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Analyzing the Relevance of Peer Relationship, Learning Motivation, and Learning Effectiveness—Design Students as an Example

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Abstract: In a design department's practice course there are often group exercises that include intensive interactions between students in the classroom or in the internship factory. In addition, students will deepen the interaction between peers due to course groupings or borrowing of model tools, etc. This study intended to carry out a differential analysis and discussion of the differences among design students from different backgrounds under the three factors of peer relationships, learning motivation, and learning effectiveness. The research method was based on literature analysis and a questionnaire survey, and the research objects were sophomores and seniors in four classes. Statistical analysis methods included the independent sample T-test, one-way ANOVA, and factor and cluster analysis, which were used to summarize different learning styles. The results showed that the students had significant differences of varying degrees in the three factor dimensions. Regarding gender, "care about classmates' lives" in peer relationships scored higher for the females than the males, and the rest had no effect. Regarding educational system, "care about the classmates' life" and "sharing life trivia" was included in peer relationships. "keep the enthusiasm in the course of learning" was included in the learning motivation. "recognition for self-directed learning" and "ability improvement" was included in learning effectiveness. The three factors all had significant differences, and the differences for full-time students were higher than for night school students. Regarding grade, there were significant differences in "friends will value my comments" and "sharing life trivia" in peer relationships, "understand course content" in learning motivation, and "data collection ability" and "understanding team member expertise" in learning effectiveness, and seniors scored higher than sophomores in these areas. In addition, the ANOVA and post-hoc tests revealed significant differences in learning the processes between different groups. In peer relationships, full-time seniors scored higher than the other groups; in learning motivation and learning effectiveness, full-time seniors scored higher than night school sophomores. In addition, the overall factors of the full-time seniors were higher than those of the other groups. In the analysis of different learning factors, under the premise of the variation of 58.975%, three factors were extracted by principal axis for analysis with Promax rotation. The different learning factors can be summarized in "emphasizing ability improvement", "care about peer friendship", and "careful and active learning". Classification of learning styles under the three factor dimensions was based on two-stage cluster analysis to obtain two clustering results, including "enthusiastic and friendly" and "active and autonomous". The results showed that the mastery of self-learning time and the learning experience performance have a key influence on the learning motivation and learning effectiveness of design students from different backgrounds. In addition, the results also showed a new opportunity for course improvement and teaching innovation at night schools. The final results of this study could be used as an important reference for research on peer relationships, learning motivation, and learning effectiveness in design education.

1. Introduction

1.1. Research Background and Motivation

During professional design practice courses in a design department, group cooperation and personal performance are often used for course interactions and exercises. Therefore, it is common to see group cooperation activities in design courses. In addition, most of the coursework in a design department takes design practice as the main course requirement. These courses provide many opportunities for interaction in the classroom and the internship factory. Therefore, based on the above-mentioned course content, it could be understood that the teamwork experience and interaction frequency between design peers is much higher than in other departments. However, in addition to teamwork training, design learning also emphasizes individual creative performance and independent thinking, especially the particularity of the design course itself, which allows students to spend time and energy on coursework execution and cannot get the same feedback. Therefore, it is not difficult to find that when students perform coursework or face a course, they will have different ideas generated in their minds. Once students' learning mentality changes, the teachers' guidance and evaluation will have varying degrees of difference. On the other hand, for students, their learning motivation and enthusiasm may have also changed.

At this time, students' learning motivation may be qualitatively changed because they do not get the same feedback. This also leads to a change in learning attitude when students face design courses. Author [1] also mentioned that learning motivation is the motivation for students' achievement in learning. An internal psychological need to pursue success for individuals will also be one of the main factors affecting academic achievement. Therefore, once students' mentality changes, teachers will have different levels of guidance and evaluation in teaching. Author [2] once pointed out that the personal learning effectiveness of students can also be called learning outcomes and learning performance, which means that after a period of learning, learners can meet the original expected results and have a certain field or stage professional competence. Author [3] also pointed out that learning motivation has a direct positive effect on learning effectiveness. In addition, Ref. [4] found that learning motivation and learning effectiveness are related to each other. Therefore, for design students, when they cannot obtain the same sense of accomplishment and feedback, the learning motivation and enthusiasm will change, which may affect personal learning performance.

No matter in which educational field, peer relationships are an important factor affecting student learning. Author [5] pointed out that the individual interacts more with peers who have high learning achievements, and then the learning attitude of the individual and the establishment of personal values will exhibit less deviations. Especially after entering junior high school, students' dependence on peers becomes much higher than on parents and teachers. Therefore, peer relationship has a status that cannot be ignored for learning development and life experience in adolescence [6–8]. When design students reach university, although it becomes a self-learning process, it is easy for them to have different relationships and interaction frequencies because of the execution of coursework. Author [9] believes that the interaction between peers includes the atmosphere within the peer group, and that it influences individual values and behaviors in addition to the two people communicating with each other. Therefore, design students of different backgrounds may have different stakes. Grades, genders, and educational systems may have differences. In addition, for college students, peer groups are like the epitome of society. Through getting along with peers, students can understand and accept themselves, and then learn to respect and appreciate others, and they can help and cooperate with each other. "Peer" has become an indispensable important figure in the socialization process of college students [10].

Especially when entering the professional design practice course from the sophomore year, new interactive caused by group cooperation and the loan of model materials and tools will

arise, this even extending to various activities outside the classroom, which will deepen their interaction. Author [11] believes that peer support refers to positive encouragement and care between individual self-perception and friends, including mutual thoughts, care, and emotional support. These relationships may evolve into engaging in active learning together and striving for outstanding results; it is also possible to indulge together, and in the end the attitude towards learning becomes indifferent. There have been many studies in the past that found that peer interaction has a significant impact on students' beliefs and attitudes [12–14]. When we look further from the perspective of students' self-identification of learning motivation and learning effectiveness, it seems however to be related to the content of the course and the way the teacher teaches. However, as mentioned above, will the interaction between design student peers of different backgrounds also affect their learning motivation and learning effectiveness? This is also the place where this study is curious and wants to investigate and understand. The goal of this study was to answer the above question through the particularity of design courses, as well as to understand and analyze the differences among the peer relationships, learning motivation, and learning effectiveness of design students from different backgrounds. It then tries to infer the key influences on the learning of design students.

1.2. Research Purpose

During the course of learning development of students, there are many factors that influence learning achievement; from the explicit factors, one can get a glimpse of the major departments, course content planning, and teacher teaching methods. Hidden factors, such as peer relationships, learning motivation, and learning effectiveness, are not easily found to be influential. However, whether explicit or implicit, some are long-term cumulative effects, while others are short-term effects. In addition, in [15] the research results of college students as the research objects found that students' social relationships (referring to making friends) will affect their motivation to learn, and thus for students with better peer relationships, their learning motivation is also high. Therefore, the main purpose of this study is to investigate the differences between peer relationships, learning motivation, and learning effectiveness of design students of different backgrounds. This study also attempts to compare and analyze the differences from the survey process and then summarize the different learning factors and learning styles. Therefore, for teachers, not only can this study give an understanding the learning status of different background design students, but it can also make corrections and innovations in teaching and courses planning, which have a substantial role and contribution to the teaching site. Therefore, in order to achieve the purpose of this study, and to be able to put forward the final results of the research, this study had the following purposes:

- Understand the differences of different students' backgrounds in the process of learning: This study investigates and analyzes whether design students of different backgrounds are affected by relevant factors during the course of learning design courses. Different backgrounds include the three factors of gender, educational system, and grade.
- Compare the impact of different groups of students on each other's process of learning: From the different groups of design students, this study compared their influence on peer relationships, learning motivation, and learning effectiveness, in order to understand the proportion of these influencing learning factors. We hope that from the process of research and investigation, we will understand the students' attitudes and thoughts in learning design courses.
- Induction the learning styles under different learning factors: In addition to discussing the differences in the learning process of design students from different backgrounds and groups, this study also hopes to use the objects and analysis collected to understand the learning styles under different learning factors and then provide teachers with suggestions for improvement and course innovation.

