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The Effect of Learning Strategies on Higher-Order Thinking Skills Students with Different Learning Styles

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Abstract: ***This factorial-experimental study investigated the comparisons among higher-order thinking skills (HOTS) of students taught by contextual teaching and learning (CTL), collaborative learning, and competitive learning; investigated the comparisons among HOTS of students with visual, auditory, and kinaesthetic (VAK) learning styles; and investigated the interaction effect among learning strategies and learning styles on students' HOTS. Confirmatory factor analysis was used to determine items validity of learning VAK styles questionnaire. The sample of the study consists of 270 students, which was taken from Faculty of Education Halu Oleo University and Muhammadiyah University, Kendari, Indonesia. Two way analysis of variance and Tukey's test were used to compare the experimental results. Results indicate that applications of CTL, collaborative learning, and competitive learning have different effect on student's HOTS. There is a statistically significant difference in higher-order thinking skills of visual, auditory, and kinaesthetic students. There is an interaction effect among learning strategies and learning styles on the students' HOTS. CTL is more effective to be applied to kinaesthetic students, collaborative learning is more effective to be applied to auditory students, and competitive learning is more effective to be applied to visual students. In addition, to increase the higher-order thinking skill of university students with differentlearning styles, the design of the learning-teaching processes should be modelled based on the students learning style preferences.***

Keywords: Learning Strategy, VAK Learning Style, Higher-Order Thinking Skill

1. Introduction

Lecturer-centred learning tends to dominate the implementation of lectures at most of universities in Indonesia nowadays. Meanwhile, student-centered learning has not been fully integrated in the planning and application of lectures.[1] In fact, according to Johnson,[2] in the college system, students only spent time on listening lectures, finishing tasks, and responding tests that merely measure the ability to memorize facts, concepts, and theories. This kind of learning can cause a bad effect on psychological development of students, isolate students, make them feel insecure, neglect, and exile, and eventually will produce students without adequate skills. Compared with students-centred learning, lecture-based teaching has been reported to be less effective to the demands of high rates of cognitive and affective outcomes.[3]

Barkley, Patricia, & Claire[4] had reviewed more than five hundreds previous research results related to learning. They found that the best learning strategy in college was student-centred learning, particularly cooperative learning strategy. In all levels of education, students in cooperative learning strategy achieved greater academic achievement[5-6] hence; lecturers should reduce their roles as experts in the classroom with using more appropriate learning strategy.[7] Teachers might adjust their teaching strategy so that it is more congruent with a given student's or class of students' learning styles.[8]Learning styles are among the factors that play a vital role in affecting students' academic performance.[9] Students will learn more and will enjoy the class experience and environment when they can use their preferred learning styles. In some cases, students are blamed when the classroom activity is not compatible with their way of learning.[10] Different teaching styles are required for different learning objectives.[11] Teaching should be performed by considering the style different of students.[12] That is why teachers should identify their own teaching styles as well as their learning styles to obtain better results in the classroom. The aim is to have a balanced teaching style and to adapt activities to meet students' learning styles.[13] Understanding students' learning styles may help teachers identify and solve learning problems among students; thus, teachers may help their students to become more effective learners.[14]

Each student has his own lerning style.[15-16]In other words, the students learn through their imagination, thought, exercise, experince, and practice.[17] Learning style refers to an individual's characteristics and preferred ways of gathering, interpreting, organizing and thinking about information.[18]Therefore understanding students' learning styles and their impact on their academic achievement is important for teachers; it is the first step in ensuring students' achievement.[19] There are many approaches to identify students' learning style preferences. Several

educational researchers including Dunn & Dunn[20] and Reid[21] have specified the different types of learning styles and categorized them into three main groups, namely visual learning (learning from observing pictures, graphs, charts, symbols, and flow diagrams); auditory learning (learning from listening to lectures, reading, discussing instructional material, and speech); and kinaesthetic learning (learning from using tactile sensory abilities such as touch, smell, taste, and sight).

