

Are We Asking the Same Questions in Different Contexts: Translation Techniques in Cross-Culture Studies in Science Education?

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ABSTRACT

Translating an existing research instrument into another language is cheaper and faster than developing a new instrument. This may explain why many science educators have translated instruments developed and validated in English into different languages for measuring the variable(s) of interest for different cultures. The quality of the translation technique may affect the validity of the results in science education studies. This study aimed at exploring the science education researchers' research instrument translation techniques: a) as a major purpose study, b) to be used in cross-cultural studies, and c) to measure variable(s) of interest in different culture. Articles published in three journals were selected for review, namely: Research in Science Education (105 issues), International Journal of Science Education (347 issues), and International Journal of Science and Mathematics Education (60 issues). The analysis revealed that a forward translation of the quantitative instruments from the source language to the target language is the most commonly used translation technique by the science education researchers (61.5 %). However, it may not ensure cultural equivalence for the target instrument when researchers use it in cross-cultural studies. Thus, consensus among science educators on how to translate an instrument, which is validated in one culture, to be used in a different culture is needed. Based on the findings, some educational implications of interest for the translation approaches are discussed.

Key Words: Cross-culture Studies; Cultural Validity; Translation Techniques; Forward Translation; Back Translation; Collaborative Translation; Combined Translation Approach.

INTRODUCTION

However, the method of description and measurement of any construct should be developed from the perspective of the cultures under investigation (Marshella, 1978). The efforts, cost, and time required to have representative researchers from all cultures involved may cause this to be impossible. This may explain why choosing an instrument to be translated or adapted and used for measuring the variable of interest which has been developed in another culture. For example, Huang and Yore (2004) translated a questionnaire



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from English to Mandarin to collect data about students' attitude, environmental behavior, and emotional dispositions in Taiwan. Taconis and Kessels (2009) translated a questionnaire from German to Dutch to investigate the relationship between the typical representative of the science culture (the science prototype) and students' self-image as being linked to not choosing science as a major.

Hambleton and Kanjee (1995) mentioned there are three reasons for translating or adapting instruments to be used in a different culture: a) to enhance fairness in assessment by allowing persons to be assessed in the language of their choice, b) to reduce costs and save time in developing new tests, and c) to facilitate comparative studies across national, ethnic, and culture groups. For example, the International Association for the Evaluation of Educational Achievement (IEA) conducted Trends in International Mathematics and Science Study (TIMSS) in 2003 in more than 45 countries, which involved preparing mathematics and science tests in over 30 languages (Hambleton, 2005; Mullis, et al., 2007) and 50 countries participated in 2007 (Martin et al., 2008).

Hambleton (2005) suggested that an adaptation for an instrument is different from a translation of the same instrument because it entails deciding whether or not the instrument can be used to measure the same phenomena in a different culture, choosing translators, identifying modifications should be done according the target culture, and check for equivalency between source and translated version. Thus, translation of any instrument is only one step in the adaptation process and is usually used only when the target population has a different mother tongue while the cultural background is the same. However, it is unrealistic to assume that a literal translation is a valid option in cross-culture studies (Tanzer & Sim, 1999).

Unlike translation, adapting a tool from one language to be used in another language is associated with constraints due to the compromise combined with any translation process (Mumford et al., 1991). Thus in the adaptation process for a research tool into a target language, the distortion from the source culture needs to be reduced. A valid adaptation of a tool requires consideration of several dimensions of cross-cultural equivalence: content, semantic, technical, criterion and conceptual (Flaherty et al., 1988). For example, Aldridge and Fraser (2000) developed a Mandarin version of the personal form of the what is Happening in this Class (WIHIC)? Researchers found some English words had no direct meaning in Mandarin. Therefore, they replaced them with other words which had equivalent meanings.

For this reasons abovementioned, guidelines for translating educational and psychological instruments for use across different cultures have been developed by different institutions, for example, the International Test Commission (ITC). Some of the guidelines are related to how to translate tests as well as other assessment materials when measuring samples that use different languages. For example, the standards state,

Instrument developers/publishers should insure that the adaptation process takes full account of linguistic and cultural differences among the populations for whom adapted versions of the test are intended....Test developers/ publishers should ensure that the data collection design permits the use of appropriate statistical techniques to establish item equivalence between the different language versions of the test (Hambleton, 2001, p. 166).

Previous standards assume that inappropriate translation and/or adaptation procedures may lead to improper conclusions about variable(s) of interest cross different cultures (Bechger et al., 1999; Sireci, 1997; Van de Vijver et al., 1998). For example, Solano-Flores et al. (2001) found that using "and/or" can benefit native English speakers, but using "y/o" in the Spanish version can be confusing to native Spanish speakers. For this reason, the validity of

results in cross-culture science education research depends on the quality of the translation and the adaptation technique(s).

