

Investigate the Learning Efficiency of a Dual Language Program in the Computer-based Flight Training Virtual Environment

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Abstract: The study investigated the effect of different language support on flight simulation training for cadets. A total of thirty Aerospace Engineering students took part in the experiment and were divided equally into three language groups: English, Dual and non-subtitled Group. The participants watched instructional videos with different subtitles and then continued their training with the corresponding language aid checklist before the final test. The results demonstrated that the dual group had the highest training accuracy, the English group was the fastest in recognition of the operations and the non-subtitled group performed the worst. The experiment provides recommendations for multimedia learning using English language materials for Chinese students. The bilingual environment is most suitable for aviation training which requires accurate comprehension and operation. The English environment is useful for content that requires word recognition and memorization. Language support is not suggested for developing long-term English listening and communication skills.

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1. Introduction

English is now the lingua franca for international flight communications and all international pilots are required to pass the ICAO (International Civil Aviation Organization) English test prior to their employment to demonstrate that their English skills are adequate for international flight communications (Albritton, 2007). However, in a 2017 report on 165 Chinese international pilots (Zhao, 2017), it was noted that junior pilots' (aviation university graduates) English skills and English training during university were not sufficient to support them in passing the ICAO test, and that their tactic was consciously using English in their daily lives to strengthen their aviation English. Although Chinese flight cadets enter college with an above-average level of English for their age group, their English aviation skills are still deficient, especially when encountering specific aviation phraseology (Aiguo, 2007). The deficiency is apparent at the time of entry because there is no specific vocational high school for pilots in China and there is a lack of targeted improvement due to the inadequacy of the Aviation English syllabus. This is not a problem unique to Chinese pilots, as other non-native English-speaking countries also have a lack of aviation English training in their curriculum, Karimi's 2014 study mentioned that the English course in Iran's aviation training programs was not sufficient to support students to become aviation professionals (Karimi, 2014). Professor Robert from Embry-Riddle Aeronautical University pointed out that many of the current entry-level cadets did not have successful radio communication skills, and then there was a more significant need for effective aviation English courses and tests in non-native English-speaking areas (Robert, 2020). Therefore, it is essential for the development of the aviation English for flight cadets to use realistic flight scenarios and training materials, especially for cross-cultural learners who are not native English speakers (Hazrati, 2015). It is also necessary to investigate how to appropriately integrate language assistance during teaching so that non-English-speaking students can understand and memorize academic English content more deeply (Douglas, 2014).

Chinese students' English is characterized by excellent reading ability and a relative lack of listening and communication skills due to a restricted teaching model and a long absence from the English environment (Hao, 2021). Since effective English teaching is crucial to the careers of aviation professionals, it is highly recommended to establish a language environment for students at an early stage (Linlin, 2018). The ideal teaching model is based on multimedia teaching and flight simulation, using English material with proper language support. The subtitle is an effective pedagogical tool for ESL (English as a Second Language) learners using English software and watching English videos (Aldera, 2013). The most significant benefit is that subtitle enhances audio-visual input and enables learners to visualize what they hear, especially when the material is slightly above their English proficiency (Yeldham, 2018).

However, which type of subtitle should be applied to ensure effective multimedia learning and a consistent language environment remains inconclusive (Hao, 2021). The variety of subtitles and learning materials has led to inconsistent conclusions from relevant studies. Based on four situations, i.e., first language (L1), second language

(L2), dual Language (L1+L2) and no subtitle, different studies have analyzed their strengths and weaknesses. The problem is that commonly used materials are about language teaching, general knowledge, and studies aimed at learning vocabulary and listening comprehension (Garcia, 2017). For providing subtitles for complex academic material that requires some grounding, such as aviation training videos, previous experiment findings are not sufficient to give appropriate advice. Moreover, the target language of most studies is Latin, with very little research into the use of the Chinese language for Chinese flying cadets. Due to the unique script and grammar, the Chinese context has a different linguistic effect from Latin (Hsieh, 2020).

There is a lack of strong literature on pilot training in a bilingual environment. Industry partners have supported the program and participated in the specification of some standards with the aim of exploring further possibilities for bilingual training for pilots. This study is not limited to examining the effects of subtitles on learning but is dedicated to building an English learning environment and providing appropriate language aids for early flight cadets. Meanwhile, three psychological state indicators used in previous task completion experiments, namely workload, situational awareness and satisfaction (Rubio, 2004; Santon, 2001; Lewis, 1995), were introduced into the experiment to investigate whether different subtitles have different psychological effects on the subjects and thus affect the training efficiency. The experiment will provide language assistance in both training software and tutorial video, thus comparing learning efficiency during flight training under different language contexts.

2. Literature review

This section reviews the previous study of the English teaching model in China, the cognitive load of teaching via multimedia, and different subtitles' learning efficiency. The reviews end with a summary of gaps in previous research and propose the research aims.

2.1. English teaching in Chinese aviation course

Aiguo (2008) had already pointed out that Chinese aviation students were less able to communicate in English when they entered college because of the greater emphasis on reading and writing in high school education and the lack of an authentic communication environment for students. Campbell-Laird (2006) also mentioned the communication difficulties of Asian cadets in the study and highlighted the importance of phraseology and communication in early teaching. In response to these issues, Linlin (2018) advocated building a complete English training environment to develop students' English listening and comprehension and to build a solid foundation for flight training abroad. Thus, early training in aviation English must base on an English context. Teaching aviation knowledge and language skills must carry out in parallel (Knoch, 2014).

In summary, a reasonable training model for Chinese cadets is to focus on flight simulation, supplemented by theoretical learning and language practice (Linlin, 2018), with appropriate language support (Douglas, 2014).

2.2. Cognitive load in Multimedia teaching

As a basis for multimedia teaching and learning research, a dual-coding theory confirmed that strengthening the connection between visual and auditory channels can effectively enhance learning (Paivio, 1980). The impact of subtitles in multimedia materials has been widely discussed since then, with both positive and negative findings. Opponents argued that subtitles consistent with audio created a redundancy effect, i.e., subtitles and image information jointly occupy the visual channel, resulting in a more significant cognitive load (Mayer, 2001). However, Mayer's research (1997, 2001, 2005) mainly focused on native English speakers. The study did not indicate a redundancy boundary for the use of English subtitles by non-native English speakers (Mayer, 2014). Supporters argued that although the absence of subtitles reduces visual stress, listening skills would limit learners' word recognition. Learners with insufficient vocabulary and listening skills would face greater listening and comprehension stress (Markham, 2001). Moreover, both L1 and L2 subtitles functioned as an additional channel to strengthen the link between auditory and written information, thus reducing the cognitive load (Hao, 2021).

