Improving student academic emotions and learning satisfaction in lectures in a foreign language with speech-enabled language translation technology

Rustam Shadiev
Nanjing Normal University

Yueh Min Huang
National Cheng Kung University

Some students are unable to fully comprehend lecture content delivered in English as a medium of instruction (EMI) because of their low linguistic competence. This negatively impacts their academic emotions and learning satisfaction. Speech-enabled language translation (SELT) technology was applied in this study to simultaneously translate lecture content from English into native language of students and show translated text to students. This study investigated the effectiveness of a SELT application on perceived academic emotions and learning satisfaction of students attending lectures in EMI. Thirty-three university students participated, and perceived academic emotions and learning satisfaction were measured and compared across two groups of students: low language ability (LLA), and high language ability (HLA). The level of perceived academic emotions of LLA students was low before lectures but high during and after lectures. HLA students perceived high levels of academic emotions before lectures and low during and after lectures. LLA students' level of learning satisfaction was much better in comparison to HLA students. The results suggest that SELT technology is beneficial for learning for LLA students. Therefore, educators and researchers may apply SELT technology to EMI lectures in order to facilitate LLA students levels of perceived academic emotions and learning satisfaction.

Implications for practice or policy:
- SELT technology is beneficial for learning of the low linguistic competency students.
- Educators and researcher may apply SELT technology to EMI lectures in order to facilitate positive academic emotions and learning satisfaction of the low linguistic competency students.

Keywords: Speech-enabled language translation, academic emotions, learning satisfaction, English as a medium of instruction

Introduction

In the last few decades, English has been used as the language to deliver education in many countries, and it has been especially expanded as a medium of learning and/or instruction (Shadiev & Sun, 2020; Shadiev et al., 2020). When English is used as a medium of instruction (EMI), instructors and students of academic subjects use English, although the students' first language is different from English (Shimoyamada et al., 2019). Evidence suggests that some issues still exist in EMI classes even though the number of EMI courses are increasing (Shadiev et al., 2020). One notable issue is linguistic incompetence of students and this may result in lower learning achievement because of inability of students to fully comprehend lecture content delivered in EMI. Shadiev and Sun (2020) explored undergraduate students' perceptions of using EMI in a photography course. It was found that students with low language ability suffered when the instruction was via EMI.

It is possible that inability to comprehend lecture content may induce negative emotions, for example, students who are unable to comprehend a lectures' content in EMI may feel stressed and anxious (Shadiev & Sun, 2020; Shadiev & Huang, 2020). Negative emotions, in turn, may impair the student learning process (e.g., make students inattentive, bring task-irrelevant thoughts, or cognitively overload them) and negatively influence academic performance (Reilly, 2015; Slate & Charlesworth, 1988; Sweller et al., 2011).

Lectures for non-native speakers of English were carried out in EMI, and speech-enabled language translation (SELT) technology was employed to enhance student understanding of lecture content. With such technological support, this study aimed to facilitate students' positive academic emotions and learning satisfaction in EMI lectures. SELT technology received the instructor's speech input, translated it, and translated texts were shown to students. Students perceived academic emotions were measured before, during, and after lectures. In addition, perceived academic emotions of students in two groups were compared, that is low language ability (LLA) and high language ability (HLA). Finally, students learning satisfaction in EMI lectures was investigated.

Literature review

Information processing in EMI lectures

To understand why students are not able to comprehend the content of EMI lectures, we can consult information processing theory (Ismaeel & Al Mulhim, 2021). According to this theory, information processing in lectures is very complex, especially if it is in EMI, because it requires taking in information and then organising and storing information for later retrieval (Shadiev & Huang, 2020). In other words, a learner first pays attention to information and takes it in. The information is then actively processed in their working memory and passively held in their long-term memory (Slate & Charlesworth, 1988). Cognitive load theorists argue that, as working memory has limited capacity, it is likely to become overloaded as the information received in an EMI lecture is often more difficult for non-native speakers of English to comprehend (Brunken et al., 2003; Sweller et al., 1998). If students are unable to fully understand lecture content, then this may induce negative emotions (e.g., students may feel stressed, anxious, and unhappy). Reilly (2015) warned that students with such negative emotions are psychologically vulnerable, and in turn, this negatively influences academic performance and the learning process itself.