Since, each student has a unique and distinctive learning style, the lecturers must be familiar with the differences. However, generally lecturers teach their students as the way they were taught by their lecturers. Many lecturers, consciously or not, always try to imitate and to exceed the lecturer who inspired them, and they tend to choose teaching strategy that reflect their preferred way of learning.[22] A person who learn will choose the most appropriate way, and out of his awareness, it will bias the way he teach others, with the hope that others can learn as he did.[23] Lecturers who have visual learning style tend to be visual lecturer as well and these things happen naturally.[24] Hence, it should be realized that the auditory and kinaesthetic students have a way to absorb and process information that is different from the visual students. Therefore, the strategies and methods used by the lecturer should also vary to accommodate the learning styles of different students. In other words, since there are individual different in learning style, adapting academic materials to these differences will facilitate learning and thus will help increase learning benefits.[25]

The applications of contextual teaching and learning (CTL) strategy, collaborative learning strategy, and competitive learning strategy on groups of students who have different learning styles (visual, auditory, kinaesthetic) are assumed to give different effects in increasing students' competence. Therefore, to what extent and how is the effect of the learning strategies applied to students with different learning styles in improving their competences need to be empirically proven through a scientific research. For this reason, the main purpose of this study is to achieve three main objectives: to investigate the comparison of higher-order thinking skills of students taught through CTL strategy, collaborative learning strategy, and competitive learning strategy; to investigate the comparison of higher-order thinking skills of students with visual, auditory, and kinaesthetic learning styles; and to investigate the interaction effects among learning strategies and learning styles on students' higher-order thinking skills.

2. Methods

2.1 Research Design

The present study used a 3x3 factorial experimental research design.[26]The research involved one dependent variable and two independent variables. The design of the research is shown in Table 1.

Table 1: The Design of 3x3 Factorial Experiment Study

Learning Styles (B)	Learning Strategies			Total
	Contextual (A1)	Collaborative (A2)	Competitive (A3)	
Visual (B1)	A1B1	A2B1	A3B1	B1
Auditory (B2)	A1B2	A2B2	A3B2	B2
Kinaesthetic (B3)	A1B3	A2B3	A3B3	B3
Total	A1	A2	A3	

The population of this study was 536 students of the Department of Education, Teacher Training and Education Faculty of Halu Oleo University (UHO) and Muhammadiyah University (UM), Southeast Sulawesi, Indonesia, who were taking Education Research Methodology course. The population from UHO involved 72 students of cooperative economics education study program, 64 students of accounting education study program, 70 students of tourism education study program, 80 students of history education study program, 67 students of civic aducation study program, 79 students of geography education study program. While the population from UM was involved 104 students of education management study program. Through an administer of the VAK learning style questionnaire to the research participants, it is found out that 47% of the students' preferred visual learning styles, 32% of the students' preferred auditory learning styles, and 21% of the students' preferred kinaesthetic learning styles. The experimental research samples consisting 270 students were selected randomly based on the tendency of learning styles and divided into three groups of learning strategies. The number of research samples is shown in Table 2.

Table 2: The Specification of Research Samples

No	Learning Styles	Learning Strategies			Total of Samples
		CTL	Collaborative	Competitive	
1	Visual	30	30	30	90
2	Auditory	30	30	30	90
3	Kinaesthetic	30	30	30	90
Total		90	90	90	270

Research procedures

The experiment was conducted for a period of 5 months (one semester), from early August until the end of December 2014. The meeting was held for 15 times. Each meeting was held for 3 hours. The treatment given to the students was conducted using three learning strategies, namely: CTL strategy, collaborative learning strategy, and competitive learning strategy. The summary of the main points of the treatment given to the students is presented in Table 3.The treatment of the experiment was fully implemented by researchers using the developed guidelines. The measurement of student learning styles was done before lecturing began and the results were applied to classify students based on their learning style preferences. Higher-order thinking skills of students were measured at the end of the semester.

