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Article

Enhancing the Critical Analysis Skills in Writing a Literature Review: An Application of Bloom's Taxonomy for Students in Higher Education

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Abstract
University students often write a literature review as a standalone assignment, or part of research papers to fulfill the course requirements. To write a good literature review, students must be able to apply critical thinking in every step of the way. The most challenging part in literature review for many students, from my observation, is the evaluation of the articles for their strengths and weaknesses. This is a critical step in literature review, as students should be able to identify gaps in the past studies and find the direction and contribution of their own papers, based on the evaluation. The objective of this study is to test if the critical thinking skills of students in higher education improved throughout a course by examining the literature review assignments submitted to fulfil the course requirement. I discuss how I introduce the concept of critical thinking in the process of writing literature review for undergraduate students at a private university in Singapore. The students attended the Introduction to Research Methods course, where they write a proposal for quantitative research, which includes a literature review section. I evaluate the effectiveness of the classroom activities designed to enhance critical thinking skills, by comparing the draft literature review with the final version. 144 students attended the course over approximately two years and worked in groups of two to seven. In total, 31 student groups submitted 62 literature reviews. To decide the level of critical thinking demonstrated in the literature review, I use Bloom's Taxonomy. The results from *t* test, Wilcoxan-signed-rank test and ANOVA show that critical thinking skills in the final version improved by approximately two Taxonomy levels, compared with the draft.

Keywords
Literature review, critical thinking, writing skills, research methods, Bloom's Taxonomy, Singapore

1 Introduction

Writing literature review is a common task university students encounter while pursuing their degrees. Nevertheless, many students find it challenging and confusing, failing to understand the main objective of literature review (Chen et al., 2016; Froese et al., 1998; Granello, 2001). A common mistake is to

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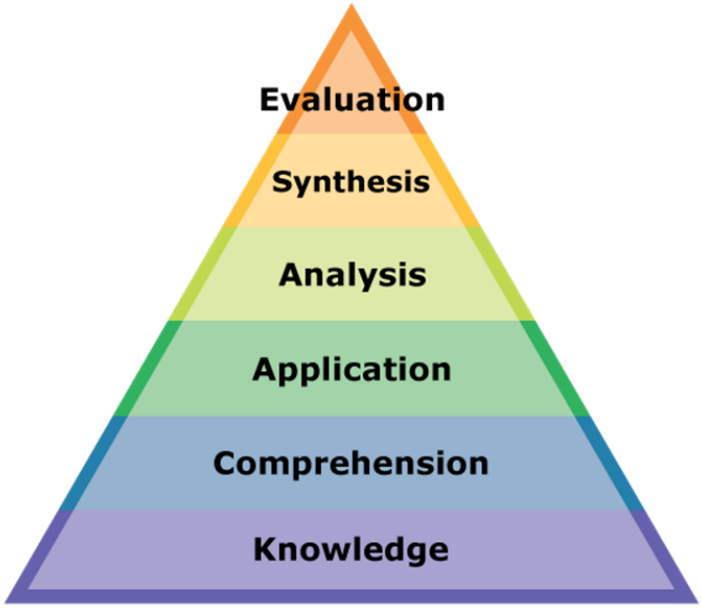
consider literature review as a laborious process of summarizing and listing articles that are somewhat related to the topic of interest. In fact, good literature review is far from that notion as the objective should be to critically analyze past studies and find gaps in the existing literature (Alvesson & Sandberg, 2020; Elsbach & Van Knippenberg, 2020; Paul & Criado, 2020). Even from the initial stage of compiling relevant literature, students must apply critical thinking skills to evaluate which articles are most relevant for their own papers. This sounds like a straightforward task, but in reality, it is more difficult that it sounds due to the sheer amount of articles available for students to review.

Once students have a collection of relevant studies, the next stage is to understand the main points of each article and connect it to students' own topics. From my experience as an instructor, the part students struggle a lot is organizing the studies by topics or themes. Such organization requires students to connect different sources with one another to group them and find an order of those groups. In the next stage, which requires the highest order of thinking, students evaluate the sources for the strengths and weaknesses and critically analyze them for their quality of argument (Granello, 2001). When successfully conducted, literature review enables researchers to understand what has been studied so far, what the findings are, and what can be done further. Several studies provide useful guidelines for students writing literature review (Denney & Tewksbury, 2013; Hart, 2018; Innoue-Smith, 2020), but not many provide the analysis of teaching critical thinking skills in the context of writing literature review. This study intends to fill this gap.