Academic emotions

Emotions are judgments of a learner about the world (Riegel & Evans, 2021). They are induced as a response to stimuli (Shadiev & Sun, 2020; Shadiev & Huang, 2020). Scholars referred to emotions as sets of interrelated psychological processes based on physiological, cognitive, affective, and motivational components (Pekrun et al., 2011). Thus, emotions are important for cognitive processes such as perception, judgment, or learning as they allow individuals to be more creative and flexible in solving problems (Riegel & Evans, 2021). According to cognitive neuroscience, there is a correlation between emotions and learning (Goetz et al., 2007). Pekrun et al. (2011) described academic emotions, as emotions that are directly linked to academic activities or outcomes. Pekrun et al. (2002) measured academic emotions and distinguished nine different types: enjoyment, hope, pride, relief, anger, anxiety, hopelessness, shame, and boredom. According to Pekrun et al. (2011), emotions are distinguished as positive or negative. Positive emotions are enjoyment, hope, pride, and relief whereas negative emotions are anger, anxiety, shame, hopelessness, and boredom (Pekrun et al., 2011). For example, a student who enjoys being in class experiences a positive emotion. If thinking about class makes a student feel uneasy, this is a negative emotion. Scholars suggest that positive emotions facilitate behavioural and cognitive activities (e.g., learning or participation) whereas negative emotions interfere in cognitive and behavioral activities (e.g., disturb information processing, decrease motivation, and distract students from learning).

Scholars have suggested that two hypotheses, *emotions-as-suppressors-of-learning* and *emotions-as-facilitators-of-learning*, to explain the influence of emotions on learning processes (Knörzer et al., 2016). The emotions-as-suppressors-of-learning hypothesis states that emotions impair information processing. Thus, emotion negatively impacts stages of information processing. Emotion is able to take attention away from information to be learned. If a student does not attend to the information it does not enter into the information processing system and learning does not take place (Slate & Charlesworth, 1988). There is limited capacity in working memory. Emotion can overload working memory when a learner thinks of things that are irrelevant to a task, because processing task-irrelevant information places additional load on working memory. Therefore, processing of task-irrelevant information interferes with the processing of the important information (Sweller et al., 2011). On the other hand, the emotions-as-facilitators-of-learning hypothesis suggests that emotions facilitate information processing (Knörzer et al., 2016). According to scholars, positive emotions have a positive effect on information processing (Pekrun et al., 2011). Emotions are useful to broaden the scope of attention. Others have suggested that emotion can foster some working

memory processes such as encoding (Knörzer et al., 2016). Scholars have found that learners in a positive mood state were able to retrieve information more successfully (Shadiev & Sun, 2020). In other words, content can be retrieved from long-term memory easily because of positive emotions. Rader and Hughes (2005) found that students in a positive state of mind learned much better.

Learning satisfaction

Learning satisfaction is an important construct in learning and instruction and should be measured. Learning satisfaction refers to a positive or negative affective response to certain stimuli, for example, learning taking place in learning environments where technology provides adaptive content (Keller, 2010). Learning satisfaction represents the degree of overall learning experiences (Peng & Fu, 2021). According to Keller (2010), learning satisfaction is a result of extrinsic and intrinsic factors influencing learning experiences, such as grades or feelings of self-esteem respectively. Hui et al. (2008) mentioned that perceived course learnability, learning effectiveness, and perceived support from learning community are important satisfaction determinants. In other words, if students think that they are able to acquire the required skills, the learning content is easy to study, and they learn in an active and strongly bonded community, then their learning satisfaction will be facilitated. Baturay et al. (2010) suggested considering learning satisfaction as one important construct when planning instructional and learning activities because learning satisfaction can affect continuous learning and contribute to consistent participation and activation in learning (Hui et al., 2008). Therefore, this study measured learning satisfaction of students attending lectures in EMI with support of SELT.

Research questions

The study addressed three research questions:

1. What are the perceived emotions of students in lectures with SELT support?
2. What are the perceived emotions of students with different language abilities?
3. How satisfied are students with their learning in EMI lectures supported by SELT?

Method

Informed by the related literature, lectures in EMI were administered and SELT technology was applied to enhance comprehension of students of EMI lecture content. We measured students' perceived emotions before, during and after lectures. In addition, students perceived emotions were compared across two groups: LLA and HLA. Finally, perceived learning satisfaction of students during lectures in EMI was investigated.

A mixed research method was selected to address the research questions. Thirty-three university students were recruited. The participants were 18-23 years old. All of them were native speakers of Mandarin Chinese, and English was taught to them as a foreign language (EFL). The study was approved by the ethics committee of the School of Education Science, Nanjing Normal University.