Table 3: The Comparative Syntax of Learning Strategies: CTL, Collaborative, and Competitive

CTL	Collaborative learning	Competitive learning
Understanding the knowledge through arranging temporarily concept, sharing, and revise the concept.	Interaction and cooperation among students.	There is no communication among students, doing the tasks individually.
Mutual aid, guiding, supporting, correcting, through discussion groups.	Effective communication, mutual sharing, mutual influence, and mutual help.	There is no mutual influence because the students designed to compete tasks individually.
Actively involved in the learning process.	The use of intelligence among members.	Completing everything with their own abilities.
Learning is associated with real-life and simulated problems in concrete examples.	There is a division of tasks between students.	There is no coordination, no division of tasks.
Insured individual and group learning.	There is a difference of opinion among students.	There is no difference of opinion.
Apply the knowledge and experience that have been studied.	There is no comparison among students	There is no comparison among students' achievement.

2.2 Research Instruments

The instruments used in this study consist of an achievement test to measure students' higher-order thinking skills and questionnaires to determine students' preference learning styles. Both of these instruments were developed by the researchers. Higher-order thinking skills test was developed by referring to the level of cognitive ability of Bloom.[27] The test comprises the ability to analyse (2 points), the ability to evaluate (2 points), and the ability to create (2 points) with the theoretical score range between 0-60 (each item has a maximum score 10). The reliability of this test was high (α=0.89).

Students' VAK learning styles questionnairesusing a five-point Likert scale (strongly disagree, disagree, undecided, agree, strongly agree) were provided to response the items. The tryout sample comprised of 300 students. This sample was randomly drawn from the students studying in the different departments of the University, Faculty of Education at Kendari city in Indonesia. Confirmatory factor analysis[28] was used to analyse the tryout results. The Kaiser-Meyer-Olkin (KMO) value of this scale composed of 73 items collected under five factors was determined as 0.83 ($p>0.05$) and Bartlett test value was determined as X^2 =745921.6 ($p>0.05$). The Cronbach Alpha[29] reliability coefficient of the scale was high (α=0.92). In conclusion, it can be said that the learning style questionnaire developed is valid and reliable scale was used to determine the sudents VAK learning Styles.

2.3 Data Analysis

The whole processes of data analysis were conducted using Statistical Package for the Social Sciences (SPSS) software Version 21.[32] The effect of learning strategies on higher-order thinking skills of students with different learning styles was tested with the following null hypothesis: (1) "There is no significant different in higher-order thinking skills of students taught by CTL strategy, collaborative learning strategy and competitive learning strategy; (2) there is no significant different in higher-order thinking skills of students who have visual, auditory, and kinaesthetic learning styles; and (3) there is no significant interaction effect among learning strategies and learning styles on students' higher-order thinking skills."

3. Results

3.1 Descriptive Analysis

Table 4: The summary of Descriptive Statistics Analysis Results

Learning Strategies (A)	Learning Styles (B)		Mean	Std. Deviation	Max	Min	N
CTL (A1)	Visual	(B1)	41.50	3.19	51.60	33.20	30
	Auditory	(B2)	39.64	4.57	44.75	28.20	30
	Kinaesthetic	(B3)	45.95	2.70	49.95	39.50	30
Total CTL (A1)			42.36	4.43	49.95	33,20	90
Collaborative (A2)	Visual	(B1)	39.82	2.68	42.90	31.75	30
	Auditory	(B2)	44.21	2.79	50.00	39.50	30
	Kinaesthetic	(B3)	39.94	1.86	42.90	33.90	30
Total Collaborative (A2)			41.32	3.20	50.00	31.75	90
Competitive (A3)	Visual	(B1)	45.49	3.93	51.50	40.35	30
	Auditory	(B2)	25.67	2.61	30.05	39.50	30
	Kinaesthetic	(B3)	31.41	2.89	20.65	27.20	30
Total Competitive (A3)			34.19	8.95	51.50	20.65	90
Total Visual (B1)			42.27	4.05	51.50	31.75	30
Total Auditory (B2)			36.51	8.63	50.00	20.65	30
Total Kinaesthetic (B3)			39.10	6.50	49.95	27.20	30
Total AB			39.29	7.04	51.50	20.65	270