Previous research on design education mostly discusses students' learning effectiveness or learning satisfaction with a course and rarely discusses the effects of peer relationships, learning motivation, and

learning effectiveness on issues such as differences in personal behavior. There are also few comparisons between full-time and night school students. In particular, there is less research on the related learning discussions of night school students. Therefore, this study attempted to explore design students from different backgrounds and discuss the differences in their peer relationships, learning motivation, and learning effectiveness so as to find out the key influencing factors and different learning styles that affect student learning. In addition to providing future teachers at the teaching site a reference for course planning and teaching innovation, we hope to use this study to construct a new research topic block that explores design education and teaching field improvement from the perspective of students, to motivate more scholars to join this research in the future, and to achieve a wealth of research results for design education and application references for design teaching innovation.

2. Literature Review

2.1. Peer Relationship

The so-called peer relationships refers to the interaction process and situation of peer groups [16]. Interpersonal relationships include various interactions between people, such as parent–child relationships, peer relationships, teacher–student relationships, and parental relationships. Author [17] mentioned that students must learn interpersonal communication skills and social norms, as well as establish values and self-concepts in interpersonal communication. Peer relationships are also a type of interpersonal relationship. They are peer interactions between individuals of a similar age who have the same values and the same cognition. When a peer relationship refers to a relationship between an individual and a peer, it can also be called a social relationship or a friend relationship. These are considered important interactions in society or school [18–20]. In addition, Ref. [21] also pointed out that peer interaction is a type of interpersonal relationship, which can be called "social relationship" or "friendship", which is an interaction between individuals and peers.

In the research of [19], four basic dimensions were proposed for the connotation of peer relationships, including emotional support, interactive relationships, social skills, and peer attraction. The two basic characteristics of a peer relationship can be used as a clear difference from other interpersonal relationships [22]. That is, although two parties may have different rights and fairness, they will be equal in their peer relationship, and the rights held will be balanced. Author [18] summarized the research of comprehensive scholars, and revealed that the interactions affecting peer relationships could be grouped into three factors: (1) personal factors, such as gender, age, physical attractiveness, IQ, personality traits, self-concept, leadership ability, ability to move, participation, similarities in values and interests, social behavior, and social skills; (2) family factors, such as being or not being an only child, number of siblings, birth order, parental discipline or attitude, parental education concerns, family socioeconomic status, and family environment; and (3) school factors, such as seating arrangements, teachers' love, five ways of life scores, and academic achievements. Regarding heterosexual and homosexual relationships, Ref. [23] believed that "opposite-sex peer relationships" also affect "same-sex peer relationships".

Therefore, according to the above theory, it could be known that such so-called peer relationships represent the fair and equal communication between people with the same values and cognition. They are also an important part of interpersonal relationships. Impacts on peer relationships can also arise from personal, family, and school factors. In addition, social skills, emotional support, topics of interest, and personality traits are also cultivated and recognized in peer-to-peer interactions. Peer relationships can be further extended to include the two dimensions of social relationships and friend relationships, which have a certain influence on interpersonal communication and emotional connection between peers. Regarding the level of peer relationship measurement, Ref. [24] researched the two dimensions of emotional interaction and mutual assistance cooperation in peer relationships. Authors [25–27] used a "Peer Relationships Questionnaire", which includes questions regarding whether peers love friends, whether they are loved by friends, whether they have good social skills, and whether they feel happy

in the group. The authors of [19] divided a peer relationship scale into the four levels: emotional support, identity imitation, social skills, and peer attraction. This study mainly adopts self-evaluation and cooperation with the research objects. From the above-mentioned research on peer relationship and the dimensions proposed by the researchers, the appropriate topics were selected and adapted to understand the peer relationships among design students. The peer relationships questionnaire by [28] uses three subscales: friendship, social skills, and imitation. Based on the above literature discussion, we found that there are many ways to evaluate peer relationship, including teacher assessment, a peer assessment test, and self-assessment. In addition, there are records through direct observation in specific or natural situations. In this research questionnaire, in the topic section of peer relationships, we selected the topics suitable for this questionnaire in the peer relationships dimensions among the above-mentioned peer relationships research and the dimensions proposed by the researchers, and the design was adapted to understand the views of design students who agree with the peer relationships.

2.2. Learning Motivation

Authors [29] mentioned learning motivation plays an important role in promoting student learning, and as long as student have a strong motivation to achieve their goal, self-generated learning will be sufficient to achieve the learning goal. In addition, students' learning motivation will guide them to achieve their set learning goals [30]. However, learning motivation itself is a kind of mental journey that triggers learner participation in and the maintenance of learning activities and that moves learners towards the established learning goals [31–33]. The authors of [34] also proposed that learning motivation is the need for students to pursue self-booking learning goals in personal learning, and it is also a psychological process that drives self-individuals to continue learning and trigger behavior. The most important factor that affects learning achievements is learning motivation in addition to their own learning ability [35]. Therefore, research related to "motivation" has always been of great interest to scholars in the field of psychology and teachers engaged in education. Of course, how to enhance students' learning motivation has always been one of the main goals of teachers in the teaching field [36]. Learning motivation can also be used as an indicator to predict the individual learning achievement of students so as to understand their needs and provide appropriate teaching strategies to improve teaching effectiveness [37]. However, learning motivation can also have a significant impact on learners' cognitive abilities [38].

Research on related motivation theories can be roughly divided into two categories. One is based on physiological effects, such as primitive motivation, drive, and demand; the other is based on psychological effects, such as achievement motivation, affinity needs, and cooperation motivation. Learning motivation is aimed at the students' willingness to participate in course learning as well as the relationship between self-perception and learning effectiveness during course learning. Therefore, the focus of measuring learning motivation is mainly at the level of psychological cognition [31,39,40]. Author [33] also proposed the theory of expectation motivation, which explores three motivational elements in the student learning process, including value, expectation, and emotion.

Author [41] researched the factors affecting learning motivation found that there are four important factors: parents, teachers, peers, and individuals. Additionally, in [42], a study of ninth grade students in Thailand found that "peer recognition" and "teacher–student relationships" are the main factors that affect learning motivation in the classroom. Author [43] summarized the factors that affect learning motivation into four points, including: "attention", "relevance", "confidence", and "satisfaction". In addition, Ref. [44] sorted out a number of motivational components that affect learning, including beliefs/perceptions, goals, values, and intrinsic versus extrinsic motivation. In addition, Ref. [45] divided learning motivation factors into the following six items: intrinsic goal motivation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Author [46], in relevant research, defined learning motivation as having four major dimensions: learning goals, learning value, self-efficacy, and expected success. In addition, Ref. [47] used the "ARCS model of learning motivation proposed" by Keller in 1983 to understand student

learning motivation, including components such as attention, relevance, confidence, and satisfaction. Therefore, according to the above-mentioned research, learning motivation is a kind of psychological process of students engaging in self-learning, and it has a decisive role in their learning. It can also be used as an indicator of student learning achievement. There have been numerous discussions on the factors that influence learning motivation; however most of them focus on self-belief, value realization, expected expectations, emotions of participating in the course, and unpredictable internal and external effects. Therefore, it could be understood that these factors influence learning motivation and have a phased impact that starts at the beginning of a course, continues into the process of learning, and remains after the learning is completed.

