

The Influence of Statistics Literacy and Flip Teaching on Learning Achievement

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ABSTRACT : This study mainly aims to explore the impact of statistics literacy of students and Flip teaching of teachers on learning achievement in statistics classes in a college in Taipei City. Besides, this study uses Purposive Sampling method to sample the population. The main subjects were college students who had taken Principles of Statistics and teachers who had taught Statistics courses in a college in Taipei City. Moreover, “Covariate Analysis of Two-Factor Single Covariate” (i.e., 2 independent variables, 1 dependent variable and 1 covariate) of quasi-experimental design method statistically analyzed data. These findings show that (1) Statistics literacy has positive and significant impact on post-test learning achievement, compared with pilot-test learning achievement; (2) Flip teaching has negative but insignificant impact on post-test learning achievement, compared with pilot-test learning achievement; and (3) Statistics literacy and Flip teaching have negatively but insignificantly interactive impact on post-test learning achievement, compared with pilot-test learning achievement. These results can be provided as references to the teachers teaching statistics in a technological or vocational college, and decision-making authorities in education field for teaching and formulation of education policies respectively.

KEYWORDS -Statistics Literacy, Flip Teaching, Learning Achievement

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I. INTRODUCTION

Over the years, colleges of management of Taiwan’s technological and vocational colleges have treated statistics as a compulsory course according to the standard curriculum guidelines of the Ministry of Education because statistics is one of the basic courses that enable the students to acquire advanced knowledge management. It is worthwhile to explore whether the interest in reading and ability to read Principles of Statistics-related materials nurtured in vocational schools and the degree of literacy of Primary statistics affect the learning achievement of the students in applied statistics courses offered by the technological or vocational colleges.

Moreover, Flip Education is one of the most important educational topics in the world at present. During the network and information era, teachers' teaching and students' learning has revolutionized, teachers have moved away from the role of traditional knowledge providers and become promoters and coordinators of students' learning, while students have also been transformed into autonomous learners by the learning model of “talking, copying and memorizing without thinking”. The courses of digital teaching materials, grinding therapists (Massive Open Online Courses, MOOCs) and SPOCS (Small Private Online Course) are all materials for students' self-learning, and classroom discussions have become an effective catalyst for learning outcomes [1]. But for every school teacher in the implementation of flip teaching, students can have the willingness to actively learn? One of the elements of success in the implementation of Flip teaching is that students must have the will to actively learning. However, in Taiwan due to the impact of “declining birthrate”, many schools cannot recruit students successfully, almost the possibility of being submerged and eliminated. In order to maintain the students' quality, some schools have been relatively affected, and the main purpose of their coming to school is really to learn skills, or for other purposes is unknown, which is one of the motives that contributed to this study. Bergmann & Sams [2] pointed out that the success or failure of flipping classrooms is closely related to students' enthusiasm for learning, and teachers should give students the opportunity to choose, in order to maintain or cultivate enthusiasm for learning.

Finally, as with traditional teaching, teachers should design complete mechanisms to ensure the quality of group discussions, as well as the design of preview content to make it interesting and in line with the level of students, these are playing the key role of the success of the flip classroom.

Therefore, based on the above motivations, this study adopted the Covariate Analysis of Two-Factor Single Covariate of quasi-experimental design method, and sampled the population consisting of students who

had taken Primary statistics and teachers teaching applied statistics in a college in Taiwan. The main objectives are briefly described as follows:

- (1) To realize that whether Statistics literacy has positive and significant impact on post-test learning achievement;
- (2) To realize that whether Flips teaching has negative and significant impact on post-test learning achievement; and
- (3) To realize that whether Statistics literacy and Flips teaching have negatively and significantly interactive impact on pilot-test learning achievement.

II. LITERATURE REVIEW

Definition and Constructs

Definition of Statistics literacy, Flips teaching, and their related literature

The definition of Statistical literacy in this study is "the learner has a statistical basis and interest".