As shown in Table 4 and Figure 1, the main effects different among learning strategies on students HOTS, the students taught by CTL strategy achieved the first rank HOTS mean (M=42.36; SD=4.43) among them, the students taught by collaborative learning strategy achieved the second rank HOTS mean (M=41.32; SD=3.20), and the students taught by competitive learning strategy achieved the last rank HOTS mean (M=34.19; SD=8.95). These findings also point out the similarity between using CTL strategy and using collaborative learning strategy in teachings since the students achieved almost the same HOTS mean. The different main effects among learning styles on students' HOTS, visual students achieved the first rank HOTS mean (M=42.27; SD=4.05) among them, kinaesthetic students achieved the second rank HOTS mean (M=39.10; SD=6.50), and auditory students achieved the last rank HOTS mean (M=36.51; SD=8.63). Therefore, these findings also showed

that visual students acquire the highest HOTS than that of kinaesthetic students and auditory students. Furthermore, to explain the different main effects among these learning strategies and learning styles on the students' HOTS can be seen in Figure 1.

As shown in Table 4 and Figure 2, in thedifferent simple effects among learning strategies and learning styles on students HOTS, visual students achieved maximum HOTS in the application of competitive learning strategy, auditory students achieved maximum HOTS in the application of collaborative learning strategy, and kinaesthetic students achieved maximum HOTS in the application of CTL strategy. Furthermore, to explain thedifferent simple effects among learning strategies and learning styles on the students' HOTS can be illustrated in Figure 2.

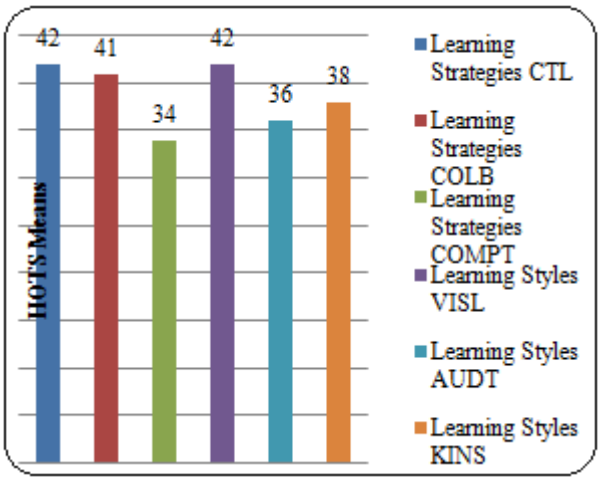

Figure 1: Main Different Effects among Learning Strategies and Learning Styles on the Students'HOTS

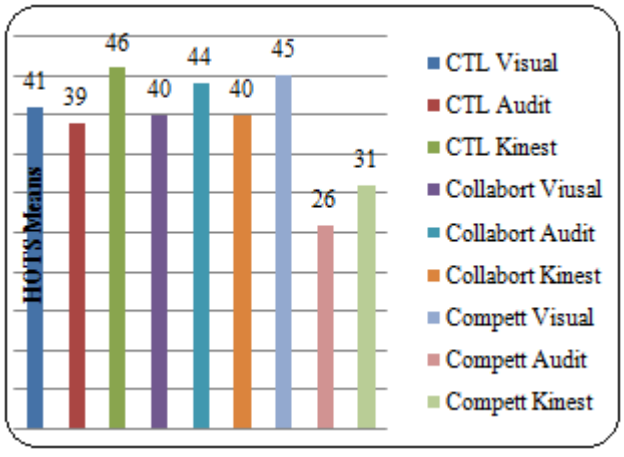

Figure 2: Different Simple effects among Learning Strategies and Learning Styles on the Students' HOTS

3.2 Hypothesis Testing

The first hypothesis testing results showed that there is statistically significant different in higher-order thinking skills of students taught under CTL strategy, collaborative learning strategy, and competitive learning strategy ($p<0.05$). Post hoc comparisons results showhigher-order thinking skills of students taught under CTL strategy (A1) and collaborative learning strategy (A2) does not differ significantly ($p>0.05$); higher-order thinking skills of students taught under CTL strategy (A1) is higher than that of students taught under competitive learning strategy (A3) ($p<0.05$); and higher-order thinking skills of students taught under collaborative learning strategy (A2) is higher than that of students taught under competitive learning strategy (A3) ($p<0.05$). The summary of the results of post hoc comparisons of the first hypothesis testing is described in Table 5.

