Preprint

This is the submitted version of a paper presented at EARLI SIG 9 Conference on Phenomenography and Variation Theory.

Citation for the original published paper:

Thota, N., Berglund, A. (2012)
At the crossroad of computer science and intercultural interactions: A framework for analysis and interpretation.
In: EARLI SIG 9 Conference on Phenomenography and Variation Theory Sweden: Jönköping University

N.B. When citing this work, cite the original published paper.

Permanent link to this version:
http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-180897
At the Crossroad of Computer Science and Intercultural Interactions: A Framework for Analysis and Interpretation


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Abstract
In an on-going study, we explore the relationship between the learning of computer science and how this learning takes place. We focus on Chinese students studying in the intercultural learning environment of a master programme in Sweden. We propose a framework based in phenomenography, which accounts for the complex relationship between the computer science content and the experienced learning situation in which the students develop skills and competences. It is in this relationship that we expect to identify the learning outcomes (theoretical knowledge and practice skills in computer science) and capabilities (intercultural competences) that the learners master. We analyse the variation in learning in the knowledge domain, and we use cultural competency theories to interpret the experience of learning in the intercultural context. Our framework is empirically grounded in our analysis of data from an earlier study that revealed that the interaction of the computer science content and the intercultural contexts in classrooms led to changes in the learning skills and understanding of computer science and to changes in students’ attitudes.

1. Relationship between Computer Science and Intercultural Interactions
In this paper, we argue that the content of Computer Science (CS) and the development of intercultural competencies are so closely linked, that they are the object of learning and cannot be analytically separated. We propose a methodological framework for analysing and
interpreting the data that we are gathering. The genesis of the framework is empirically based in the data we have previously collected in 2008. Note that this paper does not report the results of the on-going analysis. Instead, we assume the study as a typical phenomenographic study, gain knowledge from the data of students’ experiences, and take it as our starting point.

Computer Science education at the university level introduces a student to a culture that is unique to the discipline. Knorr-Cetina (2007, p. 363) refers to this as the *epistemic culture* of a scientific community that is generated from the practices and knowledge producing activities in a discipline. CS itself is characterised as a hard and applied science that is pragmatic and concerned with the creation of products and techniques (Biglan, 1973). However, the theories, concepts, and practices of CS vary across institutions and a key issue for universities is how students learn and apply them in their own practice.

When Asian students choose to study abroad, they bring with them the values and norms of their own cultural backgrounds. Social culture is rooted in traditions and social practices and seeks meanings through shared beliefs and communication (Becher, 1994). Little is known on how this influences, and is influenced by the understanding and learning of the subject area of CS. The interaction of disciplinary learning with cultural and sociocultural practices creates possibilities for researchers to explore variations in learning and teaching CS in a culturally diverse environment. An awareness of such variations is helpful, and essential, to the conduct of CS research and the development of policy in education institutions that teach CS.

In general, research within CS education aims to reveal how students understand concepts within the subject area, as well as how they go about learning these concepts. The aim is two-fold: (a) to enhance our understanding of how students understand concepts within CS (and, in this way, to also get a broader perspective on CS as such); (b) to offer a tool to improve education in CS, at schools and universities. In recent years, the forces of internationalization of education programs and the globalization of the job market have led to the increase of international students in higher education institutions (Otten, 2003). These forces have created opportunities for intercultural interactions in CS classrooms.

At Uppsala University (UU), Sweden, the interaction of disciplinary and sociocultural practices creates opportunities for researching the experiences of international students when they study CS. The Uppsala Computing Education Research Group, UpCERG¹, is internationally recognised within this field. Much of the research performed by the group (for example Berglund & Eckerdal, 2006; Bernáld, Cajander, Daniels, & Laxer, 2011; Laxer, Daniels, Cajander, & Wollowski, 2009) explores learning in cross cultural learning situations. The complex relationships between what the students strive to learn and how they understand CS concepts, when taking an internationally distributed course, are highlighted in Berglund (2005).