Several theoretical frameworks have been suggested to support the teaching or assessment of critical thinking skills. One of the popular frameworks is Bloom's Taxonomy, developed by Benjamin Bloom in 1956 (Bloom, 1956) and revised by Krathwohl (2002). Bloom's Taxonomy describes cognitive learning levels. According to its classification, there are six levels of educational objectives: *Knowledge, Comprehension, Application, Analysis, Synthesis,* and *Evaluation*, as shown in Figure 1. Knowledge describes the lowest order of thinking, while evaluation is the highest order. The revised version of Bloom's Taxonomy replaces the nouns with dynamic verbs to describe each level, *Remember, Understand, Apply, Analyze, Evaluate,* and *Create*. Bloom's Taxonomy has been widely used to teach and assess critical thinking skills across various disciplines (Crowe et al., 2008; Plack et al., 2007; Swart, 2010; Tuma and Nassar; 2021).

Figure 1

Bloom's Taxonomy (Original)



The purpose of this paper is to formally test if the critical thinking skills of students in higher education improved throughout eight-week courses. I use Bloom's Taxonomy to assess the level of critical thinking demonstrated in the literature review submitted by undergraduate students taking the Introduction to Research Methods course at a private university in Singapore. The final project for this course is a proposal for quantitative research. Students submit the literature review for the research proposal as a separate assignment. The literature review is graded twice, once as the draft and the other time as the final version. I introduce several activities designed to improve students' critical thinking skills before the submission of the draft literature review and between the submissions of draft and final versions. I determine the level of critical thinking demonstrated in each assignment based on the work by Granello (2001), who provides detailed descriptions of the contents and organization of literature review at each level of Bloom's Taxonomy.

The data contain the work by 144 students who attended the course across seven terms from January 2020 to December 2021. The students worked in groups of two to seven to write the literature review and the rest of the research proposal. In total, 31 groups submitted 62 literature review assignments. The results from *t* test show that the final versions of literature review demonstrate the higher orders of thinking, as the levels of Bloom's Taxonomy improved by about two steps between the draft and final versions. The findings of ANOVA confirm that the changes in the level of critical thinking between the two versions are statistically significant. In addition, the levels of critical thinking demonstrated by the literature review assignments vary across teaching terms, as the mean level of Bloom's Taxonomy was highest in January. The results support the use of activities described in this study, as well as the two stage submissions, which provide students with opportunities to enhance their critical thinking skills.

2 Literature Review

Writing a literature review is a common assignment for university students regardless of their disciplines of study. The literature review may form a part of larger assignments, such as research proposals, or serve as a stand-alone assignment. As the name suggests, writing a literature review is a task of surveying the existing literature to understand what has been previously investigated and what the findings are in relation to the topic of interest. Based on this knowledge, researchers identify the area for further research.

Several studies discuss what makes the good review of existing studies. Paul and Criado (2020) point out that a good review article should identify key research gaps that prior studies are yet to address. Hence, at least 20-25% of the review article should be discussing the development of the future research agenda based on the past theories, methodologies and context. This is an important point to remind undergraduate students before they embark on the journey of writing literature review, as the students, being novice researchers, tend to miss that the main objective of reviewing the existing studies is to identify the gaps in the literature. Instead, students often consider writing a literature review as summarizing past studies. Due to such belief, the first two levels of Bloom's Taxonomy, Knowledge and Comprehension, are overrepresented in the literature review by undergraduate students.

Elsbach and Van Knippenberg (2020) define integrative literature reviews as the review offering new insights that arise from the synthesis and/or critique of existing studies. The authors emphasize that the insights arise from the review, rather than they guide the review. They explain how critical analysis refers to examining the existing literature in order to identify themes and gaps, while creative synthesis integrates existing frameworks, using insights gained from such critical analysis, to develop a new model or conceptual framework. They use interesting analogy that research is like solving puzzles, while individual studies reviewed are the pieces of the puzzles. Looking at an individual piece of puzzle does not help us much to solve the puzzle. In the context of teaching undergraduate students the effective writing of literature review, critical analysis will be more realistic objective than creative synthesis.

Alvesson and Sandberg (2020) propose the problematizing review as an alternative to the integrative review by Elsbach and Van Knippenberg (2020), challenging the key assumptions underlining the integrative review approach, such as the jigsaw puzzle metaphor and that the boundary of the review is clear. Alversson and Sandberg argue that writing a review is more like a jungle or maze and that the review article should aim to cover most of the literature on a selected topic. In the alternative approach they suggest, the problematizing review, reflexivity is encouraged, where the researcher adopts a more critical and questioning mindset when reviewing the existing literature. It also advocates reading broadly but selectively. They used the expression that "allowing for critical scrutiny…rather than aiming for vacuum cleaning" (p. 1298), referring to the extensive review in the integrative review as vacuum cleaning. The approach by Alversson and Sandberg, therefore, will require researchers to be a lot more critical in reviewing the existing literature.

