

## An Information Theory Perspective on Study Abroad: Evidence from Taiwan & Japan

### 海外留学を情報理論の視点で捉える：台湾と日本の事例研究

#### 約

この論文は、海外留学と関連する多くの現象を説明する上で、情報理論が有用なツールとなり得る事について言及します。情報理論の5つの概念が海外留学を捉えるための全体的なフレームワークを提供できるかについて述べます。具体的には、L1/L2 チャネル容量(新しい受信情報を処理する機能)を考慮するだけでなく、情報と結果の確率をいかに関連づけることが有益かについて言及します。また、信号処理とデータ圧縮がどのように外国語学習と海外留学に関連するかについて言及します。この論文は、「トランスインフォメーション」と Vygotsky の近位発達領域間のいくつかの類似点を概説することで終了します。また、海外留学における情報理論の普及を妨げる3つの問題についても概説します。

キーワード：情報理論, 海外留学, 情報処理, 認知チャネル容量,  
文化的エンコーディングとデコーディング

Over the last several decades, the volume of information about study abroad and international education has expanded remarkably. Now several journals are devoted to those themes, and in the last decade alone over thirty books in English as well as a dozen in Japanese have been published on these topics. As our knowledge about this field grows, the need for a coherent framework to interpret the massive amounts of data becomes ever more acute. This paper introduces one theoretical framework that may provide a useful lens to tie together some disparate research about study abroad and overseas education.

The framework introduced herein is based on *information theory*, a discipline dating from 1948 when Claude Shannon described how to quantify and encode information without error. Branching out from theoretical mathematics, information theory concepts have been applied in many fields such as computer science (Mazumdar, 2011), sociology (Güçlü, 2012), and psychology (Lachman, Lachman & Butterfield, 1979). One way to describe information theory is as “an exploration of mathematical laws that govern the behavior of data as it is transferred, stored, or retrieved” (Rouse, 2005, par 1).

This paper introduces five concepts from information theory, outlining how they might be relevant to study abroad contexts. It concludes by acknowledging some limitations in attempting to adapt information theory in social science contexts.

#### (1) Information

Since the advent of personal computing and the Internet, the way many people think of information has changed significantly. Instead of regarding information as a collection of propositions about a given topic, Shannon encouraged us to view it as a sequence of binary, quantifiable codes linking the concepts of probability and entropy to information. If we think of *maximum entropy* as a state of random “white noise” in which any outcome is possible, then *maximum information* could be described as a condition of structured order in which specific outcomes become highly likely. Although Cover and Thomas (2006) and Stone (2015) provide a good overview of how information theory can be applied mathematically to concrete situations, this paper outlines a few basic ideas without the arcane algorithms.

Originally, information theory considered data independently of its meaning or semantic content. As Lombardi, Holik, and Vanni state, “Shannon’s theory, taken by itself, is purely quantitative: it ignores any issue related to informational content” (2005, p. 7). Some recent modifications have attempted to evaluate the *quality* of information transmitted as well as its quantity. Floridi (2002, 2003, 2011, cited in Adriaans, 2013), for example, has described *semantic information* as well-formed, meaningful and truthful data. Dretske (1981) has shown how semantic data can be “upgraded” into knowledge, suggesting that factors such as evidence, reasons, and the perceived veracity influence how messages are received. He also likened information to a *commodity* that might—or might not—yield useful knowledge.

If we conceive of information probabilistically as data that makes one outcome more likely than another, then in study abroad contexts it seems important to reflect on whether our desired outcomes are congruent with the information being provided. As Lou, Vande Berg, and Paige (2012, p. 413) attest, in many study abroad programs, outcomes are vaguely defined, inadequately communicated, and inappropriately measured. Information unrelated to desired outcomes is, from an information theory standpoint, essentially noise—or at best, *side information*. Educators trying to communicate a specific message to a target audience need to consider their “signal-to-noise ratio”: a lot of extraneous information is contained in many information packets that we disseminate.