Generally, it is a complex cognitive process when non-native English speakers learn English multimedia materials with subtitles. Whether the subtitle creates extra cognitive load remains inconclusive.

2.3. L1, L2 and dual context

No	Author, Publication year, Country	Types of subtitles	Main findings
First Language and English subtitles (L1 and L2)			
1	Aldera, A. S., & Mohsen, M. A. (2013), US	(a) Animation (English) + Keyword+ English Subtitle (b) Animation + English Subtitle (c) Animation only	Subtitled groups had higher vocabulary acquisition and comprehension, and groups without subtitles had better memory retention.
2	Hsieh, Y. (2020), China	(a) English animation without subtitle (b) English animation with English subtitles and no audio (c) English animation with English subtitle (d) (c) + highlighted keyword (e) (d) + Chinese gloss	Using English subtitles did not cause cognitive overload and improved vocabulary acquisition compared to un-subtitled videos and highlighted keywords did not improve content comprehension.

3	Hayati, A., & Mohmedi, F. (2011), Iran	(a) TV episodes (English) + English subtitle (b) TV episodes + Persian Subtitle (c) TV episodes without Subtitle	Intermediate English learners benefited from English subtitles because captioning in the target language saved time switching languages, whereas L1 led to bypassing English.
4	Markham, P. L., Peter, L. A., & McCarthy, T. J. (2001), US	(a) DVD episode (Spanish) + Spanish subtitle (L2) (b) DVD episode + English Subtitle (L1) (c) DVD episode without subtitles	The English group performed significantly better than the Spanish group, and the Spanish group was better than the un-subtitled group. The finding suggested that L1 subtitles would be used when a learner's second language listening and reading skills do not support comprehension of the material.
5	Peters, E., Heynen, E., & Puimège, E. (2016), Belgium	(a) Video clip (English) + Dutch subtitle (L1) (b) Video clip + English Subtitle (L2) (c) Video clip without subtitles	L2 subtitles were superior to L1 for learning new words for the study participants, probably because the correct written format was provided. The matching of images and vocabulary would enhance learning.
6	Van der Zee, T., Admiraal, W., Paas, F., Saab, N., & Giesbers, B. (2017), Netherlands	C+ and C- refer to more and less complex versions of the video (English). S+ and S- refer to the absence of L2 subtitles. (a) C+ S+ C- S- C+ S- C- S+ (b) C- S- C+ S- C- S+ C+ S+ (c) C+ S- C- S+ C+ S+ C- S- (d) C- S+ C+ S+ C- S- C+ S	When English videos were used for content learning rather than language learning, English (L2) subtitles did not show an obvious help for learning. However, they were vital for students with poor listening skills.
Dual subtitles			
7	Dizon, G., & Thanyawatpokin, B. (2021), Japan	(a) TV episodes (English) + English subtitle (b) TV episodes + Japanese Subtitle (c) TV episodes + Dual Subtitle	Dual and Japanese subtitles were better than English subtitles for word learning, while bilingual subtitles were found best for listening comprehension.
8	García, B. (2017), Spain	(a) Video lesson (English) without subtitle (b) Video lesson +Dual Subtitles (English + Spanish)	Using dual subtitles significantly improved students' understanding of video lessons in a second language. In addition, students mainly read the L2 subtitles and chose L1 only when they heard new words.
9	Hao, T., Sheng, H., Ardasheva, Y., & Wang, Z. (2021), China	(a) TED talks (English) + English subtitle (b) TED talks + Chinese subtitle (c) TED talks + Dual Subtitle (d) TED talks without subtitle	Advanced English learners had the best comprehension when using dual subtitles, whereas English subtitles can cause extra cognitive stress. Additionally, their listening skill can be improved without subtitles.

10	Low, L., & Lin, M. C. T. (2012), China	(a) Multimedia reading program (English) without subtitles	The four different subtitle groups did not show significant differences, probably because the images and audio captured the students' attention. Dual subtitles had a positive effect on understanding complex sentences.
		(b) Program + Chinese Subtitle	
		(c) Program + English Subtitle	
		(d) Program + Dual Subtitle	

Table.1 Summary of previous research on different subtitles

Numerous studies compared the learning effects of ESL learners using first and second language subtitles, demonstrating that L2 subtitles were more helpful as a learning tool. In the study by Hayati (2011), 90 Iranian college students of intermediate English proficiency participated in an English comprehension test after watching an English documentary with L1 and L2 subtitles. The selected part of the movie lasted approximately 5 min, and the comprehension tests were ten multiple-choice questions. The L2 group had better test results than the L1 group. Students stated that using L2 subtitles did not create an additional translation process but made identifying keywords easier. In contrast, the L1 subtitles sometimes distracted them, and the translation of Persian might have changed part of the original meaning. It was proven that L2 subtitles facilitated listening comprehension and allowed students to receive visual and auditory messages without stress.

Peters (2016) investigated the effect of L1 and L2 subtitles on vocabulary learning for ESL learners in Flanders (Belgium). 46 Dutch-speaking students of 17-20 age participated in the vocabulary test and comprehension questionnaire after watching a 13-minute video of a documentary about 'eating insects' and the series The Simpsons of 20 min. The findings suggested that L2 subtitles had the potential for students to gain more new vocabulary. However, the effects had no significant difference between ESL learners with intermediate and low-intermediate English proficiency.

Aldera (2013) highlighted that L1 subtitles could increase the interest in learning and arouse enthusiasm for students, and it was effective and easy for understanding the general idea. However, for students with poor and intermediate English proficiency, relying on L1 could lead to distraction from the original soundtrack. In addition, there might be different expressions for the same topic between L1 and L2, resulting in misunderstanding (Aldera, 2013).

Compared to the L1 subtitle, the L2 subtitle was found more helpful for vocabulary learning (Hao, 2021). Consistent subtitles with the audio track matching the visual and auditory information could deepen students' understanding of the content. However, reading the same content in English subtitles added cognitive stress to content that can be understood aurally. As a result, L1 was found suitable for effectively understanding straightforward content and L2 was suitable for academic content that may be ambiguous after translation.

