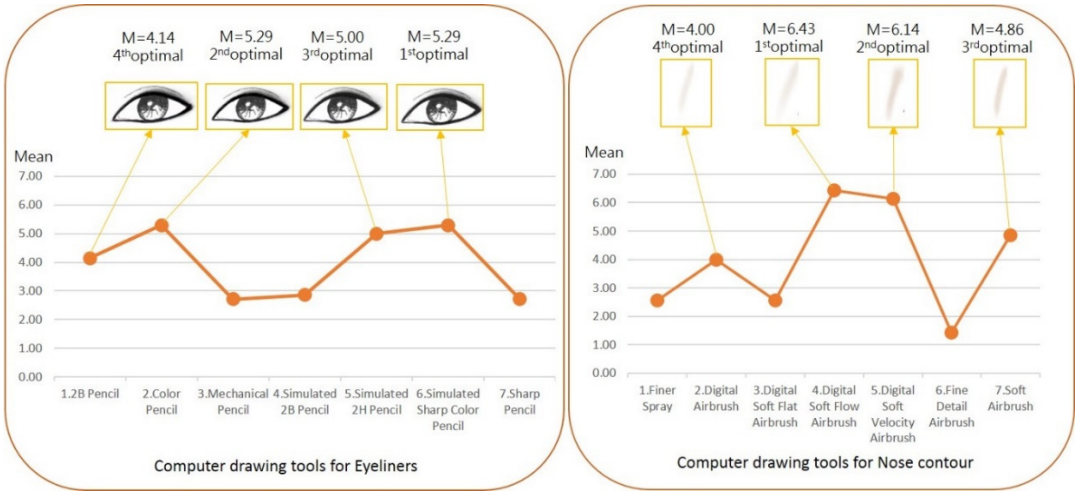
Table 9. Consistency analysis of drawing tool assessment and ratings of drawing tools for eyeshadow.

Descriptive Statistics					
Eyeshadow Stroke Statistics	**Number**	**Mean**	**SD**	**Minimum**	**Maximum**
1 Finer spray	8	1.75	1.035	1	4
2 Digital airbrush	8	5.75	1.389	3	7
3 Digital soft flat airbrush	8	1.88	0.835	1	3
4 Digital soft flow airbrush	8	4.63	1.996	1	7
5 Digital soft velocity airbrush	8	4.75	1.488	2	7
6 Fine detail airbrush	8	3.25	0.866	2	5
7 Soft airbrush	8	6.00	0.756	5	7
Test statistics					
Number			8		
Kendall's W			0.648		
Chi-square			31.125		
Degree of freedom			6		
Asymptotic significance			0.000		

Kendall's coefficient of concordance.

4.2.3. Eyeliners and Nose Contour

The results for the brush stroke of the seven types of brushes were subject to multivariate analysis in SPSS to determine their test–retest reliability, to compare the pretest and posttest statistics, and to calculate the test–retest reliability coefficient (Pearson correlation). The assessment of the seven experts were reliable: the Pearson correlation coefficient between the experts' pretest and posttest scores were significant ($p < 0.05$). The experts also gave consistent ratings: their Kendall's coefficient of concordance was 0.319 and significant ($X^2 = 13.408$, $p < 0.05$). Among the seven drawing tools, the color pencil, and simulated sharp color pencil were rated the highest (mean = 5.29); the simulated sharp color pencil, with an SD of 1.254, was identified by the experts as the best tool for drawing eyeliner (Figure 6a).



