Teaching Elementary Logic in General Education in Taiwan

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Abstract: Designing curriculum for courses on logical thinking in colleges and universities is not easy. It is also a challenge to those lecturers who teach informal logic (including critical thinking) and impart the objective tools of analyzing and evaluating arguments. In this paper, we first investigate what content should be included in a course on logical thinking. This is a research which aims at understanding the level of satisfaction of students who are enrolled in the Language and Logic course at the Yuan Ze University, in terms of learning effectiveness. This paper will elucidate the results of applying teaching practice research on courses about logical thinking and consists of two parts. In the first part, we explore the organization of the course which comprises formal logic and critical thinking. The second part presents the learning effectiveness and learning satisfaction of delivering formal logic in the course.

Keywords: Elementary Logic, critical thinking, learning effectiveness, learning satisfaction, teaching practice research.

1. Introduction

In the general education curriculum, logical thinking courses are classified as a core field. Although the names of the courses are slightly different, their common purpose is to cultivate the basic logical thinking ability of college students. But what exactly is a basic logical thinking ability? From the perspective of developmental psychology, a child's logical thinking ability develops in a gradual manner as the child develops. A logical thinking ability refers to the ability to solve mathematical and logical operations. Children implicitly adopt basic logical operations to perform deduction rather than calculation in their processes of learning arithmetic and engaging in temporal reasoning and geometrical reasoning. In other words, the ability to engage in logical thinking develops as a child grows older and this ability gradually permeates their thinking in everyday life. Compared with the ability to perform mathematical calculations, the ability of logical thinking is a cognitive ability or cognitive process that does not require special learning. It is not only an ability to perform mathematical operations.[2]

In this sense, students who have studied in colleges and universities obviously have a considerable ability to reason, think, and argue logically. When students take courses in related fields, they can apply the cognitive skills they already possess to solve problems in the new course. However, the various topics and arguments discussed in the relevant courses of colleges and universities are mostly expressed and stated through natural language, such as English and Chinese. When solving problems, most of the students use their own language (natural language) to derive schema or symbolic representation are often used as auxiliaries.

It is necessary to *cultivate the literacy* of logical thinking and scientific thinking in general education, but I believe that it is not necessary to achieve this goal by taking a complete course on logical thinking. I even proposed a question in order to clarify the special status of courses on logical thinking, this being "which courses in higher education cannot be used to cultivate students' literacy of

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[2]Although there is still academic controversy surrounding this statement, well-known child development psychology is based on the research results of the 20th century development psychologist Jean Piaget. Piaget's view of knowledge and logic is very different from the logic of traditional philosophy. Well-known related research is (Bärbel & Piaget 1964).

logical thinking?" A possible answer might be "all courses in higher education can be used to cultivate students' literacy of logical thinking".

Exactly what should be taught in a course on logical thinking? We think that teaching elementary logic[3] in a scientific way is necessary and the materials of elementary logic should be scientific as well because if an instructor doesn't deliver specific scientific materials in a course on logical thinking, many students attempt to bring their "personal logic"[4] to the course to solve problems when they take courses on logical thinking, and moreover they usually turn a de facto closed-ended question into an open-ended one which makes these questions controversial between students. If instructors do not introduce objective methods of explaining, deriving, and proving abstract issues, then instructors have to persuade students. Teaching logical thinking might become a spoon-fed activity in a single direction or might constitute bi-directional debates between students and lecturers. In this way, students sometimes need to choose their positions, i.e. to stand on one side rather than the other, and it may result in students not understanding what a truly persuasive argument is. Students may not even realize whether there is a way to evaluate arguments or not.

The basic content of learning logic may be: "the original possessed but not properly used abilities, the original possessed but not clear concepts". In general education, curriculum designs for courses on logical thinking should be indicated specifically so that students can understand. However, taking the example of the curriculum of general education of Yuan Ze University taught by me, I find that its College of General Studies aims to "train students to have a basic understanding of the eight core competencies and to develop appropriately":[5]

1. Humanities and environmental care
2. Ethical thinking and practice
3. Perceptual and interpretive understanding
4. Logical and scientific thinking
5. Citizenship and social participation
6. Communication and teamwork
7. Critical thinking and innovation
8. Cultural learning and international perspective

In view of the above, if we try to classify courses on logical thinking, then these courses cannot be regarded as cultivating logical and scientific thinking, but can be categorized as a course to develop the other seven core competencies. In addition, any course which aims to develop core competencies can be regarded as cultivating students' literacy of logical thinking. In the classification of disciplines, courses about logical thinking are actually more basic than other courses.