Garcia (2007) investigated the effect of dual subtitles on Engineering learning for Spanish students. 29 second-grade students watched the video about 'UDP hole punching' for 5 minutes with dual and without

subtitles and then finished a comprehension test. Students scored 25% better on tests with dual subtitles than without subtitles. More specifically, for general content understanding, 77% of students chose to read L2 subtitles. For difficult-to-understand content, 70% of students chose to read L1 subtitles. Overall, the dual subtitles combined the advantages of both to some extent.

Hao (2021) investigated the effects of L1, L2, dual subtitles and no subtitles on listening comprehension of Ted talks for ESL learners. 272 Chinese college sophomore students participated in the survey, of which 147 students were non-English Major, and 125 students were English Major. All the students were required to finish a comprehension test that included eight multiple choices questions after watching a TED talk (Technology, Entertainment, Design) of 7 min. It was found that dual subtitles failed to improve the vocabulary learning of intermediate students. However, it was effective for the advanced learner because they would selectively refer to the dual subtitle and improve their comprehension.

Although dual subtitle combines the features of L1 and L2, there is no specific answer to whether learners have sufficient ability to understand two languages in academic English learning (Hao, 2021). Because academic vocabulary is used less frequently and there will be polysemy in the specific academic field, which significantly increases the difficulty of understanding. For this complex cognitive process, there is a lack of specific research.

To conclude, the assistance of a dual language program to learning is closely related to the student's English proficiency and the difficulty of the content. The cognitive load of dual language programs varies under different circumstances. Therefore, it requires a specific experiment to confirm whether dual subtitles are optimal for others in the given area.

Previous relevant studies focused on reading comprehension, vocabulary learning and improvement of listening and speaking. However, English is a learning tool for highly professional content like aviation training. The most crucial learning objective is to improve the understanding and memorization of aviation knowledge. Due to international standards in aviation English, a full Chinese program will not be used in the study. This experiment investigates the learning efficiency of the English and dual language context in the virtual computer-based flight training virtual environment. The specific objectives include:

- Explore how the use of subtitles improves the efficiency of Chinese flight cadets learning with English video material
- Investigate and compare which context (i.e., No assistance, second language (English) and a dual language context) is most suitable for procedure training targeting Chinese flight cadets.

In this study, student participants were trained through tutorial videos with different language assistance in a Desktop Checklist Flight Procedure Training program. All research activities undertaken in this study have been approved by the Ethics Committee of the Faculty of Engineering at the University of Nottingham Ningbo China.

3. Methodology

3.1. Participants

The participants were 30 Aerospace Engineering students from the second to the fourth year at the University of Nottingham Ningbo China, with an average of 20 hours of simulated flight training. All students took part in the same training and there was no extra training time. Student's ages ranged from 19 to 23, with an average of 20.8 (SD= 1.2). 20 students were male, and 10 students were female. At the beginning of the flight simulation training course, we observed no significant disparity in English proficiency levels between the selected participants with aviation students. This was because the course commenced shortly after the College entrance exam, and both sets of students possessed similar levels of proficiency which were higher than the average university student. All students passed the full English flight simulation final test and can be considered to have the English language proficiency to understand flight simulation instruction. They were divided into three groups: the English language group, the dual language group, and the non-language support group (Control group). To avoid incomprehension of the audio and subtitles, the vocabulary used in the videos was taken from the Aviation Sophomore syllabus and has been reviewed by the lecturers so that all students could fully understand the content.

3.2. Material

A 210-second tutorial video of flight procedure training was created based on existing instructional videos and flight instructor guidance. The video demonstrated how to complete Checklists of Cessna 172 SP, which consisted of four sections: preflight, starting the engine, before takeoff and engine shutdown. For all participants, this was the first time they had watched the video. Flight training was conducted in X-plane11, with implanted checklist inserts done by the engineers, and video and subtitles edited by me via Xbox's video recording software and Adobe Premiere.

Group 1 was the control group and was not given any language assistance. Students watched an un-subtitled tutorial video and used a printed checklist during practice. **Group 2** was the dual language group, where students watched the tutorial video with dual subtitles and used bilingual checklists in their training. **Group 3** was the English group, where students watched the tutorial video with English subtitles and used English checklists in their training. The video highlighted the mouse and corresponding instruments to teach the corresponding operations. The subtitles were designed based on the BBC subtitle standard (BBC, 2022). The flight instructors from Aerospace Engineering at UNNC designed the checklist based on their current teaching.



CESSNA 172 SP CHECKLIST

Preflight - Cabin	
Parking Brake	ON
Ignition Switch	OFF
Avionics Master Switch	OFF
Master Switch (Battery)	ON
Avionics Master Switch	ON
Warning Light Panel	TESTED
Flaps (10 20 Full)	TESTED
Flaps	UP
Pitot Heat	ON
Pitot Heat	OFF
Master Switch (Battery)	OFF

Starting Engine	
Master Switch (Battery)	ON
Beacon Light	ON
Throttle	OPEN 1/4 INCH
Mixture	FULL RICH
Aux Fuel Pump	ON (1 SECS)
Aux Fuel Pump	OFF
Ignition Switch	START
Master Switch (Alternator)	ON
Nav Lights	ON (AT NIGHT)
Taxi Lights	ON
Avionics Master Switch	ON
Flaps	UP

CESSNA 172 SP CHECKLIST

Before Takeoff	
Parking Brake	ON
Mixture	FLIGHT
Throttle	OPEN 1800 RPM
Ignition Switch	LEFT
Ignition Switch	RIGHT
Ignition Switch	BOTH
Throttle	2000 RPM
Strobe Light	ON
Landing Lights	ON

Engine Shutdown	
Parking Brake	ON
Avionics Master Switch	OFF
Throttle	2000/1400 RPM
Mixture	CUT OFF SMOOTHLY
Landing Lights	OFF
Strobe Lights	OFF
Nav Lights	OFF
Taxi Lights	OFF
Beacon Light	OFF
Ignition Switch	OFF
Master Switch (Alternator)	OFF
Master Switch (Battery)	OFF

Fig.1. Group 1 No subtitle + Printed Checklist



Fig.2. Group 2 Dual subtitle + Bilingual Checklist



Fig.3 Group 3, English subtitle + English Checklist

3.3. Instruments

3.3.1. Flight Simulator

The experiment is based on a virtual Cessna 172 SP developed by X-plane 11, which uses a computer-based flight simulation with an external 27" monitor to enhance the participants' operating experience. All operations were performed by the mouse after voice prompts.

In the test, participants were allowed to use the printed checklist to confirm the next operation.

