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Promoting Construct Validity in Instruments for the Analysis of Transcripts of Online Asynchronous Discussions

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Abstracts

This paper describes the testing and refinement of an instrument for identifying and measuring Problem Formulation and Resolution (PFR) in online asynchronous discussions (OADs). The instrument was used to analyse a transcript of an OAD designed specifically for PFR with 30 participants in an undergraduate course for teachers in training. Results revealed construct under-representation, construct irrelevance, as well as lack of discriminant capability, or mutual exclusivity in some of the instrument's processes and indicators. The paper presents a second iteration of the instrument, which is informed by analysis of the transcript. The process of testing and redesign provides an approach to investigating and promoting construct validity using instruments for the analysis of communication and learning in transcripts of OADs.

Förderung der Zuverlässigkeit von Instrumenten zur Analyse von Transkriptionen von Asynchronen Online Diskussionen (OAD)

Dieser Beitrag beschreibt das Testen und Verbessern eines Instruments zur Feststellung und Messung von Problemformulierung und – Lösung (PFR) bei asynchronen Onlinediskussionen (OAD). Das Verfahren wurde zur Analyse einer Niederschrift einer OAD benutzt, die speziell zu einer PFR mit 30 Teilnehmern eines Lehrerausbildungskurses angesetzt war. Die Ergebnisse enthüllten sowohl Unterrepräsentanz als auch Bedeutungslosigkeit von Gedankengängen, Fehlen von Unterscheidungsmöglichkeiten wie auch gegenseitiges Ausschließen von Methoden und Indikatoren des Programms. In diesem Beitrag wird die nach der Analyse der Niederschrift verbesserte zweite Version des Werkzeugs vorgestellt. Der Prozess des Testens und der Weiterentwicklung stellt gleichzeitig eine Verbesserung der Erforschung und des Validitätszuwachses von Analyseinstrumenten für die Kommunikation und das Lernen mit Hilfe von Transkriptionen von OADs dar.

Comment favoriser la validation des variables dans les instruments d'analyse des transcriptions de discussions asynchrones en ligne

Cet article décrit les essais et l'affinage d'un instrument servant à identifier et à mesurer la Formulation et al Résolution des Problèmes (FRP) dans les discussions asynchrones en ligne (DAO). Cet instrument a été utilisé pour analyser la transcription d'une DAO conçue spécialement pour la FRP avec 30 participants inscrits dans un cours de premier cycle de formation initiale des professeurs. Les résultats ont fait apparaître des variables en cours de représentation, des variables non pertinentes, un manque de capacité de discrimination, voire même des incompatibilités, dans quelques uns des processus et indicateurs de l'instrument. Cet article présente un deuxième emploi de l'instrument qui se fonde sur l'analyse de la transcription. Le processus d'essai et de refonte fournit un mode d'approche pour l'étude et la promotion de la validité des variables lorsqu'on emploie des instruments pour analyser la communication et l'apprentissage dans les transcriptions des DAOs.

Introduction

Content analysis of online asynchronous discussions (OADs) has received attention from researchers interested in constructs such as social presence and collaboration (e.g. Roschelle & Teasley, 1995; Rourke *et al.*, 2001a), problem-solving (e.g. Jonassen & Kwon, 2001; Murphy, 2004), interaction and knowledge construction (e.g. Gunawardena *et al.*, 1997; Kanuka & Anderson, 1998), and critical thinking (e.g. Bullen, 1998; Garrison *et al.*, 2001). As Gunawardena *et al.* (1997, p. 398) observe, analysis of transcripts of OADs is necessary in order to, 'assess the quality of interactions and the quality of the learning experience in a computer-mediated conferencing environment'. The analysis is typically conducted using models or instruments that define and

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operationalize the construct being investigated and that '… assist participants and investigators in understanding the learning …' (p. 426) taking place in the discussion.