Translation techniques

In 1970 Brislin offered four techniques for maintaining the equivalence between original and translated instruments: a) back-translation technique; b) bilingual technique; c) committee approach; and d) pretest procedure.

Back translation is commonly used to check the accuracy of translation in cross-culture studies (Brislin, 1970). Three steps are involved in this technique: 1) a bilingual blindly translates an instrument from the original language to the target language, 2) another translator translates it back into the source language, and 3) The two versions of the instrument (original and back-translated version) are compared for meaning equivalence. The accuracy of the back-translated version is considered an indicator of the accuracy of the target translation (Douglas & Craig, 2007). When the last step reveals problems in meaning equivalence between the original and back translated version, another translator attempts to retranslate the instrument. This procedure continues until attaining a meaning equivalence. The major weakness related to Brislin's classic translation model is that researchers cannot estimate how many independent bilingual translators are needed to achieve to the meaning equivalence between the original and the translated versions (Cha et al., 2007). Moreover, back translation does not necessarily ensure equivalence in meaning in each context. For example, Douglas & Craig (2007) has suggested that since back translation provides a direct or literal translation from source to target language, it is possible to move from one version to another and back again without capturing the intended meaning.

Bilingual translation has been advocated as a preferred technique to achieve equivalence in meaning. In this technique two versions of the instrument should be prepared in source and target languages then both of them should be administrated to bilingual participants (Brislin, 1970). Participants' responses to the two versions are compared. When differences in participants' responses are identified, the researcher should review the items that have discrepancies. Since bilingual speakers do not use languages in the same way as monolingual participants because they are fluent in both languages, their responses may be different from those collected from monolingual population (Sperber et al., 1994).

Collaborative-based translation is a group of bilingual translation from the source to the target language (Brislin, 1970). There are two forms of this collaborative translation: a) a committee approach, and b) a team approach. The committee approach requires bilingual expert science educators to work together as a group while the team approach requires several bilingual expert science educators to make independent parallel translations of the same instrument. In the last case a team of experts is required to work individually, more than a unit, if they are located in different places. A meeting or a virtual discussion is required to review and discuss the differences between the translated versions.

Pretest procedures: After the translation is completed, it is field tested to insure that target population will comprehend all questions (Brislin, 1970). The pilot study can reveal any problems of meaning equivalence between the source and the translated instrument. Qualitative and quantitative techniques can be used in pretest procedures. In qualitative technique the instrument can be administrated to a sample from the target population to get feedback about their understanding of each item in the instrument. On the other hand, in quantitative technique two versions of the instrument should be administrated to a bilingual sample for the target culture, and the differences in responses should be compared.

Factors affecting quality of translation:

Validity of results in cross-culture studies in science education may be affected by quality of translation or adaptation process which can be affected by several factors. Brislin (1970) observed that the quality of translation depends on the language into which bilingual asked to translate. For example, translation to Chamorro is better than translation to Palauan, and French can provide better translation than German. Moreover, Cha et al. (2007) stated that the source language can affect translation quality. Equivalence can be achieved when words in the source instrument are clear. Also, the content can affect translation quality. For example translating a passage in physics or chemistry is easier than translation of passage about certain culture. Therefore, realistic problems which are related to a specific context should be reorganized to adapt the target language. The International Test Commission (ITC) standards state that:

Effects of cultural differences that are not relevant or important to the main purposes of the study should be minimized as much as possible between the different language versions of the test (Hambleton, 2001, p. 165).

Science process skills which created by Enger and Yager (2001) was translated into Arabic language by the author (in press) to be used with students in Egypt. Egyptian students were not familiar with units such as inch, mile, and Fahrenheit used in the test, so they were replaced with metric units, for example, cm, km, and temperature on the Celsius scale. A review of literature revealed that one of the most important factors affecting translation quality is the quality of the translators. Hambleton, Sireci, and Robin (1999) suggested that translators should be proficient with respect to principles of good item writing. Hambleton (2001) also stated that being fully proficient in both source and target languages, being familiar with the cultures associated with the different language groups, and knowing the subject matter and testing principles have become parts of the selection criteria for translators. Brislin (1970) suggested some rules, which may help researchers to avoid factors that may affect translation quality and achieve equivalence in meaning. These rules include using simple sentences, avoid detailed description, use active voices instead of passive voices, nouns rather than pronouns, avoiding colloquialisms, decentering, and using proficient translators and being independent.

Focus of this study:

This study is an investigation of translation or adaptation techniques used by researchers in science education to translate an instrument into a different language to be used in cross-cultural studies or as purpose of their studies. Articles published in three journals were selected for review. These journals were: a) *Research in Science Education*, b) *International Journal of Science Education*, and c) *International Journal of Science and Mathematics Education*.