3.3.2. Checklist

Three sets of checklists, printed copy, electronic English, and electronic Dual Language. The Checklists design was based on the sophomore aviation syllabus and the Air China flight manual and has been reviewed by aviation engineers. (See Appendix A). The checklist in English and Chinese comes from the syllabus, and I've made some streamlining of repetitive actions and non-essential processes in discussions with teachers and engineers. Because some Chinese terms do not directly correspond to the English ones, such as ignition switch, students were explained to avoid confusion.

3.3.3. Questionnaire

In addition to the assessment of training efficiency, the mental impact of different environments on the user needs to be assessed to avoid the impact on the psyche. After completing the test, participants were required to complete a series of questionnaires to measure their mental workload (Rubio,2004), situation awareness (Santon, 2001) and user satisfaction (Lewis, 1995) during the experiment (See Appendix B, C and D).

3.4.Procedure

A between-subjects design was selected as it allowed for the comparison of different groups of participants, with each group experiencing only one level of the independent variable. This helps to minimize the potential for order effects or carryover effects that could confound the results in a within-subjects design. Additionally, a between-subjects design can provide greater statistical power and allow for easier interpretation of the results, as each group serves as a separate data point.

Two instructors and one student participated in each experiment; one recorded the training time and the other broadcasted checklists. The experiment consisted of three rounds of practice and a final test (starting with a tutorial video with No subtitle, dual subtitle, or English subtitle - > Practice 1 - > Practice 2 - > Practice 3 - > Test - > Interview - > Fill in Questionnaires). The participants watched the tutorial video with the corresponding subtitles and then completed three rounds of practice. The content of the practice was consistent with the video. The instructor corrected the wrong operations and recorded them during practices. A test was scheduled after the practices, during which one instructor broadcasted checklists and the other recorded the errors and timing. The three groups used different checklists corresponding to their language contexts. Finally, participants were

required to participate in a brief interview and complete a series of questionnaires. The questionnaire and record sheet were placed in the Appendix.

4. Results

The following section demonstrates and analyses the data from the test. Four data sets were removed because four had recently participated in a flight competition and were more familiar with flight training than the other students.

Test Performance: $\mu \pm SD$ (μ: mean value; SD: standard deviation)	
No subtitle	
N	9
Correct Actions	41.67 \pm 1.22
Time to Complete (s)	280.44 \pm 22.82
Weighted Time	6.75 \pm 0.71
English	
N	8
Correct Actions	42.00 \pm 1.41
Time to Complete (s)	252.13 \pm 9.36
Weighted Time	5.99 \pm 0.35
Dual	
N	9
Correct Actions	42.78 \pm 1.20
Time to Complete (s)	279.56 \pm 17.98
Weighted Time	6.53 \pm 0.34

Table.2 Descriptive statistic for Participants' Performance Tests

The non-parametric test of Kruskal-Wallis test was utilized to analysis the experiment data for two compelling reasons. Firstly, the sample size was relatively small, and secondly, the Kolmogorov-Smirnov test confirmed that the data did not conform to a normal distribution in all groups. Moreover, the test was appropriate since there were more than two types of data being compared.

4.1 Correct Actions

Correct Actions	
N	26
Test Statistic	4.394
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.111

Table.3 Summary of correct actions

Table 3 illustrated the overall performance of the tests. A higher number of correct actions means a higher accuracy. Descriptive statistics indicated the dual subtitle group had the highest number of correct operations ($M = 42.78$, $SD = 1.20$), the English group were second in terms of accuracy ($M = 42$, $SD = 1.41$) and the control group (No subtitle) had the lowest number ($M = 41.67$, $SD = 1.22$). However, the Kruskal-Wallis test indicated that this observed difference was not statistically significant ($H(2) = 4.394$, $p = 0.111$). The data for the dual group was stable and close so it did not show a bar distribution. It can be assumed that the dual group has the highest accuracy but lacks statistically significance. The subsequent analysis needs to be combined with the results of the subjective interviews.

4.2. Mean Time to Complete

Mean Time to Complete	
English-Dual	
N	9
Test Statistic	-10.340
Std. Error	3.713
Std. Test Statistic	-2.785
Sig.	.005
Adj. Sig.	.016
English-Control	
N	8
Test Statistic	11.507
Std. Error	3.713
Std. Test Statistic	3.099
Sig.	.005
Adj. Sig.	.006
Dual-Control	

N	9
Test Statistic	1.167
Std. Error	3.602
Std. Test Statistic	.324
Sig.	.746
Adj. Sig.	1.000

Table.4 Summary of Time to Complete

Table 4 explained that the subjects achieved the shortest training completion time when using English subtitles (M = 252.13, SD = 9.36), while the remaining two groups had closer completion times (Control group: M = 280.44, SD = 22.82, Dual language group: M = 279.56, SD = 17.98). There was a larger standard deviation in completion time. This may be because the participants had different habits in their operations, which was considered acceptable because of the objective experiment conditions. The following Kruskal-Wallis Test confirmed the statistical significance of the English subtitles group in terms of completion time ($p = .016$, $p = .006$), compared to the dual subtitle and control groups. The results confirmed the use of English subtitles could minimize training time.

4.3. Weighted Time

Weighted Time	
English-Dual	
N	9
Test Statistic	-9.097
Std. Error	3.713
Std. Test Statistic	-2.448
Sig.	.014
Adj. Sig.	.043
English-Control	
N	8
Test Statistic	9.319
Std. Error	3.713
Std. Test Statistic	2.508
Sig.	.012
Adj. Sig.	.036
Dual-Control	

N	9
Test Statistic	.222
Std. Error	3.606
Std. Test Statistic	.062
Sig.	.951
Adj. Sig.	1.000

Table.5 Summary of Weighted Time

In this experiment, weighted time (Time/Number of correct actions) was used to measure the efficiency of the training. Because in the Boeing's previous experiments, the time to complete a correct operation was used to determine the efficiency of training. It is important to note that a lower value means that the training is more efficient.

The smaller the value the shorter the effective operating time. Subjects had the highest training efficiency when using English subtitles (M = 5.99, SD=0.35), followed by the dual group (M = 6.53, SD=0.33) and control group (M = 6.75, SD=0.71). The Kruskal-Wallis Test proved the English group had a significant advantage over the other two groups in terms of training efficiency ($p = .043$, $p = .036$), while the dual subtitle group did not show a significant effect on improving efficiency compared to the control group ($H(2)=0.222, p=1$).