Use of such instruments has led researchers to identify challenges and issues related to their design and application in transcript analysis. Rourke *et al.* (2001b) outline four methodological challenges in the analysis of transcripts, including objectivity, reliability, replicability, and systematic coherence. Henri's (1992) model for cognitive analysis, while seminal, lacked mutual exclusivity between coding units, or 'discriminant capability' (Fahy, 2001, p. 3). The results of coding a transcript for social construction of knowledge led Gunawardena *et al.* (1997, p. 427) to 'question both the validity of the instrument and its theoretical underpinnings'. Kanuka and Anderson (1998) concurred with Gunawardena *et al.* in observing that, while the model was accurate in assessing the construct, ambiguity between the coding categories or processes presented a challenge.

One issue that has not been directly addressed in the literature related to use of models and instruments for the analysis of transcripts of OADs is that of construct validity. The usefulness and value of instruments for analysing transcripts of OADs lies in their ability to accurately measure the construct or process (e.g. Problem Formulation and Resolution) they purport to measure. Ensuring a high degree of construct validity, therefore, must represent an essential pre-occupation in the design and use of such instruments. Validity can first be established theoretically using a framework that conceptually defines the construct. The construct can then be further defined and refined empirically through analysis of its manifestations in real contexts, such as what might be evidenced in communication and learning in an OAD. Finally, 'the empirical evidence must be interpreted in terms of how it clarifies the construct validity of the particular measure being tested' (Carmines & Zeller, 1991, p. 23).

Analysis of a transcript requires an instrument that supports identification of evidence of how the construct is operationalized in a given context. To be effective, the design of these instruments must overcome three threats to construct validity. These are: construct under-representation, which is the inability of an instrument to adequately define or encompass important aspects of the construct (Cook & Campbell, 1979; AERA *et al.*, 1999); construct irrelevance, or the tendency to include irrelevant constructs distinct from, or surplus to the intended construct to be measured (Cook & Campbell, 1979; AERA *et al.*, 1999); and lack of discriminant capability, a feature that, according to Fahy (2001, p. 3), refers to the ability of an instrument to 'readily and unambiguously [permit] placing of conference content into discrete and useful categories'. Discriminant capability includes the need for mutual exclusivity and low ambiguity between categories and codes within an instrument. Minimizing these threats represents a necessary achievement in order to design effective instruments.

This paper reports on the testing and redesign of an instrument for the identification and measurement of ill-structured Problem Formulation and Resolution (PFR) in an online asynchronous discussion. The purpose of the testing was to determine how and to what degree the instrument could be refined in order to promote greater validity of the construct of PFR. Results of the testing provide practical illustrations of construct under-representation, irrelevance, and lack of discriminant capability in the instrument's processes and indicators. A second iteration of the instrument is presented that minimizes these threats. The paper presents an opportunity to investigate methodological issues and challenges related to transcript analysis in general. More specifically, it focuses attention on the importance of construct validity as a foundation or starting point for successful attempts at assessing the quality of communication and learning in OADs.

Methodology

The instrument tested in the present study is a first iteration designed for the identification and measurement of PFR in an OAD (see Murphy, 2004). The instrument consists of two main categories: Problem Formulation and Problem Resolution. Three processes are associated with each of the categories, and each process is further described by indicators that detail more specifically how engagement in the processes may manifest itself in a context of an actual discussion centred around formulating and resolving a problem. The instrument also provides examples for each indicator. A conceptual framework of ill-structured problems and problem-solving (e.g. Voss & Post, 1988; Kelsey, 1993; Jonassen, 1997, 2000) supported the establishment of the two main categories and associated processes.

In the study reported on in this paper, the instrument was tested by applying it to the analysis of a transcript of an OAD. The OAD is designed specifically for solving problems in collaborative environments and is part of a learning module for teachers in training. The module also includes problem-related video segments, research-based articles, and an online asynchronous discussion with a general description of the problem, and

a series of prompts designed to engage participants in PFR. Participants were 30 teachers in training enrolled in a French-as-a-second-language methods course, who volunteered to use the learning module for 4 weeks during the Fall of 2003.