The second hypothesis testing results show there is a statistically significant difference in higher-order thinking skills of visual students (B1), auditory students (B2), and kinaesthetic students (B3) ($p<0.05$). Post hoc comparison results show higher-order thinking skills of visual students (B1) is higher than that of auditory students (B2) ($p<0.05$); higher-order thinking skills of visual students (B1) is higher than that of kinaesthetic students (B3) ($p<0.05$); and higher-order thinking skills of auditory students (B2) is lower than that of kinaesthetic students (B3) ($p<0.05$).

Table 5: The Summary of Post Hoc Comparisons of the First Hypothesis Testing Results

(I) A	(J) A	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A1	A2	1.04	0.46	0.07	-0.06	2.13
	A3	8.17*	0.46	0.00	7.07	9.26
A2	A1	-1.04	0.46	0.07	-2.13	0.06
	A3	7.13*	0.46	0.00	6.03	8.22
A3	A1	-8.17*	0.46	0.00	-9.26	-7.07
	A2	-7.13*	0.46	0.00	-8.22	-6.03
Based on observed means. The error term is Mean Square analysis (Error) = 9.72.						
*. The mean difference is significant at the 0.05 level.						

The summary of the results of the second hypothesis testing is shown in Table 6.

Table 6: The Summary of Post Hoc Comparisons of the Second Hypothesis Testing

(I) B	(J) B	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
B1	B2	5.77*	0.46	0.00	4.67	6.86
	B3	3.17*	0.46	0.00	2.08	4.27
B2	B1	-5.77*	0.46	0.00	-6.86	-4.67
	B3	-2.59*	0.46	0.00	-3.69	-1.50
B3	B1	-3.17*	0.46	0.00	-4.27	-2.08
	B2	2.59*	0.46	0.00	1.50	3.69
Based on observed means. The error term is Mean Square (Error) = 9.72.						
*. The mean difference is significant at the 0.05 level.						

The third hypothesis testing result shows there is a statistically significant interaction effect between learning strategies and learning styles on students' higher-order thinking skills (A*B) ($p<0.05$). The result of the testing is summarized in Table 7.

Table 7. The summary of the Third Hypothesis Testing Results.

(Tests of Between-Subjects Effects)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10808.04[a]	8	1351.01	139.06	0.00
Intercept	416862.97	1	416862.97	42908.66	0.00
A	3557.78	2	1778.89	183.11	0.00
B	1500.58	2	750.29	77.23	0.00
A * B	5749.68	4	1437.42	147.96	0.00
Error	2535.65	261	9.72		
Total	430206.66	270			
Corrected Total	13343.69	269			
a. R Squared = 0.81 (Adjusted R Squared = 0.80)					

Furthermore, to explain the interaction effect between learning strategies and learning styles on the students' higher-order thinking skills is illustrated in Figure 3.