Information theory encourages us to regard information as a signal that can be encoded in many ways. Study abroad information, for example, can be conveyed through pamphlets, videos, posters, blogs, or direct speech. Moreover, one signal can cancel out another, or potentially augment it if the timing is optimal. As a case in point, my university’s international education office encourages students to study at a sister school in Taiwan. However, one faculty is encouraging students to study at a different university in Mainland China. Essentially, these two messages are cancelling out each other: few students have the financial resources to engage in both options. The confusion of receiving multiple conflicting messages often makes the likelihood of attaining either less likely. Similar scenarios exist at many schools where multiple study abroad venues are marketed in Anglophone, Francophone, or Sinophone locales: if the information is not presented clearly, students may become perplexed about which place to choose, and filter out the conflicting and confusing messages.

## **(2) Channel capacity**

Although *channel capacity* was first mathematically formalized to describe the maximum rate at which communication signals can be reliably broadcast, it is also relevant to the fields of cognitive science and social psychology. Basically, it describes how fast information can flow over a conduit. That conduit might be a fiber-optical cable, a social community, or a human nervous system. In individual human terms, channel capacity is closely related to the notion of *cognitive load*: the upper limit of the rate at which information chunks can move through our working memory. From an information theory perspective, humans might be described as “noisy channels.” In other words, much of the information heading towards us is either lost or distorted. Often only a small portion of many signals get through. As Vogel and McCollough (2008) point out, we filter out far more than we take in. If a sufficient degree of redundancy and error correction is present in a message, much of the core data can be preserved. Many neurolinguistic studies have revealed that our ability to process semantic data varies widely from language to language. Generally, people can handle information more quickly in their L1 than in their L2, L3, or L4. In other words, channel capacity is partly language-dependent.

What does this mean in study abroad contexts? Many students going overseas become flustered by their inability to handle the huge volumes of foreign language information often encountered in unfamiliar environments. The result is often *information overload*, which typically leads to either social withdrawal or L1 code switching. Study abroad program

organizers need to consider how much information to send out, at what rate to disperse it, and what languages are optimal. An example of inefficient channel capacity use can be seen at the start of each academic year at many colleges: incoming students are flooded with huge amounts of confusing information about all of the study abroad programs existing at a given institution all at once. Since the cognitive workload to process such a large volume of information is quite high, most students stop listening to (or reading) the information after their cognitive thresholds have been reached. A better strategy might be to disperse the key information gradually based on prospective student interest. Instead of transmitting the same broadcast signal to all recipients, it might be more effective to send out tailored broadcast messages based on statistically predictable target audience interests. Google AdSense and Facebook employ such data distribution algorithms: different end-users receive different messages based on their personal profiles and previous responses (Caplan & Boyd, 2016). Moreover, although foreign language channel capacity can increase over time, the process is typically slow and gradual. We therefore need to consider how to encode or “chunk” the core information to obtain desired effects.

### **(3) Signal processing**

Information theory reveals how signals can be processed in many different ways. Some methods of signal processing are more efficient than others. Basically, foreign language learning strategies can be regarded as a set of signal processing procedures. A strategy typical of many Japanese university students is to look up all unknown words in a foreign language dictionary as they arise. This strategy might work when preparing for school entrance exams in L1 environments. However, it is not viable in most study abroad contexts involving exposure to massive amounts of foreign language input. Students need to learn what Sun, Karray, Basir, and Kamel (2002) describe as “fuzzy signal processing skills” —guessing overall gist and surmising global meanings instead of focusing on individual discrete words. Linguists such as Johnson (1970) and Van Dijk (1980) have emphasized the necessity of focusing on macro-structures more (paragraph-level discourse), rather than solely on micro-content (word-level data). Many foreign language learners seem to lose sight of global gist when exposed to long strings of new data in foreign language.

