Facilitating cross-cultural understanding with learning activities supported by speech-to-text recognition and computer-aided translation

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A B S T R A C T

We designed and implemented cross-cultural learning activities for this study. Participants from two countries, geographically located very far from each other, represented different cultures that have no communication language in common. Two systems were applied to learning activities in order to enable interaction and information exchange among the participants: (1) a *speech-to-text recognition system*, which generates texts from a speaker's voice input in his/her native language and (2) *computer-aided translation system*, which simultaneously translates texts into the language of the speaker's foreign peers. The goal was to test the feasibility of learning activities supported by the two systems and their effectiveness for cross-cultural learning. To this end, we evaluated participants' learning outcomes, analyzed their online communication with peers, and carried out a question-naire survey and interviews with both the participants and their instructors. The use of multiple data sources allowed triangulation of the findings, thus adding rigor to the research. We obtained three findings through this study. First, cross-cultural learning took place. Second, the questionnaire and interview results show that the two systems are easy to use and useful for cross-cultural learning. According to participants, even with no common language, they could still interact and exchange culture-related information using the two systems. Finally, the results indicate that the texts produced by the two systems are acceptable and useful for the cross-cultural learning of participants (except texts translated from Russian into Chinese in the second week). These findings suggest that the educators and researcher can implement cross-cultural learning activities for participants with no common language with the support of speech-to-text recognition and computer-aided translation systems, as these two systems can help participants to communicate and exchange culture-related information.

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1. Introduction

Today's world has been called a global village; it can be seen as a single multicultural community in which the lives of people are connected across boundaries through telecommunications (McLuhan & Powers, 1989). A global village's residents are no longer defined by their state citizenship; however, they are aware of the wider world and have a sense of their own role

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in making the world a more equitable and sustainable place (Bovair & Griffith, 2003). In a global village, people easily learn about important global issues and then attempt to address them by working together. For example, students from Italy and Germany study the building of minarets in Switzerland as a part of their international tele collaborative project, discuss the pros and cons of this global issue, and then share their opinions with a wider audience (Guth & Helm, 2012). In another global citizenship project, students in the United Kingdom and Ghana discussed the AIDS issue (Bovair & Griffith, 2003). When working on such projects, people need to understand the diverse cultural backgrounds of others in order to collaborate with them effectively. Otherwise, a lack of cultural sensitivity may hamper the relationship and cause problems. That is to say, it is important to recognize that what people from one culture are allowed to do can be prohibited in another culture. Moran, Abramson, and Moran (2014) discuss cultural differences in several dimensions, e.g. dress and appearance, relationships, values, standards, and so on. In terms of food and eating habits, they suggest that "the manner in which food is selected, prepared, presented, and eaten often differs by culture … Americans love beef, yet it is forbidden to Hindus, while the forbidden food in Muslim and Jewish culture is pork, eaten extensively by the Chinese and others" (Moran et al., 2014: 12). Therefore, understanding others' cultures helps to overcome cultural difference and helps to maintain harmonious relationships.

Culture is defined as the knowledge, customs and language a group of people share, and it is formed over many generations (Kittler, Sucher, & Nelms, 2011). Culture is passed on from generation to generation through socialization. Understanding the culture of others is very important in today's global society. It helps to maintain harmonious relations and is good for the cultural, technological, economic, and political welfare of every nation (Bartell, 2003; Bernáld, Cajander, Daniels, & Laxer, 2011). It is therefore vital for educators to teach learners to understand and value the culture of others so that they can interact effectively and comfortably in a world characterized by close multi-faceted relationships and permeable borders (Huang, Chen, & Mo, 2015). Furthermore, learners need to amass a certain level of global competence to understand the world they live in and how they fit into it.

Cultural convergence theory explains cross-cultural understanding (Gudykunst, Ting-Toomey, & Chua, 1988; Kincaid, 1979). According to this theory, cross-cultural understanding takes place through the communication and information exchange of two or more learners from different cultures when they reach a mutual understanding of each other's culture and the world in which they live. That is, experiences and insights of other cultures that learners communicate and share among themselves enable the expanding of their cultural awareness and behavior (Gudykunst et al., 1988; Kincaid, 1979).

In cross-cultural learning, learners acquire knowledge and skills related to different cultures, and they also absorb new attitudes and values as a result of this experience and participation (Yamazaki & Kayes, 2004). Traditionally, cross-cultural education in school is based on textbooks and an instructor's knowledge and experiences. However, neither source can provide a thorough and authentic cross-cultural education for two main reasons (Bloom & Johnston, 2010). Firstly, textbooks are often biased and mostly present the views of the dominant class. Secondly, teachers may be biased towards other cultures, or they may have only limited cross-cultural knowledge and experience. Therefore, Bloom and Johnston (2010) and Yamazaki and Kayes (2004) argue that cross-cultural programs need to be administering as united, connected events, and as a knowledge-building continuum. The following essential learning behaviors are underlined in related literature as leading to cross-cultural understanding and are points that educators and researchers need to emphasize in the cross-cultural learning process (Yamazaki & Kayes, 2004): (a) building relationships – interacting with others regularly, particularly with members of the host culture; (b) valuing people of different cultures – expressing interest and respect for the host culture, including its history, customs, and beliefs; (c) listening and observing – spending time observing, reading about, and studying the host culture, particularly with members of the host culture; (d) coping with ambiguity – understanding ambiguous situations and making sense of new experiences; (e) translating complex information – translating personal thoughts into the language of the host culture.