¹ http://www.it.uu.se/research/group/upcerg_new/publications
There is a paucity of research done on CS education in China, but an overview of undergraduate computing education can be found in some papers (see Xiaoming & Lunt, 2006; Zhang & Lo, 2010). Two publications from UU discuss the effects of internationalisation on changes in learning and teaching of CS (Yang & Berglund, 2008), and on Chinese exchange students’ perceptions of their learning environment in Uppsala (Chen & Chen, 2007). Therefore, the goal of our research is to add to the knowledge base of such literature by empirically studying the intercultural interactions of Chinese students studying master level CS at Uppsala University.

In the next section, we present the relevance of studying the context of learning when investigating what and how students learn. We then review definitions and models of intercultural competence (section 3) in preparation for introducing our proposed framework for analysing and interpreting the experiences of the students. The design of our study (section 4) and the description of our analytical and interpretive framework (section 5) follow. We conclude (section 6) with our discussion of the implications of applying such a framework to our study and the significance of the expected contributions.

2. The Influence of the Context of Learning

In their seminal work on phenomenographic approach to analysing learning, Marton and Booth (1997) view a learning situation as experienced in terms of a socio-spatio-temporal location constituted of a context, a time and a place. The phenomenon that the researcher is studying is interwoven and mutually influenced by the situation in which it occurs, such that a focus on the situation and the phenomenon is required to gain a holistic understanding of the learning experience.

The importance of attending to the context, when studying a learning situation, is also highlighted by Adawi, Berglund, Booth, and Ingerman (2001). They emphasize the relationship between the context as experienced by the learner and the context as created and understood by the researcher. This relationship is seen from the perspective of the individual, the collective, or the researcher. The prepared context is defined and experienced by the researcher, while the experienced context is seen as being experienced by the learner to make sense of the learning phenomenon. It is in this experienced context that we seek to ground our study and argue that the intercultural context that Chinese students experience when they study CS at UU is closely linked to the object of their learning.

The context of learning experiences has been studied earlier in phenomenographic studies and has resulted in methodological frameworks that extend the traditional phenomenographic analysis approach. For example, Berglund (2005) argued that the variation in students’ experiences of their learning of the subject content and the variations in the experienced context are mutually constituted in a phenomenographic study. Based on this argument, activity theory was used to synthesize the analysis of the phenomenographic outcomes, and to provide a holistic account of the learning in the complex course setting experienced by students learning computer systems in a distributed project course. Ingerman and Berge (2011) focused on how studying physics in groups is grounded in terms of physics content, as
well as in the communicative and interactional aspects of group work. They synthesized the application of three theoretically independent analytical frameworks: (1) phenomenography and variation theory to discern focused variation in physics phenomena experienced by students in pedagogical settings; (2) position theory to relate personal growth and change to the context of studying, participation and practicing physics; and (3) conversation analysis to integrate the processes, products and interactional components with the possibilities for learning physics.

3. Focus on Intercultural Competencies

The acquisition of intercultural competencies can be seen as part of the development of professional competencies for CS students. In today’s globalised world, to remain competitive, international businesses seek interculturally competent employees who can manage cultural diversity (Hunter, White, & Godbey, 2006; Spitzberg & Changnon, 2009). An important attribute for CS and engineering graduates is the ability to function in multidisciplinary teams and to communicate effectively (Computing Accreditation Commission, 2004; Engineering Accreditation Commission, 2004). The ability to interact in heterogeneous groups and the ability to act autonomously in social contexts are key features of intercultural competencies required in many professions (Rychen & Salganik, 2005).