4.4. Questionnaires Results

Test Performance: $\mu \pm SD$ (μ : mean value; SD: standard deviation)	
No subtitle	
N	9
Workload	63.00 \pm 7.19
Situation Awareness	44.00 \pm 5.73
Satisfaction	79.12 \pm 5.02
English	
N	8
Workload	59.22 \pm 18.93
Situation Awareness	45.55 \pm 6.84
Satisfaction	82.33 \pm 10.63
Dual	
N	9
Workload	61.88 \pm 15.10

Situation Awareness	44.78 ± 4.29
Satisfaction	84.22 ± 14.03

Table.6 Descriptive statistics of the Questionnaire

4.4.1. Workload

Correct Actions	
N	26
Test Statistic	.387
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.824

Table.7 Summary of Workload

The Nasa Task Load Index (TLX) scale was used to quantitatively measure mental stress during task completion (Rubio, 2004) and was used in this experiment to compare whether there would be a significant difference in mental stress between the different groups and higher score indicates a higher workload. Table 3 illustrated the close workload score for the three groups, with the control group scoring slightly higher (M = 63, SD = 7.19), followed by the dual group (M = 61.88, SD = 15.10) and English groups (M = 59.22, SD = 18.93). Kruskal-Wallis Test confirmed no significant difference in subtitles on workload ($H(2)=0.387, p=0.824$). There were no objective differences in workload between the groups and subsequent analysis was required in conjunction with subjective interviews.

4.4.2. Situation Awareness

Correct Actions	
N	26
Test Statistic	.107
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.948

Table.8 Summary of Situation Awareness

Situation Awareness was defined as the perception of elements in an environment, within a volume of space and time, comprehension of their meaning and projection of their status in the near future Endsley (Endsley, 1995). The SA rating was introduced in this experiment to quantify the subjects' perception of their environment, which is considered an important indicator in traffic control (Kaber, 2006). A higher score indicates that the participant has a more focused attention to the environment. Three groups were relatively close on the SA test, and it was observed that the English group was more perceptive and alert to the situation (M = 45.55., SD = 6.84), followed by the dual group (M = 44.78, SD = 4.29) and control group (M = 44.00, SD = 5.73). Kruskal-Wallis Test confirmed no significant effect on situational perception across the three

conditions($H(2)=0.107, p=0.948$). There were no significant differences between the three groups in terms of perception of the environment, and subsequent analysis needs to incorporate the results of the interviews.

4.4.3. Satisfaction

Correct Actions	
N	26
Test Statistic	2.092
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.351

Table.9 Summary of Satisfaction

The Satisfaction Scale was introduced in this experiment to quantify the usability and acceptability of the different groups, with higher scores meaning higher satisfaction. (Lewis,1995). The dual language group had the highest satisfaction scores ($M = 84.22, SD = 14.03$), followed by English group ($M = 82.33, SD = 10.63$) and control group ($M = 79.12, SD = 5.02$). Kruskal-Wallis Test showed no significant differences in user satisfaction regarding the use of subtitles during training($H(2)=2.092, p=0.351$). Although there was a 10% advantage for the dual group over the other two groups, there was still a lack of statistical significance and a comprehensive analysis is necessary in combination with the follow-up interviews.

4.5. Interview data

The main purpose of the interviews was to understand the participants' attitudes toward different language programs (See Appendix E). Table 4 shows the word frequency analysis of the advantages and disadvantages of different conditions. In the English group, 37% of comments considered that the English program would help students understand the audio, and 11% of comments expressed that English subtitles would cause visual obscuration. For the dual language group, 32% of comments thought that Chinese could help to understand, while 18% of comments highlighted that they seldom read Chinese subtitles during training. For the control group, 23% of comments felt that some words would be unintelligible, and 23% of comments felt that the absence of language assistance would allow for more concentrated training. The results of the questionnaire will be analysed in the discussion as subjective evidence.

CONTROL GROUP					
training efficiency	Unfamiliar vocabulary	3	23.1%		POSITIVE
training efficiency	Not distraction from learning	3	23.1%		
psychological	Close to the real scenario	2	15.4%		
task operation	Unable to match name and instruments	2	15.4%		NEGATIVE
visual	No obscure in screen	1	7.7%		
training efficiency	Enhancing visual and sequential memory	1	7.7%		
training efficiency	Easy to forget details	1	7.7%		
DUAL GROUP					
training efficiency	Chinese helps comprehension	7	31.8%		
training efficiency	Seldom read Chinese	4	18.2%		
training efficiency	English helps you memorize	3	13.6%		
training efficiency	Chinese subtitles cause confusion	2	9.1%		
training efficiency	Attention distribution problem	2	9.1%		
task operation	Chinese does not correspond to relevant buttons	2	9.1%		
training efficiency	Unfamiliar words can be seen in English	1	4.5%		
training efficiency	Novice friendly	1	4.5%		
ENGLISH GROUP					
training efficiency	Helping students translate content when they don't understand the audio.	7	36.8%		
training efficiency	Identify the keywords	3	15.8%		
visual	Subtitles may cause partial visual obscuration.	2	10.5%		
task operation	Students can use subtitles to confirm the corresponded operation.	2	10.5%		
training efficiency	The corresponding words in the subtitles can deepen memory.	2	10.5%		
training efficiency	Increasing learning interest which makes students more focused.	1	5.3%		
training efficiency	Indicating keywords may be enough.	1	5.3%		
training efficiency	There is no language assistance in real training.	1	5.3%		

Table.10 Interview Results

5. Discussion

This experiment analyzes the effects of different language assistant programs used for simulated flight procedure training. The results indicated that the dual group had the highest learning accuracy, and the English group had the highest learning efficiency. In the following discussion, the superiority of dual context and English context for comprehension and memory will be analyzed, respectively.

Previous studies have demonstrated that English proficiency affects the comprehension of subtitles for Chinese students. When the vocabulary involved in the experiment was above the participant's English level, the dual subtitles were superior to the English subtitles in helping comprehension (Hao, 2021). It was confirmed that the instruments and operations involved in the video were familiar to the students, which avoided the effect of unfamiliar vocabulary. All participants had above-average English proficiency and were taught in English at UNNC for more than one year, preventing the influence of low English proficiency on comprehension during the experiment.