METHODOLOGY

By the end of 2014, a literature review was conducted to identify research articles which translated instrument(s) to measure variable(s) of interest in different cultures or those developed an instrument into different language as a major study purpose. Different keywords used to conduct a search in EBSCO host database such as translation, adaptation, comparative studies, and cross-cultural studies. The result of this step revealed that over 1500 research articles had at least one keyword. In order to filter the previous results to focus only in quantitative instruments, three terms were used: cultural validity, instrument construction, and

instrument validation. The results obtained were reduced to focus only on articles in English language and published in science education journals.

Most research articles translated or adapted instruments located in three science education journals namely a) Research in Science Education, b) International Journal of Science Education, and c) and International Journal of Science and Mathematics Education. Other science education journals had no more than 2, 3, or 4 articles translated quantitative instrument as a part of the study or translated quantitative instrument into different language as a major study purpose. Target articles were reviewed in order to identify translation techniques used.

FINDINGS

A review of the target journals revealed that 39 articles translated instrument(s) to be used to achieve the main purpose of the study or the translation process was the major purpose of the study. Table 1 shows number of studies found in each of the three journals.

Table 1. *Number of Reviewed Studies in Each Journal*

Journal	No. of Issues	No. of reviewed studies
Research in Science Education (1980-2014)	105	8
International Journal of Science Education (1980- 2014)	347	21
International Journal of Science and Mathematics Education (2003-2014)	60	10

Table 1 shows that 53.9 % of the reviewed studies were found in International Journal of Science Education. This percent falls down to be 25.6 % in the International Journal of Science and Mathematics Education and down further to be 20.5 % in Research in Science Education.

The original language of the target instrument(s) was English (34), Turkish (3), Hebrew (1), and German (1). In 34 articles, the target instrument(s) translated from English into different languages, including Chinese (10), Turkish (3), Korean (3), Spanish (2), Indonesian (2), Hebrew (2), Japanese (1), Arabic (1), Dutch (1), French (1), Cree (1), Russian (1), Thai (1), Cantonese (1), Mandarin (1), Tagalog (1), Afrikaans & Xhosa (1), and Malay (1). Five of the 39 reviewed articles indicated that the translation of the quantitative instrument(s) was the major study purpose while 34 articles indicated that the translation process was only a step to validate the instrument(s) in the target culture and then be used to measure the variable(s) of interest in this culture. Table 2 shows the translation techniques used by researchers in the target journals.

Table 2. *Translation Techniques used in Science Education Articles*

Category	Descriptions	No. of Studies
No information provided	Researchers provided no information about the translation technique(s) used to translate the instrument from the original culture to the target culture.	5

Table 2. *Continued..*

Category	Descriptions	No. of Studies
Direct (Verbal) translation	The instrument was given to the target sample in the presence of a translator.	1
Forward translation	The instrument was translated to the target language from the original language by the researcher(s) and provided no information about validity and reliability of the target version.	14
Forward translation with testing	In addition to the forward translation in category (3), researcher(s) provided information about pre-testing the instrument in the target language.	10
Back translation	A bilingual blindly translates instrument from the original language to the target language, 2) another translator translates it back into the original language, and 3) the two versions of the instrument (original and back-translated version) are compared for meaning equivalence.	4
Back translation with mono/bilingual test	In addition to back translation in category (5), researcher(s) tested the target language version by mono or bilingual subjects.	5

Table 2 shows that of the 39 reviewed articles, 14 studies used forward-only translation, 10 studies used forward translation with pre-test, four studies used back translation, five studies used back translation with pre-test, one article used verbal (direct) translation, and five articles did not specify the translation technique used to translate a quantitative instrument from the original language into the target language.

RESULTS

Many instruments developed and validated in English have been translated into different languages for measuring variable(s) of interest in different cultures. In order to do that, science educators used different approaches such as verbal (direct) translation (Swain, Monk & Johnson, 1999), forward-only translation (Tan et al., 2008), forward translation with test (Huang, 2006), back translation (Taconisa & Kessels, 2009), and back translation with mono and/or bilingual pre-test (Liu & Lederman, 2007).