The research procedure is shown in Figure 1. Written informed consent was obtained from the participants and the participants' demographics and perceptions of academic emotions using a questionnaire were collected. Two lectures in EMI on general topics were delivered to the participants. SELT was applied during lectures with the aim of enhancing participant comprehension of the lecture content. SELT was employed to translate speech input during lectures, from English into Chinese. Texts translated from English into Chinese were displayed to students during the lectures (Figure 2). A questionnaire was administered to measure the participants' perceived emotions during and after lectures, and their learning satisfaction with SELT support.
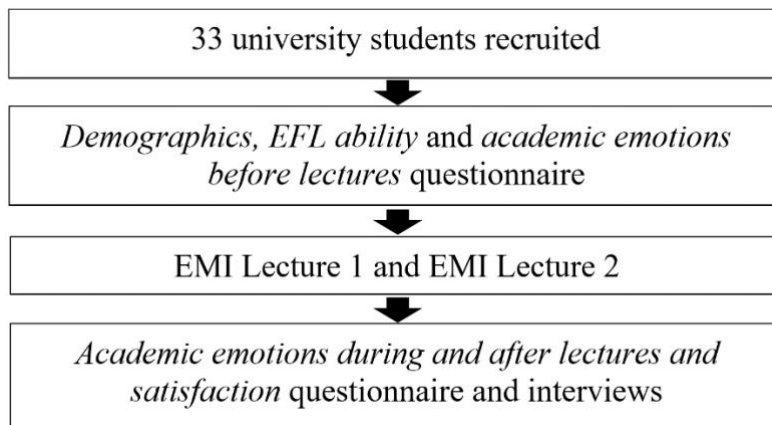
Figure 1. Research procedure

Figure 2. SELT-texts displayed for the participants in the EMI lecture

The study employed the Google® Translate system to serve as a SELT. A SELT is an automated machine translator capable of translating texts from one language into another. The SELT received voice input from the lecturer, translated it into Mandarin Chinese and then showed translated texts to students (Figure 2). The Test of English for International Communication (Powers, 2010) was used to measure the participants' EFL ability.

The Achievement Emotions Questionnaire (Pekrun et al., 2011; Pekrun et al., 2002) was used for this study. This research instrument measures academic emotions before, during and after lectures. Participants' academic emotions were measured on a 5-point Likert scale with 232 items. For example, the item "Even before a lecture in EMI, I worry whether I will be able to understand the material" measured academic emotions before a lecture, and the item "I am happy that I understood the material" measured academic emotions after a lecture. Academic emotions before lectures were measured by the researchers immediately before the lectures, and academic emotions during and after lectures were measured immediately after the lectures. Items of the questionnaire relating to academic emotions during and after lectures were split into two dimensions. This approach helped students keep the two dimensions apart and report their perceived academic emotions during and after lectures accurately. The questionnaire items to measure academic emotions before, during, and after the lectures were different. Furthermore, academic emotions were divided into positive and negative. Positive included enjoyment (e.g., "For me the test is a challenge that is enjoyable"), hope (e.g., "I have great hope that my abilities will be sufficient"), pride (e.g., "I'm proud of how well I mastered the test"), and relief (e.g., "I feel very relieved"). Negative included anger (e.g., 'I am fairly annoyed"), anxiety (e.g.. "I feel panicky when writing a test"), shame (e.g., "I feel ashamed"), hopelessness (e.g., "I have lost all hope that I have the ability to do well on the test"), and boredom (e.g., "I get bored"). More examples of academic emotions are provided in Pekrun et al. (2011).

This study used the learning satisfaction questionnaire of Baturay et al. (2010) and Keller (2010). Participants' learning satisfaction was measured with three items. One item measuring learning satisfaction was: "I am satisfied with lectures in EMI supported by SELT." The participants used a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*) to score their perceived degree of academic emotions and learning satisfaction. The questionnaire response rate was 100 percent. This study defined three different levels of perceived academic emotions: low level (range 1.00 - 1.67), medium level (range 1.68 - 3.33), and high level (range 3.34 - 5.00). The learning satisfaction level was classified in the same way (i.e., low, medium, and high) based on scores range.

Interviews were carried out with the students and the instructor. In the interviews, the students were asked about their learning experience with translated texts in EMI lectures. The instructor was asked to confirm findings obtained from interviews with the students. Two researchers transcribed interview content and then coded it. To achieve high inter-rated reliability, they discussed any experienced disagreements and reached an agreement.

Results

Perceived emotions of all students

Positive emotions
Results of perceived emotions obtained from all students are shown in Table 1. The results showed that participants ranked their perceived class related emotions highly: before (M = 3.58, SD = 0.79), during (M = 3.76, SD = 0.37), and after class (M = 3.70, SD = 0.41). Results for learning related emotions were: before (M = 3.39, SD = 0.79), during (M = 3.76, SD = 0.30), and after class (M = 3.79, SD = 0.38). Test-related emotions were: during (M = 3.77, SD = 0.57) and after class (M = 3.56, SD = 0.47). Test related emotions before class were perceived as medium level (M = 3.23, SD=1.03).