Besides, this study also defines the concept of Flip teaching as "the form of self-study of online teaching materials by students, and then in the classroom by teachers to ask questions, guide the discussion and practice of the model. Flip the tradition-first by the teacher in the classroom, and then by the students go home to do homework forms, so also known as flip classroom". This study for the Flip teaching of the sub-construct is a comprehensive Forsey, Low & Glance [3] concept, respectively. (1) Low-level learning-refers to the second half of the school students learning; and (2) High-level learning-refers to the first half of the school students learning and other two sub-construct to be verified separately.

The conceptual definition of the above Flip teaching is combined with the following literature.

Hamdan, McKnight, McKnight & Arfstrom [4] Scholars in 2013, with FLIP, put forward the key to flipping the classroom, F on behalf of a flexible learning environment, student-centered (Learner Centered) teaching, purposeful (Intentional) learning content, and teachers must have a Professional knowledge and attitude. Bergmann & Sams [2] thought that the so-called "Flip classroom" is not a new teaching strategy. It is to reverse the teaching order of the traditional classroom, the use of science and technology into the teaching way-especially the film, so that students first preview the reverse teaching (inverted Instruction) often uses the form of mixed learning (blended learning), which is a mixture of online and traditional face-to-face courses, to help students achieve higher levels of learning goals. In other words, students should preview themselves before they go to the classroom, and teachers use face-to-face teaching time to guide students to complete their homework, help students solve their schoolwork problems, so that students can have the opportunity to participate in classroom discussions and invest in classroom activities. As a result, opportunities for interaction between teachers and students are greatly improved and can even help students achieve higher levels of learning goals.

In the process, students must be responsible for their own learning, while students can get personalized learning assistance (to achieve differentiated teaching)

Chou [5] pointed out that the flip classroom refers to the class form of "Student preview before class, interactive discussion in class".

There are many methods of preview and interactive discussion, among which action learning is used as a method for students to preview before class, and cooperative learning method is used as a teaching method for teachers and students to communicate and interact in class. In addition, Liu [6] also pointed out that the flip class is called Flip Teaching and F represents a Flexible-learning environment, Learner centered teaching, Intentional learning content, and teachers must have a Professional knowledge and attitude. Moreover, Flip Learning or inverted classroom, the key to its implementation is two: (1) before class, the teacher will be self-recorded teaching content (or related ready-made material) upload or link to the learning platform, students on the platform. "Self-learning" these contents and record the problems encountered in the study; and (2) in class, teachers respond to the problems encountered by students when they are self-taught, and carry out cooperative learning or individual guidance based on discussion.

This kind of self-study online teaching material, and then in the classroom by the teacher to ask questions, guide the discussion and practice of the model, flip the tradition-first by the teacher in the classroom, and then by the students go home to do homework form, so called flip the classroom.

Forsey et al [3] believed that if the content of lecturers in the humanities including the field of education is biased towards the lower classes. (Belonging to the teaching activities of memory, comprehension, etc.). Students feel little gain in class, simply reading the data or watching the relevant films before the exam. You can still pass the exam or pay the report without going to the classroom, so you often choose to be absent or not to concentrate on the class, but the high-class teaching activities, that is, more high-level and individualized learning; for example, mathematical computing problems, social issues, etc. are time-consuming, Traditional teaching is not easy to achieve.

Hao 【7】 Flip Classroom The main concept is the student-centered thinking: The teacher flip- “that is, change”- the teacher-centered mode of thought in the past, change the student-centric concept, by incorporating appropriate scientific and technological tools-especially films, so that students preview the basic content in advance at home, and in the classroom, students under the guidance of teachers.