As for the evaluation of learning motivation, Ref. [48] explored learning motivation with four subscales: positive emotion, expected success, work value, and self-efficacy. The scale of learning motivation of [37,43] is divided into the three dimensions of value, expectation, and emotion. Additionally, Ref. [35] divided the learning motivation scale into five dimensions: learning attitude, learning needs, self-efficacy, self-affirmation, and achievement motivation. Authors [49,50] divided the learning motivation scale into the two parts of internal motivation and external motivation. Author [51] distinguished students' learning motivation into internal goals, external goals, work value, self-efficacy, and test anxiety. The content of the learning motivation scale adopted by [52] included learning fun, future development, and self-expectation. Based on the above research on the measurement of learning motivation, it is found that the most commonly used questionnaire is evaluated by the teacher or the learner themselves. In this research questionnaire, in the topic section of learning motivation, based on the above research related to learning motivation and the dimensions proposed by the researchers, the topics suitable for this study's questionnaire in the learning motivation were selected, and the design was adapted so as to understand the views of design students who agree with the learning motivation.

2.3. Learning Effectiveness

Learning effectiveness refers to the various forms of assessment and testing used to understand learners' feedback and identify their feelings after completing a learning activity. Author [53] mentioned learning effectiveness can be defined as "the degree to which a learner acquires knowledge and skills or affection through studying or training in a specific field at a specific time in the acquired". In addition, learning effectiveness is a measurement indicator of learning outcomes and is one of the main items in the evaluation of teaching quality [54]. From the perspective of students, learning effectiveness refers to a learning value that students can perceive themselves [55]. Therefore, when students participate in learning activities, they can also learn about the performance of certain indicators or changes in certain behaviors through the evaluation of learning effectiveness [56,57].

However, the learning effectiveness obtained through evaluation is usually categorized into the two extremes of high achievement and low achievement. However, not all low learning achievements are caused by intellectual factors; there are many reasons for low achievement, including learning habits, learning methods, achievement motivation, parental encouragement, parental attitude toward the child, degree of parental education, parental socioeconomic status, birth order, etc. [58]. Therefore, in addition to learning effectiveness as an indicator of students' learning outcomes, the most important purpose of evaluation is to let teachers and students understand the status of their self-learning, which can be used as a basis for teachers to improve their teaching innovation and for students to learn to modify [56]. In addition, Ref. [59] proposed a four-level training evaluation model that includes the four items of response, learning, behavior, and achievement in that order. The combination of these four items represents a summary evaluation method. Generally, any knowledge, ability, or skills learned by students through a learning activity can be regarded as learning effectiveness [60].

Authors [61,62] thought that cooperative learning will also help improve the effectiveness of learning. The learners' prior knowledge and experience, for the learning of new knowledge or new things, if it is not a necessary condition to help learners achieve successful learning in the new field, it is also one of the important factors that promote their learning effectiveness [63]. Therefore, according

to the above-mentioned related research, it could be seen that learning effectiveness is a comprehensive assessment conducted by students after learning. Its main purposes are to learn about the students' reaction to a course, provide teachers with a way to understand the psychological role of students in the process of self-learning, and play an important role in improving teaching innovation. However, there are many factors that affect the effectiveness of low learning, and intellectual ability alone cannot be relied on as an assessment. No matter which assessment method is used, it is necessary to first understand the relevant factors, such as the student's learning attitude, and then conduct a comprehensive assessment.

As for the evaluation level of learning effectiveness, one must include related scales to discuss the effectiveness of vocational training self-evaluation. This includes the research of authors [64,65] and the "adult education satisfaction scale" developed by [66]. However, according to the arguments of many scholars, the measurement of learning effectiveness is complex and diverse [67]. Scholars have evaluated the effectiveness of learning from different backgrounds and perspectives, and the results obtained vary greatly. In addition, Ref. [68] pointed out that in the evaluation of learning effectiveness or knowledge creation effectiveness, the suggestion can be directly measured by the people who use knowledge, because the value of knowledge mainly depends on the knowledge of these people's subjective perception. At the same time, Ref. [69] also observed that the measurement of learning effectiveness could not be completely objective at first, because the absorption, understanding, and application of learning content should be best understood by the learners themselves. In addition, the four-level evaluation model proposed in the "Techniques for Evaluation Training Program" developed by Kirkpatrick in 1959 is also widely used. The main concept is to evaluate the learner's reaction, learning, behavior, and the results. Additionally, Ref. [64] mentioned that this assessment model concept is also very suitable for adult learning principles. Therefore, this assessment mode can also be used as a reference for the design of the dimension of learning effectiveness. In this research questionnaire, in the topic section of learning effectiveness, which is the relevant research on the above topic of learning effectiveness and the dimensions proposed by the researchers, the questions suitable for this study questionnaire on the learning effectiveness dimension were selected, and the design was adapted in order to understand the views of design students who agree with the learning effectiveness.

3. Research Method

This study was mainly carried out through a literature analysis and discussion of related theories, after which a self-made questionnaire survey was distributed, and a discussion and analysis of the differences in the peer relationships, learning motivation, and learning effectiveness of design students from different backgrounds was presented. We aimed to find out the impact of key factors affecting student learning, as well as further induction of the learning styles under different learning factors through factor analysis. The following is a description of the research framework, research hypotheses, research objects and tools, and data processing put forth in this study.

3.1. Research Framework

The study framework was mainly aimed at discussing and analyzing the differences in the peer relationships, learning motivation, and learning effectiveness of design students from different backgrounds. The study was carried out in four stages. The first stage was a literature analysis and related theoretical discussion, including peer relationships, learning motivation, and learning effectiveness, through which the dimensions and relevant study hypotheses were obtained. The second stage consisted of the analysis and induction of the data obtained in the first stage, and the scales of the relevant dimension of the research proposed by the past researchers, followed by questionnaire survey scale design and the collection of data from the objects selected by the study. The third stage consisted mainly of processing the data and aggregating the results after verification. The final stage consisted of analyzing and discussing the data and then putting forward the final results and recommendations of this study. The research framework is shown in Figure 1.
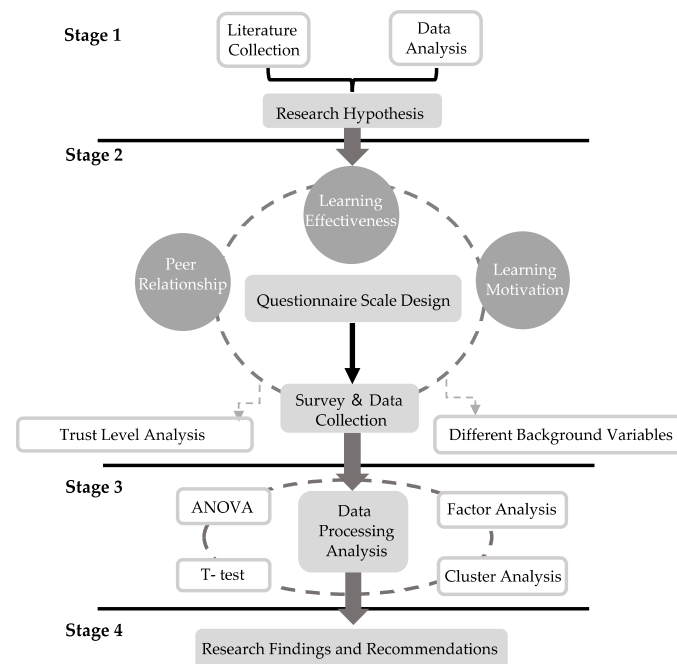
Figure 1. Study framework.