My experiences as an instructor for undergraduate courses have shown that students find it challenging to conduct the critical review of literature. Many students initially think that literature review is the juxtaposition of the summary of studies they find. They do not consider any form of evaluation and/or discussion of these studies to be necessary. When the students learn that a good literature review should critically analyze the existing literature, they often mistakenly consider critical review as criticizing past studies. This type of thinking can lead to further challenges, especially for Asian students, who do not prefer to be engaged in argumentative and/or confrontational discourses.

Tan (2017) investigates the cultural challenges and recommended strategies for teaching critical thinking skills in Singaporean schools, by qualitatively analyzing essays written by 46 undergraduate students at a university in Singapore, who had short-term teaching experience. The findings show that "Asian values", where children to be seen and not heard, and where teachers are respected as authoritative figures can be a main challenge for teaching critical thinking in schools. Similar to my experience, Tan also finds that students tend to associate critical thinking as criticizing, which Asian students find too confrontational. The misconception presents additional challenge in teaching students in Asian countries to write a critical review of literature. Based on the data, Tan recommends that cooperative learning where students share their knowledge with their peers and providing safe learning environment that supports intellectual risk taking as strategies to overcome challenges in fostering critical thinking skills in Singaporean students. She also mentions using online discussion forums, essay-writing and small group discussions as an alternative to public debates, as some students may prefer showing their critical thinking in more culturally appropriate formats.

Kim (2003) mentions that the common belief by Western teachers is that the Confucian tradition leads Asian students to be poorer critical thinkers, as respect for tradition and authority figures make students reluctant to challenge the opinions of others. She points out that Confucius' way of learning is generally not associated with critical thinking. Rather, it is believed that Confucius focuses on learning through memorization, and the mastery of customs and beliefs of the past. Kim challenges this notion and argues that Confucius' theory of learning cannot be separated from thinking. Confucius, in fact, advocated the synthesis, systemization and integration of the past knowledge into learner's own. Such processes have a close resemblance to the theory of critical thinking in the modern context.

The above studies show that it is not that Asian students do not possess critical thinking skills, or that Asian style of learning does not value critical thinking. Rather, Asian students prefer to learn and demonstrate critical thinking skills in a different way. Lee et al. (2013) point out that as East Asian students believe that learning is acquired through memorization, students' academic writing tends to focus more on repeating what the words by the other authors rather than drawing their own conclusions. This trait seems to be an obstacle to achieve a higher order of thinking; however, the authors present an interesting argument that memorization by East Asian students does not replace the understanding of contents. In fact, these students memorize to fully understand the subjects being studied. Therefore, higher orders of thinking can emerge from the East Asian type learning.

Past studies explore factors that may improve critical thinking skills in university students in their writing assignments. Some examine if the course delivery mode matters. As the pandemic increased the adoption of online delivery mode, this is a timely question to explore. Goode et al. (2018) compare the effectiveness of blended learning (BL) with face-to-face (FTF) instruction by using randomly assigned students to either BL or FTF versions of a research methods and statistics course in psychology. Expression of critical thinking through writing was one of the criteria to measure the students' performance. Early writing assignment was compared with late writing assignments to measure any differences in students' ability for critical thinking. The authors find no significant difference between BL and FTF in the expression of critical thinking through writing. The greatest difference was observed among instructors—the instructors seem to have larger impact on students' performances than the course delivery mode.

Others discuss the effectiveness of the critical thinking frameworks in improving the students' writing assignments. Patel (2021) shows how the explicit application of the Paul-Elder critical thinking framework could improve the critical thinking of Engineering undergraduate students in Singapore in a blended course. The results reveal that adopting a conceptual framework for online discussion forums encouraged students to develop criticality in their thoughts and, as a result, in their posts. Using the Interaction Analysis Model (IAM) content analysis to investigate the development in students' thoughts and posts, the study finds that the explicit adoption of the framework improved the quality of online posing greatly, in comparison to the adoption of the general guidelines, such as regulating the frequency of posts and responses, which students may follow mechanically with superficial responses.

Granello (2001) applies Bloom's taxonomy to help graduate students in counselling write quality literature review. She discusses what the literature review would look like in each level of the Taxonomy and provides the examples of advice instructors can give students to improve their levels. Athanassiou, McNett and Harvey (2003) discuss Bloom's taxonomy as a scaffolding tool to improve students' critical thinking and self-learning process, using data from two undergraduate classes in a small liberal arts college in the U.S. They use Bloom's taxonomy to demonstrate to students the differences between what instructors expect from their assignments and what the students have currently provided in the assignments. The findings show that using Bloom's concepts significantly improved the quality of students' writing assignment.