We note that the terms intercultural and crosscultural are often used interchangeably in the literature. In this paper, we accept the distinction that is made between ‘crosscultural’ as something which applies to more than one culture, and ‘intercultural' which implies interaction between the cultures in question (Bernáld et al., 2011). Many definitions of intercultural competence have been advanced. In essence, it is the appropriate and effective management of interaction between people who, to some degree or another, represent different or divergent affective, cognitive, and behavioural orientations to the world. These orientations will most commonly be reflected in such normative categories as nationality, race, ethnicity, tribe, religion, or region (Spitzberg & Changnon, 2009, p. 7).

The developmental stages of intercultural capabilities have been identified by researchers to span the core attributes of motivation, knowledge, skills, context, and outcomes (Bennett, 1993; Cross, Bazron, Dennis & Isaacs, 1989; Deardorff, 2006; Hammer, Bennett, & Wiseman, 2003; King & Baxter Magolda, 2005). The underlying assumptions are that cultural differences experienced during interactions in a situation or in an environment have the potential for developing increasingly more sophisticated intercultural competencies. The outcomes of intercultural interactions are seen as deeper awareness and understanding of the contexts, role, and impact of culture, the broadening of one’s worldviews, and the ability to use one’s intercultural knowledge, skills, and attitudes to communicate effectively and appropriately in intercultural situations (Deardorff, 2006).

Several problems have been identified in interactions between learners from different social cultures in studies of user interface design, usability evaluation, interaction with World Wide Web, information systems, computer supported collaborative learning, open-ended group
projects, and online learning (Daniels, Barker, Cajander, Laxer, & Moore, 2005; Egea, Kim, Andrews, & Behrens, 2010; Lu, Chin, Yao, Xu, & Xiao, 2010; Vatrapu, 2008). Some of these studies have reported issues related to crosscultural teaching in universities and the learning of Asian students in the IT field. However, within CS education research, the interactions of Chinese students with university level CS disciplinary culture and their culturally situated social experiences have not been explored as yet.

4. Exploring the Experiences of Chinese Students Studying CS

4.1 Earlier work in 2008

Many Chinese students are enrolled in master programs in CS at UU. A qualitative study was conducted in 2008. Data was gathered from 19 Chinese students about their perspective on the content of CS, on teaching and learning CS at UU, and on their own studies and personal development in Sweden. The data (not reported here) from open-ended email interviews reveals interesting insights into the experiences of the students and the capabilities they developed. This paper reports on the design and the theoretical underpinnings to explore the themes that emerged for data collected in a follow-up study in spring, 2012.

On inspection, the data from the 2008 study revealed there were differences in the subject content areas, and in the ways of learning computer science at UU and at Chinese universities. The students perceived the core of computer science at UU to be research based with theoretical and practical orientation. They identified the CS taught at their home universities as practice orientated with a focus on the job market. The differences in learning and teaching between UU and the students’ previous universities related to learning outcomes, assignments, teaching activities, learning tasks, and resources.

In the data from the 2008 study, the students reported the changes in the knowledge and skills that they had acquired, and also changes in their beliefs, feelings, and values from learning and living in Sweden. The outcomes of living in Sweden were seen as improvement in communicative and English language skills, being able to work collaboratively in teams, and an appreciation of different cultures and customs including the Swedish way of life, work attitude, and way of thinking. The students also mentioned developing the capability to live independently and of being able to make their own decisions in life.

The 2008 data revealed two interesting aspects worthy of further investigation. The first aspect related to the noticeable difference between the CS disciplinary cultures relating to what was taught and how the students learned CS at the different universities. The second aspect emerged from the students’ reflections about their own studies and life in Sweden and the perceived impact of their studies and stay for their future life. It appeared that the socio-cultural effect of studying and living in Sweden led to the distinct development of cultural sensitivities and competencies amongst the Chinese students.

4.2 On-going work in 2012

The specific aims of our on-going study in 2012 are to empirically address the following research questions:
1. What are the variations within *what* and *how* Chinese students learn when they study CS at UU?
2. What are the competencies that Chinese students develop from the intercultural interactions during their study of CS at UU?