3.2. Research Hypotheses

According the purpose, problems, and related literature in this study, the study hypotheses, including the three factor dimensions of peer relationships, learning motivation, and learning effectiveness, were proposed:

Hypothesis 1 (H1). *Design students with different background variables have significant differences in peer relationships at all levels.*

Hypothesis 2 (H2). *Design students with different background variables have significant differences in learning motivation at all levels.*

Hypothesis 3 (H3). *Design students with different background variables have significant differences in learning effectiveness at all levels.*

Hypothesis 4 (H4). *Design students of different groups have significant differences in the comparison of peer relationship.*

Hypothesis 5 (H5). *Design students of different groups have significant differences in the comparison of learning motivation.*

Hypothesis 6 (H6). *Design students of different groups have significant differences in the comparison of learning effectiveness.*

3.3. Research Objects and Tools

This study was mainly aimed at sophomore and senior students from four classes in the Department of Industrial Design at Midlands University in Taiwan. The total number of students was 126, made up of 64 seniors and 62 sophomores. Sophomores and seniors were chosen because the sophomore year represents the first contact with the content of professional design courses and beginning to construct the understanding of product design, while, seniors were chosen because after three years of design

learning, seniors have a certain degree of experience in design courses. This study hopes to understand views from the perspective of senior students too. This study was mainly carried out through a literature analysis combined with a questionnaire survey. The questionnaire was titled "Analyzing the relevance of peer relationships, learning motivation, and learning effectiveness—using design students as an example" and was used as a study tool for collecting relevant data. The questionnaire consisted of four parts. The first part was the basic information, including gender, grade, and educational system. The second part was the peer relationship survey, the third part was the learning motivation survey, and the fourth part was the survey of learning effectiveness. The second to fourth parts each had 10 questions, and the questionnaire scales were designed according to a Likert five-point scale. To answer each question one had to choose the degree of agreement. According to the degrees of strong disagreement, disagreement, no opinion, agree, and strongly agree one must give 1–5 points, respectively, and there were no reverse questions.

3.4. Data Analysis Steps

The questionnaire was distributed in the form of an online questionnaire, and the survey time was from October 28 to November 3, 2019. After the questionnaires were sent out, 119 valid questionnaires and seven invalid questionnaires were recovered. The effective recovery rate was 94%. This study analyzed the characteristics of the samples based on the valid responses. Regarding gender, the proportion of male students was 59.7% and the proportion of female students was 40.3%. Regarding grade, sophomores accounted for 48.7% and seniors accounted for 51.3%. The proportion of full-time students was 57.1% and the proportion of night school students was 42.9%, indicating that the number of full-time students was relatively large. This study used SPSS statistical software as the tool for data analysis. Reliability analysis and exploratory factor analysis were carried out on the collected questionnaire data to check the construct validity of the scale. A difference analysis was used to discuss whether design students from different backgrounds would vary in their peer relationships, learning motivation, and learning effectiveness. An independent sample t-test was then used to examine the significance of the differences. Next, a one-way analysis of variance (ANOVA) was conducted on the design students from different groups to discuss the differences in the processes of learning between various groups. Then, we used the different learning factors obtained by factor analysis to perform cluster analysis to understand the learning styles under different learning factors and verify the research hypotheses. The analysis steps of the data are as shown in Figure 2.
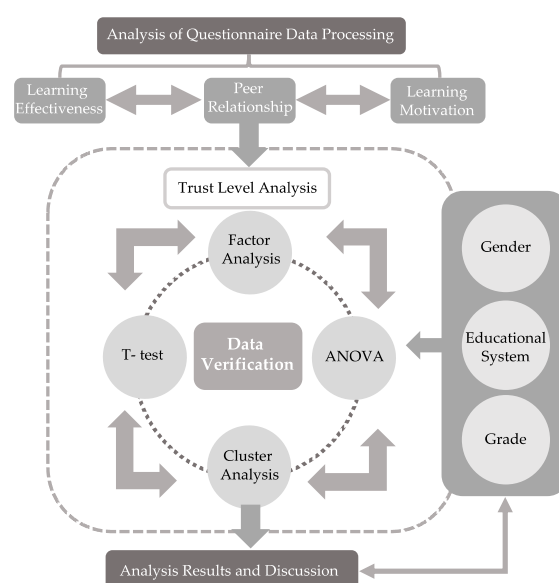

Figure 2. Data analysis steps.

4. Analysis of Results

4.1. Trust Level Analysis

This study scale used Cronbach's α for the internal consistency reliability analysis of this scale. The internal consistency reliability coefficient of the scale should be above 0.60 [70]. According to Table 1, after the reliability analysis and verification of the questionnaire dimension, the reliability value was between 0.899 and 0.943, which met the reliability standard of the scale and indicated that the research tool had good reliability.

Table 1. Reliability analysis summary.

Dimension	Cronbach's Alpha	Number of Questions
Peer Relationship	0.899	10
Learning Motivation	0.912	10
Learning Effectivenes	0.943	10

4.2. Analysis of Different Learning Factors of the Research Objects Under Three Factor Dimensions

The study questionnaire was mainly aimed at sophomore and senior students in four classes from the Department of Industrial Design at Midlands University in Taiwan. An exploratory factor analysis was performed for the three factor dimensions of peer relationships, learning motivation, and learning effectiveness, and the results were used to check the construct validity of the scale. According to [71], the number of exploratory factors can be between 100 and 200. In addition, from the perspective of the number of questionnaire questions, assuming that the pre-test questionnaire was used as an example, it was recommended that the number of pre-test questions should be 3–5 or 5–10 times the number of pre-test questions [72–74]. According to the factor analysis requirements for research statistics, at least 100 valid samples are required, and preferably there should be more than 300 samples [72,75]. According to the above literature, although only 119 valid questionnaires were collected in this research, the ratio of the number of samples to the number of questions was about 3.97 and the objects were all design students. Therefore, the number of samples in this study was within the acceptable range. In addition, when the KMO value is larger (closer to 1), it means that the more common factors there are between variables, the more suitable the variables are for factor analysis. According to Kaiser's point of view in 1974, if the value of KMO is less than 0.5, it is less suitable for factor analysis, and the mediocre criterion for factor analysis is a score of at least 0.60 [72]. The data collected in this study were verified by the Bartlett's test results, the variables between dimensions were not unrelated to each other, and the KMO values were all greater than 0.5, indicating that the data were suitable for factor analysis. The details are shown in Table 2.

Table 2. Summary of Bartlett's test

Dimension	KMO	Chi-Square Test	df	*p*
Peer Relationship	0.879	586.549	45	0.000
Learning Motivation	0.919	630.808	45	0.000
Learning Effectiveness	0.939	875.043	45	0.000

Note: $p < 0.05$.

Using the requirement of having an eigenvalue greater than 1, five factors should have been taken, but three factors should have been taken according to the scree plot, since eigenvalues greater than 1 often result in an overestimation of the number of factors [76]. Taking three factors based on the steep scree plot could also meet the three factor dimensions set in this study. Three factors were extracted using the method of principal axis for analysis with Promax. According to the recommendations of [77] and others, when the number of samples is 100, the factor load should be greater than 0.55, and when

the number of samples is 120, the factor load should be greater than 0.5. Although the sample number of this study was more than 100, but the factor load was still greater than 0.55 as the standard, and the factor questions below 0.55 are deleted. Items with a factor load of less than 0.5 included Q9 (I often actively join the topic of classmates' chats), Q7 (When I talk to my classmates, I will care about how my classmates feel), and Q15 (I think that I can get problem-solving skills in the course of learning). Items that needed to be removed due to having a factor load less than 0.55 included Q14 (I hope to get a sense of accomplishment in the course of learning), Q18 (I think the knowledge learned in the course is important), Q24 (After course learning, I feel that teamwork can bring better benefits), and Q27 (After course learning, I have more curiosity about the knowledge outside the course). After re-analyzing the data, the final factor load matrix was as shown in Figure 3.