Have more opportunities to interact with peers and teachers to conduct higher-level, individualized learning (e.g., mathematical computing problems, social issues, etc.). In addition, the flip classroom four principle includes a four principle that provides help for teachers to Flipped Classroom: (1) Select 15 of the topics that can be explained: Flip classroom teaching method is suitable for students to understand the topic. Teachers can put together in advance can let students understand the film or data, heavy non-weight; (2) clearly plan the discussion and activity time in the classroom as the coach designed the ball to play for the students, rather than allowing the students to discuss or self-study on their own; (3) Do not flip every class, because this is not the only teaching method. It's good to try different subjects once a week in the first place; and (4) for students who do not have a network at home to design the record, flip learning depends on the preview, if the previous lessons need to be completed online, teachers need to consider the home without network or computer students, to provide them with a preview of the data alternative 【8】 .

Definition of learning achievement and related literature

Learning effectiveness refers to changes in knowledge, skills and attitudes of learners at the end of teaching 【9】 . The conceptual definition of "learning effectiveness" in this study is "three observable variables (explicit variables) that can be performed by students after school, the professional skills shown and the test ability to participate in various external tests. As an index to the measurement of learning effectiveness", and its operational definition is summarized as follows:

(1) School performance: refers to the students through the school study process, after studying in the school test results; (2) Number of professional certificates: refers to the number of professional certificates obtained by students in the verification of various professional abilities after the process of learning through school or other abilities; and (3) Foreign examinations: refers to the process by which students participate in various professional competence tests outside school after studying in schools or majors.

However, the conceptual definition and construct of the above learning results are synthesized from the reference to the following literatures.

Chen 【10】 pointed out that the definition of learning effectiveness refers to “a guideline for measuring learners ' learning outcomes and one of the most important items in assessing the quality of teaching”.

Wen 【11】 described the learning effect is defined as “the learner's academic achievement, including the result of formative and summary evaluation”.

Li 【12】 pointed out that the definition of learning effectiveness refers to “learning an activity and going through a period of time, by the assessor to carry out some form of evaluation of the learner, which may be the time, tool or pointer, the learning effect of the learner.”

Lin 【13】 described the learning effectiveness is defined as a guideline for measuring learning outcomes. And one of the most important items in evaluating the quality of teaching; it refers to learners who, after a certain period of time, have studied in a certain field, through test tools, cognition, emotion, skills and other oriented assessment, to measure the learning effect of students. For the evaluation method of learning effectiveness, the use of accuracy, completion time, difficulty, complexity and the value of the answer to provide a more fair and reasonable assessment method, teachers can be assessed through the student's various learning results record data. Like oral examination, written examination, operation, report, homework, study order, normal test, periodic evaluation examination, etc. can be defined as a wide range of learning outcomes, and if defined from a narrow definition, it refers to the academic performance of the subject, or the average academic achievement after the synthesis of the various disciplines.

Chen 【14】 pointed out that the definition of learning effectiveness refers to “the capacity of learners to perform various possible line evaluation tests after the learning activities have come to an effect.”

As for the scholars' way of measuring the effectiveness of learning, they have different views and research results.

Jones 【15】 pointed out that learning effectiveness would be influenced by learning patterns, curriculum design, teaching and other factors.

Loo 【16】 studied also believe that learning performance will be influenced by learning patterns, curriculum design, teaching and other factors.

The evaluation of learning effectiveness can generally be directly determined by the students' performance in school, the ability to obtain professional certificates and the effectiveness of participating in various external examinations to see the effectiveness of learning.

In this study, the conceptual definition of learning effectiveness is “the impact on and achievement of the learners after learning. The measurement indicator is academic record.” The above definition is summarized from the following literature.

Wang [17] believed that learning effectiveness is the impact and outcome that a learner acquires through learning, which includes instructor's teaching, learning environment, course curriculum and learning outcomes.

Huang [18] pointed out that learning effectiveness is the accumulated ability and accomplishment a learner acquires after the course is completed, through active participation in the experience of the teaching process.

Chen [14] argued that the learning effectiveness refers to “a student’s demonstrated ability after various possible forms of assessment tests are conducted on the student at the end of the learning activity.”