The current study revealed that forward translation (61.5 %) is the main approach used by science education researchers to translate an instrument from one language into another one to measure variable(s) of interest in a different culture. This percent falls down to be (23%) in back translation and further down to 2.5 % for verbal translation. These results disagree with previous studies. For example, in their review of *Journal of International Marketing* (52 Issues), Douglas and Craig (2007) found out of 45 articles reviewed 34 articles used back translation approach to check accuracy translation. Maneesriwongul and Dixon (2004) reviewed 5 nursing journals and found out of 47 articles reviewed 31 articles used back translation to achieve meaning equivalence. Therefore, consensus among researchers in Marketing and Nursing on how to translate or adapt an instrument, which is validated in source culture, to be used in a different culture is better than this one among researchers in science education. Translation approaches used by researchers in science education can be grouped into three main categories:

Verbal (Direct) translation

In this case, researchers ask bilingual translator to translate the instrument, item by item, from the source language to the target language. Of 39 reviewed articles, only one study used verbal translation. A sample of Korean science teachers was given a questionnaire about attitudes to the aims of practical work in the presence of a bilingual translator. Collected data were used in cross culture study including three samples from Korea, Egypt and UK. However verbal translation can save time, cost and effort, yet it *cannot* ensure meaning, culture, and psychometric equivalence because it depends on the quality and the experience of the bilingual translator. Verbal translation should *not* be used to translate an instrument to be used in a different culture or to compare samples in cross culture studies (Brislin, 1970). Without accurate comparisons of the scores in different cultures, the research results will not be validated. Based on this idea, when an instrument is used to measure the variable of interest in two different cultures, the items must be culturally and psychometrically equivalent to promote a valid score comparison. In other words:

How do we know we are studying the same phenomena in different contexts; how do we know that our observations and conclusions do not actually refer to “quite different things” which we unjustifiably include in the same conceptual categories? (Nowak, 1976, p.105).

Forward translation

In this approach the instrument(s) was translated from the source language into the target language by the author(s) or other researchers in science education. The last case includes two approaches: a committee approach and a team approach. In the committee approach expert bilingual science educators work together as one unit while in the team approach several bilingual expert science educators work independently to translate the same instrument. Meetings or virtual discussions were held to review and discuss differences between the original and target versions.

Of the 39 reviewed articles, 24 articles used forward translation. In 14 cases researchers provided no information about validity and reliability of the translated instrument(s). While 10 studies conducted pre-test for the translated instrument(s) in the target culture, after doing forward translation, in order to provide an evidence for the validity and reliability of the instrument in the target culture.

Forward translation can save time and cost. Moreover, it can be used, after pre-testing the instrument with monolingual sample, to measure variable(s) of interest in *only* the target culture. However some researchers pre-tested the translated instrument in the target culture, forward translation cannot be used in comparison studies because it cannot ensure cultural and psychometric equivalency to promote a valid score comparison. Besides, forward translation can provide researchers with literal translation (Merenda, 2005) and do not help them to avoid culture decentering. At the same time using bilingual subjects to check the appropriateness of the translation is inadequate because they do not use language in the same way as monolingual (Sperber et al., 1994).

The current study revealed that forward translation for the quantitative instruments from the original language into the target language is the most commonly employed translation technique in the reviewed articles (61.5 %). However, this may not ensure cultural and psychometric equivalence for the target instrument when researchers use the translated instrument in cross-culture studies.

Back translation

Four studies used back-only translation to translate the instrument from the source language to the target language. This approach involves three steps: a) the instrument was

translated by bilingual science educator(s) from the source language to the target language, b) another translator translates it back into the source language, and c) the original and back-translated versions are compared for meaning equivalence. The accuracy of the back-translated version is considered an indicator of the accuracy of the target translation (Douglas & Craig, 2007). When the last step reveals problems in meaning equivalence between the original and back translated version, another translator attempts to retranslate the instrument. This procedure continues until reaching meaning equivalence. In addition to the previous steps, five studies used pre-test, in conjunction with back translation, to provide an evidence for validity and reliability. In this case qualitative and quantitative techniques were used. In qualitative technique the instrument was administrated to a sample from the target population to get feedback about the respondents' understanding of each item in the instrument. In quantitative technique two versions of the instrument were administrated to a bilingual sample of the target culture, and the differences in responses are compared.

Even though back translation can help researchers to identify problems and errors in translation, it is not sufficient to ensure culture equivalence. For example, Douglas & Craig (2007) suggested that since back translation provides a direct or literal translation from the source to the target language, it is possible to move from one version to another and back again without capturing the intended meaning. Harkness et al. (2003) explained this situation using an example from a German social survey. "Das Leben in vollen Zügen geniessen" is an item in the survey. Literally this was translated into English as "Enjoy life in full trains". When this sentence is translated back into German again, the same exact sentence is generated as the original German translation, which would suggest that the translation is accurate. However, the more suitable translation into English "Live life to the fullest" Not "Enjoy life in full trains." Thus another technique may be needed to obtain appropriate translated instrument. Moreover, in back translation researchers cannot estimate how many independent bilingual translators are needed to attain the meaning equivalence between the original and the translated versions (Cha et al., 2007).