Question number	Components		
	1	**2**	**3**
Q29. After course learning, I can understand the expertise of the team members better.	0.857	0.105	-0.152
Q30. After course learning, I have increased the ability to think creatively about design.	0.836	-0.041	0.051
Q28. After course learning, I can find the materials needed for the course at more experience.	0.822	0.02	-0.005
Q23. After course learning, I have communication skills progress.	0.762	0.051	0.015
Q22. After course learning, I feel that my practical ability to solve problems has improved.	0.757	0.047	0.069
Q21. After course learning, I feel that the absorption of professional knowledge theory has improved.	0.749	-0.032	0.173
Q26. After course learning, I know more about my strengths and weaknesses and the ability to make up for it.	0.652	0.057	0.102
Q25. After course learning, I will have more confidence in my future learning performance.	0.557	-0.049	0.324
Q01. I like to travel with friends.	0.117	0.899	-0.353
Q03. I will actively care about the living of my classmates.	0.062	0.748	-0.059
Q02. I like to discuss homework or review course with my classmates.	0.08	0.702	-0.047
Q06. I think that I can interact well with my classmates.	-0.085	0.657	0.22
Q05. My classmates are willing to help when I have a problem.	-0.203	0.637	0.386
Q08. I will be willing to share life trivia with my classmates.	0.246	0.625	-0.027
Q04. Friends will value my comments.	-0.205	0.585	0.331
Q10. I am happy to share my belongings with my friends.	0.112	0.579	0.101
Q20. I will supplement professional theoretical knowledge with extra time.	-0.03	0.048	0.719
Q17. I like challenging design professional course.	0.276	-0.12	0.656
Q13. I will keep the enthusiasm that in the course of learning process.	-0.038	0.194	0.63
Q19. I think the current learning content is very relevant to future work.	0.09	-0.101	0.628
Q16. I think the learning content of the course is interesting.	0.388	-0.099	0.584
Q11. I am confident that I will get excellent results in the course.	0.064	0.068	0.579
Q12. I can understand the content of the course taught by the teacher.	0.186	0.058	0.551

Legend: 1.0 / 0.8 / 0.6 / 0.4 / 0.2 / 0.0

Figure 3. Matrix of load factors for each dimension.

As can be seen from Figure 3, the first factor included eight questions that were related to learning effectiveness, including Q29 (After course learning, I can understand the expertise of the team members better) and Q22 (After course learning, I feel that my practical ability to solve problems has improved); therefore it could be defined as "emphasizing ability improvement". The second factor included eight questions that were related to peer relationships, including Q3 (I will actively care about the living of my classmates) and Q2 (I like to discuss homework or review courses with my classmates); therefore it could be defined as "care about peer friendship". The third factor included seven questions that were related to learning motivation, including Q13 (I will keep the enthusiasm in the course of learning) and Q19 (I think the current learning content is very relevant to future work); therefore it could be defined

as "careful and active learning". These three factors could explain a total of 58.975% of the amount of variation. The correlation matrix between factors is shown in Table 3.

Table 3. Correlation matrix between factors.

Factors	1	2	3
1	1.000	462	661
2	0.462	1.000	0.518
3	0.661	0.518	1.000

4.3. Analysis of the Learning Differences of Design Students from Different Backgrounds

This study used different background variables to understand the differences in the learning performance of design students regarding their peer relationships, learning motivation, and learning effectiveness. The independent samples T-test was used to analyze the significance of differences in the peer relationships, learning motivation, and learning effectiveness of design students according to gender, educational system, and grade.

4.3.1. Analysis of Gender

The T-test results showed that regarding gender, females and males showed a significant difference in their peer relationships in Q3 (I will actively care about the lives of my classmates). Females are also more active than males, therefore female peers will naturally be closer than male peers in their peer relationships. This result was consistent with the research of [78], which also concluded that the degree of peer attachment for girls is higher than that for boys, possibly because boys tend to show independent behavior patterns. Girls value the closeness of relationships with the same result. As for learning motivation and learning effectiveness, the T-test results on different genders did not show significant differences. This result indicated that there were no significant differences in the views of design students from different genders on learning motivation and learning effectiveness. This result was the same as that in the study of [79] on the learning motivation and creativity of junior high school students, which found that gender has no significant difference in learning motivation. In addition, there was no significant difference in the motivation of science learning between male and female students in the experimental group taught by POE (prediction-observation-explanation) in [80]. In addition, Ref. [81] discussed learning effectiveness from the perspective of digital learning and found no significant difference in learning effectiveness due to gender. Additionally, in the discussion in [82] of the learning effectiveness of students regarding their metacognitive ability, no significant difference due to gender was found. The details of the results are shown in Table 4.

Table 4. Three factors dimension of different genders.

	Mean (SD)		df	*t* Value	*p*	Effect Size (*d*)
	Male (*N* = 71)	Female (*N* = 48)				
Peer Relationship Q3	3.49 (0.969)	3.83 (0.694)	116.565	−2.231	0.028	0.391

Note: *p* < 0.05.

4.3.2. Analysis of Different Educational System

In the educational system, full-time and night school students showed significant differences in their peer relationships, including Q3 (I will actively care about the lives of my classmates) and Q8 (I will be willing to share life trivia with my classmates). According to the results, the full-time students were more proactive than the night school students regarding caring about the lives of their classmates, and they were more willing to share life trivia with their classmates. The main reason is that the full-time students have been in school for a long time, so they will naturally have better peer

relationships than the night school students. However, night school students work during the day, so the time in school is short, and they cannot have more interactions with classmates or establish deeper peer relationships. Regarding learning motivation, full-time and night school students showed significant differences for Q11 (I am confident that I will get excellent results in the course), Q12 (I can understand the content of the course taught by the teacher), Q13 (I will keep the enthusiasm in the course of learning), Q17 (I like challenging in the design professional course), and Q20 (I will supplement professional theoretical knowledge with extra time). According to the results, the full-time students had a more positive evaluation of the design course learning than the night school students. Whether it is in order to get good performance of learning, focus on the course, extracurricular autonomous learning, or understanding of the content of the class, it is better than the night school. Scholars believe that if the course content of the night school does not meet the needs, or the students cannot adapt to the teacher's teaching method, or there is no ideal learning environment, etc., an adult may be caused to stop further education [83]. Full-time students have more time to prepare for their courses and concentrate on designing assignments. Naturally, their motivation for learning is higher than night school students. Night school students usually only want to pass their exams, therefore their enthusiasm for their courses will not be higher than the full-time students. According to [43], for the factors that affect learning motivation include the attention factor, such as understanding the course content; the confidence factor, such as having confidence in obtaining excellent results and like challenging design professional course; the satisfaction factor, such as keeping the enthusiasm during the process of learning; and the related factor, such as supplementary knowledge outside of class. Among them, regarding understanding the content of the course and supplementing extra-curricular knowledge, the difference between the full-time and the night school is the largest, indicating that the learning motivation of night school is affected by two factors: attention and relevance.

Regarding learning effectiveness, the full-time students and night school students showed significant differences for Q22 (After course learning, I feel that my practical ability to solve problems has improved), Q23 (After course learning, I have communication skills progress), Q26 (After course learning, I know more about my strengths and weaknesses and the ability to make up for it), and Q30 (After course learning, I have increased the ability to think creatively about design). The results of [3,4] both show that learning motivation has a direct positive effect on learning effectiveness. This trend could also be extended from the learning motivation, that is, the full-time students are higher than the night school students in autonomous learning. Therefore, there were differences in the feedback after course learning in areas such as problem-solving practical ability, communication ability, recognition of the strengths and weaknesses of the self, and design creativity. The full-time students had a higher degree of recognition than the night school students regarding learning effectiveness. Therefore, they had more use of their spare time for introspection and to strengthen the design practice. Among them, the part of self-communication ability improvement is the biggest difference between the full-time students and the night school students, implying that one must think about what kind of learning motivation can be provided to improve the communication ability of the night school students.

Based on the comparison of the differences between the three factors, although it was shown that the full-time students were higher than the night school students, it could not be said that the night school students were very low on these three factors. In other words, the night school students are affected to varying degrees in all three factors. I addition, by showing the topics that are very different, the results also reflected that the attitude of night school students is significantly lower than that of full-time students in their general lives and in their courses. After all, full-time students need to stay in school longer than night school students, who may need to work in the daytime and go to school in the evening, thus naturally shortening the amount of available time. Therefore, their attentiveness to the course, learning feedback, and peer relationships are naturally not comparable to those of full-time students. The details are shown in Table 5.