Bloom's Taxonomy has been widely used as a tool for enhancing the critical thinking skills of learners in various disciplines. For example, Swart (2010) analyzes final examination papers in an engineering module, Electronics, at an Institution of Higher Education in the Republic of South Africa for five years (2002-2006) to investigate how many questions in the final examination fall into the category of higher order questions, which stimulate critical thinking. In Biology, Crowe, Dirks and Wenderoth (2008) developed an assessment tool based on Bloom's Taxonomy, Blooming Biology Tool (BBT), to help faculty and students to incorporate higher-order cognitive skills in both designing and answering examinations and tests at college level.

In the field of medicine, Plack et al. (2007) assess 308 reflective journal entries from 21 medical students doing pediatric clerkships at Georgetown University Hospital based on the modified Bloom's taxonomy, which reduced the six levels of Bloom's Taxonomy to three levels. Tuma and Nassar (2021) demonstrate three practical examples of applying Bloom's taxonomy levels for daily teaching in clinical surgery. For instance, when teaching Hernia, the lowest level will require students to remember the anatomy and treatment approaches of hernia, while the highest level will facilitate students to create a new approach to repair hernia or modify current application.

As the existing literature proves that Bloom's Taxonomy has been a helpful tool to assess cognitive learning levels, the current study adopts Bloom's Taxonomy to evaluate the critical thinking skills of undergraduate students at a private university in Singapore. Specifically, I examine the literature review assignments submitted as a part of course requirements for Introduction to Research Methods class

to determine if the critical thinking skills of students improved during the course. Previous research emphasizes that critical analysis is a crucial part of good literature review. Therefore, the literature review assignment provides instructors an excellent opportunity to teach and assess the critical thinking skills of students. As the research method course that I examine in this paper requires students to submit the literature review twice, once as a draft and the other time as the final version, it provides an ideal setting to examine improvement, if any, in students' critical thinking skills. Cultural nuance is an important element to consider in the discussion of teaching critical thinking skills, as shown by the studies reviewed above. These studies acknowledge the challenges encountered by Asian students and suggest that implementing more culturally appropriate ways of teaching critical thinking will be beneficial. This paper intends to provide empirical evidence of how effective these suggestions are, such as small group discussions and discussions in writing in addition to verbal discussions, in a classroom in Singapore.

3 Methodology

3.1 Participants and course

The data for analysis are collected from the Introduction to Research Methods course at a private university in Singapore. The university provides specialized education in Aeronautics; therefore, most students who take the course are in either Bachelor of Science in Aeronautics or Bachelor of Science in Aviation Business Administration. The final project required to complete the course is a research proposal, where students provide the details of quantitative analysis they propose to conduct for the topics of their choices. The research proposal was a group project, where a group of two to six students were co-authors. The data are collected from January 2020 to December 2021. In total, 144 undergraduate students across seven terms attended this course and 31 groups submitted the research proposals. As I use quantitative analysis techniques to examine the scores of the assignments, it was deemed that human subjects were not in use. Hence, the ethics approval from the university was not required for this study.

The course runs for eight weeks and is designed that every two weeks students submit a section of the proposal as a graded assignment. The literature review takes a large proportion of the total grades, as the draft of the literature review and final version are graded separately. In the third week, students submit the draft of literature review. After receiving feedback for the draft, they make a revision and hand in the final version of the literature review in the fifth week. The design of the course provides me with an opportunity to enhance the critical skills of students, as I am able to provide guidance before the draft submission and between the draft and final submissions. Cavdar and Doe (2012) also advocate a two-stage writing assignment for students, where students submit a draft and final paper for the same topic. They point out that when revision is not allowed, students are less likely to improve their critical thinking skills. The two-stage writing assignments give students incentive to think about instructors' comments and made changes accordingly and encourage them to expand their thoughts.

3.2 Classroom activities

Prior to the submission of draft literature review, as well as between the two stages of submission, I implemented several activities to help students practice critical thinking. To create environment where students feel comfortable to share their critical analysis with the rest of the class, the students worked in a small group for most of these activities. When students are engaged in individual activities, they had an option to discuss their thoughts verbally or in writing by posting on the course webpage. I find that for some students having an option to post their answers in writing enhances the ability to formulate and

present critical analysis. For those activities where I allow both verbal and written participation, I start the discussion with the students who are willing to participate verbally, and then go through the written posts together. Students who participate through posting have an option to explain their posts verbally at this point if they wish to.