Table 1. *Results related to perceived emotions (all students)*

Emotions	Class related emotions		Learning related emotions		Test related emotions	
	M	*SD*	*M*	*SD*	*M*	*SD*
Positive emotions						
Before	3.58	0.79	3.39	0.79	3.23	1.03
During	3.76	0.37	3.76	0.30	3.77	0.57
After	3.70	0.41	3.79	0.38	3.56	0.47
Negative emotions						
Before	2.75	0.73	2.69	0.87	2.86	1.04
During	2.35	0.39	2.17	0.44	1.96	0.37
After	2.11	0.42	2.39	0.37	1.96	0.47

To compare the effect of the treatment of the SELT technology application to lectures in EMI on perceived emotions, before, during, and after class, a one-way between subjects ANOVA was conducted. ANOVA results revealed no significant effect of the treatment on perceived class related emotions before, during, and after class (F = 0.92, p = 0.40). However, ANOVA results showed that there was a significant effect of the treatment on perceived learning related emotions before, during, and after class (F = 5.67, p = 0.005) and on test related emotions before, during, and after class (F = 4.42, p = 0.015). Post hoc comparisons were carried out using the Scheffe test to distinguish the statistically significant effects among research variables. Post hoc results revealed that the mean score for the learning related emotions before class was significantly lower than during (p = 0.024) and after class (p = 0.012). Post hoc results also revealed that the mean score for the test related emotions before class was significantly lower than during class (p = 0.016).

Negative emotions
The results showed that the participants perceived their class related emotions at medium level before (M = 2.75, SD = 0.73), during (M = 2.35, SD = 0.39), and after class (M = 2.11, SD = 0.42). Results for learning related emotions were: before (M = 2.69, SD = 0.87), during (M = 2.17, SD = 0.44), and class (M = 2.39, SD = 0.37). Test related emotions were: before (M = 2.86, SD = 1.04), during (M = 1.96, SD = 0.37), and after class (M = 1.96, SD = 0.47).

The results of the ANOVA test showed that the effect of the treatment was significant on perceived class related emotions (F = 11.63, p = 0.000), learning related emotions (F = 6.19, p = 0.0030), and test related emotions (F = 18.68, p = 0.000). Post hoc comparisons showed that class related emotions before class were significantly higher compared to those during (p = 0.013) or after class (p = 0.000). The results also showed that perceived learning related emotions before were higher than those during class (p = 0.003). Furthermore, the results of post hoc comparisons revealed that test related emotions before class were higher than during class (p = 0.000) and after class (p = 0.000).

Perceived emotions of varying EFL ability participants

Positive emotions
Results of emotions perceived by the students (i.e., low and high EFL ability) are presented in Table 2. The results related to LLA students showed that their perceived emotions before class were at a medium level, that is, class related (M = 3.18, SD = 0.83), learning related (M = 2.94, SD = 0.78), and test related (M = 2.62, SD = 0.97). In addition, LLA students had a high level of class related emotions during (M = 3.93, SD = 0.26) and after class (M = 3.87, SD = 0.33). Learning related emotions were: during (M = 3.85, SD = 0.27), and after class (M = 3.93, SD = 0.32). Test related emotions were: during (M = 3.70, SD = 0.37) and after class (M = 3.72, SD = 0.56).

The effect of the treatment on perceived emotions was tested with a one-way ANOVA. There was a significant effect of the treatment on perceived class related emotions (F = 10.03, p = 0.000), learning related emotions (F = 19.43, p = 0.000), and test related emotions (F = 14.48, p = 0.000). The results of post-hoc comparisons demonstrated that the mean score for the learning related emotions was significantly lower before class than during (p = 0.001) and after class (p = 0.003). Similarly, the mean score for the class related emotions before class was significantly lower than during (p = 0.000) and after class (p = 0.000). The mean score for the test related emotions before class was significantly lower than during (p = 0.000) and after class (p = 0.000).

Students in the HLA group class related perceived emotions were high before (M = 3.99, SD = 0.48), during (M = 3.57, SD = 0.38), and after class (M = 3.53, SD = 0.41). Learning related emotions were: before (M = 3.87, SD = 0.45), during (M = 3.66, SD = 0.31), and after class (M = 3.65, SD = 0.38). Test related emotions were: before (M = 3.89, SD = 0.62), during (M = 3.83, SD = 0.73), and after class (M = 3.39, SD = 0.29).

The results from the analysis of variance demonstrated a significant effect of the treatment on perceived class related emotions (F = 5.79, p = 0.006) and test related emotions (F = 3.61, p = 0.035). There was no relationship between the treatment and learning related emotions (F = 1.73, p = 0.188). Post hoc comparisons results showed that the mean score for the learning related emotions before class was significantly higher than during class (p = 0.028) and after class (p = 0.013).

Negative emotions
As shown in Table 2, LLA students perceived class related emotions were: before (M = 3.22, SD = 0.70), during (M = 2.35, SD = 0.49), and after class (M = 2.08, SD = 0.37). Learning-related emotions were: before (M = 3.23, SD = 0.90), during (M = 2.25, SD = 0.28), and after class (M = 2.40, SD = 0.42). Test related emotions were at a medium level during (M = 2.00, SD = 0.31) and after class (M = 2.00, SD = 0.43). In addition, before class, LLA students had high levels of test related emotions (M = 3.56, SD = 0.89).