To facilitate these essential behaviors, various learning activities have been proposed in the literature. *Self-introduction* is one activity that enables learners to become acquainted with one another and with other cultures (Liu, 2007; Tu, 2004). According to Curtis and Lawson (2001), this activity reinforces the comfort level in a classroom and encourages more social interaction among learners. Self-introduction helps learners to identify and examine their own cultural values and those of their peers (Chase, Macfadyen, Reeder, & Roche, 2002). *Creating media content and sharing it with others* is another activity. This enables peer-to-peer learning, diversification of cultural expression, more empowered cross-cultural understanding, and respect for multiple perspectives across diverse communities (Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009). In addition, learners are able to discern important concepts from shared content and then synthesize them with information from other sources during this activity (Jenkins et al., 2009). *Performance and appropriation* activities enable learners to adopt alternative identities and sample and remix media content meaningfully for the purpose of improvisation and discovery (Jenkins et al., 2009). Through performance and appropriation, learners from various cultures can introduce their own culture, share their ideas, artifacts and perspectives, as well as experience their peers' foreign culture (Bloom & Johnston, 2010). Finally, a *reflecting on foreign culture* activity enables learners to share their reflections and experiences with peers. This activity also allows learners to gain a better cross-cultural understanding and an understanding of the strengths and weaknesses of cross-cultural learning activities (Tu, 2004).

Cooking is defined as the preparation of food for consumption by the use of heat (Katz & Weaver, 2003). According to Kittler et al. (2011), cooking tends to be associated with a specific culture, environment, and history, and as a result, each culture's culinary approach is distinctive in terms of ingredients, methods, and dishes. Cusack (2000: 207) argues that "every

nation has its own cuisine." Following this notion, Chuang proposed the term "National Cuisine" (2009). It refers to food cultures that are practiced in terms of production and consumption in specific ethnic communities and places. "Stinky tofu" is one distinct example of Chinese national cuisine. It is a kind of fermented tofu which has a very strong, unpleasant odor. According to Liu, Han, and Zhou (2011), stinky tofu was a favorite food of the Chinese in the period from the Wei Dynasty to the Qing Dynasty. Despite its unpleasant smell, many develop an appetite for Stinky tofu, and it is currently a popular local food in Taiwan and many regions of China (Liu et al., 2011).

It is believed that learners from different countries may understand each other's cultures better if they perform the learning behaviors discussed in Yamazaki and Kayes (2004) and participate in the learning activities proposed in Bloom and Johnston (2010), Chase et al. (2002), Curtis and Lawson (2001), Jenkins et al. (2009), Liu (2007) and Tu (2004). Furthermore, if learning activities are framed within a specific topic, such as "National Cuisine," it is assumed that learners will be more interested in cross-cultural learning and the topic will draw their attention and motivate their interest (Shadiev, Hwang, & Huang, 2015). However, spoken language is not the same in different cultures (Moran et al., 2014). Therefore, how can educators ensure that learners from different cultures with no common language can communicate and exchange culture-related information with each other? This is a question that concerns most educators and researchers working in this field. One possible solution to this issue is computers. For example, the Speech-to-text recognition (STR) system synchronously transcribes text streams from speech input (Shadiev, Hwang, Yeh et al., 2014). According to related studies, the STR system is a potential learning tool that has been successfully applied in many educational studies (Hwang, Shadiev, Kuo, & Chen, 2012; Kuo, Shadiev, Hwang, & Chen, 2012). For example, this system has been used to assist learners with cognitive or physical disabilities and those who attend speeches given in languages other than their mother tongue (Shadiev, Hwang, Chen, & Huang 2014; Wald & Bain, 2008). Computer-aided translation (CAT) allows translating texts into different target languages (Godwin-Jones, 2011). Related studies suggest that CAT systems have a great potential to aid learning, especially in second or foreign language learning. For example, CAT has been applied to assist learners in writing texts in the target second or foreign language and to correct grammatical and lexical errors in texts (Hermet & Désilets, 2009). In a study by Omar, Embi, and Yunus (2012), EFL learners had an online discussion for which they utilized CAT to translate and search for appropriate words to express their opinions and ideas and to check grammar and spelling to overcome problems in constructing sentences. When both systems are applied, interlocutors from different cultures are able to communicate in their mother tongue and understand each other. However, to the best of our knowledge, not many studies have been carried out using these two systems to support the communication of interlocutors from different cultures. Particularly, whether such a technological approach facilitates cross-cultural understanding or not has not yet been tested. Therefore, this study is an attempt to address the existing gaps in the related research. That is, we designed cross-cultural learning activities supported by speech-to-text recognition and computer-aided translation systems and tested the feasibility of using learning activities supported by the two systems and then examined their effectiveness with regard to cross-cultural understanding.

2. Method

Ten junior high school students aged 14 to 18 voluntarily participated in the online cross-cultural learning activities designed for the purposes of this study. Six participants were Chinese native speakers from Taiwan, and four participants were Russian native speakers from Uzbekistan. None of the participants had experience with speech-to-text recognition use, but they all had two to three years of experience with computer-aided translation (i.e. electronic dictionaries and web-based translation systems such as Google Translate) and more than 5 years' computer and Internet experience. The participants did not have any prior knowledge of the food introduced by their foreign counterparts or the related culture, as the curricula of primary and secondary education in Taiwan and Uzbekistan do not cover such topics. This was confirmed by the participants' self-reports. In addition, the participants indicated that none of them had ever participated in online cross-cultural learning activities.

Two instructors, one Chinese native speaker in Taiwan and one Russian native speaker in Uzbekistan, guided the participants during the learning activities. Both instructors are experienced in online cross-cultural learning as they have designed and taught such courses for several years. Initially, the instructors explained all the learning activities to the participants and showed them how to communicate information to their foreign counterparts more efficiently in order to enhance their foreign counterparts' cross-cultural understanding and avoid any culture-related misunderstandings and miscommunications. In situations where the students couldn't understand some information communicated by their peers, the instructors explained it. Therefore, no serious communication flow issues were experienced by students. In addition, the instructors trained the participants in how to use speech-to-text recognition and computer-aided translation. Participants then practiced using STR to generate texts in their native language and then used computer-based translation software to simultaneously translate the STR-texts into the target language. During the learning activities, an instructor guided participants through the use of systems and offered instant support for technology-related questions.