As the first activity prior to writing the literature review, each student posts on the course web page the short summary and evaluation of a past study they find. This activity is not done in a group so that I can identify students who need more assistance. A common example of evaluation that I encounter is that the source is credible as it was written by a professor from a reputable university and published in a peer-reviewed journal. This confirms the observations from the past studies that Asian students respect authority figures, which at times may pose obstacles to critically evaluate the work by authoritative figures (Kim, 2003; Tan, 2017). For the follow-up activity to enhance the understanding of critical review, students evaluate the reviews of restaurants posted on Google. Students contemplate issues such as the validity of five-star reviews. For example, if a restaurant has a few five-star reviews, is it better than another restaurant with hundreds of reviews with the average score of 4.8? Questions such as this are posed to students to introduce the Impact Factor for academic journals as a tool to evaluate the credibility of publications. Another discussion focuses on the reviews written by those who have been commissioned or given free products or other benefits from the merchants. This discussion leads students to check if a study they are reviewing is funded by certain organizations.

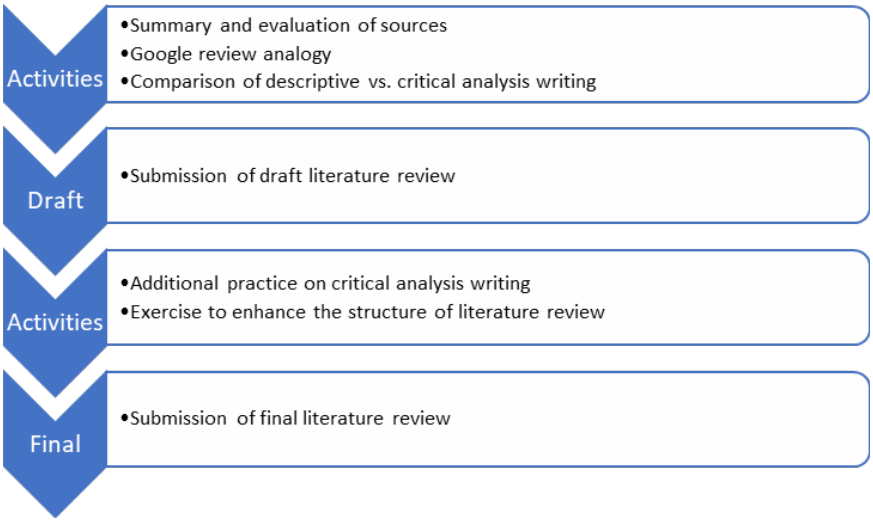
After the discussion on Google reviews, students work in groups to summarize and evaluate a published research paper assigned to each group. I introduce the specific examples of phrases students could use when gathering their thoughts to evaluate and analyze the previous studies. These examples are from Greener and Martelli (2020), who provide practical advice to move beyond descriptive writing to critical analysis. For instance, they show that if writers "give the story so far", it is descriptive writing, whereas if they "weigh on piece of information against another", it falls into critical analytical writing (p.33). Students submit the draft literature review after these activities.

After the submission of the draft literature review, students are engaged in two additional classroom activities. Many students are unfamiliar with the critical review of literature in the beginning. Some display reluctance to provide negative comments on the studies they are reviewing. Surprisingly, the recurring issue that emerged in the draft literature review is at the other end of the spectrum, as many students consider critical analysis as a synonym for criticizing past studies. To mitigate this problem, we revisit the examples from Greener and Martelli (2020). This time I invite students to focus on each example of critical analytical writing and encourage them to find a way to apply more than one example to their own literature review. According to the examples presented by the authors, critical analytical writing "identifies the significance", "evaluates strengths and weaknesses", "shows why something is relevant or suitable", and "identifies why the timing is of importance", among others (p.33).

Another common issue encountered was in relation to the structure of literature review. Instead of listing each source individually, students need to organize the sources by topics or themes. As this is a higher order of thinking, which would fall under the level of *Synthesis* in Bloom's Taxonomy, activities to build skills for lower orders of thinking took place before I engage students in discussions to find themes for the sources they found. To practice identifying themes and organizing the sources to make the story flow smoothly, students read a research paper and discuss the themes of the paper's literature review section. This discussion also highlighted that the themes often arise from the gaps researchers identified from the literature review. For instance, if students identified the lack of solid data analysis methods as a gap in the existing literature, an appropriate structure would be to organize the past studies by different analysis methods and evaluate the strengths and weaknesses of each method. After this activity, students submit the final version of the literature review. Figure 2 describes the types and timings of the classroom activities implemented to enhance the critical thinking skills in writing the literature review.