ANOVA results demonstrated a significant effect of the treatment on perceived class related emotions (F = 20.88, p = 0.000), learning related emotions (F = 13.39, p = 0.000), and test related emotions (F = 38.38; p = 0.000). Post hoc comparisons results showed that the mean score for the class related emotions before class was significantly higher than during class (p = 0.000) and after class (p = 0.000). The mean score for the learning related emotions before class was significantly higher than during class (p = 0.000) and after class (p = 0.001). The mean score for the test related emotions before class was significantly higher than during class (p = 0.000) and after class (p = 0.000).

Table 2. *Results of perceived emotions of varying EFL ability participants*

	LLA		HLA			
	M	*SD*	*M*	*SD*	*t*	*p*
Class related						
Positive emotions:						
Before	3.18	0.83	3.99	0.48	-3.44	0.002
During	3.93	0.26	3.57	0.38	3.19	0.003
After	3.87	0.33	3.53	0.41	2.60	0.014
Negative emotions:						
Before	3.22	0.70	2.24	0.32	5.23	0.000
During	2.35	0.49	2.35	0.27	0.01	0.988
After	2.08	0.37	2.15	0.48	-0.45	0.654
Learning related						
Positive emotions:						
Before	2.94	0.78	3.87	0.45	-4.24	0.000
During	3.85	0.27	3.66	0.31	1.87	0.070
After	3.93	0.32	3.65	0.38	2.27	0.030
Negative emotions:						
Before	3.23	0.90	2.11	0.22	4.99	0.000
During	2.25	0.28	2.08	0.56	1.13	0.265
After	2.40	0.42	2.19	0.54	0.18	0.859
Test related						
Positive emotions:						
Before	2.62	0.97	3.89	0.62	-4.43	0.000
During	3.70	0.37	3.83	0.73	-1.70	0.493
After	3.72	0.56	3.39	0.29	2.11	0.043
Negative emotions:						
Before	3.56	0.89	2.13	0.60	5.42	0.000
During	2.00	0.31	1.91	0.43	0.71	0.480
After	2.00	0.43	19.91	0.53	0.53	0.598

Note. *p < 0.05

HLA students perceived class related emotions before ($M = 2.24$, $SD = 0.32$), during ($M = 2.35$, $SD = 0.27$), and after class ($M = 2.15$, $SD = 0.48$). Learning related emotions were: before ($M = 2.11$, $SD = 0.22$), during ($M = 2.08$, $SD = 0.56$), and after class ($M = 2.19$, $SD = 0.54$). Test related emotions were at a medium level before ($M = 2.13$, $SD = 0.60$), during ($M = 1.91$, $SD = 0.43$), and after class ($M = 1.91$, $SD = 0.53$). Statistical results from the ANOVA test did not show any significant effect of the treatment on perceived class, learning, or test related emotions.

Differences in emotions perceived by HLA and LLA students

Positive emotions
The differences between the HLA and LLA groups in their perceived class related emotions before, during, and after class were significant. These results were interesting because students in the HLA group had significantly higher levels of perceived emotions than the LLA group before class ($t = -3.44$, $p = 0.002$). The level of perceived emotions of students in the LLA group became significantly higher than that of the HLA group during ($t = 3.19$, $p = 0.003$) and after class ($t = 2.60$, $p = 0.014$). Similar results were observed for learning related emotions. The differences in perceived learning related emotions before, during, and after class between students in the two groups was also revealed. Before class, LLA students had a lower level of perceived emotions compared to HLA students ($t = -4.24$, $p = 0.000$). However, the perceived emotions of LLA students were higher during class ($t = 1.87$, $p = 0.070$) and after class ($t = 2.27$, $p = 0.030$) compared to HLA students. Test related emotions were lower for LLA students before class ($t = -4.43$, $p = 0.000$) but higher after class ($t = 2.11$, $p = 0.043$) compared to those of HLA students. No differences were observed in perceived emotions of LLA and HLA groups during class ($t = -0.70$, $p = 0.493$).

Negative emotions
The results of the independent *t*-tests showed that the difference between two groups in their perceived class related negative emotions before class was significant ($t = 5.23$, $p = 0.000$). Perceived class related

negative emotions of students in the LLA group was higher compared to those in the HLA group. However, the difference was not significant during ($t = 0.01$, $p = 0.988$) or after class ($t = -0.45$, $p = 0.654$). Similar results were observed for learning related and test related negative emotions. LLA students had a higher level of perceived learning related negative emotions ($t = 5.00$, $p = 0.000$) and test related emotions ($t = 5.42$, $p = 0.000$) compared to those of HLA students. The difference between the two group with respect to learning related negative emotions during ($t = 1.13$, $p = 0.265$) and after class ($t = 0.18$, $p = 0.859$) as well as test related negative emotions during ($t = 0.71$, $p = 0.480$) and after class ($t = 0.53$, $p = 0.598$) was not significant.