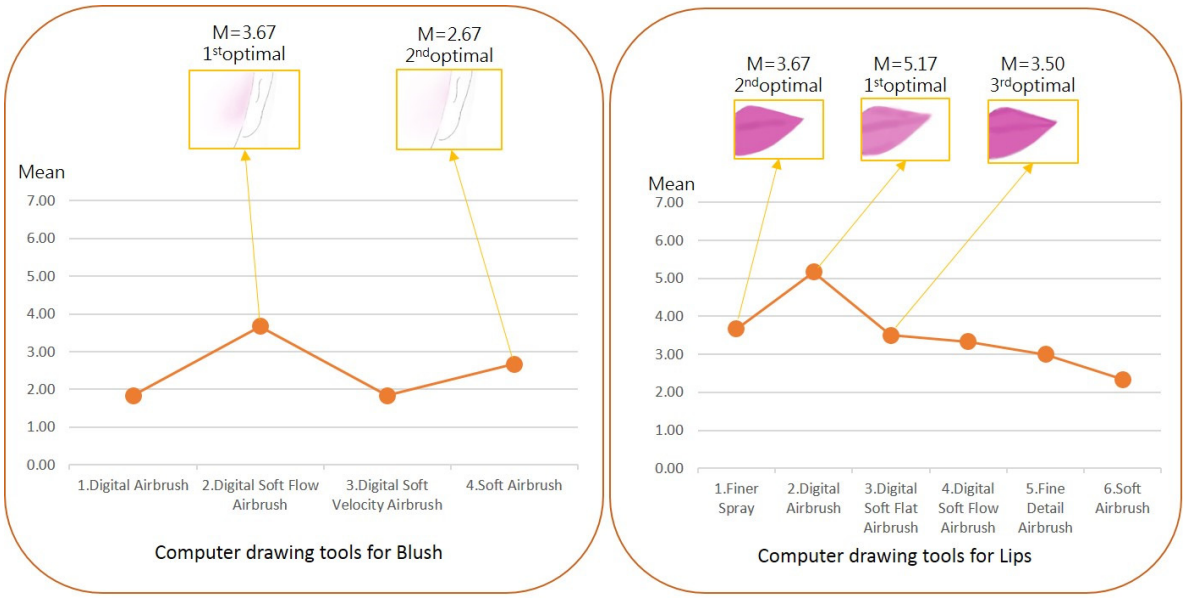
(**a**) (**b**)

Figure 6. The optimal drawing tools rank list of computer drawing tools for (**a**) eyeliners and (**b**) nose contour.

Nose contour: regarding the brush stroke results for the seven types of brushes, the 10 experts gave reliable ratings: their test–retest reliability coefficient (Pearson correlation coefficient) of the pretest and posttest scores was significant ($p < 0.05$). The experts also gave consistent ratings: their Kendall's coefficient of concordance was 0.783 and significant ($X^2 = 32.878$, $p < 0.001$). Among the seven brush types for designing the nose contour, the digital soft flow airbrush had the highest rating (mean = 6.43, SD = 0.787) and was identified by the experts as the best tool for drawing the nose contour (Figure 6b).

4.2.4. Blush and Lips

A test–retest reliability analysis was performed using SPSS to obtain the Pearson correlation coefficient between the pretest and posttest. Six experts reached the significance level ($p < 0.05$), which indicated that their assessments were reliable. The assessments of the six experts were then subjected to the Kendall's W test to obtain the level of consistency among their assessments. Descriptive statistics (number of experts, mean, SD, minimum, and maximum) were used to determine the optimal drawing tool. According to the consistency analysis result, the Kendall's W was 0.456 and reached the significance level ($X^2 = 8.2$, $p < 0.05$), showing a consistency among the six experts' assessments. Of all strokes produced by the four drawing tools, Digital Soft Flow Airbrush had the highest rating (mean = 3.67; SD = 0.816) and was identified by the experts as the optimal drawing tool for blush (Figure 7a).



(**a**) (**b**)

Figure 7. The optimal drawing tools rank list of computer drawing tools for (**a**) blush and (**b**) lips.

Lips: the results for the brush stroke of the six types of brushes for makeup design of the lips were subject to multivariate analysis in SPSS to determine their test–retest reliability, compare the pretest and posttest statistics, and to calculate the test–retest reliability coefficient (Pearson correlation). The assessment of the six experts were reliable: their Pearson correlation was significant ($p < 0.05$). However, the experts did not give consistent ratings: their Kendall coefficient of concordance was 0.254 and nonsignificant ($X^2 = 7.619$, $p > 0.05$). Among the six brush types used for makeup design of the lips, the digital soft flow airbrush had the highest rating (mean = 5.17, SD = 1.169), and was identified by the experts as the best brush for makeup design of the lips (Figure 7b). In general, the results indicated that the brush tool for the lips features a consistent color output and high color saturation. However, it was difficult to make fine-grained distinctions between each brush

tool, which was possibly why the rating results were inconsistent. To resolve this problem, researchers should include the quantified color output of brush tools as a research item to clarify the selection of computer brush tools.