In line with this position, elementary logic is more basic than any other courses in higher education; any inference or statement in academic thinking should be a valid inference or statement. We say: "Shakespeare is a good playwright" is the opinion of a certain person. "Trump is not a good president" is the opinion expressed by another certain person. However, it is obviously problematic to allow an analyzable argument become different personal opinions. For example:

Argument. If Trump is a good US president, then he is a good American citizen. Trump is not really a good US citizen. Therefore, Trump is not a good US president.

The instructor should be able to explain why the argument is a "valid argument" rather than focusing on students' judgments about "whether Trump is a good US president" or "whether Trump is a good US citizen", let alone the positions or viewpoints of students on these two statements.

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[3] I believe that the meaning of the term "elementary logic" is still debatable and it is perhaps a challenge for logicians and philosophers to study the nature of elementary logic. For example, in (Hintikka, 1995), he stated that "the belief in the status of quantification theory (first-order logic) as the true elementary (basic) logic is not unanimous. For instance, some philosophers and mathematicians have argued that second-order logic is the appropriate universal medium of mathematical theorizing." However, what I refer to is the first-order logic when I use the term "elementary logic" in this paper.

[4] "Personal logic" means the value judgments that people usually use in their thinking and inferring.

[5] According to the course system used by me, the courses offered by instructors must be designed to meet the core competencies with two higher weights, so that students can select their courses. There can be no more or less than two core competencies.

When reviewing the syllabuses from different universities, it is not difficult to see that some teachers emphasize teaching content on critical thinking because they may wish to make classroom activities lively and interesting. They sometimes use debates to conduct class discussions. However, the debate process tends to have problems with different positions. In a debate, people tend to want to win rather than give up their particular position. Therefore, it is difficult to avoid taking sides. Since a basic logical thinking ability comes with age, what is the essence of the elementary logic that students have to learn in class? The answer is obviously not to learn logical thinking, because if logical thinking is a cognitive process, then logical thinking is a psychological process as one develops with age. However, it may be possible to promote this ability through relevant exercises. The answer is obviously not how to apply logical systems to reasoning, because to be able to apply logical systems to reasoning activities, one must be able to understand the logical system applied, which would be an advanced course in any curriculum.

A basic logic curriculum design should include the original possessed but not properly used ability. Teaching elementary logic, where the scope of the subject has been defined properly, can help learners understand some relevant principles and logical notions about logic, and they can further try to systematically apply logical systems to analyze and understand some specific problems.[6] This ability to analyze and understand is possessed by human beings as a species (homo sapiens), but the use of formal methods has to be acquired, among which the usage of language can be said to be the most basic of these acquaintances.[7] As for "the original possessed but not clear concepts", lecturers can deliver materials about critical thinking and informal logic, which can be described using natural language to articulate these concepts. In other words, we believe that matching elementary logic and critical thinking is an important key in designing an elementary logic course; and the design of courses on logical thinking may be reduced to how to design an elementary logic[8] course without emphasising only one side.

2. Studying Learning Effectiveness in Learning Formal Logic

Several colleges and universities have made logical thinking courses compulsory or a required course in core curriculums, for example, National Pingtung University (compulsory/required course in core curriculums), National Kaohsiung University (required course in core curriculums) and the Department of Medical Management of Chang Jung Christian University (compulsory).

In my course Logical Thinking and Argument at the National University of Kaohsiung, I delivered consecutive materials on formal logic for three semesters starting in the Spring Semester 2015 (three-semester credit hours). The material in this kind of course can be extended from propositional logic to predicate logic. Also, the scores that the students attained in their final examinations were good, and the SET scores were also above average: 4.41, 4.25, 4.44, respectively. Although the students passively absorb the content, they are eventually able to understand that there are objective tools for evaluating arguments. This shows that delivering a course on formal logic in general education is acceptable to most students at some universities if there is enough teaching time. However, it also

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[6] We believe that the ability to use formal language for representation and making inferences and demonstration can be regarded as the initial application of logical systems for inference. It is not necessary to understand how to construct a logical system to be able to apply logical systems for inference. In the case of college students as learners, if they can use formal language to express and abstract logical reasoning relationships, they actually learn an important cognitive tool. (Dutilh Novaes 2012) provides a philosophical and cognitive analysis of the formal language in logic.