When participants had completed the learning module, the transcript of the OAD was analysed using the instrument. Only one coder completed the analysis. There was no check for inter-test variance (Krippendorff, 1980) to verify a possible change in the coder's judgement over time. While reliability in coding is an important issue (see Rourke *et al.* (2001b) for a discussion of this issue), the emphasis in this study was on an investigation of issues related to construct validity.

While the transcript contained 315 messages in total, only 280 messages were coded using the instrument. The remaining 35 messages were not problem-related, and consisted primarily of participants' introductions. The method of analysis was based on the thematic unit (see Gunawardena *et al.* (1997) for a discussion on unit of analysis), and did not account for repetition of a particular code; for example, a message containing multiple solutions for the problem was assigned only one code, as opposed to coding each instance of the solution separately. In this method of analysis, one relatively short message might contain evidence of several different indicators, whereas longer messages might contain few or just one indicator.

Testing of the instrument provided an opportunity to identify instances and examples of when the instrument failed to effectively support analysis of the transcript. The failings resulted from construct under-representation, construct irrelevance, and lack of discriminant capability in the instrument. These failings are described in detail in the next section, and are discussed in relation to the three threats to construct validity. The discussion is followed by a second iteration of the instrument, which is designed to minimize these threats.

Results of testing of the instrument

Table 1 shows the results of the testing of the first iteration of the instrument based on 280 messages. As noted previously, the results are based on the number of messages receiving a code, and did not include messages for which no process of PFR was found. Table 1 shows the number of messages containing codes for each of the processes in the instrument. For example, 118 instances of the process *Viewing Perspectives* were coded for within a total of 280 messages. The percentages do not total 100%, as each message may have contained more than one process.

The first process in the Problem Formulation category is *Articulating the Problem Space*, which is described as, 'specifying what the problem is that must be discussed', and 'setting up broad boundaries within which the problem can then be further represented, identified, formulated and understood' (Murphy, 2004, p. 8). The instrument does not include indicators related to this process. In place of an indicator is the mention that the problem is *Determined in advance in the OAD*. For this reason, the instrument does not support coding of this process. However, analysis of the transcript revealed that participants engaged in (1) agreeing with the problem as stated; (2) redefining the problem space, or shifting the focus of the original question, without completely digressing from the problem space; and (3) articulating problems outside of, or peripheral to the problem space.

Table 1 *Results of the testing of the instrument*

	Instances of this process (out of total 280 messages)	
Process	Number	Percentage
Problem formulation		
Articulating problem space	Not coded	Not coded
Viewing perspectives	118	42.1%
Building knowledge	79	28.2%
Problem resolution		
Identifying solutions	142	50.7%
Evaluating solutions	109	38.9%
Acting on solutions	19	0.7%

The second process associated with Problem Formulation in the instrument is *Viewing Perspectives*. Analysis of the transcript revealed ambiguity with the process's first and second indicators: *Perceiving causes and/or contexts of the problem*; and *Understanding the nature of the problem and the ways in which it manifests itself*. The term 'context' of the problem does not demonstrate a good fit with 'perceiving causes of the problem', as 'context' implies a broad notion of interpretation. During the analysis of the transcript, 'causes' appeared as specific contributing factors to the problem, as opposed to the general context. The terms 'context' of a problem and the 'nature' of a problem can overlap. Furthermore, the term 'nature' of the problem is not the same as 'ways in which [the problem] manifests itself', where nature indicates the essential make-up, or characteristics of the problem, and manifestation implies the results or what is made evident from the problem. The third indicator, *Determining the extent of the problem*, was identified in the transcript, and in addition to defining the enormity or complexity of the problem, participants also appeared to define the extent of a problem through minimization or denial of the problem.