The aim of this study was to enhance participants' cross-cultural understanding through their participation in online learning activities implemented over a period of four weeks. In the first week, participants make self-introductions, explain where they are from and introduce their interests (e.g. what they like to do or what their favorite local food is). Participants introduce their favorite local food and recipes in the second week. In addition, participants are encouraged to mention history and traditions related to that food. In the third week, the participants cook food according to recipes introduced by their

interlocutors from the other culture. Finally, in the fourth week, all participants share their experiences related to cooking food and reflect upon what they have learned related to culture. Examples of self-introductions, recipes and the reflections of participants are included in Appendix 1.

Another aim of this study is to support bi-cultural communication and information exchange among participants from two different cultures who do not share a common language. To this end, STR and CAT systems are used. An Android based Google voice recognition system served as the STR tool, and the Google Translate system served as the CAT tool. Fig. 1 shows the communication flow among the participants. Participants from Taiwan spoke into a microphone, and the STR system generated Chinese text from their speech input. The STR-texts were then translated from Chinese into Russian. After that, CAT-texts in Russian were posted online on the project website so that participants from Uzbekistan could read them. Participants from Uzbekistan communicated in the same way: their speech in Russian was transcribed into text; the newly generated STR-texts were translated into Chinese, and then CAT-texts in Chinese were posted online on the project website for participants from Taiwan to read. Students had to turn the STR on to get STR-texts from their voice input, and they had to turn it off after their speech was completed. The CAT translated all STR-texts.

ElShiekh (2012) and Shadiev, Hwang, Yeh et al. (2014) assert that texts produced by STR and CAT systems may contain mistakes and ambiguities. Therefore, two instructors corrected language-based inaccuracies (misspellings, wrong translations, and so on) in texts that were produced either by the STR or CAT, and they prepared error-free STR- and CAT-texts for participants.

The data for analysis was collected from multiple sources: (1) participants' online communication during learning activities, (2) a questionnaire survey, and (3) one-on-one semi-structured interviews. The use of multiple data sources allowed triangulating the main findings and rendered the conclusions richer, more nuanced, and more reliable.

First, based on the participants' learning outcomes, *cross-cultural understanding was measured*. Learning outcomes were extracted from participants' online communication, namely, their reflections in which they shared their cooking experiences and reflected upon what they had learned concerning their interlocutors' culture, history and traditions. A concept as a coding unit was adopted. Text segments that represented participants' cross-cultural understanding with respect to the following three dimensions: (1) a foreign food, (2) related history, and (3) tradition were highlighted and coded. Codes were then sorted to form categories; codes with similar meanings were aggregated. Established categories produced a framework for reporting research findings. Anderson and Krathwohl (2001) taxonomy was employed during the evaluation. Specifically, the following two rubrics of the taxonomy were employed for the evaluation: (1) remember - retrieve relevant knowledge from long-term memory and (2) understand - construct meaning from instructional messages, including oral, written, and graphic communication. A score of "1" was given if participants remembered but did not understand how to cook a foreign food and its related history and traditions whereas a score of "2" was given if participants both remembered and understood how to cook a foreign food and its related history and traditions. Participants got a score of "0" if they did not remember or understand either one. Three raters were involved in the evaluation process. The inter-rater reliability coefficients among them were calculated using Cohen's kappa. The mean inter-rater reliability among the three raters exceeded 0.90, which demonstrates excellent agreement—well beyond chance.

Second, a questionnaire survey was administered at the end of the learning activities to *explore participants' perceptions* regarding the ease of use and usefulness of the learning activities supported by the STR and CAT systems to facilitate cross-cultural learning. The questionnaire was designed based on TAM (Davis, 1989). Three dimensions were covered in the questionnaire: perceived ease of the technology's use, perceived usefulness of learning activities supported by the technology for cross-cultural learning, and behavioral intention to use these technologies for learning activities in the future.

(I) Perceived ease of use - is the degree to which a participant believes that using STR and CAT systems are free of physical and mental effort:
  1. Learning to operate STR and CAT systems are easy for me;
  2. I find it easy to get STR and CAT systems to do what I want them to do;
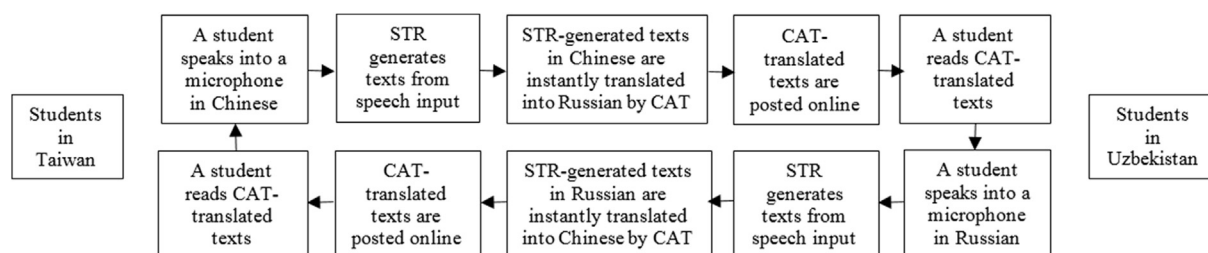 3. Interacting with STR and CAT systems does not require a lot of mental effort;

Fig. 1. Communication flow among participants.