The project is restricted to Chinese students to delimit the complexity that accrues from introducing participants from more cultures/nationalities. We used email interviews, which are a qualitative method of inquiry in educational research, to gather data. Through iterations of follow-up questions that are sent by the researcher, the method leads to increasing reflexivity and descriptive data from the respondents (James, 2007). Email interviews have previously been used for collecting deeply considered and rich data in a phenomenographic study of educators’ conceptions of student diversity in their classes (e.g. Gordon, Reid, & Petocz, 2010). In our case, the semi-structured email interviews provided the time and space for the students (who were non-native English speakers) to reflect on their experiences. The open ended questions enabled the participants to express their own ideas without researcher interference, while the follow-up questions enabled us to ask probing questions depending on the original response.

The interview procedure consisted of three e-mail interviews that we sent to the 2011-2012 cohorts of Chinese students studying masters in CS at UU. Nineteen students responded. We asked 25 questions concerning their opinion of the content of CS, of teaching and learning CS, their own studies in UU, and their personal development in Sweden. We followed up each reply with further questions about interesting or unexpected answers relevant to our study, as well as to further clarify the conceptions expressed by the student and to probe the understanding of the student’s experience. Two movie tickets were given to each participant as recognition of our appreciation for volunteering for the study.

5. The Framework for Analysis and Interpretation

The application of a framework for analysis and interpretation in our on-going study seeks to broaden the perspectives on the complex and interesting aspects of learning computer science in intercultural contexts. We address the contextual issues fundamental to learning CS within the intercultural interactions that students undergo. We propose phenomenography and variation theory for analysis of the interview data and cultural competency models for interpretation of the results. We deepen our understanding of the contextual issues of learning CS with the rationale that disciplinary culture and intercultural interactions in CS classrooms are deeply intertwined in a complex relationship that lead to changes in learning.
Figure 1, shows the key areas of focus for the three stages of the study: analysis, interpretation, and explanation. In stage 1, we perform phenomenographic analysis of the interview data and describe the phenomenographic outcome space identifying variation in learning CS. In the interpretive stage, we again use the interview data, as well as interpret the findings from stage 1. Using intercultural competency models, we identify the intercultural competencies the students gained from the interactions in CS classrooms. In the last stage, we explain our understanding of the complex relationship of the situation and phenomenon of learning set within the contextual and interactional aspects of learning CS. Finally, we describe the relational, contextual, and disciplinary outcomes expected from applying the framework. Sections 5.1 to 5.3 further explain how the analytical, interpretive, and explanation stages of our framework are designed and relate to the outcomes of the study (described in section 5.4).

Figure 1. Analysis and Interpretation Design. The text in *bold italics* indicates the key areas of focus for each stage of the study.

### 5.1 The Analytical Design

In stage 1 of the framework, the empirical basis of the study will be established in the qualitative analysis of the expressions of the students’ experiences. Phenomenographic analysis of interview data.
analysis (Marton, 1981) of the data will be carried out to reveal qualitative differences in the what and how aspects of learning CS, and to identify experienced variation and the knowledge domain relevance of that variation (see Figure 2).

The what aspect of learning CS

Following the reasoning in prior work that dimensions of variation in learning relate both to concepts and practice in CS (Eckerdal, 2009), we intend to identify the principal object of learning (the direct object) as what content and practice of CS are being learned by the students within the intercultural context of the classroom. The outcome of our analysis will be the description of the phenomenographic outcome space (Marton, 1981) revealing the variation in learning the content, concepts and practice of CS (see Figure 2).

![Analytical framework for study of intercultural experiences](image)

The how aspect of learning CS

The quality of the act of learning will then be identified as the how aspect of learning, which is related to the experience or way in which the learning is carried out in intercultural contexts. In turn, the how aspect should have its own aspects of how and what (see Figure 2). The former would refer to the act of learning CS or the experience of the way in which it is carried out in intercultural classrooms. The latter would refer to the capabilities (the indirect
object of learning) that the learners have mastered by learning CS and experiencing intercultural interactions. It is within the contextual grounding of the acts of learning in the intercultural interactions in the classrooms, that we expect to identify the indirect object of learning in the form of outcomes (theoretical knowledge and practice in CS) and capabilities (intercultural competences) that the learners have mastered.