The third process of Problem Formulation outlined is that of *Building Knowledge*. The first indicator in this process, *Identifying unknowns or gaps in knowledge*, was clearly represented in the transcript. Yet, transcript analysis revealed ambiguity with the second indicator, *Accessing and reporting on external sources of information*. By 'external sources' was it meant external to the discussion, to the problem, or outside of one's own perspective? The third indicator, *Determining the value of information*, could be interpreted as determining the value of *any* information, such as the perspective of another participant, or could be seen as determining the value of external information, as defined in the previous indicator. The final indicator in *Building Knowledge* refers to, *Reflecting on one's own thinking*, and was easily identified in the transcript.

The category Problem Resolution begins with the process of *Identifying Solutions*. For this process, the instrument distinguishes between: (1) *Proposing solutions and strategies without justification*, and (2) *Proposing solutions and strategies with justification*. The distinction between proposing solutions with or without justification could be coded for in the transcript. However, this distinction appeared to be irrelevant to participants' engagement in PFR. Where the indicators presented difficulties was in the lack of exclusivity in the terms 'solutions' vs 'strategies'. Use of two distinct terms within each indicator, encompassing both solutions and strategies together, presented confusion in the coding. A solution is a more complete response to the problem, whereas a strategy is a component of a solution or a technique.

The process of *Evaluating Solutions* includes the indicators, *Agreeing with solutions proposed by others*, and *Weighing alternative solutions*, which were clearly identified in the OAD. The next indicator, *Critiquing solutions proposed by others*, appeared in the transcript in examples where participants judged and assessed the feasibility of solutions. However, the transcript revealed instances whereby participants critiqued solutions that they themselves had proposed in previous contributions—an activity unaccounted for in the instrument. Therefore, deletion of the words *proposed by others* would allow for the inclusion of critiquing one's *own* solutions in addition to the solutions of others. In addition, participants in the OAD hypothesized about solutions, using if-then structures that included the potential consequences of their solutions. In a process of PFR, appreciating the consequences of proposed solutions represents an appropriate, even necessary step in arriving at Problem Resolution. However, the instrument presented no indicators to account for this behaviour. The final indicator in this process, *Rejecting/eliminating solutions that are judged unworkable*, was identified in the transcript.

In the process of *Acting on Solutions*, the indicator *Planning to act* presented a challenge to coding in that there were cases where participants indicated intentions, but did not explicitly state a plan of action. Instead, they may simply have reached a conclusion, arrived at an understanding of the problem, or brought closure to the problem. There was, however, no indicator to represent this type of behaviour.

Discussion of the results

The previous section of this paper presented the results of testing the instrument in the analysis of the transcript of an OAD. The section highlighted the successes and challenges in this process. This discussion elaborates on these challenges within a framework of construct under-representation, construct irrelevance, and lack of discriminant capability. A second iteration of the instrument is provided based on the results and on the discussion.

Construct under-representation provides a perspective from which to interpret the results. Four of five processes related to PFR were distributed evenly with coding for 118, 79, 142, 109 instances of the first four processes. In contrast, only 19 instances of the final process were coded for. Gunawardena *et al.* (1997) encountered a similar pattern in their results of analysing a transcript for evidence of knowledge construction. Their

Table 2 *Illustration of clustering of results of coding*

Present study		Gunawardena *et al.* (1997)	
Viewing perspectives	118	Phase I:	191
Building knowledge	79	PhaseII:	5
Identifying solutions	142	Phase III:	4
Evaluating solutions	109	Phase IV:	2
Acting on solutions	19	Phase V:	4

results, however, presented a starker contrast between their five processes, which they refer to as phases. Results of their testing revealed 191, 5, 4, 2, 4 instances in phases one-to-five, respectively. Table 2 shows the clustering of results for both studies.