Huang [19] believed that learning effectiveness is the indicator for measuring a learner's learning outcomes. For students, learning effectiveness is the outcome that can only be recognized after students have experienced a long period of school education.

Literature Review on Pairwise Correlations of the Constructs of this Study

Literature regarding the impact of Statistics literacy on learning achievement

Now we have not found any literature on the relevance between statistics literacy and learning achievement. However, in this study, we subjectively believed that statistics literacy is relevant to learning achievement. Therefore, this exploratory study proposed the following hypothesis:

Hypothesis 1 (H_1): Statistics literacy has positive and significant impact on post-test learning achievement, compared with pilot-test learning achievement.

Literature regarding the impact of Flips teaching on learning achievement

The literature regarding the relevance of Flips teaching and learning achievement is summarized as follows:

The new teaching mode: The help of flip teaching to improve the effect of learning has been proved in many studies abroad.

Yan & He [20] thought that the use of information technology into teaching can improve students' learning effectiveness, but the main body is still the content of the curriculum and teaching activities, information technology is only one of the auxiliary tools.

Wang [21] pointed out students with the flip teaching mode of concept composition have a significantly better learning effect than the traditional teaching mode.

Wu [22] described that after accepting the flip teaching method, the students in the experimental group were significantly better than the students in the control group.

Chou [5] believed that the learning effect of the flip classroom combined with the action learning teaching mode is significantly better than that of the students under the traditional teaching mode. Compared with the traditional teaching mode, the flip classroom combined with action learning allows students to have a deeper understanding of the “proportional” unit, and the willingness to learn is improved.

Through the feedback and interview of the questionnaire, we can understand that teachers and students give a positive attitude to the teaching method of flipping the classroom.

Synthesize the above; this study proposes the following hypothesis:

Hypothesis 2 (H_2): Flips teaching has negative and significant impact on post-test learning achievement, compared with pilot-test learning achievement.

Literature regarding Flips teaching and Statistics literacy

Now we also have not found any literature on the relevance between Flips teaching and statistics literacy on learning effectiveness. However, in this study, we subjectively believed that Flips teaching and statistics literacy are relevant to learning effectiveness. Therefore, this exploratory study proposed the following hypothesis:

Hypothesis 3 (H_3): Statistics literacy and Flips teaching have negatively and significantly interactive impact on post-test learning achievement, compared with pilot-test learning achievement.

III. RESEARCH METHOD

Based on the above research motives, purpose and literature review, this study deduced research hypotheses, and constructed a conceptual research framework, as shown in Figure 1.
Research Framework

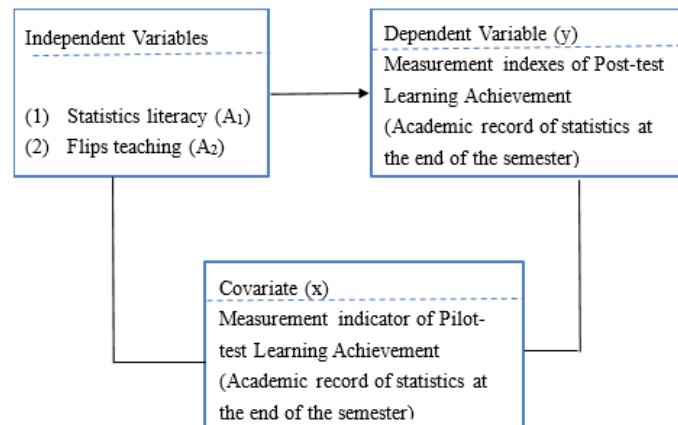


Figure 1 Research Framework

Sampling Method and Questionnaire Design

This study applied Purposive Sampling method on this research population, and targeted students who had taken Principles of Statistics and teachers teaching Statistics courses in a college in Taipei City for a questionnaire survey. This study issued 40 copies of questionnaire to experts as a Pilot-test. After revising the questionnaire according to experts' feedback for improvement, a Post-test was conducted. The Purposive Sampling method was used to formally distribute 523 copies of questionnaire. There were 432 copies of valid returned samples, a valid returned rate of 82.60%.