[7] From the development history of logic, the *use* of formal language is not necessary to *explore* sophisticated logical concepts. However, the use of formal language is important for a person to be able to accurately *explain* and *interpret* the so-called "logical concept" at the level of language use, and not only to *use* logical concepts in the process of thinking. (See Chapter 1-3 in Dutilh Novaes 2012).

[8] Elementary logic has been studied by using formal languages since 20th century. Hence, two terms ``elementary logic'' and ``formal logic'' will be used interchangeably in this paper.

dependents on the instructors' backgrounds, because such kinds of courses cannot be executed properly if taught by instructors without appropriate training in modern logic.[9]

Courses on logical thinking are usually two-semester credit hours in general education in Taiwan. Hence, it is not an easy job to expand the course into the area of predicate logic. However, in order to ensure students have a better understating of the scope of modern logic and possibly choose other related courses in the future, it may be possible to assist students to gain an initial understanding of predicate logic, but this will require the instructors to redesign these courses.

I initially studied the possibility of introducing material on critical thinking in my course Logical Thinking and Argument at the National University of Kaohsiung in the Spring Semester 2016 (course number 1052A). This course was initially delivered by teaching formal logic consecutively for three semesters. This course was redesigned to consist of 50% critical thinking and 50% formal logic. In addition to a higher score of 4.65 in the student evaluation of teaching (SET) scores at the end of that semester, I felt that the students had been enthusiastic about the course over the whole semester. However, it is not possible to determine whether this was caused by the fact that the author introduced materials on critical thinking into the course.

I taught two courses, Modern Logic and the Method of Thought in his first semester at Yuan Ze University (Spring Semester 2017), delivering content on formal logic in the former and critical thinking in the latter. In Modern Logic, I intended to progress to units that were designed to impart an understanding of predicate logic, however, the author refrained from doing so and instead, in the last two classes he gave lessons which reviewed propositional logic because the learning situation was not good. In the Method of Thought, in addition to content on critical thinking that is usually delivered at Shu Zen College of Medicine and Management (five-year junior colleges), I included content on linguistic analysis, such as analysis vs. synthesis, a priori vs. a posteriori, causal relations, and the indeterminacy of translation which is usually taught in the Department of Philosophy to bring the course to the level of a university degree. The SET score was 4.42.

From my past SET scores from 2014 to 2018, I found that delivering a course on logical thinking in a general education course by only teaching critical thinking does not translate to higher SET scores and conversely only teaching formal logic does not translate to lower SET scores. However, a course consisting of both critical thinking and formal logic could satisfy the general requirements of most students. Hence, I think that it is improper to teach only critical thinking in a course on logic. A better way is to teach elementary logic as the main body of a course on logical thinking and the core of teaching elementary logic might be teaching formal logic with the help of material on critical thinking.

3. Teaching Practice Research Framework

Instructors hope to improve their teaching and improve their understanding of teaching through teaching practice research. Teaching practice research refers to educational practice in order to improve the quality of teaching or to promote the effectiveness of students' learning.

This teaching practice research was carried out to prove my long-term teaching practice beliefs, and further, through the final self-assessment of the students, so that the instructors can continue to observe and reflect on courses about logical thinking (including teaching about formal logic) and the effectiveness of learning related courses. This study is based on the subjects in the Language and Logic course, taught by me in the Fall Semester 2018 and the Spring Semester 2019. They are: Fall Semester 2018 Class B (1071LLCb), Spring Semester 2019 Class A (1072LLCa), Spring Semester 2019 Class B (1072LLCb). In the Fall Semester 2018, I followed the course design for the 2017 Spring Semester (1052LLC course) Logical Thinking and Argument and for classes 1071LLCa and 1071LLCb, the course comprised critical thinking (50%) and formal logic (50%). Whether the percentage of formal

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[9] I observed that the learning response to the three semester credit hour course is similar to those seen in the general education courses of the National Chung Cheng University nearly 15 years ago. The only difference is the number of students. At that time, the instructors were mainly professors, based in the Department of Philosophy, and each class comprised between 150--200 students. Students were required choose one of three courses that have a mathematical-orientation: logic, statistics, or calculus.

logic can be increased in the future to 70% (for around 1 – 2 weeks) so that students can learn more about formal logic is being considered. Although teaching on formal logic may not be particularly lively, when reviewing my teaching experience, the class participation and questioning frequency of the students was relatively high when entering the natural deductive method of sentential logic (propositional logic). If instructors are able to explain basic predicate logic in a similar way without delving too deeply, it will give the students a clearer perspective on logic. Therefore, I adjusted the course content to 70%+30% in the two classes of the Spring Semester 2019 (class number 1072LLCa, 1072LLCb) and then asked the students to complete the questionnaire.