4. My interaction with STR and CAT systems is clear and understandable;
5. It is easy for me to become skillful at using STR and CAT systems;
6. Overall, I found the STR and CAT systems to be easy to use.

(II) Perceived usefulness is the degree to which a participant believes that participating in cross-cultural learning activities supported by STR and CAT systems enhances his or her learning performance:

1. Participating in learning activities supported by STR and CAT systems improves the quality of my cross-cultural understanding;
2. Participating in learning activities supported by STR and CAT systems helps me to accomplish tasks more quickly;
3. Participating in learning activities supported by STR and CAT systems increases my productivity;
4. Participating in learning activities supported by STR and CAT systems enhances effectiveness of my cross-cultural understanding;
5. Participating in learning activities supported by STR and CAT systems improves my performance;
6. Overall, I found participating in learning activities supported by STR and CAT systems to be useful for my cross-cultural understanding.

(III) Behavioral intention is a major determinant of whether or not a participant actually uses STR and CAT systems:

7. I intend to continue using STR and CAT systems in the future;
8. I plan to use STR and CAT systems often;
9. I will strongly recommend to others that they use STR and CAT systems.

Participants scored each item of the questionnaire using a five-point Likert scale anchored by the end point "strongly disagree" (1) and "strongly agree" (5). The Cronbach α values exceeded 0.90 in all dimensions, indicating that the internal consistency reliability of the survey was satisfactory.

At the end of the learning activities, in-depth, one-on-one semi-structured interviews with all students and the instructors were carried out. The interviews consisted of open-ended questions in which students and the instructors were asked about their experiences during learning activities and about how useful they considered the learning activities supported by the two systems to be for cross-cultural learning. Each interview took approximately 30 min. Interview content was audio-recorded with the participants' permission and then was fully transcribed for analysis. Three raters were involved in this analysis. Raters first examined the most distinctive responses and resolved big differences in the responses through discussion and by consensus. After that, they were engaged in the formal coding process. Raters coded the transcribed texts and categorized codes to produce a framework for reporting the research findings. Cohen's kappa was adopted to evaluate the inter-rater reliability; the results exceeded 0.90, which indicates high reliability.

Finally, it was necessary to analyze the accuracy rates of the STR and CAT collected from the participants' original posts before they were edited by the instructors. The number of all correct words in an original post was divided by the number of all words in an edited post and then multiplied by 100 in order to calculate the accuracy rate of both the STR and CAT.

3. Results and discussion

3.1. Measuring cross-cultural understanding

According to the participants, none of them had had any prior knowledge regarding the food they cooked in this study, nor of the related food history and traditions. After the evaluation of participant outcomes, it was found that students could both remember and understand both how to cook the food introduced by their international peers and how it related to their culture's food history and traditions. According to Anderson and Krathwohl (2001), the *Remember* cognitive level represents the ability to retrieve relevant knowledge from long-term memory while the *Understand* level represents the ability to grasp the meaning of the learning material. The evaluation results showed that participants could recall, interpret, summarize, compare and explain what they had cooked and the related food culture and traditions. Some text segments representing key concepts related to the cooked food and associated history and traditions were extracted from the participants' communications (see examples in Appendix 2). Participants' outcomes showed that they understand how to cook the food introduced by their foreign peers. In addition, text segments from Participant ID 7, Participant ID 8 and Participant ID 9 showed that when participants made comparisons of the foods and provided the appropriate explanations, it was clear that they understood the differences between the food they had cooked and the food of their own culture. Participant ID 8, Participant ID 9, and Participant ID 10 discussed the origins of the food they cooked and compared it to their local food and related history. This shows that participants acquired adequate understanding of the historical origins of the food. Furthermore, the results showed that the participants understood the relevant food culture and traditions as all four participants compared and explained the similarities and differences between the food and related culture and the traditions introduced by their peers as well as their own. These results suggest that cross-cultural learning took place and could be attributed to the learning activities supported by the STR and CAT systems. According to the related literature, cross-cultural learning takes place after learners communicate and exchange culture-related information with each other (Gudykunst et al., 1988; Kincaid, 1979). In the process designed for this study, students discuss their local food, exchange

recipes and also cook the food using recipes from their foreign peers. Such learning experiences enable cross-cultural learning to take place.

3.2. Perceptions of participants

The results of the questionnaire survey analysis show that participants perceived STR and CAT systems to be easy to use (M = 4.92; SD = 0.28) and the learning activities supported by the systems to be useful for cross-cultural learning (M = 4.9; SD = 0.30). Participants also indicated a high level of behavioral intention to use STR and CAT systems in the future (M = 4.3; SD = 0.88). The interview data indicated that the participants believe that the learning activities supported by STR and CAT systems facilitated their cross-cultural understanding. For example, participants communicated and exchanged information among themselves with the help of the systems. Self-introductions enabled them to become acquainted with each other. In addition, participants could learn about each other's interests, hobbies and favorite food and notice some cultural differences between themselves and their foreign peers. When participants posted recipes for their local food or cooked food using recipes posted by peers, they were able to learn more about both their foreign peers' and their own food and related culture. This type of reflection is may be considered particularly beneficial as it enables participants to gain insight into their cooking experiences and related culture. In addition, participants could compare their local food and related culture to that presented by their distant peers and could find some similarities and differences. These findings of participants were also shared with their distant peers.

Data analysis of the interviews with the instructors confirmed that learning activities supported by the STR and CAT systems were beneficial for participants' cross-cultural understanding. According to the instructors, useful information related to the participants' own or the culture of their peers was exchanged. It was provided in one language and then translated into the language of their peers. All the students participated in sharing information about food, history and traditions, and their input was well understood by participants from both countries.