Dealing with unfamiliar cultural norms also represents a signal processing dilemma. For example, the gestures for confusion, hope, anger, or encouragement vary across cultures and *signal errors* occur when people interpret verbal or non-verbal cues differently. Study abroad pre-departure training can be described as an attempt help participants process or interpret signals in new ways. Post-return programs should focus on helping participants decipher or “unpack” some of the confusing signals that participants may have been unable to effectively process overseas.

### **(4) Data compression**

From an information science perspective, we can say that study abroad pre-departure training is an attempt to compress core information about a target destination to enhance the likelihood of achieving desired program outcomes. Information theorists would assert that no noise-free or lossless representation of the overseas experience is possible: pre-departure programs can only offer approximate overviews of some of the most likely scenarios that might arise overseas. Data distortions are inevitable. Study abroad participants need to understand that theoretical models of what is likely to happen frequently differ from events that actually occur. Moreover, as Bennett (2012, p. 109) and other cognitive constructionists suggest, our understanding of “what happens” depends a lot on how incoming information is processed: experience alone does not lead to understanding. It is necessary to reformat,

compress, and filter perceptual experiences to gain what is generally called an “understanding.”

The U-curve hypothesis (Lysgaard, 1955; Oberg, 1960) and W-curve hypothesis (Westwood, Lawrence, & Paul, 1986; Martin & Harrell, 2004) are two data compression models often used in study abroad orientation programs. The inherent validity of these two models may be questionable, though both might have some heuristic value in providing possible ways to scaffold experiences. However, information theory concepts might provide a more sophisticated cognitive scaffold. Study abroad pre-departure program organizers need to consider what *compression scheme* to use when encoding the information they wish to convey. How should a huge amount of information about the host country and travel protocols be compressed into meaningful tidbits so that students—who are frequently only half-attentive—can digest it?

This is probably a good point to contrast how study abroad is marketed in Taiwan and Japan. Marketing itself is a form of data compression and manipulation: study abroad programs attempt to sell promising slices of overseas sojourns to potential consumers. Although study abroad can be described as a commercial commodity that is bought and sold, as Kinginger (p. 218) suggests, it also has the potential to be an educationally valid experience.

Examining the top page of Japan’s government-sponsored *Study in Japan!* website (Appendix A), one of the first things that might be apparent is how the language choices for this website mirror the linguistic choices often present within Japanese society. Four main languages are listed: Japanese, English, Chinese, and Korean. At least 60% of the study abroad students coming to Japan speak at least one of these languages (JASSO, 2017). There is also a sub-menu with seven other less common languages: Thai, Indonesian, Vietnamese, French, Spanish, Russian, and Arabic. It would seem Japan is trying to attract students from countries where these languages are spoken. The website also emphatically encourages students to contact the Japanese embassies in their respective countries to obtain study abroad scholarships.

Another thing you might notice is how Another thing you might notice is the website emphatically encourages students to apply for scholarships via their local Japanese embassies. The selected interviews of foreign students who have studied in Japan are also prominently placed on this website.

By contrast, the Taiwan Foundation for International Cooperation in Higher Education (FICHET, 財團法人高等教育國際合作基金會) website offers a dual language interface with a choice of English or Chinese as well as five different rotating images of young people experiencing various parts of Taiwan (Appendix B). An RSS newsfeed, YouTube and Facebook links, and location of three overseas FICHET offices promoting study abroad in Taiwan are also highlighted. A comparison of these two websites appears in Table 1.

Table 1. *Some contrasts between the Study in Japan! and Taiwan FICHET websites.*

	<i>Study in Japan!</i> website	FICHET website
size (bytes)	10256	30603
download time (@ 56K/sec)	2.24 seconds	6.3 seconds
total word count	929	1292
Asian characters	853	1174
non-Asian words	76	118
most prominent words	Japan (5.3%), Study (2.6%), 日本留学 (2.6)	2017 (5.1%), 最新消息 (3.4%), 基金會活動 (3.4%),
lines of text	81	76
number of images	9	21
number of male/female faces	7 / 5	5 / 6

% blank space*	≈ 35%	≈ 33%
language interface choices	7	2

\* Approximate values when viewed on a 1024 x 768 pixel-per-screen browser, varies with screen size.