Table 5. Three factor dimensions of different educational systems.

	Mean (SD)		df	*t* Value	*p*	Effect Size (*d*)
	Full-time (*N* = 68)	Night School (*N* = 51)				
Peer Relationship						
Q3	3.78 (0.826)	3.43 (0.922)	117	2.164	0.032	−0.403
Q8	3.96 (0.818)	3.51 (0.857)	117	2.883	0.005	−0.539
Learning Motivation						
Q11	3.57 (0.834)	3.25 (0.868)	117	2.026	0.045	−0.377
Q12	3.74 (0.704)	3.33 (0.792)	117	2.921	0.004	−0.552
Q13	3.54 (0.800)	3.24 (0.790)	117	2.096	0.038	−0.377
Q17	3.75 (0.780)	3.39 (0.940)	117	2.268	0.025	−0.423
Q20	3.62 (0.915)	3.22 (0.945)	117	2.339	0.021	−0.431
Learning Effectiveness						
Q22	3.84 (0.765)	3.55 (0.808)	117	1.992	0.049	−0.370
Q23	3.87 (0.710)	3.45 (0.730)	117	3.130	0.002	−0.584
Q26	3.90 (0.694)	3.57 (0.831)	96.350	2.287	0.024	−0.437
Q30	3.84 (0.704)	3.49 (0.880)	93.445	2.321	0.022	−0.446

Note: $p < 0.05$.

4.3.3. Analysis of Different Grades

Among the different grades in the peer relationships, sophomores and seniors had Q4 (Friends will value my comments), Q8 (I will be willing to share life trivia with my classmates), and Q10 (I am happy to share my belongings with my friends). There are significant differences. From this result, it can be seen that compared with the degree of peer interaction of the sophomores, the cumulative three-year peer relationships of the seniors will definitely be deeper than that of the sophomores. It can also be said that new emotions have been established among the seniors. Peer relationships are of course higher for seniors than for sophomores. This and [84–86] found that the peer relationships of the ninth grade in junior high school is better than seventh grade, and it had the same result. That is, the upper grades are significantly better than the lower grades. Therefore, it is easier to express opinions and values, as well as share life trivia and one's own things in the senior's peer relationships. Among them, in the value comments, the difference between seniors and sophomores is the largest, showing that the sophomores' respect and trust in peer relationships is far lower than seniors'.

There was a significant difference in the learning motivation only in Q12 (I can understand the content of the course taught by the teacher). This result indicated that the seniors had a better understanding of the course content than the sophomores. This result is similar to the study [87] of 109 Chinese immigrant students aged 13–19 years in Hong Kong in English learning motivation, which found that the older the age, the stronger the learning motivation. It could be explained that after three years of training, seniors should be able to understand the content of the teacher. Sophomores may have been exposed to the design course for a shorter period of time, and therefore their understanding of the course content will be different. Regarding learning effectiveness, the sophomores and seniors showed significant differences for Q28 (After course learning, I can find the materials needed for the course and have more experience) and Q29 (After course learning, I can understand the expertise of the team members better). This result indicates that the seniors had higher learning effectiveness than the sophomores. It could also be explained from the differences in the course content understanding of learning motivation. As seniors near the graduation stage, their mastery of autonomous learning will be better than the sophomores. They are familiar with data collection and the expertise of their classmates to a certain degree, and the recognition of classmates' expertise can also be extended to explain the closeness of their peer relationships.

Based on the comparison of the differences between the three factors, although the seniors were higher than the sophomores, the sophomores were not low in the recognition of learning effectiveness. This result also showed that no matter whether they were sophomores or seniors, as long as they were seriously invested in the course they could get good feedback on their learning effectiveness. Actually, the seniors had already accumulated three years of learning, and they were familiar with all dimensions. Compared with the sophomores, who were still in the stage of building their personal design professional ability, the impact of their learning experience had different results. The details are shown in Table 6.

Table 6. Three factor dimensions of different grades.

| | Mean (SD) | | df | *t* Value | *p* | Effect Size (*d*) |
	Sophomore (*N* =58)	Senior (*N* = 61)				
Peer Relationship						
Q4	3.36 (0.693)	3.79 (0.777)	117	−3.141	0.002	0.583
Q8	3.57 (0.881)	3.95 (0.805)	114.726	−2.465	0.015	0.451
Q10	3.45 (0.776)	3.80 (0.771)	117	−2.503	0.014	0.453
Learning Motivation Q12	3.38 (0.813)	3.74 (0.681)	117	−2.613	0.010	0.481
Learning Effectiveness						
Q28	3.59 (0.773)	3.89 (0.709)	117	−2.200	0.030	0.405
Q29	3.57 (0.819)	3.90 (0.724)	113.576	−2.344	0.021	0.428

Note: $p < 0.05$.

4.4. Analysis of the Differences Between the Learning Process of Design Students from Different Groups

One-way analysis of variance (ANOVA) was used to test the comparison of the views of different groups of design students on peer relationships, learning motivation, and learning effectiveness. The objects were divided into four groups for testing, including full-time sophomores, night school sophomores, full-time seniors, and night school seniors. When a significant difference was found, Scheffe's posterior comparison was used for verification.

4.4.1. Comparative Analysis of Peer Relationship in Different Groups

The variation analysis and post-hoc test results showed that for peer relationships, a number of items had significance, including Q1 (I like to travel with friends), Q3 (I will actively care about the lives of my classmates), Q4 (Friends will value my comments), Q8 (I will be willing to share life trivia with my classmates), and Q10 (I am happy to share my belongings with my friends). Regarding Q1 (I like to travel with friends), the full-time seniors and full-time sophomores showed a significant difference, and the full-time seniors in Q1 were higher than the full-time sophomores. Therefore, we can know that the full-time students attach more importance to travel. Additionally, because the seniors have completed most of the courses, they have more time. The full-time seniors and night school seniors showed a significant difference for Q3 (I will actively care about the living of my classmates), and the full-time seniors in Q3 were higher than the night school seniors. Therefore, we can know that when they are about to graduate, they want to cherish the time get together with classmates. The full-time seniors showed significant differences with the other three groups for Q4 (Friends will value my comments). Among them, the full-time seniors in Q4 were the highest followed by full-time sophomores, night school seniors, and night school sophomores. Therefore, it can be seen that the full-time students attach more importance to the expression of value comments among peers than the night school students. The full-time seniors showed significant differences with the other three groups for Q8 (I will be willing to share life trivia with my classmates), among which in Q8 the full-time seniors were the highest followed by night school sophomores, night school seniors, and full-time sophomores.

The comparison order of this part had a higher degree of difference. The more special is that the night school sophomores preferred to share life trivia more than the full-time sophomores. This may be because the night school sophomores have a work in day, and they have practical experience of life. Thus, they have something about life trivia to share with classmates. Finally, the full-time seniors and night school sophomores showed a significant difference for Q10 (I am happy to share my belongings with my friends), and the full-time seniors in Q10 were higher than the night school sophomores. This result may be due to the highest degree of freedom in the time of the full-time seniors, and although the night school sophomores have not mastered time well, but because they are still sophomores, so they usually want to maintain good peer relationships with classmates. The details are shown in Table 7.

Table 7. Analysis of peer relationship variations and post-hoc comparison in different groups.

	Variable	SS	df	F	P	Scheffe's Test
Q1	Between groups	8.737	3	3.798	0.012	
	Within groups	88.188	115			c > a
	Total sum	96.924	118			
Q2	Between groups	6.710	3	2.863	0.040	
	Within groups	89.845	115			※
	Total sum	96.555	118			
Q3	Between groups	8.650	3	3.991	0.010	
	Within groups	83.081	115			c > d
	Total sum	91.731	118			
Q4	Between groups	10.357	3	6.771	0.000	
	Within groups	58.635	115			c > a > d > b
	Total sum	68.992	118			
Q6	Between groups	6.768	3	2.934	0.036	
	Within groups	88.409	115			※
	Total sum	95.176	118			
Q8	Between groups	11.346	3	5.718	0.001	
	Within groups	76.066	115			c > b > d > a
	Total sum	87.412	118			
Q10	Between groups	5.672	3	3.195	0.026	
	Within groups	68.059	115			c > b
	Total sum	73.731	118			

Note: *p* < 0.05, ※ indicates no significant difference; > means greater than; (a) full-time sophomore; (b) night school sophomore; (c) full-time senior; d) night school senior.