Figure 2

Examples and Timings of Classroom Activities



3.3 Assessment

Granello (2001) points out that when instructors read students' papers, they are often able to see which level of Bloom's Taxonomy each student is at. She lists specific examples of the format and contents of papers in each level. For instance, a paper at the level of *Knowledge*, the lowest order of Taxonomy, are organized by articles rather than by theme and overuses direct quotations. In contrast, a paper at the highest level of Taxonomy, *Evaluation*, is organized by theme, evaluates the strengths and weaknesses of the source, and provides the objective critique of the quality of the source. I use these examples as the guideline in assessing the literature review assignments. The literature review submitted by students is assigned a score from one to six, based on the level of Taxonomy (the lowest level is one).

4 Results

Table 1 presents the descriptive statistics of the data, which comprise of 31 student groups across seven terms. The total number of students is 144.

Table 1

Descriptive Statistics (N=31)

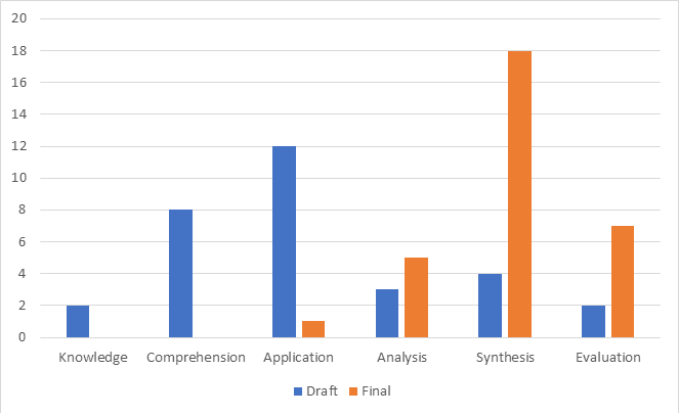
	Mean	Standard deviation	Minimum	Maximum
Bloom's Taxonomy Level for Draft Literature Review[a]	3.16	0.24	1	6
Boom's Taxonomy Level for Final Literature Review	5	0.13	3	6
Change in the level	1.84	0.22	0	5
Number of students in a group	4	0.22	2	7
Number of total students in the course	19	3.76	6	39

[a] A scale of 1 to 6 has been assigned to indicate each level of Bloom's Taxonomy. The lower number in the scale indicates the lower order of thinking.

Figure 3 presents the distribution of the assignments in both stages. In the draft stage, 6.5 percent of the assignments were at the lowest level of Bloom's Taxonomy, *Knowledge*, followed by 25.6 percent at the *Comprehension* level, 38.7 percent at the *Application* level, 9.7 percent at the *Synthesis* level, and 6.5 percent at the highest level, *Evaluation*. The most common level for the draft literature review was *Application*, where students were able to link the summarized sources to their own topics but hardly made connections between the sources. For the final version of literature review, none of the assignments are at the two lowest levels, *Knowledge* and *Comprehension*. 3.2 percent are at the *Application* level, 16.1 percent at the *Analysis* level, 58 percent at the *Synthesis* level, and 22.6 percent at the *Evaluation* level.

Figure 3

Distribution of Bloom's Taxonomy Level

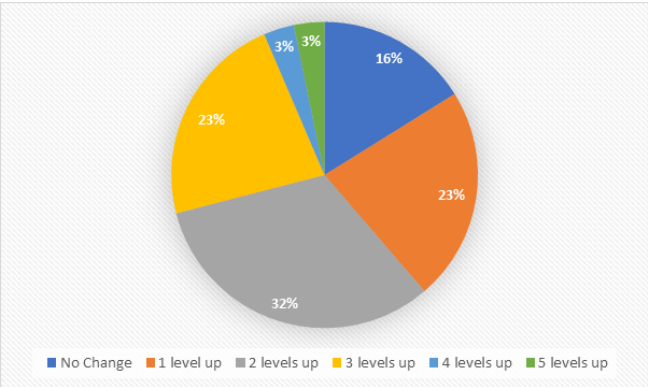


Note: The bars demonstrate the number of assignments in each category.

Figure 4 demonstrates the changes in the level of Bloom's Taxonomy between the two stages of submission. The change observed most frequently is the increase of levels by two steps (32.3%). The same proportion of assignments improved their levels by one or three steps (22.6%). Approximately 16 percent of the assignments had no change in the level of critical thinking. Four out of the five draft literature review whose levels remained the same were at the top levels, as two belong to the *Evaluation* level and the other two were at the *Synthesis* level. As these drafts already demonstrated the high levels of critical thinking, there was little to no room for improvement. The remaining one draft, which perhaps warrants concern, was at level 3, *Application*. As the students who wrote this literature review did not revise the draft after receiving the feedback and submitted the same version, the level remained the same.