The outcomes from this stage of analysis describe the logical structural relationships between the phenomenographic outcome space revealing the variation in learning the content, concepts and practice of CS and are further explained in section 5.4.

5.2 The Interpretive Design

The phenomenographic analysis is followed by stage 2 of the framework (see figure 1). In this stage, we interpret the learner’s subjective experience of learning CS in an intercultural context. By overlaying an interpretive component of the framework over the interview data and the phenomenographically analysed results, we seek to understand the learning phenomenon, the learning situation, and the learning outcomes embedded within the entire learning experience. The outcomes from this stage are context related and are further explained in section 5.4.

The rationale for our interpretive design is that the Chinese students who learn CS at UU experience intercultural interactions in the classroom when they engage in the learning tasks and in the engagement with students from different socio-cultural backgrounds. The specific learning task makes up the immediate theme of awareness (Marton & Booth, 1997) while through the cultural situatedness the students imbibe practices, values, and ways of thinking that they take to new learning contexts. Therefore, the students’ experiences of learning CS and adjusting to life in Sweden will be examined to discern the stages in the development of cultural competencies. The results will be interpreted using intercultural competency models and theories of cultural awareness (Bennett, 1986; Cross et al., 1989; Deardorff, 2006; King & Baxter Magolda, 2005).

Developmental models of intercultural competences show that such competences evolve over time (Spitzberg & Changnon, 2009). While an exhaustive review of all such models is beyond the scope of this paper, the main features of some well-known models are given here to indicate the kind of competences we expect to identify in our study. The Developmental Model of Intercultural Sensitivity (Bennett, 1993) sees individuals as acquiring increasing cultural sensitivity as they progress through six ethnocentric stages of denial, defence, and minimisation towards the ethnorelative stages of acceptance, adaptation and integration of another culture. Levels of progressive competence are also provided by the Intercultural Maturity Model (King & Baxter Magolda, 2005). In this model, the stages of initial, intermediate and mature development of intercultural competences are identified through three domains: cognitive, intrapersonal and interpersonal. The Pyramid Model of Intercultural Competences (Deardorff, 2006) represents motivational (requisite attitudes), cognitive (knowledge and comprehension), and skills that lead to desired internal and external manifestations of intercultural competences. The models display considerable similarity in
their identification of the conceptual orientations of motivation, knowledge, skills, context, and outcomes of intercultural competences (the interested reader is referred to Table 1.1 in Spitzberg & Changnon, 2009 for a listing of the concepts).

5.3 Explaining the Complex Relationship
In stage 3 of the framework (see figure 1), we seek to explain the complex relationship of the learning situation and the phenomenon of learning. In this stage we identify the learning outcomes (theoretical knowledge and practice skills in computer science) and capabilities (intercultural competences) that the learners master and relate them to the contextual and interactional aspects of learning CS in intercultural classrooms. The outcomes from this stage are disciplinary specific and are further explained in section 5.4.

5.4 The Expected Outcomes of the Study
There are three outcomes that we expect from applying the framework for analysis and interpretation in our study: relational, contextual, and disciplinary (see Figure 1).

- Relational outcomes:
  - Categories of description that capture what students learn in CS and the acts of learning CS. In each category the critical differences relating to the direct object and to the indirect object are highlighted.
  - An outcome space which describes the logical structural relationships between the categories. It represents the variations in conceptions with a hierarchical structure of increasing complexity.

- Contextual outcomes:
  - Interpretive results that are applicable to the learning context at UU and are related to the internationalization of the student intake.
  - Inferences in the form of recommendations to the local community of CS educators at the Department of IT, UU, and transferable by reflective practice (Schön, 1995) to other learning contexts.
  - A relational model to show the development and progression of intercultural competencies of Chinese learners studying CS in Sweden.

