

**Characterize the Difficulties that International  
Computer Science Students Face**

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## **ABSTRACT**

International Computer Science students, who form the majority of students in Engineering colleges in the U.S (Anderson, 2013), face a lot of difficulties and barriers that are unknown and unexpressed. Hiding these struggles may affect the quality of their education, and will repeat the struggles over and over with the coming students. We conducted a qualitative study to discover the barriers that international Computer Science students have and their special needs. The data was collected by interviewing international Computer Science students and some of their instructors in the University of Colorado at Colorado Springs (UCCS). The study found that international Computer Science students have English barriers evaluated on the following dimensions: listening and understanding lectures, participating and expressing ideas, presenting, writing, and reading. Moreover, students have identified another set of difficulties, which is technical barriers based on educational background and the ability to deal with advanced software tools.

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# CHAPTER 1

## INTRODUCTION

Nowadays, in the era of globalization students travel far away from their home lands and obtain academic degrees. They travel not only to pursue their education, but also to learn another language and to taste the flavor of foreign culture. Andrade defines international students in the United States as “Individuals enrolled in institutions of higher education who are on temporary student visas and are non-native English speakers.” (Andrade, 2006) These international students in their learning journeys face divers difficulties and barriers due to the cultural differences. Hiding these difficulties may affect the students’ academic achievement and the quality of their education.

International students have different kinds of barriers including but not limited to the following: learning while living in a foreign culture, learning while developing English in the background (Arkoudis, 2006), difficulties in listening and understanding what the instructors expect them to understand, difficulties in expressing their ideas and participating in class discussions as well as American students, discomfort particularly in the beginning of their learning journeys because of being a minority and feeling foreign, and difficulties in finding jobs (Lee, 2007).

Even though International Student Affairs offices in most universities offer lots of services to facilitate the integration of international students, and to ease their educational experiences in the hosting universities and countries, international students still experience struggles and difficulties that are suffered silently.

In the literature, there is some research on international students’ adjustments

and the quality of the services provided by international students' departments in the universities. However, most of this research is either survey-based, which limits the results of the studies to the listed questions only, or based on interviewing the faculties and not the international students themselves. Also, little is known about the experience of computer science international students in American universities, even though they form the majority of the graduate students in the U.S. According to Anderson,

International students account for 70 percent of the full-time graduate students (masters and Ph.Ds.) in electrical engineering, 63 percent in computer science, 60 percent in industrial engineering, and more than 50 percent in economics, chemical engineering, materials engineering and mechanical engineering. These students represent a vital source of talented professionals, researchers and innovators for U.S. employers.<sup>1</sup>

The research question is: What are the difficulties that foreign computer science students face and what are their special needs? We conduct a qualitative study to reveal the barriers that international computer science students have, and discover the needs that have not been yet met. The data is collected by interviewing foreign computer science students and some of their instructors, as they are the only people who can tell us stories about the difficulties that international students face. We then quantify the narrative text and perform numerical analysis in an effort to identify key factors and attempt to predict student success.

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<sup>1</sup> (Anderson, 2013)

## CHAPTER 2

### REVIEW OF THE LITERATURE

(Arkoudis, 2006) in her article *Teaching International Students: Strategies to Enhance Learning* gave practical advice to help faculties to deal with the cultural and language issues when teaching international students based on interviewing some faculties and students. She provided some tips to encourage international students to better understand their lectures, and participate in their classes. She concluded that international students face the following challenges: pursuing their degrees while living in different countries and cultures and foreign universities contexts, developing their English proficiency in the background while learning, and learning the academic discipline in the foreign universities. Also, she suggested the following to create a better learning environment for international students: Having international curricula, making lectures accessible in different ways, such as watching the lecture online after the class to collect any missing information, educating international students about plagiarism and cheating, helping international students develop critical thinking, and clarifying the assessment expectation for the students. However, student's views were not the core of her work. In our work, we focused on the students' views and some instructors' views as well.

(Andrade, 2006) wrote a literature review about research done on international students' adjustment in English-speaking universities, and identified the factors that affect international students' adjustment and achievement. She concluded that the adjustment is correlated to English proficiency and cultural issues while the academic achievement is also correlated to English proficiency, educational background, and learning skills. It might be worth noting that these same problems are faced by

incoming (American) freshmen.