4.4.2. Comparative Analysis of Learning Motivation in Different Groups

Regarding learning motivation, only Q12 (I can understand the content of the course taught by the teacher) showed significance. There was a significant difference between the full-time seniors and night school sophomores, and the full-time seniors in Q12 were higher than the night school sophomores. This result shows that the full-time seniors have advantages in the learning experience itself, and are therefore much higher than other groups. The enthusiasm of the night school sophomores is obviously higher than the night school seniors and the full-time sophomores. It shows that the enthusiasm of the night school sophomores for the learning motivation of the course cannot be ignored. The result of this comparison is the same as the test for variables of different grades. The details are shown in Table 8.

Table 8. Analysis of learning motivation variations and post-hoc comparison in different groups.

	Variable	SS	df	F	p	Scheffe's Test
Q12	Between groups	7.958	3	4.975	0.003	
	Within groups	61.319	115			c > b
	Total sum	69.277	118			
Q10	Between groups	8.697	3	3.448	0.019	
	Within groups	96.698	115			※
	Total sum	105.395	118			

Note: $p < 0.05$, ※ indicates no significant difference; > means greater than; (a) full-time sophomore; (b) night school sophomore; (c) full-time senior; d) night school senior.

4.4.3. Comparative Analysis of Learning Effectiveness in Different Groups

Regarding learning effectiveness, Q22 (After course learning, I feel that my practical ability to solve problems has improved), Q23 (After course learning, my communication skills have progressed), and Q29 (After course learning, I can understand the expertise of the team members better) showed significant differences between the full-time seniors and night school sophomores, and the full-time seniors in Q22, Q23, and Q29 were higher than the night school sophomores. Hence, from the results of this study, it can be seen that the full-time seniors are superior to the other three groups in terms of improvement ability and learning cognition. Secondly, the night school sophomores should also not ignore the recognition of learning effectiveness. Such results in the analysis of the differences between different educational systems and grade also show the same trend as research results. The details are shown in Table 9.

Table 9. Analysis of learning effectiveness variations and post-hoc comparison in different groups.

	Variable	SS	df	F	p	Scheffe's Test
Q21	Between groups	5.607	3	3.171	0.027	
	Within groups	67.788	115			※
	Total sum	73.395	118			
Q22	Between groups	5.340	3	2.969	0.035	
	Within groups	68.945	115			c > b
	Total sum	74.286	118			
Q23	Between groups	5.930	3	3.816	0.012	
	Within groups	59.566	115			c > b
	Total sum	65.496	118			
Q28	Between groups	4.781	3	2.949	0.036	
	Within groups	62.144	115			※
	Total sum	66.924	118			
Q29	Between groups	5.087	3	2.875	0.039	
	Within groups	67.837	115			c > b
	Total sum	72.924	118			
Q30	Between groups	4.999	3	2.719	0.048	
	Within groups	70.496	115			※
	Total sum	75.496	118			

Note: $p < 0.05$, ※ indicates no significant difference; > means greater than; (a) full-time sophomore; (b) night school sophomore; (c) full-time senior; d) night school senior.

4.5. Cluster Analysis in the Classification of Learning Styles Under Three Factor Dimensions

This study used two-stage cluster analysis. The first stage used Ward's method to determine the number of groups. The second stage used K-Means clustering to perform cluster classification to determine which sample observations should be assigned to a particular cluster and then name that cluster according to the highest average of the final cluster center.

Table 10 shows the change of the scheduling coefficient of successive agglomeration clusters for the three factor dimensions through Ward's Method. From the point of view of coefficient change, it is most suitable to divide into two groups. After the number of clusters was determined to be two groups, K-Means clustering analysis was used to perform cluster classification. According to the highest average of the final cluster center results, cluster 1 had the highest average number in peer relationships. This cluster was named "enthusiastic and friendly". Cluster 2 had the highest average number in learning effectiveness and was named "active and autonomous". Table 11 shows the test results of the average difference between the two clusters.

Table 10. Aggregation schedule coefficient of Ward's method.

	Combined Cluster			**First Time Emerge of Stage Cluster**		
Stage	Cluster 1	Cluster 2	Coefficient	Cluster 1	Cluster 2	Next Stage
1	16	24	0.002	0	0	6
2	14	26	0.005	0	0	3
3	10	14	0.009	0	2	16
4	5	8	0.013	0	0	9
5	11	19	0.018	0	0	12
6	9	16	0.026	0	1	13
7	1	20	0.034	0	0	18
8	12	22	0.043	0	0	16
9	5	21	0.057	4	0	17
10	25	28	0.071	0	0	13
11	6	18	0.089	0	0	19
12	7	11	0.112	0	5	15
13	9	25	0.136	6	10	21
14	4	23	0.161	0	0	23
15	7	27	0.202	12	0	22
16	10	12	0.242	3	8	24
17	5	13	0.284	9	0	21
18	1	17	0.328	7	0	20
19	2	6	0.398	0	11	24
20	1	15	0.485	18	0	23
21	5	9	0.575	17	13	26
22	3	7	0.698	0	15	25
23	1	4	0.870	20	14	25
24	2	10	1.093	19	16	26
25	1	3	1.557	23	22	27
26	2	5	2.184	24	21	27
27	1	2	4.563	25	26	0

Table 11. Average cluster difference verification result.

Dimension	Enthusiastic and Friendly (Cluster 1)	Active and Autonomous (Cluster 2)	p
Peer Relationship	4.04	3.56	0.000
Learning Motivation	3.70	3.35	0.000
Learning Effectiveness	3.89	3.61	0.001

Note: $p < 0.05$.

In order to verify the segmentation effect of cluster analysis, this study used discriminant analysis to verify the cluster analysis results. The discriminant variables were mainly cluster variables; that is, the three factor dimensions of peer relationships, learning motivation, and learning effectiveness. We aimed to construct effective discriminant functions through selected discriminant variables, and predict the clusters to which the new sample observations belong. The discriminant function

obtained by this study showed a significant differentiation effect. The final test results are as shown in Table 12.

Table 12. Significance test of the discriminant function.

Test of Function	Wilks' Lambda (λ)	Chi-square Test	df	*p*
1	0.226	36.478	3	0.000

Note: $p < 0.05$.

5. Conclusions and Suggestions

5.1. Conclusions

5.1.1. Discussion on the Difference of the Three Factors in Different Backgrounds Design Students

The results of this study indicated that design students from different backgrounds showed significant differences in peer relationships, learning motivation, and recognition of learning effectiveness. Therefore, hypotheses 1–3 of this study were valid. Gender revealed a significant difference only in peer relationships, indicating that gender has a certain degree of influence in peer relationships. Female classmates were found to care more about their classmates' lives than male classmates, and this phenomenon was defined as "females are the group that attaches more importance to relationships" in the discussion of gender factors. This result was similar to many domestic and foreign studies, and it showed that there is a correlation between peer relationship and gender [88–91]. Usually, the age when females develop the need for friendship will be earlier than that of males, and the phenomenon of trying to establish an intimate relationship after developing a friendship occurs mostly among females. Therefore, in terms of peer relationships, females have a higher degree of intimacy, sharing behavior, and loyalty than males. While females tend to have smaller friendship circles and intimate relationships, males are used to participating in large peer groups and treat most people as friends. Females spend more time than males in interpersonal relationships and socializing [92,93]. This result also echoes the discussion of the relationship between opposite-sex peer relationships and same-sex peer relationships in [23]. In addition, for learning motivation and learning effectiveness, the results showed that gender had no effect on these two factors. This result was the same as that found by [79,80] on gender factors in learning motivation. This result was also the same as that was found by [81,82] on gender factors in learning effectiveness.