The dual group showed the highest accuracy in the experiment but without a statistical significance. In this regard, the results of the interviews were introduced for further support. The highest percentage of voice in the dual group's interviews was that Chinese helped with comprehension, which was not limited to semantic understanding, but also included understanding of operations and the environment. Based on the data from experiment and interview, it can be assumed that the dual group had the highest accuracy for

knowledge learning. The results reinforced the conclusion in the study of Hao (2021) that advanced English learners did not experience additional cognitive stress when receiving both L1 and L2 language support, as they selected the appropriate textual information to enhance listening comprehension. Moreover, bilingual support provided the most effective comprehension aid when dealing with difficult vocabulary, thus enhancing content understanding (Lwo, 2012). This was consistent with the results of the interviews, in which listening comprehension of unfamiliar words and sentences was more difficult compared to direct reading due to changes in ambient sounds and workload during training, and further demonstrates the advantages of bilingual subtitles.

Despite the lack of data significance in the satisfaction test, the bilingual group demonstrated a clear trend towards high satisfaction. This result supports the view that a bilingual environment enhances interest in learning and increases listening comprehension (Dizon, 2021). However, the interest in learning may sometimes affect learning efficiency, as students may focus on the L1 support that is easier to understand or the interesting plot, thus detracting them from the more important English content (Hao, 2021; Hayati, 2011). Moreover, However, dual language support could also cause some comprehension difficulties and concentration problems, which was in line with the disadvantage that Chinese support can lead to a tendency to read the native language (Linlin, 2018). This may be one of the reasons for the long task completion time in the dual group during the experiment. The results and related research confirmed that a critical prerequisite for adopting the bilingual context is an academic and professional learning content.

The English group had a shorter response time during training compared to the dual language and control condition. The Series of data, combined with the weighted time significance, demonstrated the superiority of the English group in terms of training efficiency. The results confirmed that when processing textual and image information simultaneously, corresponding dual-channel processing could deepen the memory and comprehension (Mayer, 2001). However, when the visual information processing system was overloaded, it would weaken the connection between two pieces of information and reduce memory transferability. In conjunction with the attention issues mentioned in the dual group interviews, it could be interpreted that in this experiment, the students may have exceeded their visual processing threshold when reading the Chinese subtitle in dual subtitles (Mayer, 2001). The cognitive stress generated did not affect correct operation but took them more time to recall. In contrast, the audio, text and video information in the English group corresponded exactly to each other, thus better directing the student's attention and making recall easier (Peters, 2016).

The high efficiency in the English group validated the dual-coding theory that subjects were able to process image and textual information and establish a connection (Paivio, 1980). The students in the English group may deepen their memory of the corresponding operation according to the English annotation, thus increasing the efficiency of the training. A similar confirmation was received in the follow-up interviews that the corresponding words deepened their memory, assisted comprehension, and made them feel more focused. However, students

still raised several concerns in the English group. Although image blocking caused by the language assistance did not affect the learning of the content, it did affect the learning experience. In addition, subtitles with full content may not be helpful for students with advanced English proficiency, and occasional keyword annotations were considered sufficient.

The control group had the lowest performance, but the language context was the closest to the real flight training. It was found that long-term training without language assistance would improve students' listening skills (Hao, 2021). The follow-up interviews also revealed that students in the control group had to focus on the operation during the experiment and, to some extent, increased visual and sequential memory, which to some extent confirmed that un-subtitled learning had a better memory retention (Aldera, 2013).

6. Conclusion

This study investigated the learning efficiency of different language support in the computer-based flight training virtual environment for Chinese students. Compared to previous studies, the training involved a standard procedure training of simulated flight, where content learning and language learning took place simultaneously. The experiment proved that for Chinese students with advanced English proficiency and limited simulated flight training hours (With an average of 20 hours), training in a bilingual context led to the highest accuracy while training in the English context achieved the highest learning efficiency. In addition, learning in those contexts did not create an excessive workload.

Based on the finding, suggestions can be derived for Chinese students learning English materials. A bilingual environment is recommended when the content is complex, when accuracy and understanding are essential and when training time is not primarily critical. The English environment is optimal when vocabulary recognition and memorization is the main learning goal. Language support is not suggested when long-term development of English listening and communication skill is required. Finally, for professional and precise aviation courses, training in a bilingual context is the most recommended, because an accurate understanding of aviation English and standardized operations is essential for a professional flying career.

7. Limitations and future studies

There are some limitations to the study. Firstly, the participants recruited in the current experiment had relatively limited simulated flight hours, and the learning content was relatively basic. More experienced flight cadets could be recruited to address more challenging learning tasks in future studies. Secondly, as the effectiveness of the subtitle language option is dependent on the English proficiency levels of the selected participants. Therefore, caution should be taken when applying the outcomes of this research to Chinese flight cadets. Finally, the memory retention tests could not be completed due to time constraints.

In the future study, a memory retention test will be conducted two weeks after the first test to compare the effect on memory persistence across the different conditions.

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Appendix A: Checklists

CESSNA 172 SP CHECKLIST

Preflight - Cabin	
Parking Brake	ON
Ignition Switch	OFF
Avionics Master Switch	OFF
Master Switch (Battery)	ON
Avionics Master Switch	ON
Avionics Master Switch	OFF
Warning Light Panel	TESTED
Flaps(10 20 FULL)	TESTED
Flaps	UP
Pitot Heat	ON
Pitot Heat	OFF
Master Switch (Battery)	OFF

Starting Engine	
Master Switch (Battery)	ON
Beacon Light	ON
Throttle	OPEN 1/4 INCH
Mixture	FULL RICH
Aux Fuel Pump	ON (3 SECS)
Aux Fuel Pump	OFF
Ignition Switch	START
Master Switch (Alternator)	ON
NAV Lights	ON(AT NIGHT)
Taxi Lights	ON
Avionics Master Switch	ON
Flaps	UP

CESSNA 172 SP CHECKLIST

Before Takeoff	
Parking Brake	ON
Mixture	FULL RICH
Throttle	OPEN 1800 RPM
Ignition Switch	LEFT
Ignition Switch	RIGHT
Ignition Switch	BOTH
Throttle	1000 RPM
Strobe Light	ON
Landing Light	ON

Engine Shutdown	
Parking Brake	ON
Avionics Master Switch	OFF
Throttle	1000/1200 RPM
Mixture	CUTOFF SMOOTHLY
Landing Lights	OFF
Strobe Lights	OFF
NAV Lights	OFF
Taxi Lights	OFF
Beacon Light	OFF
Ignition Switch	OFF
Master Switch (Alternator)	OFF
Master Switch (Battery)	OFF