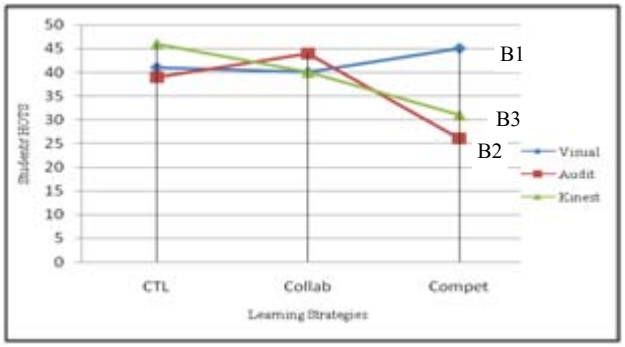

Figure 3: The Interaction Effect between Learning Strategies and Learning Styles On Students' HOTS

As seen in Figure 3, the line B1 show higher-order thinking skills of visual students, in which the terms of the average value, the higher-order thinking skills of students taught through CTL strategy is higher than the higher-order thinking skills of students taught through collaborative learning strategy and is lower than the higher-order thinking skills of students taught through competitive learning strategy. The B2 line that moved increases and decreases after the point A2 shows the learning strategy which most suitable for improving higher-order thinking skills of auditory student is collaborative learning strategy. The B3 line, which moved down indicates the learning strategy which most suitable for improving the higher-order thinking skills of kinaesthetic student is CTL strategy followed by collaborative learning strategy and competitive learning strategy. Lines B1, B2, and B3, which intersect indicates an interplay interaction between learning strategies and learning styles on the students' higher-order thinking skills.

4. Discussion

The first hypothesis testing result shows that there are statistically significant differences among higher-order thinking skills of students taught through the three learning strategies. Post-hoc comparisons support that higher-order thinking skills of students taught through CTL and collaborative learning strategy are not differ significantly. CTL strategy is a learning process that links the course material to the real world situations that do not turn out to significantly different from the implementation of collaborative learning strategy. This happens because CTL strategy and collaborative learning strategy, both implemented using class discussion. The findings of this study provide empirical support for beliefs on the greater effectiveness of CTL and the collaborative learning compared with the competitive learning strategy to develop students' higher-order thinking skills. Glynn & Winter,[33] Hudson & Whisler,[34] explain that CTL strategy is best implemented when teachers used them in conjunction with collaborative interaction with students, a high level of activity in the lesson, a connection to real-world contexts, and an integration of science content with other content and skill areas.

The present study result is in accordance with those of some other researchers, such Zhining, Johnson, & Johnson;[35] Johnson & Johnson;[36]found that cooperative learning results in greater academic achievement, social and psychological benefits than the traditional lecture-based teaching group. Similarly, several empirical studies have offered various perspectives that illuminate the positive effect of collaborative learning on a variety of cognitive and affective outcomes.[37-39] The major findings of those studies arrive to the conclusions that the use of collaborative learning strategies had significant positive effects on a variety of cognitive and affective outcomes, such as: improving students' achievement and students' thinking skills, improving students' analytical skills, improving students'communication skills, improving students' teamwork skills, and improving students' appreciation for diversity.

The present study also shows higher-order thinking skills of students taught through CTL strategy is higher than that of students taught through competitive learning strategy, and higher-order thinking skills of students taught through collaborative learning strategy is higher than that of the students taught through competitive learning strategy. This finding is also consistent with results of studies conducted by Tran,[40] that collaborative learning can provide a higher influence on student achievement compared to competitive learning and individual learning. Studies conducted by Johnson, Johnson, & Smith[41] also confirmed that collaborative and cooperative learning experience can increase academic achievement better than competitive learning experience. Furthermore, Johnson, Johnson, & Smith[42] have conducted research on 26 groups of primary school students, secondary school students, and high school students. Among the 26 studies, there are 21 researches showing significant evidence that higher learner achievement reached in collaborative learning strategy. Thus, CTL and collaborative learning experiences can improve learning achievement and advocates mixed-ability groups working together and taking responsibility for one another's learning.[43]

The second hypothesis testing result shows there is a statistically significant difference in higher-order thinking skills of visual, auditory, and kinaesthetic students. This finding validates the results of some earlier studies (Gokalp;[44] Ariffin, Solemon, Din, & Anwar[45] which indicated that there is a statistically significant difference

effects VAK/VARK learning styles on the students' academic achievement. This possibility is also recognised by other researchers (Zywno & Waalen;[46] Sharp, Bowker, & Byrne[47]), all of these previous studies indicated support for grouping of students based on their learning styles can facilitate them in understanding the subject matter because the students learn according to their learning styles and they can be assembled in accordance with their same communities.