The Taiwanese website attempts to communicate 138% more textual information than the Japanese site: it is more lexically dense. The Japanese site has a clearer focus and its manga-like illustration at the top provides a more striking visual impact. Whereas the Taiwanese website has a limited bilingual interface, the Japanese website offers a wide choice of language options, making it more attractive to those outside the Anglosphere. The FICHET website utilizes SNS resources more than the *Study in Japan* website. Moreover, the Taiwanese website uses a JavaScript code to promote five different message panels in Chinese and two in English, each directed to a slightly different audience. If we compressed the information in Chinese from one of these looping panels into a single sentence, it might go like this: “Young students—Taiwan is a great place to experience lively, authentic Chinese and your memories of learning in Taiwan will be a lifelong treasure!”

This is but a cursory analysis of how study abroad is packaged in Japan and Taiwan, but it hints at how information about very similar consumer products can be encoded in quite different ways.

## (5) Transinformation

The concept of transinformation (mutually shared information indicating how closely two entities are linked) is pertinent to international education contexts. Simply stated, for an effective data exchange communication between two entities, a degree of shared information appears to be optimal.

Since transinformation may be a new concept, it is worth explaining carefully. As Figure 1 suggests, transinformation is a mathematical way of indicating how much information that two entities, say X and Y, share in common.

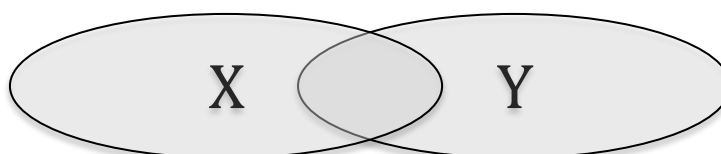


Figure 1. A graphic representation of the transinformation between two fields.

In Figure 1, the darker central area represents transinformation shared by both X and Y. Let us suppose X is a group of people conducting an overseas education program and Y are potential program participants. If X and Y both knew precisely the same things about a given topic, they would have perfect transinformation. However, there would be no new information to learn about that given topic. However, if the gap between their common knowledge of X and Y about a given field was too wide, then mutual understanding or effective communication would be difficult. On a social level, this suggests that there should be a degree of shared background information for optimal communication to take place. A scenario with zero transinformation would be akin to an alien encounter: when an insufficient amount of mutually shared information is present, the transinformation level is low. When transinformation levels are low, outcomes become statistically uncertain. For example, when studying abroad in places where familiar linguistic codes cease to function, often people rely on very basic body language and gestures to communicate (Surkamp, 2014). In such scenarios, the chances of error are high and the information exchange rate is slow. Study abroad participants who have undergone some pre-departure training and target language training should—at least in theory—have higher transinformation levels than unprepared novices. In

other words, they should be more adept at error-correction protocols and be able to exchange information at a faster rate.

Perhaps the most useful way for educators to interpret transinformation is in terms of Vygotsky's (1934, [1962]) *zone of proximal development*. If there is too much transinformation, chances are there will be a lack of novelty or a sense of overfamiliarity: not much learning is apt to occur in such scenarios. However, if not enough transinformation is present, the dissimilarities may seem too vast and tasks will likely seem too alien. The Japanese adage *tsuki to suppon* conveys this concept aptly, suggesting an insurmountable gap that can exist between two objects. In such situations, communication breakdowns become frequent and learning outcomes are uncertain. Ideally, a mixture of new and old information should be present to facilitate mutual understanding and communication.

Transinformation levels can be increased by adjusting messages to the target audience, utilizing an appropriate body language for a given target audience, and providing a sufficient degree of *data redundancy*—repetitions of previous signals. As stated earlier, humans are really “noisy receivers” with a lot of internal chatter at any given point in time, and chances are other messages are occurring simultaneously.