(Lee, 2007) performed a study to identify discrimination based on international students' views, to ensure continued enrollment in the U.S. universities. They interviewed 24 international students in one of the universities in the U.S. southwest. They found that international students, who are western or from an English speaking country, experienced no to minimal discrimination, while other international students experienced different kinds of discrimination including: discrimination in finding jobs, verbal discrimination and negative comments from some people, discomfort due to being foreign, and insult from some professors.

(Tran, 2008) performed a qualitative study to find how international students in different disciplines overcome struggles, and meet expectations. The study found that students' interactions and having conversations with instructors play a significant role in students' success in courses.

(Robertson, 2000) surveyed staff and students to discover the contextually relevant issues facing international students. This study is done in one of the Australian universities using a Delphi technique in which the participants are surveyed using open-ended questions in several iterations. They found that the English understanding barrier is at the heart of the difficulties that international students face. Also, some international students expressed that some faculty members are not interested in them. In addition, some faculty members see that international students do not take enough responsibility for their learning.

(Kingston, 2008) studied the experience of East Asian students who pursue their higher education in United Kingdom and the issues that they may have because

of belonging to the East Asian culture that emphasizes collectivism which is the opposite of the Western culture that emphasizes individualism. They brought some of East Asian students at London University into focus groups and asked them about their educational experiences. They also asked instructors about their experiences when teaching East Asian students to match the gap between students' views and instructors' expectations. Students were asked to complete a short bibliographical questionnaire prior to the start of the focus group.

The study concluded that the new generations of East Asian students are valuing deep learning and personal opinions even though they still exploit rote-learning strategy. Regarding lecturers, students noted that instructors' support is very important, and they cited the importance of founding a support system for instructors teaching international students. In respect to the assessment type, students indicated that the limited time exams are the most stressful kind of examinations due to the language difficulties. They also preferred the written feedback from their teachers as it gives more information. In addition, students expressed that group work is enjoyable as it provides them opportunity to build their own ideas in a supportive environment, and speak English with native speakers. (Kingston, 2008)

On the other hand, instructors indicated that they start viewing international students more positively instead of seeing them as problematic. They also noted that grammatical correctness is a common issue for international students. The study concluded that teachers must employ teaching methods to both meet the needs of both international and native students. (Kingston, 2008)

(Dunstan, 2007) surveyed 21 Australian institutions to discover the quality of international students' services. The study's focus is on the experience of the staff

who support international students. They found that the level of services given to international students is high and well established.

## CHAPTER 3

### PROBLEM AND METHODOLOGY

#### **Problem:**

International students are successful learners; Otherwise they would not satisfy the restricted conditions that universities require international students to meet prior to their acceptance, such as acquiring high scores in English proficiency tests and other educational assessment tests, such as GRE and JMAT. They also work hard during semesters to acquire more knowledge, but they have lots of barriers that require them to work harder and even harder. From own anecdotal experience and observation in lectures as an international student, second language English students are not only listening to the instructors and interpreting what the instructors are saying as native speakers do, but they are listening, translating in the background, and then trying to understand what instructors said. This process consumes their energies and sometimes causes them to be lost especially if the instructors use a lot of idioms and allude to historical events with which international students are unfamiliar. They usually have lots of questions regarding what has been said in the class and need to have the information repeated at least twice.

The difficulty in understanding the lectures as quick and well as native speakers is not the international computer science students' only problem. They also have problems working in group projects and feeling that others are not interested in them. This is what I heard from my colleague in one of her projects. These are only examples of what barriers computer science international students may face, but we believe that there are a lot of other barriers that remain unknown. In this study, we want to characterize the difficulties that international Computer Science students are

suffering from to help their instructors be aware of their needs, to give them better services, and to inform international students about the main categories of barriers that they may face. Once the common difficulties are known, international students can develop systematic strategies to better deal with them.

### **Challenges:**

First of all, before conducting this study that deal with human subjects, we had to get an approval letter from the Institutional Review Board (IRB), which can be a lengthy process.

The second challenge was to get enough participants and to schedule the interviews with the participants at a time convenient to them. We recruited students in their classes by distributing survey letters to them. The letters gave students an overview about the study, ask if they were willing to participate in the study, and collect their contact information. Also, we sent emails to recruit instructors to participate in the research. Next, we used meeting scheduling tools such as Doodle (Doodle, n.d.) to schedule interviews with the students and the instructors who wanted to take part in the study.