It has been suggested that the acceptance of technology should be evaluated on a pedagogical basis to interpret its usage. According to Davis (1989), perceived ease of use, perceived usefulness and behavioral intention are dimensions that measure technology acceptance. The results of this study show that participants accepted both the STR and CAT systems in terms of ease of use, and indicated their willingness to use these systems in the future. Furthermore, they made it clear that they felt that the learning activities supported by the systems were useful for cross-cultural learning. Interviews with both the participants and the instructors supported this finding.

3.3. Accuracy rates of STR and CAT

Table 1 shows the accuracy rates of STR and CAT systems for Chinese and Russian text generation and translation. According to the data, the self-introduction texts were STR-generated with a 99 percent accuracy rate when spoken in Chinese and with 100 percent accuracy when spoken in Russian. Recipes for local food were STR-generated with a 91 percent accuracy rate when spoken in Chinese and with a 96 percent accuracy rate when spoken in Russian. Spoken reflections in Chinese had 94 percent accuracy rate, and those spoken in Russian had a 98 percent accuracy rate. One reason that might explain the slight difference between the accuracy rates between Chinese and Russian (especially five percent in Week 2 and four percent Week 4) is that the Uzbek participants practiced with STR and CAT systems for a longer time than the Chinese students. It has been suggested that the STR system-based teaching and learning activities should be designed in a way that encourages users, i.e. instructors and students, to use them more regularly (Hwang et al., 2012; Kuo et al., 2012). Through this approach, users become able to identify the strengths and limitations of the STR through real experience. For example, after noticing that the STR system generates text with errors when speech is too fast or too slow, not fluent, and spoken in a low voice, speakers learn to adapt to the limitations of the STR recognition system. That is, speakers start to speak with moderate speed and volume, less spontaneity, and with better fluency.

According to the results, during Week 2, the STR system had a lower accuracy rate when generating texts from input in both Chinese and Russian. This may be because the sentences used to introduce local food and related culture were longer and more complex than the sentences in which students introduced themselves (Week 1) or reflected on their experiences (Week 4). Another reason may be that the sentences in Week 2 contained some specific names of food ingredients or terminology related to history and culture that the STR system could not recognize correctly.

Table 1
STR and CAT accuracy rates (in percentage).

Input	STR				CAT			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Chinese	99	91	NA[a]	94	89	76	NA[a]	82
Russian	100	96	NA[a]	98	88	74	NA[a]	80

[a] Participants have been cooking and no communication took place.

After STR-texts were generated and before the CAT process, texts were edited to make them 100 percent accurate in order to increase the CAT accuracy rate. That is, all errors in the STR-texts were determined and corrected by the instructors. An error constitutes a misspelled word, e.g. "хануМ" (spoken and correct) → "ханны" (generated by the STR and misspelled). In addition, missing punctuation marks, such as commas and periods, were added in the revised texts. According to the table, self-introduction texts were CAT-translated from Chinese into Russian with an 89 percent accuracy rate and from Russian into Chinese with an 88 percent accuracy rate. Recipes were CAT-translated from Chinese into Russian with a 76 percent accuracy rate while recipes in Russian were translated into Chinese with a 74 percent accuracy rate. Texts of reflections were CAT-translated from Chinese into Russian with an 82 percent accuracy rate and from Russian into Chinese with an 80 percent accuracy rate.

The difference between the CAT accuracy rates in Chinese and Russian was only one or two percent. The lowest CAT accuracy rate occurred in Week 2 for both languages (74 and 76 percent). Perhaps, the low CAT accuracy rate was due to the same reasons mentioned earlier: sentences were longer and contained specific names of food ingredients and terminology related to history and culture. According to researchers in the field (Barrachina et al., 2009; Mellebeek, Khasin, Owczarzak, Van Genabith, & Way, 2005), current CAT systems are still not able to deliver perfect translations. It has also been suggested that CAT systems produce better translations when confronted with short sentences compared to longer and more complicated ones because of highly limited linguistic context (Mellebeek et al., 2005). That is, the longer the sentence, the more likely it is that the CAT system will be led astray by the complexities in the source and target languages. Researchers (Hwang et al., 2012; Kuo et al., 2012; Shadiev, Hwang, Yeh et al., 2014; Wald & Bain, 2008) argue that STR-texts or CAT-texts with only reasonable accuracy rate are acceptable and useful for students. That is, texts with accuracy rates of only 75–85 percent (Wald & Bain, 2008) can still enable teaching and learning. Following this suggestion, it can be concluded that all of the STR-texts and CAT-texts in this study were acceptable and useful for the participants, except for recipe texts CAT-translated from Russian into Chinese (74 percent accuracy rate). To address the low accuracy rate of CAT-texts, several approaches have been proposed in the literature. One of them is that students or the instructor should correct errors in CAT-texts (e.g. correct misrecognized words, insert missed words, or delete superfluous wording) (Barrachina et al., 2009; Mellebeek et al., 2005). In this way, all CAT-texts can eventually be revised into 100 percent accurate texts so as to make them optimally useful and meaningful for teaching and learning. To minimize confusion and miscommunication, it is important that the instructors explain to students that they need to make sentences shorter and less complex so that a better translation can be obtained from the CAT. Students should also be encouraged to train on the two technologies in advance—the longer the training, the better. This is particularly true for cross-cultural communication that contains a lot of specific terminology that may not be included in the system's database. Wald and Bain (2008) suggest that the accuracy rate of untrained STR is only 75 percent, but that it reaches 90 percent after moderate training and 91 percent after the STR dictionary has been customized with unfamiliar domain-specific terminology. How much training is necessary to reach an STR accuracy rate of higher than 90 percent is not clear; different suggestions have been made in related studies, i.e. 1 month (Hwang et al., 2012), 3 weeks (Kuo et al., (2012) and 1 week (Shadiev et al., 2015; Shadiev, Hwang, Huang, & Liu, 2016). Looking at the time when these studies were published, it seems that the capacity of the STR has increased dramatically due to rapid advances in technological development. Therefore, in this current study, we asked students to train on both the STR and CAT systems for at least one week. As a result of the training, students were able to achieve fairly high accuracy rates in their STR and CAT texts. Practice with the STR and CAT was part of the training that enabled students to learn by doing. For example, students translated a sentence, and if they were not satisfied with the results, they quickly learned to change the sentence structure, to use more common words, or to make the sentence shorter.