Figure 4

Change in the levels of Bloom's Taxonomy



I run the *t* test to check if the differences in the levels of Bloom's Taxonomy between the draft and final versions of literature review are statistically significant. As I compare the means of the levels taken from the same groups of students, I use the paired sample *t* test. The results, as shown in Table 2, confirm that the improvement in the levels of Bloom's Taxonomy in the second stage of submission is statistically significant.

Table 2

Paired t Test

t	df	p-value (two-tailed)
-8.2502	30	.000

Although 144 students attended the course in total, they worked in groups and every student received the same score of the assignments. In total, there were 31 student groups. As each group submits the assignment in two stages, there are 62 assignments (31 pairs). By convention the size of the sample is considered to be sufficiently large for the sample distribution to approximate a normal distribution, following the Central Limit Theorem; however, concerns may arise over the use of a parametric test, such as *t* test, if the data is non-normally distributed. As the visual inspection of the data suggests the possibility of a non-normal distribution, I apply the Wilcoxan signed-rank test to the data, in addition to the *t* test. The result remains qualitatively same (p-value=0.000).

Next, to examine if any other factors than the two stages of submission lead to the differences in the levels of critical thinking, I use the two-factor ANOVA. The factors I consider in addition to the two stages are the group size, the timing of the term, and the year when the class was held. The group size may affect the quality of in-class discussions, resulting in the differences in the level of critical thinking. The timing of the term refers to in which term the class was offered. There are four terms in a year: January, March, July and October. The years when the classes took place are either 2020 or 2021. The findings from the two-factor ANOVA are presented in Table 3.

Table 3

Two-factor ANOVA

	Sum of Squares	F-value	p-value (two-tailed)
		A. Group size	
Number of students in a group	0.04	0.035	0.852
Submission stages	52.40	45.37	.000
Residual	68.15		
		B. Teaching term	
Term	11.59	4.79	0.005
Submission stages	52.40	55.05	.000
Residual	56.60		
		C. Teaching year	
Year	0.08	0.069	0.794
Submission stages	52.40	45.39	.000
Residual	68.11		

Note: Panel A presents the results from two-way ANOVA, where the two factors are the group size and different stages of submission. Panel B presents the results from the ANOVA model where the two factors are teaching terms (January, March, July or October) and different stages of submission. Panel C presents the results from the ANOVA model where the two factors are teaching years (2020 or 2021) and different stages of submission. "Residual" presents the within-group variations.

In all the models, the different stages of submission retained the statistical significance, confirming that the levels of Bloom's Taxonomy for the draft literature review are different from those for the final versions. The group size and years seem to have no effect on the levels of critical thinking, as their p-values are 0.852 and 0.794, respectively. Interestingly, the mean levels of critical thinking vary across teaching terms (p-value=0.005). As there are more than two levels of teaching terms, to check which pair of terms shows differences in mean scores, I compute Tukey HSD (Honest Significant Differences) as a post-hoc test. The results from the multiple pairwise-comparisons, shown in Table 4, reveal that January and July terms are significantly different from each other. This result may indicate that the type of students taking the course varies between January and July terms. For instance, more senior students may take the course in January. Further insights from the department handling student enrollment may provide explanations for such differences.

Table 4

Tukey HSD Results

	Difference	P-value
January – October	0.40	0.58
July – October	-0.65	0.22
March – October	-0.65	0.63
July – January	-1.05	0.01
March – January	-1.05	0.23
March – July	0.00	0.99

To further examine what other factors than the different stages of submission have impact on the levels of critical thinking, I conduct regression analysis by estimating the following model:

$$L_i = \beta_0 + \beta_1 F_i + \beta_2 T_i + \beta_3 G_i + \beta_4 S_i + \beta_5 Y_i + \varepsilon_i \quad (1)$$

L_i denotes the level of Bloom's Taxonomy assigned to literature review i, F_i is a dummy variable which takes the value of 1 if the submitted literature review is the final version, and 0 if it is the draft. T_i is the total number of students in class, and G_i is the number of students in a group. S_i is a teaching term indicator variable (October term is the omitted category) and Y_i is the year dummies (2020 is the omitted category). ε_i is the error term. Table 5 presents the results.