The similarity between their results and those presented in this paper lies in a clustering of instances of behaviours into certain processes or phases. For example, in the present study, instances of processes were distributed over four of the five processes, with one process presenting few instances. Likewise, Gunawardena *et al.*'s (1997) analysis shows a clustering of results in one of five phases. In their interpretation of these results, the authors questioned whether the results indicated lack of support for construction of knowledge, which was the construct they were measuring, or whether the instrument 'had failed to document that construction' (p. 427). Fahy (2001) commented regarding their results that their tool or instrument was a poor discriminator. Kanuka and Anderson (1998, p. 64) used the same instrument, and observed 'the overwhelming number of messages coded to the first phase (Phase I: Sharing/Comparing) of knowledge construction'. They 'concluded that the model needed fewer and more explicit boundaries between phases' (p. 70).

The problems encountered by use of the Gunawardena *et al.* (1997) model can be interpreted from the perspective of lack of discriminant capability in the instrument. In the case of the results reported on in this paper, however, lack of discriminant capability does not appear to account for the distribution of instances of the various processes. In fact, with the exception of the final process of *Acting on Solutions*, the instances are very evenly distributed as compared to Gunawardena *et al.* (1997). The presentation of the findings revealed instead that there were ways that participants engaged in *Acting on Solutions* that were not accounted for in the instrument. Only one indicator, *Planning to act*, is provided in the instrument for this process, compared to an average of three or four for the other processes. It was noted, however, that, at the end of the discussion in the OAD, a pattern emerged of concluding and bringing closure to the problem. Although these behaviours reflected engagement in Problem Resolution, they were not represented by the indicators in the instrument. The addition of indicators to this process might produce more codes in this category.

A similar challenge was encountered with the first process. Construct under-representation was most evident in this first process of *Articulating Problem Space* in the category of Problem Formulation. The addition of indicators was required in order to account for behaviours manifested in the transcript, but that were absent in the first iteration of the instrument. Participants' tendency to redefine, minimize, or even deny the problem needed to be reflected in the instrument in order to accurately represent the construct of Problem Formulation.

Construct irrelevance was not an issue in the analysis of the transcript. Every indicator present in the instrument was coded for in the transcript. Only one instance of construct irrelevance was observed. The second process of *Viewing Perspectives* failed to represent an accurate label for the indicators that were associated with this process. These indicators were so closely related to those in *Articulating the Problem Space* that they could be included in that process, thus making *Viewing Perspectives* a surplus, and irrelevant process.

Numerous instances of lack of discriminant capability were observed when applying the instrument to the analysis of the transcript. Ambiguity in wording and lack of exclusivity between terms made necessary the omission, as well as substitution of words from indicators to avoid overlapping terms and confusion of meaning. For example, *causes and/or contexts* and *strategies and solutions* were reduced to *causes* and *solutions* in each of the respective indicators. The indicator *Understanding the nature of the problem and the ways in which it manifests itself* was made simpler and clearer by a substitution with the indicator *Specifying ways that the problem manifests itself.* These three changes to the wording of the indicators made for a less cumbersome instrument and promoted clarity in understanding and interpretation. To further promote discriminant capability, certain verbs in the indicators were substituted. The verbs that were chosen to replace those in the instrument were meant to more

easily refer to or label the types of behaviours that were observed in the OAD. Thus, the indicator *understanding* (the problem) was replaced by *specifying* (the problem). The user of the instrument may more easily observe an example of attempts of a discussant to *specify a problem*, whereas *understanding the problem* may be a less easily observed behaviour.

The aforementioned examples provide insight into how an instrument can be refined in order to promote construct validity. Table 3 presents the second iteration of the instrument.

Conclusion

The study reported on in this paper provided an opportunity to promote construct validity of Problem Formulation and Resolution through testing an instrument that identifies and measures manifestations of the construct in a real context of communication and learning, such as in an online asynchronous discussion. Three threats to construct validity framed the analysis of the transcript of the OAD. Identification and elimination of instances and examples of construct under-representation, construct irrelevance, and lack of discriminant capability presented a means to refine the instrument. The second iteration of the instrument is designed to promote greater construct validity than the original or first iteration of the instrument by more precisely defining operationally the construct.