The five-point Likert scale is used to measure the questionnaire, where various degrees of agreement are given scores from five to one, with 5 being strongly agree and 1 being strongly disagree. The higher the level of agreement, the higher the score; conversely, the lower the score.

This article designed the four-question questionnaire as for statistics literacy.

And the four-question questionnaire regarding Flips teaching was designed based on the questionnaire from Lin [23].

Additionally, the six-question questionnaire relating to Learning achievement were designed based on the questionnaires from Wang [17] and Huang [19].

Quasi-Experimental Design Method

This study adopted the “Covariate Analysis of Two-Factor Single Covariate” (two independent variables, one dependent variable, and one covariate) of the Quasi-experimental design method as the statistical analysis method. The two independent variables were the statistics literacy of students who had taken Primary Statistics in a college in Taipei City and the Flips teaching adopted by teachers teaching statistics courses. The dependent variable was post-test learning achievement, and the covariate of this study was pilot-test learning achievement. It is worth mentioning here that the measurement indicator of learning achievement of this study was academic record. These data were obtained from the questionnaires of this study.

Tools for Statistical Analysis

(1) The reliability analysis of these questionnaires is measured by Cronbach α coefficient; while validity analysis relies on Expert Validity (or Content Validity).

(2) Statistical Analysis

The statistical analysis method adopted in this study was the Covariate Analysis of Two-Factor Single Covariate (i.e., two independent variables, one dependent variable and one covariate). The two factors were two independent variables: Statistics literacy and Flips teaching (A1 & A2), and the covariate (x) is pilot-test learning effectiveness. The dependent variable (y) is the post-learning achievement. The purposes aim to realize: (1) whether statistics literacy has positive and significant impact on post-test learning achievement, compared with pilot-test learning achievement; (2) whether Flips teaching and statistics literacy have positively and significantly interactive impact on post-test learning achievement, compared with pilot-test learning achievement; and (3) whether Flips teaching has positive and significant impact on post-test learning achievement, compared with pilot-test learning achievement.

In addition, Bryman & Cramer [24] argued that intra-group regression coefficient homogeneity test should be conducted before the analysis of covariate (ANCOVA) to determine whether the Covariate Analysis of Two-Factor Single Covariate (i.e., two independent variables, one dependent variable and one covariate) is applicable to a study. Furthermore, if the F value of covariate is significant, then post hoc analysis is conducted, using "adjusted means" as the standard for comparison to find the pair that presents significant differences. Lastly, three factors were taken into consideration when selecting covariates in this study, that is: (1) it has to

relate to the dependent variable, rather than an experimental treatment; (2) if the correlation between two covariates is above .80, then only one of them is selected as the covariate for the study; and (3) when there are fewer test subjects, less covariates should be selected. It is easier to control extraneous variables when there are more covariates, thus rendering a more accurate statistical test in an experimental treatment [25].

IV. RESULTS AND DISCUSSION

With regard to the reliability analysis of the Statistics literacy and Flips teaching questionnaires, Cronbach α coefficient is higher than 0.8, which indicated good reliability of the questionnaires, as shown in Table 1.

Table 1 Reliability Analysis on the Statistics Literacy, Flips Teaching, and Learning Achievement Questionnaire

Reliability Analysis	Dimension	Cronbach α coefficient
Flips teaching, Statistics literacy, and Learning Effectiveness Questionnaire Survey	Statistics literacy	0.832
	Flips teaching	0.823
	Learning achievement	0.851
Overall Scale		0.835

As for the validity, the questionnaire of this study adopted expert questionnaire, which in itself has sufficient content validity. In addition, after compiling and analyzing the following computer report as shown in Table 2.