The present study also indicates that higher-order thinking skill of visual students is higher than that of auditory students, higher-order thinking skills of visual students is higher than that of kinaesthetic students, and higher-order thinking skill of auditory students is lower than that of kinaesthetic students. The average score obtained proves that visual students acquire the highest higher-order thinking skills than that of auditory students and kinaesthetic students. These results are in accordance with Breckler, Teoh, & Role[48] as they found that among the highest performing students the visual learning style is the most common learning style while none of the high performers favoured the auditory style and the students with a visual learning style had the greatest academic achievement in their major. This finding is also consistent with results of studies conducted by Ozbas[49] it was found that approximately half of the university Students in Turkey learned visually.

Kassaian[50] in his researchfound that, students with a visual learning style retained vocabulary items they had learned visually better than the items they had learned aurally, but the students with an auditory learning style did not show better retention for items they had learned aurally; the students retained visually presented items better than aurally presented items in the immediate and delayed tests. In their research, Kia, Alipour, and Ghaderi[51] found that among students with the visual learning style have the greatest academic achievements. By observing the influence of the gender on the learning styles of the students, in visual learning, girls have obvious higher averages rather than boys in statistical terms. By comparison, the worst performers are dominated by those with auditory learning style. Similarly, Abdollahi & Tahriri[52] found out that there was a significant difference between visual and auditory scores of the participants in EFL vocabulary recall, and visual learning style was found to be more influential and successful in vocabulary recall.

The third hypothesis testing result shows there is an interaction effect between teaching strategies and learning styles on students' of higher-order thinking skills. This finding is consistent with earlier studies conducted by Curry[53]; Elkaseh, Wong, & Fung[54]). The present study also reveals that the interaction effects in this study due to the differences in the effect of each learning strategy to increase higher-order thinking skills of students. Higher-order thinking skill of visual students taught through CTL learning strategy is lower than that of students taught through competitive learning strategy. Higher-order thinking skills of visual students taught through collaborative learning strategy are lower than that of students taught through competitive learning strategy. These findings indicate that visual students achieved maximum learning results in the application of competitive learning strategy. Higher-order thinking skill of auditory students taught through CTL strategy is higher than that of students taught through competitive learning strategy. Higher-order thinking skills of auditory students taught through collaborative learning strategy are higher than that of students taught by competitive learning strategy. The results also showed that auditory students achieved maximum higher-order thinking skills in the application of collaborative learning strategy. Higher-order thinking skills of kinaesthetic students taught through CTL strategy is higher than that of students taught through competitive learning strategy, and higher-order thinking skills of kinaesthetic students taught through collaborative learning strategy is higher than that of students taught through competitive learning strategy. The results also show that kinaesthetic students achieved maximum higher-order thinking skills in the application of CTL strategy.

5. Conclusions

The results of the present study prove there is a significant difference in higher-order thinking skills of students taught through CTL strategy, collaborative learning strategy, and competitive learning strategy. CTL strategy is more effective to improve the higher-order thinking skills of students compared with the implementation of collaborative learning strategy and competitive learning strategy; there is a significant difference in higher-order thinking skills of visual, auditory, and kinaesthetic students. Higher-order thinking skills of visual students are higher than that of auditory students and kinaesthetic students; there is an interaction effect between learning strategies and learning styles on the students' of higher-order thinking skills. This interaction effect is caused by the differences in the effect of each learning strategy on higher-order thinking skills of students with different learning styles. However, CTL strategy is more effective to be applied on kinaesthetic students, collaborative learning strategy is more effective to be applied to auditory students, and competitive learning strategy is more effective to be applied to visual students. In addition, the result of this study could be used for developing appropriate learning strategies for the university students with different learning styles. Lecturers should consider students' learning styles in the classroom activities, and should also consider the importance of guiding students to focus on student-centred cooperative learning context.

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