CESSNA 172 SP CHECKLIST

Preflight - Cabin	
Parking Brake 刹车	ON
Ignition Switch 磁电机	OFF
Avionics Master Switch 电子设备电门	OFF
Master Switch (Battery) 电瓶电门	ON
Avionics Master Switch 电子设备电门	ON
Avionics Master Switch 电子设备电门	OFF
Warning Light Panel 警告灯板	TESTED
Flaps 襟翼	TESTED
Flaps 襟翼	UP
Pitot Heat 皮托管加热电门	ON
Pitot Heat 皮托管加热电门	OFF
Master Switch (Battery) 电瓶电门	OFF

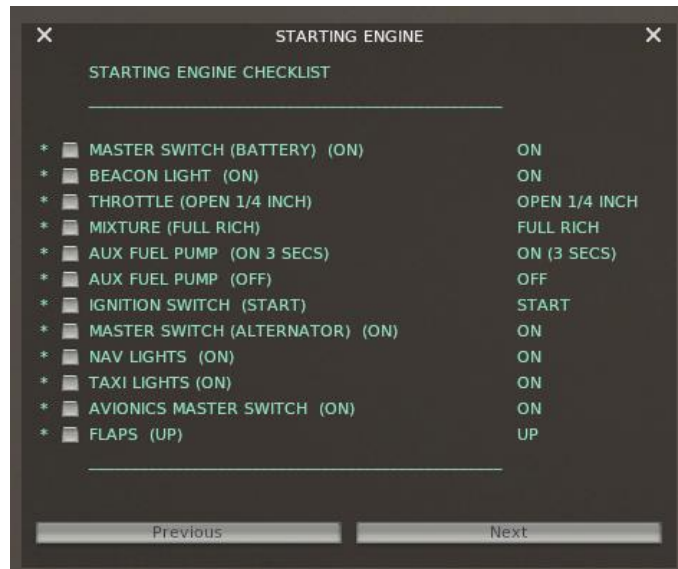
Starting Engine	
Master Switch (Battery) 电瓶电门	ON
Beacon Light 防撞灯	ON
Throttle 油门	OPEN 1/4 INCH
Mixture 混合比	FULL RICH
Aux Fuel Pump 电动燃油泵	ON (3 SECS)
Aux Fuel Pump 电动燃油泵	OFF
Ignition Switch 磁电机	START
Master Switch (Alternator) 发电机电门	ON
NAV lights 航行灯	ON(AT NIGHT)
Avionics Master Switch 电子设备电门	ON
Flaps 襟翼	ON
Master Switch (Battery) 电瓶电门	UP

CESSNA 172 SP CHECKLIST

Before Takeoff	
Parking Brake 刹车	ON
Mixture 混合比	FULL RICH
Fuel Selector Valve 燃油选择活门	OPEN 1800 RPM
Throttle 油门	LEFT
Ignition Switch 磁电机	RIGHT
Ignition Switch 磁电机	BOTH
Ignition Switch 磁电机	1000 RPM
Throttle 油门	ON
Strobe Light 频闪灯	ON

Engine Shutdown	
Parking Brake 刹车	ON
Avionics Master Switch 电子设备电门	OFF
Throttle 油门	1000/1200 RPM
Mixture 混合比	CUTOFF SMOOTHLY
Taxi Lights 滑行灯	OFF
Beacon Light 防撞灯	OFF
Ignition Switch 磁电机	OFF
Master Switch (Alternator) 发电机电门	OFF
Master Switch (Battery) 电瓶电门	OFF
Parking Brake 刹车	OFF
Avionics Master Switch 电子设备电门	OFF
Throttle 油门	OFF

(Made by myself, check with the Engineer)



(The content designed by myself, plugin was created by Engineer)

Appendix B: Questionnaire of Workload

Name:

Age:

Gender:

ID:

1. Mental demand 心智需求

How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?

需要多少心智及感觉活动? 如: 思考、决策、计算、记忆、看和搜寻等有关。此一任务之心智需求是低还是高? 是简单还是复杂? 是严格还是宽松?

Low 低

High 高

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

2. Physical demand 体力需求

How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

需要多少体力活动? 如: 推、拉、转动、控制等有关。此一任务之体力需求是低还是高? 是慢还是快? 是轻松还是激烈? 是可休息还是持续努力?

Low 低

High 高

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

3. Temporal demand 时间需求

How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

由任务或是任务的要素之发生率或步调感觉到多少时间压力? 任务的步调是悠闲还是忙乱或是慢还是快?

Low 低

High 高

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

4. Performance 自我绩效

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

觉得自己在完成任务目标方面有多成功？自己对自己在完成任务目标方面有多满意？

High 满意

Low 不满意

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

5. Effort 努力

How hard did you have to work (mentally and physically) to accomplish your level of performance?

需要多努力（心智方面与体力方面）和能力完成自己的任务目标和表现？

Low 低

High 高

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

6. Frustration 挫折

How insecure, discouraging, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

自己在此任务中觉得轻松还是沮丧？如：可靠度、沮丧、压力和烦恼等有关。此一任务是从容还是焦躁？

Low 从容

High 沮丧

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Appendix C: Questionnaire of Situation Awareness

Name:

Age:

Gender:

ID:

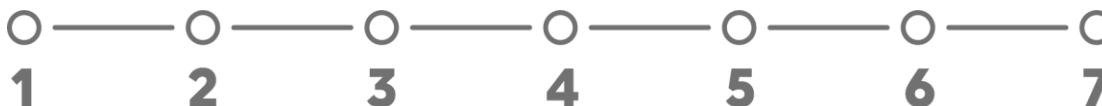
1. Instability of situation 情境的不稳定程度:

How changeable is the situation? Is the situation highly unstable and likely to change suddenly (high) or is it stable and straightforward (low)?

情境变化的灵活程度如何？情境非常稳定变化不大（不稳定程度低）；情境不稳定,极有可能突然发生变化（不稳定程度高）

Low 低

High 高



2. Variability of situation 情境的可变程度:

How many variables are changing within the situation? Are there a large number of factors varying (high) or are there very few variables changing (low)?

情境中存在多少可变因素? 情境中只有少量可以改变的因素 (可变程度低); 情境中存在大量的可以改变的因素 (可变程度高)



3. Complexity of situation 情境的复杂程度:

How complicated is the situation? Is it complex with many interrelated components (high) or is it simple and straightforward (low)?

情境的复杂程度如何? 情境中的信息比较简单, 直截了当 (复杂程度低); 情境中各项信息之间的相互联系非常紧密 (复杂程度高)



4. Arousal 精神唤醒程度:

How aroused are you in the situation? Are you alert and ready for activity (high) or do you have a low degree of alertness (low)?