Construct under-representation presented the most obvious threat to promoting construct validity in the design of the instrument for measurement of PFR. The capacity of the instrument to represent the ways that participants engaged in PFR in the context of the OAD was enhanced by the addition of indicators. Few instances of construct irrelevance and surplus constructs were uncovered in the instrument. The selective addition of indicators in the first and last processes of *Articulating Problem Space* and *Acting on Solutions*, respectively, presents examples of how the representativeness of the construct was enhanced. The collapsing of the processes *Articulating Problem Space* and *Viewing Perspectives* into one is an example of how construct irrelevance was reduced. Instances of discriminant capability were observed in the indicators. The elimination and substitution of terms reduced opportunities for misinterpretation, ambiguity, and confusion.

The value and importance of attempts to promote construct validity using instruments for the analysis of OADs relates to a need for researchers to evolve methods for analysis of communication and learning in OADs. Their value and importance lie as well at a practical level. Instruments such as the one presented in this paper can provide support to instructional designers in the design of OADs for specific learning purposes. Such instruments can potentially support students in their efforts to engage more effectively in processes such as Problem Formulation and Resolution, knowledge construction, collaboration, or critical thinking. Finally, instructors can make use of this type of instrument as a starting point for rigorous and systematic attempts at evaluating learners' participation in OADs. To further promote construct validity, testing in varying contexts with other transcripts is needed. Such testing might also include a number of coders and a focus on inter-rater reliability.

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Table 3 *Second iteration of an instrument for identifying and measuring PFR in an OAD*

Process	Indicator	Example
Problem formulation		
Defining problem space	Agreeing with problem as presented in OAD.	… there is a problem with getting students to speak French in the classroom, or for that matter to get the teacher to speak French in the classroom.
	Specifying ways that the problem manifests itself	The reality is that students will use English, or their first language to communicate as often as possible.
	Redefining problem within problem space	Perhaps the ultimate question really should be: when should L1 be used in the classroom, what contexts make it acceptable and beneficial to speak English instead of French?
	Minimizing and/or denying problem	I would argue that you can indeed use English in the Core French classroom.
	Identifying extent of problem	It seems to me that this issue of French/English use in the classroom will be one of the biggest challenges we will face as teachers.
	Identifying causes of problem	My understanding of the problem is that core French teachers are unsure of how much French to use because they don't know how much their students will understand.
	Articulating a problem outside problem space	I believe it is true that non-English speaking children are losing their mother tongue through the education system. Look at the focus of our ESL programmes.
Building knowledge	Identifying unknowns in knowledge	How can we reach those students who have below grade level skills, and provide them with some understanding of the target language?
	Accessing and reporting on sources of information	According to the author, pupils should be allowed to use English between themselves while working in teams.
	Identifying value of information	This article was not effective in teaching me about this problem.
	Reflecting on one's thinking	Once again, the negative view I previously had on this problem is becoming increasingly more positive.
Problem resolution		
Identifying solutions	Proposing solutions	I feel teachers need to use French more if they expect their students to use it.
	Hypothesising about solutions	I believe that if a teacher were to make mistakes and correct them in front of a class, it would ease the students' minds about making mistakes themselves and enable them to correct themselves as well.
Evaluating solutions	Agreeing with solutions proposed by others	I agree strongly with participant 6's views. Especially for Immersion students.
	Weighing and comparing alternative solutions	I sincerely believe that using the target language 100% of the time creates a stagnant environment for learning. On the other hand, too much use of English would only serve to 'baby' students.
	Critiquing solutions	While I agree somewhat with participant 3, I think some students at lower levels may become too frustrated when trying to learn the language when a teacher uses only French.
	Rejecting/eliminating solutions judged unworkable	I don't think it is right to start the year off with a solid plan of attack.
Acting on solutions	Planning to act	Personally, I have decided to speak English the first day of classes.
	Reaching conclusions, or arriving at an understanding of problem	The methods which all of these sources have suggested prove that language use in the classroom is a major problem, but is also easily mended with use of the proper tools, and creativity.

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