Based on the research purposes of this study, I propose the following assumptions:

H1: Varying the amount of formal logic in the Language and Logic course impacts students' learning effectiveness.

H2: Varying the amount of formal logic in the Language and Logic course impacts students' learning satisfaction.

H3: There is a significant positive correlation between subjective self-improvement, learning effectiveness in learning formal logic, learning effectiveness and learning satisfaction of the whole course.

3.1 This study and data analysis

3.1.1 Subjects of this study

The subjects of this study were students of Yuan Ze University enrolled in the Language and Logic course, namely 1071LLCb, 1072LLCa and 1072LLCb. The total number of valid samples was 135. In terms of gender, the ratio of men to women is equal, 49.6% for men and 50.4% for women. There are five colleges in the University, namely College of Engineering, College of Management, College of Humanities and Social Sciences, College of Informatics, and College of Electrical and Communication Engineering. There are 43 participants (31.6%) from the College of Information followed by the College of Management (26.5%), the College of Engineering (22.1%)the College of Humanities and Social Sciences (15.4%), and the least number of students are from the College of Electrical and Communication Engineering (4.4%), as shown in Table 1. All students in the course must complete the course feedback form and the questionnaire after completing the course, and they should complete the SET on the YZU portal.

Table 1. *Descriptive Statistic.*

(n =135)

Variable	Number (%)
Gender	
Male	67 (49.6)
Female	68 (50.4)
College	
Engineering	30 (22.1)
Management	36 (26.5)
Humanities and Social Science	21 (15.4)
Information	43(31.6)
Electrical and Communication Engineering	6 (4.4)
Grade	
First	20 (14.8)
Second	54 (40.0)
Third	31 (23.0)
Fourth	28 (20.7)
Fifth (above)	2 (1.5)

3.1.2 Research Instrument

After referring to the relevant literature and scales, this study uses the Learning Effectiveness Questionnaire on Elementary Logic. The questionnaire comprises five parts, namely subjective self-improvement, formal logic learning effectiveness, learning effectiveness, learning satisfaction and personal background variables.

The subjective self-improvement is a self-edited scale with three items. The topics are: I think that the formal logic course after the mid-term examination improved (enhanced) my ability to understand the material about critical thinking which was delivered before the mid-term exam. I think that the formal logic course after the mid-term examination improved (increased) my ability to think about the material on critical thinking which was delivered before the mid-term exam. I think that the formal logic course after the mid-term examination improved (increased) my ability to learn the material about critical thinking which was delivered before the mid-term exam. The formal logic learning effectiveness and learning effectiveness sections are self-edited scales with 11 items for each. Learning satisfaction is based on Bhattacherjee's (2001) definition of satisfaction with three items, measuring the students' degree of satisfaction with the courses on logical thinking.

This questionnaire used the Likert five-point scoring model where 1 means "strongly disagree", 2 means "disagree", 3 means "neutral", 4 means "agree", and 5 means "strongly agree". The subjects select the appropriate response to each question based on their personal feelings about the course. Reliability refers to the stability and reliability of the scale. In this study, Cronbach's α coefficient is used for reliability analysis, and the scores of the questions are tested for internal consistency. The higher the value, the higher the consistency of the questions. The internal consistency reliability of this questionnaire is $\alpha = 0.974$, indicating that the questionnaire has good internal consistency, and the reliability coefficients of the remaining items are shown in Table 2.

Table 2. *Reliability.*

Variable	Cronbach's α
Subjective self-improvement	.914
Subjective learning effectiveness of learning formal logic	.946
Subjective learning effectiveness	.942
Subjective learning satisfaction	.938
All items	.974

3.1.3 Statistical analysis

Descriptive statistics: The samples in the three classes (1071LLCb, 1072LLCa and 1072LLCb) were collected through questionnaires. A total of 137 questionnaires were collected, and incomplete questionnaires were rejected, leaving a total of 135 valid questionnaires. The number and percentage of samples will be found by descriptive statistics.

3.2 Findings

The results show (Table 3and Table 4) that there is no significant difference between subjective learning effectiveness and subjective learning satisfaction across 1071LLCb, 1072LLCa, and 1072LLCb. In other words, there is no difference in the results for the course with 70%+30% formal logic tuition and of the course with 50%+50% formal logic tuition.