3.4. Pedagogical usefulness of learning activities supported by STR and CAT systems

Based on our results, we can highlight some points related to the pedagogical usefulness of learning activities supported by STR and CAT systems for cross-cultural learning. First, an application of STR and CAT systems to online cross-cultural learning activities can facilitate bi-cultural communication among participants who are geographically and culturally distant and do not share a common language. In such cases, participants do not need to rely on translators and can communicate independently. There is no limit to the amount of information they can communicate using these systems once they learn to navigate their basic weaknesses i.e. using more, but shorter sentences for the sake of accuracy. Second, through bi-cultural communication supported by the two systems, participants are able to learn and understand foreign culture in an authentic context as they communicate with members of the partner culture. Third, participants not only receive information about a foreign culture from their correspondents, but also have an opportunity to ask questions and to share personal opinions, ideas and reflections to better and more deeply understand the foreign culture. Fourth, this communication method makes the instructors and participants less anxious because no foreign language skills are required. Therefore, STR and CAT systems have significant value and importance and can be utilized in education, especially for cross-cultural learning. As the approach used in this study is convenient and independent, it holds great potential for solving problems teachers and students typically encounter when teaching and learning cross-cultural understanding through participating in learning activities.

4. Conclusions

This study tested the feasibility of learning activities supported by the two systems under consideration and their effectiveness for cross-cultural learning. To this end, participants' learning outcomes were evaluated; their online communication with their peers was analyzed, and a questionnaire survey and interviews with participants and their instructors were carried out. The findings obtained through the use of multiple data sources were triangulated to make the research more rigorous. The results of this study show that cross-cultural learning took place. Furthermore, according to the results, speech-to-text recognition and computer-aided translation are easy to use, and participants enjoyed the activity to the degree that they indicated that they would like to use them in the future. According to these participants, learning activities supported by the systems are useful for cross-cultural learning. Particularly, application of these two systems helps participants from two different cultures to interact, communicate, and exchange information without the benefit of a common language. Finally, the results confirm that all the STR and CAT-texts were acceptable and useful for participants, except texts translated from Russian into Chinese in the second week's learning activity.

Based on these results, several implications and suggestions may be made. First, it is suggested that teachers and students utilize STR and CAT systems for supporting teaching and learning activities. Namely, this approach is useful for courses on cross-cultural understanding when bi-cultural communication is desired between teachers and students who do not have a common language. However, teachers and students need to be alerted about the accuracy rate of texts produced by STR and CAT, which can be low in some cases. In the current study, instructors manually corrected STR-texts and CAT-texts when they had low accuracy rates before they were sent to the recipients. This issue requires serious consideration as the editing process takes the instructors' time and effort, and it slows down the communication flow among students. One may argue about necessity of the STR technology for cross-cultural communication since produced texts have to be manually corrected. There are several reasons against this argument, one of which is that we corrected only a small amount of the text in this study (less than 4%, on average, was inaccurate, i.e. four words out of one hundred). The other argument is that we need to manually edit the text due to the current capacity of the STR. However, as this type of technology has been improving exponentially in recent years, so it is reasonable to believe that the accuracy rate of the STR will improve dramatically and that there will be no need for correcting STR-texts in the very near future. In addition, we claim that STR input is more fun and convenient than typing when students use mobile technology for cross-cultural communication, as mobile technology plays an integral role in students' everyday lives nowadays whereas typing on mobile devices is not so easy. Furthermore, we argue that the accuracy rate of STR-texts and CAT-texts can be increased to make them acceptable and useful for learning although to accomplish this, the following suggestions should be followed: First, students need to practice with STR and CAT systems for a fairly long period of time and fairly frequently. In this way, they will soon find the strengths and limitations of the systems so as to fully utilize it afterwards. Second, making input sentences shorter is helpful for the accuracy rate; therefore, one is often wise to split a long sentence into two or more shorter sentences. In addition, we suggest training on both systems so that the software can learn to recognize some specific words and terminology that are frequently misrecognized. This can be done by adding these words into an STR or CAT terminology bank so that they will be remembered and recognized correctly in the future. Furthermore, we suggest that STR-texts or CAT-texts should be edited by the students themselves. That is, mistakes in texts should be corrected to make the texts more accurate and therefore more acceptable and useful for learning. Our project lasted for four weeks during which participants exchanged information about food and culture as well as cooked some food according to the communicated recipes. One may wonder whether this could have been done in a shorter time. We admit that this is possible if participants have different demographic characteristics and if the time given to accomplish activities is shorter. Participants in the current study were junior high students. Usually, such participants are busy studying many subjects since they need to prepare for the final exam in junior high school and entrance exam to senior high school, so they do not have much time for other activities. It also takes time to collect information, e.g. recipes and related culture, and to cook food introduced by peers. Given these two reasons, we asked the students to complete each activity in a week.

Some limitations of this study need to be acknowledged. A small sample size was involved, and a short period of time was allotted for learning activities. For these reasons, the obtained results cannot easily be generalized. In a future study, more students should be involved in longer-term learning activities. In addition, students' cross-cultural understanding should be investigated in more detail because it can be cultivated at different depths. Of particular interest to future research is a web-based learning activity in which students from different classrooms around the world, which represent more than two cultures and speak in more than two languages, communicate and exchange information with each other.