Learning satisfaction with SELT

The results of the questionnaire (Table 3), showed how satisfied students were with their learning. Learning satisfaction level was high ($M = 3.38$, $SD = 1.10$). The high standard deviation value of learning satisfaction level indicated high variability in student perceptions. We compared the perceptions of LLA students ($M = 4$, $SD = 0.82$) and HLA students ($M = 2.73$, $SD = 0.98$) and found the difference was significant ($t = 6.94$, $p = 0.000$). Students in the LLA group had a higher level of perceived learning satisfaction compared to those in HLA group.

Table 3. *Learning satisfaction with SELT*

Variable	All		LLA		HLA		t	p
	M	SD	M	SD	M	SD		
Learning satisfaction	3.38	1.10	4.00	0.82	2.73	0.98	6.94	0.000

Interview results

The results of the interview data analysis are reported in Table 4. Eleven codes were derived: enjoyment, hope, pride, relief, anger, anxiety, hopelessness, shame, boredom, satisfaction, and dissatisfaction. Codes were grouped into three categories: positive emotions, negative emotions, and satisfaction. For example, in terms of positive emotions, students felt relieved when SELT technology was applied to EMI lectures because they could read translated texts and understand the EMI lecture content (coded: relief). Student also enjoyed EMI lectures with SELT support because it was impossible for them to comprehend lectures content without SELT-texts (coded: enjoyment). In terms of negative emotions, students were anxious before lectures in EMI because of their low language ability (coded: anxiety) and they had lost hope to be able to comprehend EMI lecture content (coded: hopelessness). As for their satisfaction, low language ability students were satisfied with lectures in EMI supported by SELT (coded: satisfaction) but high language ability students were dissatisfied with lectures in EMI supported by SELT (coded: dissatisfaction).

Table 4. *Interview results*

Categories	Codes	Examples
Positive emotions	Enjoyment	A student enjoyed EMI lectures with SELT support. It was impossible for them to comprehend communicated content without translated texts.
	Hope	Students had great hope to get high score on the test because they believed that their abilities will be sufficient after EMI lectures with SELT support.
	Pride	A student felt proud of how well they understood EMI lecture content because of SELT-texts.
	Relief	A student felt relieved because SELT technology was applied to EMI lectures. They could read translated texts and understand the EMI lecture content.
Negative emotions	Anger	A student felt annoyed when SELT was applied to EMI lectures because translated texts in Chinese distracted her/him from hearing the instructor's speech in English. Their EFL ability was high enough so they did not need any additional support.
	Anxiety	Student were anxious before lectures in EMI because of their low language ability.
	Hopelessness	A student had lost hope that they had the ability to comprehend EMI lecture content.
	Shame	Student felt ashamed that they cannot comprehend EMI lecture content.
	Boredom	A student felt bored in EMI lectures because they didn't understand what the lecturer lectures about.
Satisfaction	Satisfaction	A student is satisfied with lectures in EMI supported by SELT.
	Dissatisfaction	A student is dissatisfied with lectures in EMI supported by SELT.

Discussion

The results showed that the perceived level of academic emotions was lower before class compared to during or after class. The reason students gave for this was because they were non-native speakers of English and the lecture was in EMI. Some non-native speakers of English who attend such lectures do not fully comprehend lecture content because of their linguistic incompetency (Shadiev & Sun, 2020; Shadiev et al., 2020), and therefore, their level of perceived academic emotions is low. This finding was supported by the interview results. In the interviews, the students mentioned they were anxious attending EMI lectures because of their low language ability. These students either had no hope that they had the ability to comprehend EMI lecture content or felt ashamed because of their inability to comprehend EMI lecture content. Scholars have argued that level of perceived academic emotions increases if additional support is provided, for example, real-time transcriptions of lectures (Kushalnagar et al., 2014), lecture notes (Goodman, 2014), and audio-recorded (Soruç et al., 2018) or video-recorded (Shimoyamada et al., 2019) files, to enhance student comprehension of lecture content. This was observed in our study, where the level of perceived academic emotions increased after SELT was introduced in EMI lectures. This finding was also supported by the interviews with the instructor, where students reported perceived academic emotions as low before lectures, however, changing and becoming higher during and after lectures.