你在情境中的唤醒度如何? 警觉性较低 (唤醒度低); 高度警觉、思维敏捷, 并能及时行动 (唤醒程度高)



5. Spare mental capacity 精力剩余程度:

How much mental capacity do you have to spare in the situation? Do you have sufficient to attend to many variables (high) or nothing to spare at all (low)?

你在情境中有名少剩余精力? 根本没有多余的精力关注情境中的突变因素 (剩余程度低); 有充足的精力关注情境中的突变因素 (剩余程度高)





6. Concentration 注意力集中程度:

How much are you concentrating on the situation? Are you concentrating on many aspects of the situation (high) or focused on only one (low)?

你能够在多大程度集中你的注意资源? 只能集中少量的注意资源应对任务(集中程度低); 能集中所有注意资源应对任务(集中程度高)

Low 低

High 高



7. Division of attention 注意力的分配程度:

How much is your attention divided in the situation? Are you concentrating on many aspects of the situation (high) or focused on only one (low)?

你能够同时注意多少情境中的信息? 只能同时注意情境中的少量信息(分配程度低); 能够同时注意情境中的大量信息(分配程度高)

Low 低

High 高



8. Information quantity 获得的信息数量:

How much information have you gained about the situation? Have you received and understood a great deal of knowledge (high) or very little (low)?

你能够获得和理解多少情境中的信息? 只能获取和理解少量情境信息(信息数量少); 能获取和理解大量情境信息(信息数量多)

Low 低

High 高



9. Information quality 获得的信息质量:

How well the information has informed you about the situation? Have you received the informative knowledge (high) or very limited (low) to understand the situation?

你能够了解情境中信息的程度有多深？只能获取和理解有限情境信息（理解程度低）；能获取和理解有效情境信息（理解程度高）

Low 低

High 高

— — — — — —

1 **2** **3** **4** **5** **6** **7**

10. Familiarity 对情境的熟悉程度:

How familiar are you with the situation? Do you have a great deal of relevant experience (high) or is it a new situation (low)?

你对情境的熟悉程度如何？对于当前情境，你的经验相对不足（熟悉程度低）；对于当前的情境，你有丰富的相关经验（熟悉程度高）

Low 低

High 高

— — — — — —

1 **2** **3** **4** **5** **6** **7**

Appendix D: Questionnaire of Satisfaction

Name:

Age:

Gender:

ID:

1. It was easy to work with the software.

我使用这个软件很容易。

Low 低

High 高

— — — — — —

1 **2** **3** **4** **5** **6** **7**

2. I became familiar with the software very quickly.

我很快就熟悉了这个软件。

Low 低

High 高

— — — — — —

1 **2** **3** **4** **5** **6** **7**

3. I understood how to use the software for training.

我了解如何使用这个软件进行训练。

Low 低

High 高



4. The feedback recommended by the software fit my interests.

软件提供的反馈符合我的兴趣。

Low 低

High 高



5. The software helped me prepare actions for a difficult situation.

这个软件在困难情况下提供操作指引。

Low 低

High 高



6. The information by the software was new.

这个软件提供的信息是新的。

Low 低

High 高



7. The information from the software was diverse.

这个软件提供的信息是多种多样的。

Low 低

High 高



8. The interface of the software was adequate.

这个软件的界面是适合的。

Low 低

High 高



9. I felt able to use the software for flight training.

我觉得可以使用这个软件进行飞行训练。

Low 低

High 高



10. The software provides sufficient support for training.

该软件为培训提供了足够的支持。

Low 低

High 高



11. In general, I am satisfied with the software.

总的来说，我对这个软件比较满意。

Low 低

High 高



12. I can trust the software.

我可以信任这个软件。

Low 低

High 高



13. The software helped me to feel confident in training.

这个软件让我在培训中更加自信。

Low 低

High 高



14. I would recommend to friends to use the software for training.

我会推荐朋友们在培训时使用这个软件。

Low 低

High 高



15. I am convinced the software could facilitate my training.

我相信这个软件对我的培训有帮助。

Low 低

High 高



Appendix D: Record Sheet

Name:

Group:

Interviewer:

Preflight - Cabin		
Parking Brake	ON	
Ignition Switch	OFF	
Avionics Master Switch	OFF	
Master Switch (Battery)	ON	
Avionics Master Switch	ON	
Avionics Master Switch	OFF	
Warning Light Panel	TESTED	
Flaps(10 20 FULL)	TESTED	
Flaps	UP	
Pitot Heat	ON	
Pitot Heat	OFF	
Master Switch (Battery)	OFF	
Time & Note		

Starting Engine		
Master Switch (Battery)	ON	
Beacon Light	ON	
Throttle	OPEN 1/4 INCH	
Mixture	FULL RICH	
Aux Fuel Pump	ON (3 SECS)	
Aux Fuel Pump	OFF	
Ignition Switch	START	
Master Switch (Alternator)	ON	
NAV lights	ON(AT NIGHT)	
Taxi Lights	ON	
Avionics Master Switch	ON	
Flaps	UP	
Time & Note		

Before Takeoff		
Parking Brake	ON	
Mixture	FULL RICH	
Throttle	OPEN 1800 RPM	
Ignition Switch	LEFT	
Ignition Switch	RIGHT	
Ignition Switch	BOTH	
Throttle	1000 RPM	
Strobe Light	ON	
Landing Light	ON	
Time & Note		

Engine Shutdown		
Parking Brake	ON	
Avionics Master Switch	OFF	
Throttle	1000/1200 RPM	
Mixture	CUTOFF SMOOTHLY	
Landing Lights	OFF	
Strobe Lights	OFF	
NAV Lights	OFF	
Taxi Lights	OFF	
Beacon Light	OFF	
Ignition Switch	OFF	
Master Switch (Alternator)	OFF	
Master Switch (Battery)	OFF	
Time & Note		

(Made by myself, checked with Engineer)

Appendix E: Interview

Interviewee: What do you think are the advantages and disadvantages of training in a bilingual environment?
 Zongxuan LIU (Dual Group): Chinese annotation can help beginners understand the words, and English subtitles showed the written form of unfamiliar words. But sometimes the Chinese can be distracting.

Interviewee: What do you think are the advantages and disadvantages of training in an English environment?
 Qinghe NI (English Group): English annotation helps me to identify keywords, but sometimes it causes obsuration.

Interviewee: What do you think are the advantages and disadvantages of training without language support?
 Yuhao Shi (Control Group): It is very close to the real scenario without any language support, but easy to forget

the details of the training.

(Conducted by myself)