There is a necessity for re-examinig the translated instrument in the target culture. Thus using a well-established translated instrument in a certain language does not remove the need for establishing reliability and validity in the target language. This point is clearly mentioned in the International Test Commission (ITC) *Guidelines for Adapting Educational and Psychological Tests* (Hambleton, 1994). Of the 39 reviewed articles, only 15 articles used pre-test in conjunction with forward translation and back translation. In other words, 61.5 % of the reviewed articles neglected or inadequately addressed culture validity and psychometric equivalence. Transporting of instruments from one culture to another one is the most dangerous practices in the science education assessment during the last half century, which continues to the present days (Merenda, 2005).

Interestingly, 80 % of the studies translated an instrument as a major study purpose used pre-test as illustrated in Table 3.

Table 3. Pre-test in Studies Translated an instrument as A major/minor purpose study

	Major purpose study	Minor purpose study
Pre-test	4	11
Without pre-test	1	23
Total	5	34

Among the five studies translated an instrument as a major study purpose, four studies conducted qualitative and quantitative techniques. In qualitative technique the instrument was administrated to a sample from the target culture to receive feedback about the respondents'

understanding of each item in the instrument and in quantitative technique two versions of the instrument administered to a bilingual sample of the target culture, and the differences in responses are compared. Only 32.4 % of the studies translated an instrument as a step to achieve another goal, such as measuring students' attitude and students' achievement, used pre-test. These results agree with what Tanzer and Sim (1999) found out. They observed that translating the original instrument from the source language into target languages without examining cultural validity issues is the most commonly used procedure in cross-culture studies. Moreover, Solano-Flores et al. (2001) mentioned that culture validity has been neglected or inadequately addressed in current assessment practices. In practice, however, translation procedures are rarely viewed as part of the instrument design efforts and often treated as an addendum. Researchers should integrate translation procedures in their studies (Harkness, 2001).

Literature review revealed that in order to achieve both meaning and cultural equivalence, researchers will need to do some modifications. These modifications can be classified according to the type of equivalence being sought: a) a vocabulary equivalence, some words in the original instrument had no direct meaning in the target language therefore researchers used other word(s) to keep the original meaning, b) a grammatical-syntactical equivalence, in some cases, translated items are simpler than the items in the original language, c) an idiomatic equivalence, idioms related to the original culture are replaced with expressions that are more appropriate to the target context. According to the changes required, Tazner and Sim (1999) distinguished between four levels of modifications: a) **Application**; if the target and the original populations have the same cultural and linguistic background, the instrument can be applied without any modifications, b) **Translation**; this option usually used when the target population have a different mother tongue but the cultural background is the same, c) **Adaptation**, in this option some modifications should be done according to the target culture. For example, some instruments contain expressions and/or examples related to the local culture which must be replaced by other expressions and examples from the target culture. d) **Assembly**, in this case, many modifications should be done to the original instrument that, practically speaking, a new instrument is created.

The following example are from a study that examines how culture influences the way in which participants respond to a questionnaire.

In the Euro barometer, which measures social and political attitudes in the European Union, the French and English scales differ in structure and, to a lesser extent, in semantics. Both uses the semantic dimension of agree, but in the French scale, the use of *d'accord/pas d'accord* suggests a unipolar scale, whereas the English scale uses a bipolar construction in which the wording is linguistically symmetrical with the endpoints modified by "strongly." Equally, the "do-not know" category is "cannot choose" in English compared with *ne sais pas* or "do not know" in French (Douglas & Craig, 2007, p.37).

Douglas and Craig's (2007) experience provide an exemplary of how disregarding culture background may lead to misinterpretations.

Recommended translation approach "Combined approach"

Even though forward translation has been used for a long time in cross-culture studies, Brislin (1970) recommended forward translation in conjunction with back translation as a combined technique to check the translation accuracy. Since forward and back translations can provide researchers with literal translation (Merenda, 2005) yet do not help researchers avoid cultural decentering, and at the same time using bilingual subjects alone to check appropriateness of translation is inadequate because they do not use the language in the same way as monolinguals use (Sperber et al., 1994), a combined translation technique of forward

translation in conjunction with back translation, collaborative translation, and qualitative & quantitative pre-test is recommended by several studies (Harkness et al., 2003; John et al., 2006; Cha et al., 2007) to achieve meaning and cultural equivalence. Figure 1 shows the three phases for the modified combined approach presented by Cruz, Padilla, and Agustin (2000).