## Conclusion

This paper has briefly elucidated five concepts from information theory and described their significance in study abroad contexts. Reading this paper, some people might question whether information theory provides a working model of actual mathematical processes or merely a set of metaphors with some heuristic value. The answer is that information theory can probably be used both ways—with several important caveats.

First, information theory has a tendency towards reductionist simplification. As Lakoff and Johnson (1999) suggest, people are much more than disembodied signals. Despite this, viewing people in terms of the messages they are sending/receiving—and more importantly *how* those messages are being sent/received—offers one useful way to interpret trans-cultural and trans-lingual experiences. As Allen (2007, p.247) asserts, each theoretical lens probably comes with its own set of biases. It would be foolish to suggest that information science is the *only* useful way of interpreting trans-cultural and trans-linguistic data, but I believe that information theory merits a wider degree of use in our field.

Second, many of the developmental changes reputed to occur from study abroad are not easily quantifiable: often the data does not seem to fit into neat algorithms. We are currently seeing some attempts to quantify at least some the changes that may occur as a result of overseas experiences. The Intercultural Development Inventory (Hammer, 2012) represents an example. However, the fact that this instrument is a commercial product that is not open to independent examination makes independent validation difficult. It seems likely that as more statistical software becomes widespread and the field of study abroad matures we will see increasingly sophisticated attempts to quantify some aspects of foreign language and intercultural learning. This does not imply that qualitative research is without value. However, quantitative results—if based on valid assessment procedures—have a greater degree of *information density* than qualitative results. Simply stated, more information can be expressed with fewer words quantitatively. The problem is that many end-users may not know how to interpret such rarified quantitative information. Since assessment literacy skills are often not adequately taught in many tertiary educational contexts (Newfields, 2006, p.50), this is not a surprise.

A third limitation to the widespread adoption of information theory is that many people do not understand the mathematics underlying it. A basic understanding of integral calculus, set theory, and topology is needed to adequately comprehend information theory. Perhaps a degree of what Brown (1910) describes as “mathematical intelligence” or Gardner (1989) terms “logical-mathematical intelligence” is also a requisite to appreciate this theory in depth.

Without a mathematical grounding, the actual mechanics underlying information theory are apt to appear arcane or enigmatic. However, the fundamental concepts of information theory—even without the mathematical detail—have a useful degree of explanatory value. It can offer a practical window to reinterpret how people often change as a result of new information. In conclusion, it is worth remembering we are not merely passive information consumers: we modify the signals we receive and manipulate information both consciously and unconsciously (Salti, et al., 2015). Hence, even those without backgrounds in mathematics can appreciate the core ideas of information theory and the logic upon which information theory is based.

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Appendix A. The top page of the *Study in Japan* website as it appeared in September 2017



**Appendix B.** The top page of the Taiwan Foundation for International Cooperation in Higher Education website as it appeared in September 2017


**財團法人高等教育國際合作基金會**  
 Foundation for International Cooperation In Higher Education of Taiwan


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**學華語到臺灣 永難忘懷的青春旅程**

為吸引國際青年學子來臺學習華語，財團法人高等教育國際合作基金會今（7）日發表「學華語到臺灣」微电影（Learning Chinese in Taiwan），由多位國際學生擔綱演出，以清新風格傳達臺灣華語教學活潑、正體中文、學習與生活完美融合等特色，強調未來不管是在臺求學、工作或是回到自己的國家，在臺灣學習的回憶都將是一生永難忘懷的青春旅程。

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國際學生溫暖分享 留學臺灣的收穫與成長

網路已是年輕世代最重要的資訊管道，為了鼓勵更多海外國際學生來臺留學，基金會近年除經營Study in Taiwan 臉書專頁外，亦持續拍攝在臺國際學生專訪紀錄片，分享在臺留學成功經驗。首支曝光的影片是來自淡江大學的何希瑞同學，他在專訪影片中表示.....

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