Acknowledgement

Appendix 1

Examples of self-introduction (1) in native language, (2) translated into Chinese/Russian, and (3) translated into English.

Participant ID 1

(1) Здравствуйте, меня зовут Виктория. Мне 18 лет. Я живу в Ташкенте. Я учусь в акдемическом лицее. Я люблю читать книги и рисовать. Сейчас я учу китайский язык и это очень интересно. Мое любимое национальное блюдо это плов.

(2) 你好，我的名字是維多利亞。我今年18歲。我住在塔什干。我在學術高中就讀。我喜歡看書，畫畫。現在我學漢語，它非常有趣。我最喜歡的道地菜餚就是 plov。

(3) Hello, my name is Victoria. I am 18. I live in Tashkent. I study in academic lyceum. I love reading and drawing. I learn Chinese at the moment and it is interesting. My favorite local food is pilaf.

Participant ID 2

(1) 我的名字是廖竑曄。今年13歲就讀國中二年級。我喜歡打球跑步游泳聽音樂。我喜歡吃蒸蛋牛排咖哩不喜歡吃茄子。我最喜歡的球星是科比布萊恩。我最喜歡吃的台灣小吃是 雞排。

(2) Меня зовут Ляо Хун Е. В этом году мне13 лет. Я студент-второкурсник младшей средней школы. Мне нравится играть музыку, бег и плавание. Мне нравится есть яйца или стейк, не нравится есть баклажаны и карри. Мой любимый игрок Коби Брайант. Моя любимая тайваньская еда жаренная курица.

(3) My name is Liao Hong Ye. This year, I am 13. I am second grade student in junior high school. I like play music, jugging and swimming. I like to eat eggs or steak and I do not like to eat eggplants and curry. My favorite basketball player is Kobe Briant. My favorite Taiwanese food is fried chicken.

Examples of recipes (1) in native language, (2) translated into Chinese/Russian, and (3) translated into English.

Participant ID 3

(1) 蝦仁煎: 首先放一些油在平底鍋裡，接著放入蝦仁，並把打好的蛋放入平底鍋，然後放入青菜，為了讓它有點黏稠，我們需要放入太白粉，等到蝦仁都熟了，它就完成了。

西元1661年，荷蘭軍隊攻打台灣，台灣軍隊贏了這次的戰爭，所以荷蘭人很生氣，並把所有的糧食都藏起來，為了解決這個問題，台灣軍人把蝦仁蛋和太白粉和在一起，煎成餅的樣子，蝦仁煎就誕生了。

(2) Жареные креветки: Во-первых, налить немого масла в сковороду, затем добавить креветки и взбитые яйца в кастрюле, затем добавить овощи. Чтобы сделать его немного липким, мы должны добавить кукурузный крахмал. Дождаться когда креветки будут готовы, потом подавать.

В 1661 году, голландская армия напала на Тайвань. Вооруженные силы Тайваня выиграли войну, так как голландцы были очень злы, они спрятали всю еду.. Чтобы решить эту проблему, военные Тайваня смешали креветки, яйца, и крахмал вместе и пожарили. Так появились жареные креветки.

(3) Shrimp omelet: Pour some oil in the pan, and then put shell-less shrimps into the pan. Then, whisk the egg and add it into the pan with some vegetables. To make it a bit sticky, we need to add a bit of potato starch. When everything is cooked, the dish can be served.

In 1661, the Holland militaries attacked Taiwan and had a serious war with Taiwan. The Holland was angry that Taiwan won, so they hid all the food sources. To feed themselves, the Taiwanese mix shrimps with potato starch. This is how Shrimp omelet came into existence.

(1) Плов: Ингредиенты: мясо говядины 600 грамм, лук 3 штуки, морковь 600 грамм, рис 700 грамм, чеснок 2 головки, масло растительное 110 мл, зира 1 чайную ложку, соль.

Приготовление: мясо нарезать кубиками, лук полукольцами. Опустить в масло лук и жарить. Добавить мясо. Выложить нарезанную морковь. Все время размешивать. Залить горячей водой чтобы вода покрыла овощи. Положить две головки чеснока. Хорошо посолить. Положить перец и специи. Тушить все под крышкой 30-40 минут. Положить рис, разровнять его по всей поверхности. Посолить, залить рис горячей водой (на 1 сантиметр).

История: Принцип приготовления распространялся с востока. Особо был принят и развит в средней азии. Слово плов имеет персидское происхождение и было упомянуто в биографии Александра Македонского которым его угощали в Бактрии (провинции Персии и Самарканде).

(2) 抓飯: 食材：600克牛肉，洋蔥3個，胡蘿蔔600克，大米700克，2頭蒜，植物油110毫升，1茶匙孜然，鹽

烹飪：肉切成小塊，洋蔥半環。蘸了油，炒洋蔥。添加肉類。來切胡蘿蔔。所有的材料同時攪拌。倒入熱水使水覆蓋的蔬菜。再加入大蒜2大顆、鹽、孜然粉，煨煮30-40分鐘。放米飯，平滑其整個表面。以鹽調味，倒入熱水米飯（1厘米）的

源自東方，但在中亞地區的發展。字抓飯是起源於波斯，並在亞歷山大大帝自傳中出現，他在經過大夏，波斯省撒馬爾罕時被招待此菜餚。

(3) Pilaf. Ingredients: beef meat 600gr, onion 3, carrot 600gr, rice 700gr, garlic 2, vegetable oil 110ml, cumin 1 teaspoon, salt.