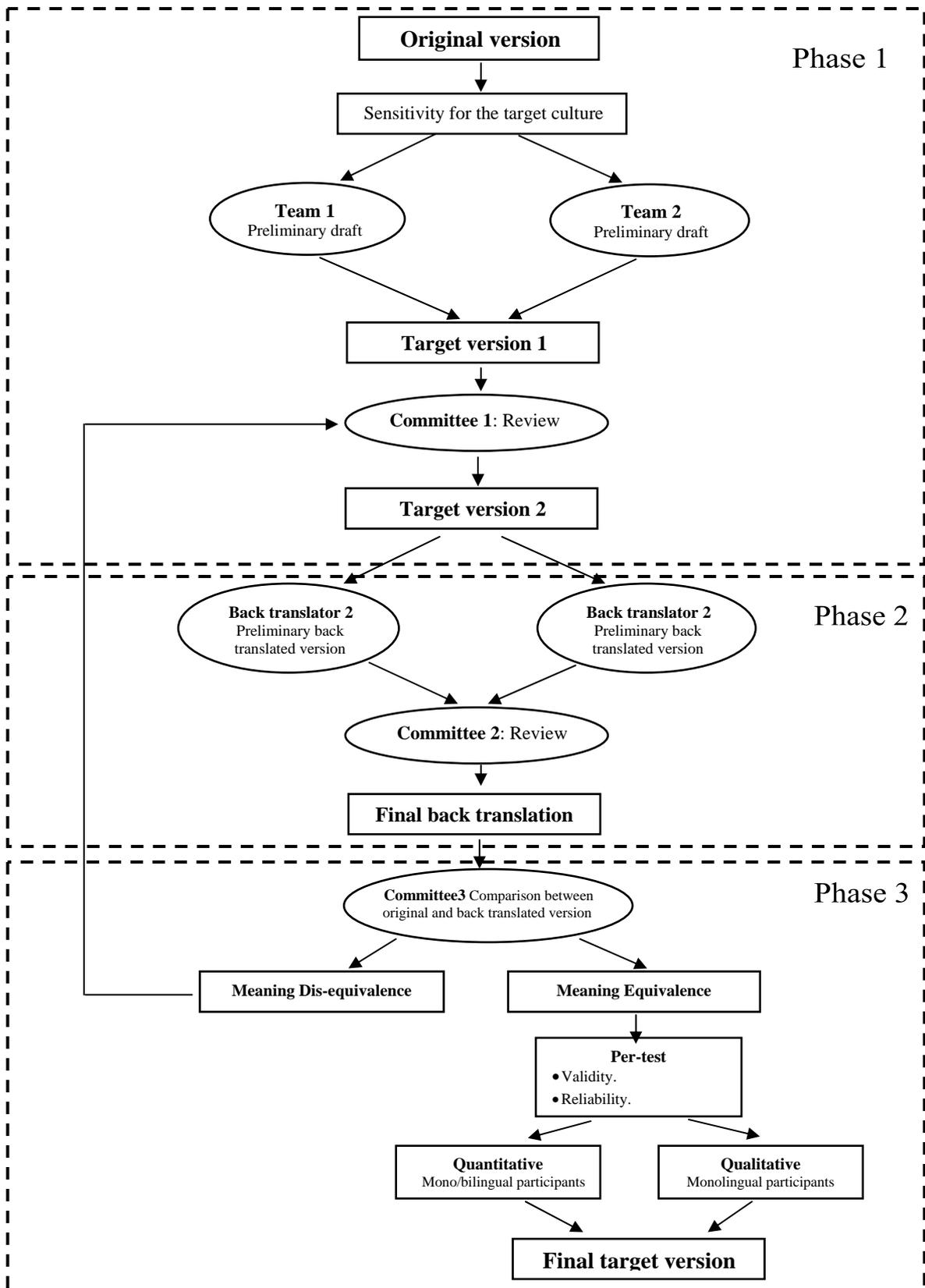


Figure 1: Combined Translation Approach

First phase aims to prepare an initial version of the instrument in the target language “version 2” Thus the relevance and sensitivity of the instrument for the target context should be established through discussion with bilingual science educators. Moreover, two pairs of the translators work as two independent teams to translate the instrument from the source language into the target language. Within each pair of translators there should be a discussion to resolve the inconsistencies. Team one and team two should consist of science educators who are proficient in source and target languages, familiar with the target culture, familiar with knowledge of the subject matter and testing principles as recommended by Hambleton (2001) and have experiences with effective item writing as recommended by Hambleton et al. (1999). A further round of review is necessary to ensure that the source and the target version accurately capture the same meaning. For this reason, a review meeting “committee one” should be held with translators and an independent reviewer to resolve inconsistencies.

Second phase aims to retranslate the instrument from the target language to the source language again “Back translation”. Two independent translators retranslate the instrument from the target language to the source language. A review meeting should be held with translators and an independent reviewer to review the final back translation.

Third phase In this stage a monolingual native speaker with a background in science education should check the equivalence in meaning between the source instrument and its back translation. Rather than the literal meaning, the conceptual meaning should be the focus of this step. Problems in conceptual equivalence between the original and the back translated versions should be returned back to the committee one and be incorporated into the final version of the instrument. Once the modifications were done by the committee one, the process should be repeated to ensure that the changes were adequate and the target instrument is ready for the field test.