### **Methodology Design:**

To characterize the difficulties and the barriers that international computer science students face we used qualitative research techniques and interviews. Usually, data collected from qualitative studies is much deeper and more reliable than those collected using quantitative techniques. (Baker, 2012) Also, the qualitative technique

is more suitable to collecting people's opinions and characterizing issues than the quantitative technique, as it can discover unexpected findings. An adequate number of qualitative interviews as suggested in (Baker, 2012) is from 12 to 60 with the median of 30 interviews. However, the practical way to know how many interviews are enough, is to keep interviewing people until one obtains a consistent pattern of issues. At this point, one concludes that more data will not significantly alter the conclusions. For more information about qualitative research and its difference with quantitative research see (Wyse, 2011) and (Marshall, 2014).

The main technique of collecting data in this study was conducting 30-minute interviews. Students were asked about the difficulties that they face, the expected reasons behind having these difficulties, and about their experience in general. Instructors were asked about their experience when teaching international computer science students in general, and what, if anything, they do to take care of international students' needs.

**First, the procedures that were taken with the international Computer Science students:**

We contacted students in class to ascertain if they would participate in 30-minute interviews at their convenience. Students who agreed to participate in the interviews were asked to sign the informed consent prior to the start of their interviews. The survey, that was used to collect the students' demographic data, is at appendix II. The interview questions are at appendix III, and student consent is at appendix I. Of course follow up questions were asked as needed and depending on the situation.

**Second, the procedures that were taken with the instructors who have taught international Computer Science students:**

We invited instructors to participate in the study by sending them emails. Next, if they accepted to take part in the study we scheduled 30-minute interviews with them at their convenience, and they were asked to sign the consents prior to the start of the interviews. The interview questions are at appendix III, and instructor consent is at appendix I.

The interviews of both students and instructors were recorded after obtaining the participants' consent. The identity of the subjects was kept confidential. Subjects were referred to by an arbitrarily assigned study number for analysis purposes.

## **CHAPTER 4**

### **ANALYSIS AND RESULTS**

#### **First: Student Interviews**

We have interviewed 19 international Computer Science students from different countries. The distribution of participants is as follows: 6 are from Saudi Arabia, 6 are from India, 2 are from Libya, 2 are from Vietnam, 1 is from Mexico, 1 is from Iraq, and 1 is from China. The collected data is particularly valuable and contains more information than just students' difficulties and struggles; it provides recommendations for international students, and needs to be considered by schools and instructors.

The analysis of student interviews is organized under three main sections. The first section is categorization and evaluation of English and academic difficulties that international Computer Science students have, which is the main purpose of this study. The second section provides evidence from student interviews on the identified issues.

The third section contains data that cannot be measured, but it contains information that is useful and helpful, and it should not be ignored. This information includes the following: recommendations for international students, needs that ought to be addressed by schools and instructors, the most common difficulties that are seen among international students in other international students' eyes, and whether students have experienced any kind of discrimination because of being foreign.

## **First: Categorization and Evaluation of English and Academic Difficulties, that International Computer Science Students Have**

The process of analyzing and evaluating barriers is organized as follows:

1-Categorizing difficulties that are mentioned in interviews.

2-Scaling difficulties.

3-Preparing dependent and independent variables matrix.

4-Correlation and regression analysis.

5-Validation of results.

After listening to student interviews and writing them down, we categorized each kind of difficulty that was mentioned by all or nearly all subjects. The main identified difficulties are English barriers evaluated on the following dimensions: listening and understanding lectures, participating and expressing ideas, presenting, writing, and reading. Also, we had a third party native speaker who listened and evaluated the communication effectiveness of each participant. Moreover, students have identified another set of difficulties, which is technical barriers evaluated on educational background and the ability to deal with advanced software tools. Appendix IV contains a list of definitions of difficulties that were mentioned in student interviews, and criteria that were collected from demographic data survey.

Qualitative research often ends by categorizing issues and providing evidence of data and discussing them. The most used way to quantify data, if any, is to categorize issues and then count and provide percentages. We chose to categorize barriers and then quantify and scale them. Although this is not what it is usually done when analyzing qualitative research. By scaling a difficulty, e.g., rating the writing skill, we were able to perform advanced analysis such as correlating the students' estimated success (the dependent variable) with their writing scores. Quantifying

qualitative data provides researchers with the advantage of using the different statistical measurements and tools on data, so the results can be interpreted more effectively.