The correlations between subjective learning satisfaction, subjective learning effectiveness of learning formal logic, subjective learning effectiveness, and subjective self-improvement are as follows:

(1) Subjective self-improvement and subjective learning effectiveness of learning formal logic are significantly positively correlated. This shows that the higher the subjective self-improvement scores, the higher the subjective learning effectiveness scores for learning formal logic.

(2) Subjective self-improvement and subjective learning effectiveness are significantly positively correlated. This shows that the higher the subjective self-improvement scores, the higher the subjective learning effectiveness scores.

(3) Subjective self-improvement and subjective learning satisfaction are significantly positively correlated. This shows that the higher the subjective self-improvement scores, the higher the subjective learning satisfaction scores.

(4) Subjective learning effectiveness of learning formal logic and subjective learning effectiveness are significantly positively correlated. This shows that the higher the subjective learning effectiveness of learning formal logic scores, the higher the subjective learning effectiveness scores.

(5) Subjective learning effectiveness of learning formal logic and subjective learning satisfaction are significantly positively correlated. This shows that the higher the subjective learning effectiveness of learning formal logic scores, the higher the subjective learning satisfaction scores.

Table 3. *1071B vs. 1072 AB One-way analysis of variance*

Class	number	mean	SD	*F*	*p*	
Subjective	1071B	50	3.76	.60		
learning	1072A	44	3.68	.66	.343	.711
effectiveness	1072B	36	3.67	.49		
Subjective	1071B	49	3.95	.71	.097	.908
learning	1072A	44	3.98	.75		
satisfaction	1072B	3	4.01	.57		

Table 4. *Pearson Correlation （1072A and 1072B）*

	Subjective learning effectiveness	Subjective learning effectiveness of learning formal logic	Subjective learning effectiveness	Subjective learning satisfaction
Subjective learning effectiveness	1			
Subjective learning effectiveness of learning formal logic	.590***	1		
Subjective learning effectiveness	.537***	.961***	1	
Subjective learning satisfaction	.503***	.778***	.778***	1

4. Discussion

Hypotheses 1 and 2 are not accepted in this study. I observed that there is no difference between the two courses with different amounts of formal logic tuition. Instructors can decide to include 70%+ 30% or 50%+50% formal logic in their courses because the different percentages do not affect students' learning effectiveness and learning satisfaction.

According to my past experience and observations of my previous courses, students have the best learning effectiveness in the case of 50%+50%, so I assumed that learning effectiveness and learning satisfaction in the case of 50%+50% will better than the case of 70%+ 30%. However, this study shows that there is no difference. I infer that this is because the credits and types of courses are different (compulsory or elective courses). In courses with three-semester credit hours, students may have more time to understand the materials whereas students do not have sufficient time to understand the materials in courses with two-semester credit hours. In the case of 70%+30%, I observed that students' subjective learning effectiveness, the subjective learning effectiveness of learning formal logic, subjective self-improvement, and subjective learning satisfaction are significantly positively

correlated. I may be able to explain this because 70% of the course is about formal logic. Further research is needed to verify whether these variables are still positively correlated in the case of 50%+50%.

According to the results, hypothesis 3 of this study is accepted. There is a significant positive correlation between subjective self-improvement, subjective learning effectiveness in learning formal logic, subjective learning effectiveness, and subjective learning satisfaction of the whole course. This result will be discussed in three sections.

First, when the majority of the course (70%) is on formal logic, students have the opportunity to discover that the relevant critical thinking materials, involved in the first 30% of the course, can be analyzed by objective logical analysis without evolving into personal positions. For example, when dealing with critical thinking materials, students can also use basic tools in formal logic, such as truth tables, simple natural deductions, the non-contradiction principle in arguing and reasoning, and many more. Moreover, when students believe that the learning of formal logic has a certain enhancement in relation to their understanding, thinking and learning of critical thinking materials, they also think that their learning of formal logic has been beneficial.

Second, according to the first point, students feel courses which offer 70% formal logic enhance (understand, think, learn) and 30% critical thinking also feel the effectiveness of learning formal logic and vice versa. It can be further inferred that students are positive about the overall learning effectiveness of the course.

Third, according to my past experience and observations, learning about formal logic is not more difficult than learning about critical thinking, but the mathematical characteristics of formal logic sometimes make students feel uncomfortable in relation to their learning. Therefore, it is right to let students understand the essence of formal logic or let them understand that the discipline of formal logic can be learned independently of mathematics. For students, if they can learn formal logic part step by step, learning effectiveness and learning satisfaction of the entire course will be positive.