The purpose of the pre-test is to know do the actual respondents will comprehend all items in the instrument as the translators. Thus a pilot study should be conducted to assess the appropriateness of the translated instrument. In other words, qualitative and quantitative techniques should be used in pre-test procedures. In qualitative technique the instruments “target version” should be administered to a sample from the target culture consisting of monolingual participants to get a feedback about user’s understanding of each item in the instrument. In quantitative technique, the source and the target versions of the instrument should be administered to a bilingual sample and the target versions should be administered to a monolingual sample of the target culture, and the differences in responses should be compared.

CONCLUSION

Since there is no perfect technique for translation, using forward translation in conjunction with back-translation method, the team approach or committee approach and the pretest procedure using monolingual and bilingual participants are recommended in this study. The literature review revealed that collaborative work in translation, review, and pretest are necessary for translation or adaptation. Harkness (2003) defined five steps for collaborative-based approach: a) translation, b) review, c) adjudication, d) pretesting, and e) documentation. Douglas and Craig (2007) suggested that documenting translation procedures is desirable when the questionnaire is likely to be repeated annually or semiannually.

To promote a valid comparison between respondents from different cultures, the instrument must be culturally and psychometrically similar as much as possible (Sireci et al., 2006). The validity of results in cross-culture science education research depends on the quality of the translation or the adaptation process. For this reason, there is a need for consensus among the science educators on how to translate or adapt an instrument, which is validated in the source culture, to be used in a different culture. Moreover, studies that which use translated or adapted instrument(s) should provide information about the translation and/or adaptation procedures. In other words, translation or adaptation procedures should be integrated into the study design (Harkness, 2001).

What is already known about this topic

- Translation or adaptation of an existing instrument into another language is cheaper and faster than developing a new instrument.
- Translation/adaptation quality may affect validity of results in cross-culture studies.
- Several translation/adaptation techniques have been created to maintain the meaning equivalence between source and target culture.

What this paper adds

- There is a need for consensus among science educators on how to adapt an instrument to be used in a different culture.
- Cross-culture studies should provide information about translation/adaptation process.
- A combined translation technique of forward translation in conjunction with back translation, collaborative translation, and qualitative & quantitative pre-test presented as an example.
- A combined translation/adaptation technique is ideal to maintain culture and psychometric equivalence.

REFERENCES

- Aldridge, J. M., & Fraser, B. J. (2000). A Cross-culture study of classroom learning environments in Australia and Taiwan. *Learning Environments Research*, 3, 101–134.
- Bechger, T. M., van den Wittenboer, G., Hox, J. J., & De Gloppe, C. D. (1999). The validity of comparative educational studies. *Educational Measurement: Issues and Practices*, 18(3), 18-26.
- Behling O., & Law K.S. (2000). *Translating Questionnaires and other Research Instruments: Problems and Solutions*. Sage Publications, Inc., USA.
- Brislin, R. W. (1970). Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, 1, 185-216.
- Cha, E. S. et al. (2007). Translation of scales in cross-cultural research: issues and techniques. *Journal of Advanced Nursing*, 58(4), 386–395.
- Cruz, F., Padilla, G., & Agustin, E. (2000). Adapting a Measure of Acculturation for Cross-Cultural Research. *Journal of Transcultural Nursing*, 11(3), 191-198
- Douglas, S. P., & Craig, C. S. (2007). Collaborative and Iterative Translation: An Alternative Approach to Back Translation. *Journal of International Marketing*, 15(1), 30–43.
- Enger, S., & Yager, R. (2001). *Assessing students understanding in science*. Corwin Press, Inc.
- Flaherty J.A., Gaviria F.M., Pathak D. et al. (1988) Developing instruments for cross cultural psychiatric research. *Journal of Nervous and Mental Disease*, 176(5), 257-263.
- Hambleton, R. K. (1994). Guidelines for adapting educational and psychological tests: A progress report. *European Journal of Psychological Assessment*, 10, 229-244.
- Hambleton, R. K. (2001). The next generation of the ITC test translation and adaptation guidelines. *European Journal of Psychological Assessment*, 17(3), 164–172.
- Hambleton, R. K. (2005). Issues, Designs, and Technical Guidelines for Adapting Tests into Multiple Languages and Cultures, in R. K. Hambleton, P. F. Merenda, & C. D. Spielberger. *Adapting educational and psychological tests for cross-cultural assessment*. Mahwah, N.J.: L. Erlbaum Associates.
- Hambleton, R. K., & Kanjee, A. (1995). Increasing the validity of cross-cultural assessments: Use of improved methods for test adaptations. *European Journal of Psychological Assessment*, 11, 147-157.
- Hambleton, R. K., & Patsula, L. (1998). Adapting tests for use in multiple languages and cultures. *Social Indicators Research*, 45, 153-171.
- Hambleton, R. K., Sireci, S. G., & Robin, F. (1999). Adapting credentialing exams for use in multiple languages. *CLEAR Exam Review*, 10(2), 24-28.
- Harkness, A. J., Van de Vijver, F., & Peter, M. (2003). *Cross-Cultural Survey Methods*. New York: John Wiley & Sons.
- Huang, H., & Yore, D. L. (2004). A comparative study of Canadian and Taiwanese Grade 5 children's environmental behaviors, Attitudes, concerns, emotional dispositions, and Knowledge. *International Journal of Science and mathematics Education*, 1, 419–448.
- Huang, S. L. (2006). An Assessment of Science Teachers' Perceptions of Secondary School Environments in Taiwan. *International Journal of Science Education*, 28 (1), 25–44.
- John, M.T., Hirsch C., Reiber, T., & Dworkin S.F. (2006). Translating the research diagnostic criteria for temporomandibular disorders into German: evaluation of content and process. *Journal of Orofacial Pain* 20, 43–52.
- Liu, S., & Lederman, G. (2007). Exploring Prospective Teachers' Worldviews and Conceptions of Nature of Science. *International Journal of Science Education*, 29 (10), 1281–1307.
- Maneesriwongul, W. & Dixon, J. K. (2004). Instrument translation process: A methods review. *Journal of Advanced Nursing*, 48 (2), 175-186.