Preparing: cut meat into small cubes, onion into rings. Add onion into oil and fry. Add meat. Add sliced carrot. Stir all the time. Add hot water until it covers vegetables and meat. Add 2 garlics. Add salt. Add cumin. Cover the pot and keep cooking 30-40 minutes. Add rice, flat it. Add salt and add water (to cover everything over 1 cm).

History: the method of cooking comes from east. Accepted and developed in central Asia. The word "pilaf" has Persian origin and was mentioned in biography of Alexander the Great. He was treated by pilaf in Bactria, province of Persia and Samarkand.

(1) Омлет с креветками: Я приготовила омлет с креветками. Я выбрала это блюдо потому что оно готовится быстро и легко. Я еще никогда не пробовала креветки потому что в нашей стране нету морей и океанов и поэтому нету креветок. Они привозные и замороженные. Они стоят очень дорого. Омлет с креветками мне очень понравился. Мне было легко приготовить это блюдо. Это блюдо у нас называется омлет, только без креветок. Вместо креветок и овощей мы добавляем колбасу и сосиски. Можно еще добавить вареную картошку. Мне было интересно узнать историю омлета с креветками. Когда-то голландцы завоевали юг Тайваня и поэтому эта еда очень популярна на юге Тайваня.

(2) 蝦仁煎: 我煮蝦仁煎。我選擇了這個菜，因為它可以快速，輕鬆地準備。我從來沒有嘗試過的蝦，因為在我們國家沒有的海洋，因此沒有蝦。蝦都是進口，而且都是冷凍的，所以很貴。我很喜歡蝦仁煎，這是很容易做準備這道菜。此菜，我們叫煎蛋卷，但沒有蝦。我們加入香腸和熱狗，和馬鈴薯。我對蝦仁煎的歷史感到興趣。因為之前荷蘭人征服了台灣南部，因此，這種食品是在台灣南部很受歡迎。

(3) Shrimp omelet: I cooked shrimp omelet. I selected this dish because it is easy and fast to cook. I never tried shrimps because we do not have sea or ocean in my country and this is why we do not have shrimps. Shrimps here are imported and frozen. They are very expensive. I like shrimp omelet. I easily cooked it. Here, this dish is called omelet too, but without shrimps. We add sausage instead of shrimps and vegetables. We also add potatos.it was interesting to know about history of shrimp omelet. Before, Hollanders invaded south of Taiwan and this is why shrimp omelet is popular in south of Taiwan.

(1) 抓飯: 這道菜不僅看起來很漂亮，嚐起來也很好吃。當我們打開鍋蓋時，散出來的味道讓我很驚艷。飯、蔬菜和肉都煮在一起，很美味。我最喜歡紅蘿蔔的部分。以前我害怕吃紅蘿蔔，但是現在我敢吃了。紅蘿蔔奇怪的味道都不見了。另外我最喜歡的部分是這道菜的風味。它和台灣料裡不一樣。我們通常不會在米飯中放香料。我們通常米飯、蔬菜和肉是分開的。

(2) Это блюдо не только выглядит красиво, и на вкус слишком хорошее чтобы поесть. Когда мы открываем крышку, запах распространяется вокруг, что очень удивительно. Рис, овощи и мясо варят вместе, и очень вкусно. Моя любимая часть морковь. Я боялся есть морковь, но теперь я смею есть её. Странный вкус моркови ушёл. Кроме того, моя любимая часть - вкус блюда. Это блюдо не похоже на блюдо Тайваня. Мы обычно не ложим специи в рис. Мы, как правило, готовим рис, овощи и мясо разделено.

(3) It was really good. It not only looks good but also tastes delicious. When we open the lid, the smell came out and that amazed me. The rice, meat and vegetables mixed together. They are wonderful. I think the best part is the carrots. I used to be afraid of eating carrots, but now I like it so much. There isn't any bad smell or strange taste from the carrots. I can eat a lot of carrots in pilaf. Another part I like pilaf is that I can eat original flavor of this dish. It's different from Taiwanese cuisine. We usually don't put lots of spice in the dish. We usually have rice and vegetables/meat separately.

Appendix 2

Text segments with key concepts related to a food and related history and traditions

Participant ID 7

It seems that pilaf is similar to fried rice. In fried rice, we also need to add some meat, like chicken or beef, and some vegetables. I think, our cultures are somehow similar. We have rice and they have rice. We both have rice food. Pilaf is served during weddings. In Taiwan, sometimes, we can also see fried rice in weddings. Our weddings are also very big with many invited guests, sometimes around 500 people. The difference is that pilaf is food for Muslims and they do not add pork but beef or mutton.

Participant ID 8

Shurpa is similar to beef noodles and hot pot in Taiwan. We add meat and vegetables to these dishes. Shurpa, beef noodles, and hot pot are useful for health. They all contain vitamins, proteins and good for digestion. But we use noodles in beef noodles and we add sliced meat in hot pot. This is different from shurpa. We do not have nomads and shepherds in Taiwan. In contrast, we keep animals in farms and Taiwan is too small for having nomads. Perhaps, this culture can be more similar to culture of Mainland China. And beef noodles comes to us from there.

Participant ID 9

I cooked shrimp omelet. I selected this dish because it is easy and fast to cook. I never tried shrimps because we do not have sea or ocean in my country and this is why we do not have shrimps. Shrimps here are imported and frozen. They are very expensive. I like shrimp omelet. I easily cooked it. Here, this dish is called omelet too, but without shrimps. We add sausage instead of shrimps and vegetables. We also add potatoes, it was interesting to know about history of shrimp omelet. Before, Hollanders invaded south of Taiwan and this is why shrimp omelet is popular in south of Taiwan.

Participant ID 10

Our people also experienced some difficulties many years ago. Many people could not afford meat. They used to cook animals parts, like leg of lamb. People cooked kalla pocha, aspic, and so on.

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