Table 5

Regression Results

	Bloom's Taxonomy Level	
Final version	1.84**	(0.25)
Number of students in class	-0.07*	(0.03)
Group size	-0.09	(0.10)
January	1.96**	(0.75)
March	-0.74	(0.57)
July	-0.08	(0.41)
Year	-0.40	(0.31)
N	31	
adj. R^2	0.52	
F (p-value)	10.48 (.000)	
Estimation method	Ordinary Least Squares	

Note: The table reports the effects of the submission stage, class size, student group size, teaching term and year on the level of critical thinking, measured by Bloom's Taxonomy levels (equation 1 in the text). Standard errors are in parenthesis.

**Significant at 1 percent level.

* Significant at 5 percent level.

The results from regression analysis show that the final versions of literature review are at a higher Taxonomy level by about two steps. The number of total students in class has negative impact on the level of critical thinking, as an increase of one student in class reduces the Taxonomy level of the literature review by 0.07. Although statistically significant, the impact of class size only leads to a minute reduction in the level of critical thinking. The teaching term effect is still present in the regression model, as the levels of critical thinking shown in the literature review assignments are higher in January term by almost two Taxonomy levels.

5 Discussions and Conclusions

This study provides the empirical analysis of the level of critical thinking in undergraduate students by examining literature review assignments. As the process of writing literature review requires critical thinking in every step, from the collection of sources to the final writing stage, the literature review assignment provides instructors with great opportunities to teach and assess critical thinking skills. The data for analysis are from an introductory research methodology course for undergraduate students at a private university in Singapore. This course requires students to submit the literature review twice, so that the students have a chance to revise the draft based on the feedback received. Between the two stages of submission, as well as prior to the submission of the draft literature review, I use several activities in classroom to improve the critical thinking skills of students. To assess the draft and final versions of literature review, I assign each assignment a level in the Bloom's Taxonomy, based on the descriptions by Granello (2001). The findings show that the level of critical thinking improved from the draft to the final literature review. The increase in the Taxonomy level by approximately two steps is the average. The results from ANOVA and regression further suggest that the timing of the teaching term when the course was offered creates differences in the level of critical thinking.

One of the limitations of this study is that there is only one evaluator who assigns the level of Taxonomy to each literature review. For more objective assessment, having multiple evaluators will be ideal. This is true especially since the names of the students who submit the assignments are visible to the evaluator, who is also the instructor. Also, the evaluation of the level of critical thinking may vary depending on the evaluators. A better design would be where multiple examiners assign the Taxonomy levels to the literature review and the consistency of the levels across examiners is tested. Despite the shortcomings of the current evaluation methods, it is unlikely that the assigned levels of Taxonomy are systematically biased. The assessment is based on the concrete set of descriptions, most of which have already been communicated to the authors of the literature review as feedback. Moreover, I review the assignments from the completed courses, where the final grades of the students, as well as teaching evaluation from the students, are finalized. The teaching of critical thinking skills and/or improvement between the draft and final versions of literature review are not one of the criteria in the evaluation of the course and instructor, which students submit at the end of the course.

Another limitation of the study is that although this research is able to show that the critical thinking skills of students have improved throughout the courses, it is difficult to show which activities were most helpful. I implemented five different classroom activities before and after the submission of the draft literature review. The effectiveness of each activity in facilitating students to write the critical analysis

of review is unclear. One possible way of addressing this issue in the future would be to ask students to complete a short survey where they can identify which activity was most helpful for enhancing their critical thinking skills. This type of survey may even show further insights into if certain activities work better for different types of students (e.g. students in different academic years or programs).

The third point of discussion lies with the somewhat puzzling result that teaching terms affect the mean level of critical thinking measured by Bloom's Taxonomy. There is no compelling reason to believe that some terms will lead students to display the higher orders of thinking. A possible explanation may be that in certain terms more senior students take the course. Since senior students take writing courses prior to the research methodology course and have more experiences in writing a research paper, they may be familiar with the critical analysis of literature. Including more information on the students, such as their native language, age, years of study in the university and gender, in the empirical analysis may reveal further insights.

Lastly, in this paper I use the Bloom's Taxonomy as the assessment tool only. Introducing students to the Taxonomy and using it for in-class discussions will be an effective way to teach them to write the critical analysis of literature. Athanassiou, McNett and Harvey (2003) and Patel (2021) demonstrate in their articles how the explicit use of these frameworks in class facilitates students' learning. Since I use the levels of Taxonomy to gauge improvement in the critical thinking skills of students, a helpful classroom activity may be where students learn about the Bloom's Taxonomy and assign a corresponding level to the work of their own as well as another group. In addition to the existing rubric the course provides, the lists by Granello (2001) that describe the organization and contents of literature review in each level of the Taxonomy can provide a practical guide to students and may lead to further improvement of their critical thinking skills.

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