- Pragmatic disciplinary outcomes:
  - Insights that contribute to furthering CS education research and teaching and learning CS in intercultural and distributed classrooms.
  - Addition to the body of knowledge of what we know about the development of intercultural competencies during the interaction of disciplinary learning and sociocultural practices.
6. Discussion of the Issues of Applying the Framework

We have argued that CS content and the context generated capabilities are so closely linked that they are the object of learning and are inseparable. We see it as an artificial construct in this situation to separate the learning from the setting of the learning experience. Instead, we acknowledge that the framework that we have proposed is an analytic and interpretive tool that provides a way to theoretically discern and describe several important facets of a learning phenomenon where the experiences of learning and the cultural context are intertwined.

By unravelling some of the complexity of learning CS in intercultural situations, we plan to show that students’ learning of CS is not isolated from their cultural experiences. We are aware that the cultural models that we plan to use for our interpretive approach are derived from western contexts. There is however emerging literature on non-western perspectives on intercultural competencies (see Deardorff, 2009) that we are looking into. The western emphasis on individualism versus the eastern emphasis on collectivism as an ideal attribute (Hofstede, 1980) would also have to be kept in mind when interpreting the results. We therefore see it as part of our on-going work to exemplify from our own data that cultural differences cause the learning.

On a practical level, the application of our framework for analysis and interpretation of data in our phenomenographic based study is complex. The inspection of the data from our previous study in 2008 shows that students can discern the differences in the experiences of learning and that student cohorts share similar experiences of learning in and from a different culture. In our role as researchers in the current study, we adopt phenomenography to focus on meaningful phenomenon, identify the outcome spaces, and build relationships between the different critical aspects of learning in intercutural situations. We risk imposing another layer of researcher imposed constructs by applying cultural competence models to interpret the data. We address these issues by following guidelines (Collier-Reed, Ingerman, & Berglund, 2009) to distinguish the domains of the researcher, the individual and the collective participants, and by undertaking measures of credibility with regard to the content, method, and communication to be used in our research study.

Our analytical and interpretive framework opens the way for understanding the complex interplay between the students’ learning and the experienced learning situation embedded in intercultural interactions at several levels. We expect the outcomes of the study to make significant methodological, pedagogic, and disciplinary contributions.

- **Methodological contribution:** The theoretically underpinned study draws on previous experience in developing phenomenography and variation theory analytical frameworks. By attending to the contextual and interactional aspects of learning in intercultural classrooms, the current study contributes to increased methodological awareness of the role of context in the interpretation of learning experiences in the phenomenographic tradition.
Pedagogic contribution: The study opens for scrutinizing the perceptions, values and approaches of Chinese students towards their learning. The variations in the students understanding of CS have pedagogical implications that can help to improve learning in environments where students with different cultural backgrounds collaborate. Educators can integrate the findings into the planning of courses and teaching strategies for international students in general. The insights gained from the study in 2012 will be specifically used to improve the learning experiences of international students studying at UU.

Pragmatic disciplinary contribution: An awareness of intercultural interactions is helpful, and essential, for teaching and learning within the CS discipline. The study potentially offers new insights concerning sociocultural factors and development of competencies from the intercultural experiences, an area that has not been adequately explored so far in CS education research. The study will broaden the theoretical understanding and also contribute to the discourse of how, and to what extent, CS is culturally situated. With this understanding, we can better adapt the teaching of CS to cater for the diversity in global educational contexts.

In conclusion, this paper has attempted to describe a framework for analysis and interpretation of a complex learning phenomenon situated in an intercultural context. By maintaining an awareness of the intercultural context experienced by Chinese students during their study of CS, we further the understanding of how our experience of a learning phenomenon and its situation are mutually altered, transformed, and deepened.

7. References