In view of the above, a correct understanding of formal logic and its scope can help students to learn in courses about logical thinking. For example, in any argument, questions as to whether the premise itself is true or false, whether the premise is sufficient, and whether there is a good reason to justify the premise, etc. are not a matter of formal logic. Formal logic can be clearly regarded as a tool for argumentation analysis, not a tool for judging the truth or falseness of a premise. In short, students who believe they can master formal logic will understand the scope of the use of formal logic in critical thinking materials. Specifically, students can clearly distinguish the difference between critical thinking and logic.

5. Conclusion and Recommendations

Logic education is quite different from professional logic education. (The ASL Committee on Logic and Education, 1995)[10] In Taiwan, professional logic education is a part of philosophy education. I believe that logic education should not be restricted to professional logic education only. In the general education of universities, logic is often included in the core curriculum. In the past, many instructors and students regarded the curriculum of general education as a simplified version of the curriculum of the professional department. This view is not appropriate.

The meaning and educational purpose of general education is different from those of specific departments. I believe that adopting the Department of Philosophy's approach to logic education in general education is debatable and worth deliberation. It is not necessary to look at logic education from the perspective of philosophy education. It can even be said that if we only use the viewpoints of specific departments to look at many subjects without focusing on the current situation of higher education and general education (in Taiwan), students may be more reluctant to take these subjects and instructors are not aware that they are spoon-feeding the students.

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[10] https://www.ucalgary.ca/aslcle/guidelines

Instructors need to let learners learn real logic rather than allowing learners to feel that formal logic is difficult, allowing learners to avoid active learning, or allowing the course to become trivial by steering the course toward informal logic simply because the instructors want students to be more willing to attend classes. Without understanding the overall picture of logic, instructors need to work hard to correct students' wrong impressions about logic, where students usually become involved in endless debates and discussions about value judgments.

Under such conditions, I believe that it is not appropriate to seek in-depth teaching, but to consider the breadth of the whole course. Therefore, adjustments in curriculum design are necessary to ensure students see the whole picture as much as possible. More importantly, it is necessary to pique the interest of learners to explore this subject. Over the past few years, I have found that the introduction of appropriate proportions of informal logic into the course is a useful strategy, but this does not include the most advanced research and teaching materials about informal logic, rather the basic methods of critical thinking. As stated earlier in this paper, informal logic should be a part of advanced logic, and it is not appropriate to teach these materials in general education. In the past, learners only had the impression that logic is "if P then Q" after studying this subject and students of the department of philosophy are no exception, which explains the necessity of adjusting the teaching of logic.

Compared with other relevant courses offered by other university departments, for most learners in general education, this may be their first and last opportunity to take a course in logic. Selecting the appropriate content for a logic course, as discussed in this study, needs to be done in consideration of the different levels of the students who are usually from different backgrounds, in order to evaluate what percentage of critical thinking and formal logic is the most suitable for each school, so that instructors can develop an appropriate curriculum design for different classes. Therefore, I suggest that instructors should conduct experiments and undertake research with instructors from other schools to better understand the how to organise courses on logical thinking that are suitable for their students.

The methods of teaching critical thinking and formal logic are completely different. However, all of these can be taught according to the instructors' personal learning experiences. After the curriculum of logical thinking become the core dimension of general education, even if students want to contact this type of course, the way of past one-way lecture still make students passive. However, in a course about logical thinking, if a suitable proportion of critical thinking and formal logic content is selected, learners will have the opportunity to compare the similarities and differences between the two types of courses and to distinguish the difference between subjective beliefs and objective evaluations. This will give students the opportunity to engage in study that triggers their interest. Instructors in this field can consider using the results of this study in teaching practice.

This paper is a teaching practice study with the goal of improving the learning satisfaction and learning effectiveness of learning formal logic in general education. I explored the proportion of formal logic and critical thinking content in a course about logical thinking, and further explored whether learning formal logic can help students understand courses about logical thinking. Teaching practice research refers to educational practice in order to improve the quality of teaching or to promote the effectiveness of students' learning (Chang 2018). However, before planning how to achieve these goals, I believe that the essence and connotation of this subject should have an appropriate explanation. As with the courses on logical thinking that we discussed in this paper, instructors should try to teach effectively before trying to improve student' learning satisfaction. The necessary condition of effective teaching is to teach appropriate course content. As described in this paper, the appropriate content of a course about logical thinking must include appropriate tools for analysis and evaluation of arguments, including arguments in daily life that can be described by natural language.

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