When considering different EFL abilities, it was found that the level of perceived academic emotions was significantly different across the two groups. Students in the LLA group had low levels of perceived academic emotions before lectures but these increased during and after lectures. By contrast, students in the HLA group perceived academic emotions at a high level before lectures but these decreased during and after lectures. According to the LLA students, this was because their linguistic competency was low therefore their perceived level of academic emotions was already low before the lecture. However, this increased after the students received SELT support. As opposed to LLA students, students in the HLA group had high levels of perceived academic emotions before lectures. However, these decreased during and after lectures with the introduction of SELT. Therefore, this finding could be attributed to the

application of SELT technology during lectures. When SELT texts were shown to LLA students they were able to read translated texts during the lecture, enabling understanding of content. Their level of perceived academic emotions was higher during and after lectures. In contrast, the HLA students were already linguistically competent. They understood lecture content and did not need any support and had a high level of perceived academic emotions before the lectures. However, when they were exposed to translated texts, their level of perceived academic emotions decreased during and after lectures. Some possible reasons to explain this were found during the interviews with the students. For instance, students in the LLA group mentioned that they were always anxious and felt hopeless and ashamed when they needed to attend EMI lectures because they could not understand the EMI lecture content as their EFL ability was low. However, when SELT technology was used and they could read translated texts and comprehend the content of the lecture, they felt very relieved and even enjoyed the lectures. On the other hand, the HLA students said in interviews that their abilities were high and no support was required. They reported that SELT texts distracted and confused them because they were exposed to multiple media in different languages simultaneously (i.e., the instructor's speech in English and SELT texts in Chinese). This finding was supported by the instructor interviews This finding can be explained by the expertise reversal effect (Kalyuga et al., 2003). According to the principle of expertise reversal, learning material and methods that lower language ability students find highly effective can be ineffective for higher language ability students.

When all students were considered, the results showed they were very satisfied with learning supported by SELT. It was also noted that the standard deviation value was high and this suggested that there was high variability in perceptions. On the other hand, when considering different EFL abilities, it was found that students in the LLA group had significantly higher perceived learning satisfaction than those in the HLA group, indicating SELT was beneficial for the LLA students but not so useful for the HLA students. For example, in the interviews, students in the LLA group said that they were satisfied with lectures in EMI supported by SELT because they understood the lecture content. However, students in the HLA group claimed that SELT-texts were distracting and for this reason they were dissatisfied with lectures in EMI supported by SELT. The instructor also confirmed this finding in the interviews, where students in the LLA group reported being were more satisfied with EMI lectures supported by SELT compared to students in the HLA group.

Conclusion and limitations

The aim of this study was to address the lack of research evidence about the impact of the SELT application on students' perceived academic emotions and learning satisfaction in EMI lectures. The aim was achieved by conducting this qualitative research in which students' perceived academic emotions and learning satisfaction were measured and compared across two EFL ability groups. Accordingly, the main contribution of this research is that it provides much needed empirical data on how applications of SELT can be effective in EMI. This information is important given that limited attention has been paid to this research issue. The findings of this study may serve as a valuable reference for educators and researchers who design EMI courses in the future. The results of this study may also be useful for educators and researchers in the field of the open education and users of electronic libraries. The EMI lectures were stored on the university's research laboratory website for open global access. The website also contains many other educational resources related to EMI lectures, language learning, and cross-cultural education. Students around the world can access these resources. The participants of this study as well as any other students, educators, and researchers are able to access stored resources on the research laboratory website.

The results of this study suggest that educators may apply SELT in EMI lectures, as a method to benefit for LLA students' learning via improving their understanding of lecture content. Further, as SELT texts may not be useful for all students (e.g., less useful for HLA students compared to LLA students), an adaptive approach should be employed when using SELT. If students have an option and can freely choose to use SELT texts or not, then SELT texts will not distract from learning. As SELT technology supports more than 100 languages, educators and researchers can apply SELT to lectures delivered in languages other than English. In the future, SELT technology can be extended with other tools to generate multiple media. For example, pure texts were generated in this study, however, different media content (e.g., charts or tables) can be generated as well. In this way, SELT can generate charts or tables along with textual explanations in students' native languages. In the future, scholars may consider designing learning activities that involve collaboration around SELT texts. Such an approach will enable students' collaboration and discussion about lecture content using texts translated by SELT.

A few limitations to this study need to be recognised. The study was carried out with 33 participants who were native speakers of Mandarin Chinese, and academic emotions and learning satisfaction were evaluated using subjective data. The small sample size may limit generalisation of the results to a broader population, and the findings need to be interpreted with caution as they were collected in the specific cultural context. In addition, future studies may collect other data (e.g., heart rate, facial expressions, or electroencephalogram information) that can measure academic emotions and learning satisfaction objectively, and scholars may use this to confirm findings based on the subjective evidence.