Regarding the educational system, the results showed significant differences for peer relationships, learning motivation, and learning effectiveness. The full-time students were higher than the night school students in the areas of caring about classmates' lives and sharing life trivia, understanding the content of the course, maintaining enthusiasm for the course, having the practical ability to solve problems, the improvement of communication skills, and the improvement of creative design ability. The educational system variable is an interesting setting in itself. After all, compared with full-time students, night school students generally already have work experience and choose to go to school at night. Therefore, although there are significant differences in peer relationships, learning motivation, and learning effectiveness, because of the different identities, educational systems need further exploration in future.

Author [18] suggested that the factors affecting peer relationships include personal, family, and school aspects. In [94], a research on learning motivation and learning satisfaction for night school students, it was found that night school students have strong learning motivation, especially for learning expectations and learning value. Therefore, it cannot be considered that the learning motivation and learning effectiveness of night school students are low. On the other hand, the income, occupation, and age of night school students indicated significant differences for learning motivation. In other words, night school students actually hope to achieve self-achievement and improve their income through learning. Author [83] showed that it is easy for night school students to give up

their learning because of the school environment, course understanding, and teaching adaptations. However, no matter what effect these internal and external factors have, according to the results of this study, the biggest difference between full-time and night school students is due to the time of learning. After all, full-time students must stay at school for a longer time, but night school students need to work during the day and can only learn at night. This was therefore defined as "students' mastery of self-learning time" in the discussion on the results of school system factors.

The results for the effect of grade showed that there were significant differences in peer relationships, learning motivation, and learning effectiveness. Regardless of peer relationships, learning motivation, or learning effectiveness, the seniors all scored better than the sophomores. Authors [84–87] all found the same trend as this study. In other words, the higher the grade, the higher the peer relationship and the learning motivation. Including value comments, sharing life trivia, understanding course content, ability to collect data, and understanding of group members, etc. This can be understood from the degree of accumulated time of senior students' interactions in peer relationships, as well as their understanding of the course and learning experience. Such results were also echoed the findings of [15], who proposed that students with good peer relationships have higher learning motivation. However, the results of this study also showed that the value of learning effectiveness in the sophomores is not low, which also means that although the level of design learning experience varies between grades, there is a certain extent of recognition for learning effectiveness. Therefore, in the discussion of the grade results, this phenomenon was defined as "student's personal learning experience performance".

The mastery of self-learning time and learning experience performance have a key influence on the learning motivation and learning effectiveness of design students from different backgrounds. Author [95] mentioned that if the consideration of one's own ability is excluded, students' perception of an overall course unit will be positively correlated with their learning effectiveness. Although peer relationships are not a critical influence, Ref. [9] mentioned that peer relationships affect individual values and behaviors. This also shows that peer interactions will also have a certain impact. In particular, the value of the learning effectiveness factor in the night school and sophomore students was not low. It is worthwhile to use positive and encouraging teaching methods to improve the sense of learning achievement and self-confidence. These results also revealed the learning gap between full-time and night school students and showed an opportunity for the improvement of courses and teaching innovation in night schools.

5.1.2. Discussion on Difference of the Three Factors in Different Student Groups

The analysis of the results after one-way analysis of variance (ANOVA) and a post-hoc test comparison showed there were significant differences in peer relationships, learning motivation, and learning effectiveness. Therefore, hypotheses 4–6 of this study were valid. First, in peer relationships, there were significant differences in traveling with friends, caring about classmates' lives, value comments, sharing life trivia, and sharing belongings. In travelling with friends, the full-time seniors were higher than the full-time sophomores. In the comparison of caring about classmates' lives, the full-time seniors were higher than the night school seniors. Therefore, it could be seen that the full-time seniors were more concerned about their classmates' lives than the night school seniors. On the comparison of value comments, the full-time seniors were the highest, followed by full-time sophomores, night school seniors, and night school sophomores. In the comparison of sharing life trivia, the full-time seniors were the highest, followed by night school sophomores, night school seniors, and full-time sophomores. In the comparison of sharing belongings, the full-time seniors were higher than the night school sophomores.

For learning motivation, there were significant differences between different groups in only in understanding the course content. The results of the post-hoc tests revealed that the full-time seniors were higher than the night school sophomores. In addition, there were significant differences in the learning effectiveness of different groups, such as the improvement of practical ability and communication ability as well as understanding the expertise of the team members. The comparison

of the three parts after the post-hoc tests revealed that the full-time seniors were higher than the night school sophomores. Therefore, according to the above research results, regardless of the overall comparison of peer relationships, learning motivation, and learning effectiveness, the full-time seniors had the highest results. There was a consistent trend in the analysis of differences in the discussion of grade variables; that is, a good peer relationship will increase the learning motivation and affect the recognition of learning effectiveness. The comparison results revealed an interesting phenomenon, in that in terms of learning motivation and learning effectiveness, only the full-time seniors and night school sophomores had significant differences. This could mean that night school sophomores have a strong recognition of learning motivation and learning effectiveness. This result echoed the findings of [94], who studied night school students.

5.1.3. Discussion of Different Learning Factors and Classification of Learning Styles

This study mainly focused on the three factor dimensions of peer relationships, learning motivation, and learning effectiveness to conduct exploratory factor analysis and discuss various learning factors. On the premise that these three factors could explain a total of 58.975% of the variation, three factors were extracted by the principal axis method, and the load matrix was obtained using Promax analysis. Three different learning factors were then summarized after the resulting load matrix. They could be defined as "emphasizing ability improvement", "care about peer friendships" and "careful and active learning". The "care about peer friendship" section referred to the degree to which friendship caring can be regarded as the key to peer relationships. The "careful and active learning" section emphasized how learning influences the positive degree of learning motivation. The "emphasizing ability improvement" referred to how the improvement of ability will be reflected in the recognition of learning effectiveness. In addition to the study of the classification of learning styles under the three factor dimensions, this study used the two-stage cluster analysis method for cluster classification. The final result showed that cluster 1 had the highest average number in the peer relationships. Therefore, it was named "enthusiastic and friendly". Cluster 2 had the highest average number in the learning effectiveness. Therefore, it was named "active and autonomous". The above results indicated the existence of two different learning styles. Therefore, "enthusiastic and friendly" could be equivalent to the "care about peer friendship" factor, and in the "active and autonomous" cluster, there can be to a combination of the "careful and active learning" factor and the "emphasizing ability improvement" factor. Finally, the discriminant analysis showed significant differences and verified that the cluster classification in this study had a segmentation effect.

5.2. Suggestions

This study was mainly aimed at design students with different backgrounds and analyzed the differences in peer relationships, learning motivation, and learning effectiveness in order to find out the key influencing factors affecting the learning process of different backgrounds design students. The results of this study showed that there were significant differences in varying degrees under the three factor dimensions. Among the study results, some more interesting aspects were discovered. For example, females were found to be superior to males in peer relationships. This result can be further explored from the perspective of females in the future. Secondly, for different educational systems, many interesting aspects and possible factors were found. Peer relationships, learning motivation, and learning effectiveness can all become independent research propositions. This study mainly discussed these three factors from a general aspect to obtain preliminary research results. We will focus on individual research propositions in the future, such as a discussion of the peer relationships of design students in different educational systems, the learning motivation of female design students in different grades, or the influencing factors learning effectiveness for female design students. This study attempted to construct a new research topic block that discusses design education and teaching site improvements from the student perspective. Therefore, in addition to opening a new window for

design education research, this study also provides a new opportunity for the improvement of teaching practices on-site.

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