4.3. Establishing a Stroke Application Database

The research results were used to build a stroke database of Painter drawing tools for application in makeup design drawing and develop teaching models to improve the teaching of makeup design drawing. Based on the optimal drawing tool determined for each face part, the following model was established for using the optimal drawing tools (Figure 8).

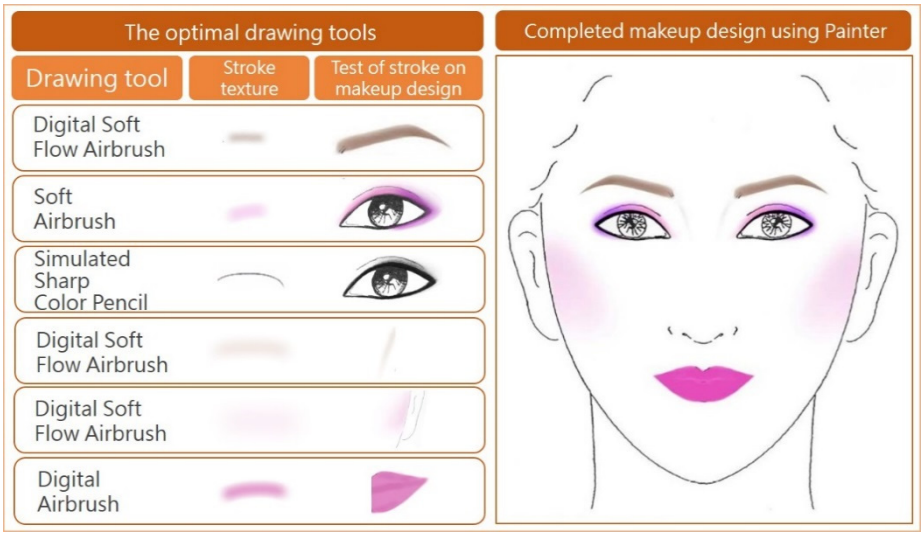


Figure 8. Teaching model for the optimal drawing tools.

According to the results, users may make adjustments to the recommended drawing tools and change how these tools are applied according to their preferences. The application of computer drawing tools in makeup design drawing transformed the conventional learning of makeup design and—by making changing colors facile—enabled learners to experiment with various creative and innovative makeup designs, thereby improving both teaching and learning effectiveness. This paper reports the research results of almost complete makeup design containing all facial features.

5. Conclusions

This study tested graphic design software drawing tools suitable for makeup design, created a database of these, and developed a new model for makeup teaching. Through comparison and testing, this study identified drawing tools with strokes that resemble those of the hand-drawn eyebrows, eyeshadow, nose contour, eyeliners, blush, and lipstick in the sample makeup design. Subsequently, the optimal drawing tools were obtained through analyses and a survey to ensure reliable assessment of the tools. On the basis of the research results, which exhibited satisfactory consistency among the expert assessments of the drawing tools, this study proposed new teaching models for innovative beauty design. Additionally, it made recommendations and consolidated standards on the use of computer graphic design in relation to makeup design, thereby encouraging the revisiting and redesign of relevant courses. Computer graphic design software facilitates an innovative teaching method that allows for unlimited trial and error, modifications, undos, and replications in makeup design, which transforms the conventional teaching of makeup design that has stagnated. The results were as had been expected. The research framework, methods, and results, which were verified to have high developmental potential, may serve as reference for future research. The preliminary results on the computer drawing

tools and their strokes—obtained through repeated modifications and tests and the use of relevant analytic methods to solve various problems—will be extended to explore other topics, such as the paint flow of drawing tools, comparison of stroke position, as well as the strategic design of teaching modules and materials. In the future, the authors will focus on student learning to develop innovative and efficient teaching models for professional makeup design, with the aim of boosting students' learning effectiveness because having excellent makeup design skills is crucial to their competitiveness in the job market. This study's approach may help improve the learning effectiveness of professional makeup designs, initiate research into makeup teaching in academia and industry, and reestablish the channels and methods of interdisciplinary teaching in makeup courses.

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