References

Baturay, M. H., Daloglu, A., & Yildirim, S. (2010). Language practice with multimedia supported web-based grammar revision material. *ReCALL*, *22*(3), 313-331. https://doi.org/10.1017/s0958344010000182

Brunken, R., Plass, J. L., & Leutner, D. (2003). Direct measurement of cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 53–61. https://doi.org/10.1207/S15326985EP3801_7

Goetz, T., Frenzel, A. C., Pekrun, R. H., Hall, N. C., & Ludtke, O. (2007). Between- and within-domain relations of students' academic emotions. *Journal of Educational Psychology, 99*(4), 715–733. https://doi.org/10.1037/0022-0663.99.4.715

Goodman, B. A. (2014). Implementing English as a medium of instruction in a Ukrainian University: Challenges, adjustments, and opportunities. *International Journal of Pedagogies and learning, 9*(2), 130-141. https://doi.org/10.1080/18334105.2014.11082026

Hui, W., Hu, P. H., Clark, T. H., Tam, K. Y., & Milton, J. (2008). Technology‐assisted learning: A longitudinal field study of knowledge category, learning effectiveness and satisfaction in language learning. *Journal of Computer Assisted Learning*, *24*(3), 245-259. https://doi.org/10.1111/j.1365-2729.2007.00257.x

Ismaeel, D., & Al Mulhim, E. (2021). The influence of interactive and static infographics on the academic achievement of reflective and impulsive students. *Australasian Journal of Educational Technology*, *37*(1), 147-162. https://doi.org/10.14742/ajet.6138

Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*(1), 23-31. https://doi.org/10.1207/s15326985ep3801_4

Keller, J. M. (Ed.). (2010). *Motivational design for learning and performance.* Springer.

Knörzer, L., Brünken, R., & Park, B. (2016). Emotions and multimedia learning: The moderating role of learner characteristics. *Journal of Computer Assisted Learning, 32*(6), 618-631. https://doi.org/10.1111/jcal.12158

Kushalnagar, R. S., Lasecki, W. S., & Bigham, J. P. (2014). Accessibility evaluation of classroom captions. *ACM Transactions on Accessible Computing, 5*(3), 1-24. https://doi.org/10.1145/2543578

Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary Educational Psychology, 36*(1), 36-48. https://doi.org/10.1016/j.cedpsych.2010.10.002

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of quantitative and qualitative research. *Educational Psychologist, 37*(2), 91–106. https://doi.org/10.4324/9781410608628-4

Peng, R., & Fu, R. (2021). The effect of Chinese EFL students' learning motivation on learning outcomes within a blended learning environment. *Australasian Journal of Educational Technology, 37*(6), 61-74. https://doi.org/10.14742/ajet.6235

Powers, D. E. (2010). Validity: What does it mean for the TOEIC tests. *ETS Research Rep. No. TC10-01.* Educational Testing Service.

Rader, N., & Hughes, E. (2005). The influence of affective state on the performance of a block design task in 6-and 7-year-old children. *Cognition & Emotion*, *19*(1), 143-150. https://doi.org/10.1080/02699930441000049

Reilly, N. (2015). *Anxiety and depression in the classroom: A teacher's guide to fostering self-regulation in young students*. WW Norton & Company.

Riegel, K., & Evans, T. (2021). Student achievement emotions: Examining the role of frequent online assessment. *Australasian Journal of Educational Technology*, *37*(6), 75-87. https://doi.org/10.14742/ajet.6516

Shadiev, R., Chien, Y. C., & Huang, Y. M. (2020). Enhancing comprehension of lecture content in a foreign language: comparing speech-to-text recognition with speech-enabled language translation. *SAGE Open, 10*(3), 1-11. https://doi.org/10.1177/2158244020953177

Shadiev, R. & Huang, Y. M. (2020). Investigating student attention, meditation, cognitive load, and satisfaction during lectures in a foreign language supported by speech-enabled language translation. *Computer Assisted Language Learning, 33*(3), 301-326. https://doi.org/10.1080/09588221.2018.1559863

Shadiev, R., & Sun, A. (2020). Using texts generated by STR and CAT to facilitate student comprehension of lecture content in a foreign language. *Journal of Computing in Higher Education, 32*(3), 561-581. https://doi.org/10.1007/s12528-019-09246-7

Shimoyamada, S., Nakazawa, A., & Fujimoto, T. (2019). Blending online and offline learning: A study on the development of an English as a medium of instruction workshop. *Proceedings of the 2019 8th International Conference on Educational and Information Technology,* pp. 141-146. https://doi.org/10.1145/3318396.3318405

Slate, J. R., & Charlesworth Jr, J. R. (1988). *Information processing theory: Classroom applications.* https://files.eric.ed.gov/fulltext/ED293792.pdf

Soruç, A., Dinler, A., & Griffiths, C. (2018). Listening comprehension strategies of EMI students in Turkey. In Y. Kırkgöz, & K. Dikilitaş (Eds.), *Key issues in English for specific purposes in higher education* (pp. 265-287)*.* Springer.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer.

Sweller, J., Van Merrienboer, J. J., & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251–296. https://doi.org/10.1023/A:1022193728205

Corresponding author: Yueh Min Huang: huang@mail.ncku.edu.tw