- Marsella A.J. (1978). Thoughts on cross-cultural studies on the epidemiology of depression. *Culture, Medicine and Psychiatry* 2, 343-357.
- Martin, M.O. (2008). TIMSS 2007 International Science Report. Available online at: http://timss.bc.edu/TIMSS2007/PDF/TIMSS2007_InternationalScienceReport.pdf
- Merenda, P. F. (2005). Cross-culture adaptation of educational and psychological testing. In R. K. Hambleton, P. F. Merenda, & C. D. Spielberger. *Adapting educational and psychological tests for cross-cultural assessment*. Mahwah, N.J.: L. Erlbaum Associates.
- Mullis, I. et al. (2007).TIMSS 2007 “Assessment Framework”. Available online at: http://timss.bc.edu/TIMSS2007/PDF/T07_AF.pdf.
- Mumford, D.B., Tareen I.A., Bajwa M.A., Bhatti M.R., & Karim R. (1991). The translation and evaluation of an Urdu version of the Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, 83(2), 81-85.
- Nowak, S. (1976). *Understanding and prediction: essays in the methodology of social and behavioral theories*. Dordrecht, Holland
- Sireci, S. G. (1997). Problems and issues in linking tests across languages. *Educational Measurement: Issues and Practice*, 16(1), 12-19.
- Sireci, S., Yang, Y., Harter, J., & Ehrlich, E. J. (2006). Evaluating guidelines for test adaptation: A methodological analysis of translation quality. *Journal of Cross Culture Psychology*, 37(5), 557-567.
- Solano-Flores, G., & Nelson-Barber, S. (2001). On the Cultural Validity of Science Assessments. *Journal of research in science teaching*, 38(5), 553-573.
- Sperber, A.D., DeVellis R.F., & Boehlecke B. (1994). Cross-cultural translation. *Journal of Cross-Cultural Psychology* 25, 501–524.
- Swain, J., Monk, M., & Johnson, S. (1999). A comparative study of attitudes to the aims of practical work in science education in Egypt, Korea and the UK. *International Journal of Science Education*, 21 (12), 1311-1324.
- Taconis, R., & Kessels, U. (2009). How Choosing Science depends on Students’ Individual Fit to ‘Science Culture’. *International Journal of Science Education*, 31(8), 1115–1132.
- Tan, K. C., et al. (2008). Students’ Conceptions of Ionisation Energy: A Cross-cultural Study. *International Journal of Science Education*, 30 (2), 265–285.
- Tanzer, N. K., & Sim, C. Q. (1999). Adapting instruments for use in multiple languages and cultures: A review of the ITC guidelines for test adaptations. *European Journal of Psychological Assessment*, 15(3), 258-269.
- Van de Vijver, F., & Poortinga, Y. H. (2005). Conceptual and Methodological issues in adapting tests. In R. K. Hambleton, P. F. Merenda, & C. D. Spielberger. *Adapting educational and psychological tests for cross-cultural assessment*. Mahwah, N.J.: L. Erlbaum Associates.
- Van de Vijver, F., & Tanzer, N. K. (1998). Bias and equivalence in cross-cultural assessment: An overview. *European Review of Applied Psychology*, 47, 263-279.