Table 2 A Summary Table of the Simple Main Effect Analysis of, Statistics Literacy and Flips Teaching in Post-Test Learning Achievement

Sources of Variation	SS	DF	MS	F	Post Hoc
Factor (statistics literacy, Flips teaching)					
in A ₁ (Statistics literacy)	221.22	2	110.61	3.93	Learning Achievement (Pilot-test) > Learning Achievement (Post-Test)
in A ₂ (Flips teaching)	-136.33	2	-68.17	-2.40**	Learning Achievement (Post-Test) > Learning Achievement (Pilot-test)
Error	84.83		28.32		

Note: *P<0.05 **P<0.01 ***P<0.001

Table 3 A Summary Table of Covariate Analysis of Statistics Literacy and Flips Teaching and Post-test Learning Achievement

Source	Type I&II Sum of Squares	df	Mean Square	F	Eta Squared	Observed Power(a)
Statistics Literacy (A ₁)	282.12	2	141.06	3.33**	.64	.48
Flips Teaching (A ₂)	-127.22	2	-63.61	-1.51	-.23	.47
The Interactive Effects of Post-Test Learning Achievement (A ₁ *A ₂)	-88.33	2	-44.17	-1.01	-.42	.83

Note: *P<0.05 **P<0.01 ***P<0.001

According to Tables 2 &3

- (1) Statistics literacy has positive and significant impact on post-test learning achievement, compared with the pilot-test learning achievement. Therefore, Hypothesis 1 (H₁) is supported. (Tenable)
- (2) Flips teaching has negative but insignificant impact on post-test learning achievement, compared with the pilot-test learning achievement. Therefore, Hypothesis 2 (H₂) is not tenable.
- (3) Statistics literacy and Flips teaching have negatively but insignificantly interactive impact on post-test learning achievement, compared with pilot-test learning achievement. Therefore, Hypothesis 3 (H₃) is barely tenable.

V. CONCLUSION

According to the above results and discussion, the conclusions and contributions of this study are given below followed by the limitation of the study and recommendation for follow-up studies.

Conclusions

- (1) Hypothesis 1 (H₁) is tenable, i.e., Statistics literacy has positive and significant impact on post-test learning achievement, compared with the pilot-test learning achievement.
- (2) Hypothesis 2 (H₂) is not fully tenable, i.e., the Flips teaching has negative but insignificant impact on post-

test learning achievement, compared with the pilot-test learning achievement.

(3) Hypothesis 3 (H_3) is barely tenable, i.e., Statistics literacy and Flips teaching have negatively but insignificantly interactive impact on post-test learning achievement, compared with the pilot-test learning achievement.

According to the above, we can get findings that Flips teaching is one of the ways that supplement normal face-to-face teaching in a technological or vocational college in the field of statistics. Flips offer a variety of courses for on-the-job training and life-long learning, but they cannot completely replace the traditional face-to-face teaching.

Research contributions

These findings can be provided as references to the teachers teaching statistics in a technological or vocational college, and decision-making authorities in education field for teaching and formulation of education policies respectively.

Research Limitation

Despite the limited resources, this study was conducted in a rigorous manner at every phase of this research. However, the following research limitations still exist:

(1) This study sampled the population by means of purposive sampling, which is one type of non-probability sampling. Although it has higher recovery rate of valid samples, such method may cause sampling bias and thus affects the results.

(2) Because of limitation on research resources, this study was based only on students who had taken Primary Statistics and teachers teaching statistics courses in a college in Taipei City. The scope of this study did not cover technological or college students, and teachers teaching statistics courses in those of Taipei City.

Recommendation for Future Studies

(1) Because the main subjects of this study were limited to students who had taken statistics and teachers teaching statistics courses in a college in Taipei City. For extensive data, the follow-up researchers can try to expand the scope of this study for further analysis.

(2) The follow-up studies can adopt stratified random samplings or simple random sampling when sampling the population.

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