The identified difficulties are scaled using predefined criteria based on the severity of each barrier as mentioned by students. For example, the level of writing difficulty for one of the cases is 4, which means that the student has writing difficulty only at the beginning of the program and no more. See the evaluation table in Appendix V, that contains details of how we assigned the Likert scale to each category of difficulties, and each criterion of demographic data.

After assigning scaled values to each identified difficulty, and each demographic data criterion, we produced a matrix of variables. Each column of the matrix, except the last one, represents either a category of difficulties or a criterion of demographic data, which are all together our independent variables. The last column of the matrix represents the dependent variable, which is the estimated success. Estimated success is based on what students said in interviews about their college careers; for example, estimated success equal to 5 means that the student does not have any kind of difficulties in her college career at all, and estimated success equal to 2 means that the student faces major difficulties in completing her college program. It is worthy to note here that the estimated success of each student (our dependent variable) does not depend at all on how well a student did on the other criteria.

Each row of the matrix represents a student case. See the matrix of variables (data sheet) in Appendix VI. Note that we have excluded some variables, that are already defined in the table of definitions, from the matrix of variables. That is because some variables are difficult to measure, including the native language and the country of previous degree. Other variables, including presenting, dealing with tools,

and English proficiency scores have many missing values in the matrix of variables, which makes them impossible to consider in correlation and regression tests as we will do later. However, this excluding does not affect the results of analyzing data as we already have more than enough other variables.

The following tables compare mean, median, standard deviation, mode, minimum, and maximum of each variable listed in the matrix of variables in Appendix VI.

<i>listening and understanding</i>	<i>participating and expressing ideas</i>	<i>writing</i>	<i>reading</i>
Mean	3.95	Mean	3.26
Median	4	Mean	3.05
Mode	4	Median	3
Standard Deviation	0.91	Mode	3
Minimum	2	Standard	Standard
Maximum	5	Deviation	0.78
n	19	Minimum	2
		Maximum	5
		n	19

*Table 1 descriptive analysis of data- part 1*

<i>communication effectiveness</i>	<i>educational background</i>	<i>degree program</i>
Mean	3.79	Mean
Median	4	3.58
Mode	4	Mean
Standard Deviation	0.79	3
Minimum	2	Mode
Maximum	5	3
n	19	Standard
		Standard
		Deviation
		0.96
		Minimum
		2
		Maximum
		5
		n
		19

*Table 2 descriptive analysis of data- part 2*

<i>USA residence (years)</i>	<i>UCCS residence (years)</i>	<i>estimated difficulties</i>
Mean	5.95	Mean
Median	4.00	2.42
Mode	6.00	Mean
Standard Deviation	5.61	2.00
Minimum	1.00	Mode
Maximum	20.00	3.00
n	19.00	Standard Deviation
		1.30
		Minimum
		1.00
		Maximum
		5.00
		n
		19.00

*Table 3 descriptive analysis of data- part 3*

As the qualitative data is converted to numbers, it is ready for statistical analysis. First, we used Pearson's  $\rho$  for dependent and independent variables to show the relationships between them. The correlation values are interpreted as follows: if the absolute value of the correlation is equal to 0.25 or above, that means that there is a strong correlation between the two variables. The correlation value can be either positive or negative. Positive value means that increasing one of the two variables causes increasing the other (correlation in the same direction); negative value means that increasing one of the two variables causes decreasing the other (correlation in the opposite directions). The following are the correlation tables.

	<i>Listening and understanding</i>	<i>Participating and expressing ideas</i>	<i>Writing</i>	<i>Reading</i>
Listening and understanding	1			
Participating and expressing ideas	0.518	1		
Writing	0.473	0.308	1	
Reading	0.556	0.604	0.374	1
Communication effectiveness	0.448	0.375	0.471	0.308
Educational background	0.354	0.440	0.328	0.211
Degree	0.005	0.184	0.223	0.318
USA residence (years)	0.152	0.248	-0.139	0.007
UCCS residence (years)	0.253	0.093	0.032	-0.119
estimated success	0.585	0.683	0.649	0.431

*Table 4 Correlation table- first part*

	<i>Communication effectiveness</i>	<i>Educational background</i>	<i>Degree</i>
Listening and understanding			
Participating and expressing Ideas			
Writing			
Reading			
Communication effectiveness	1		
Educational background	0.317	1	
Degree	0.137	-0.240	1
USA residence (years)	0.337	0.614	-0.222
UCCS residence (years)	0.362	0.282	0.177
estimated success	0.400	0.587	0.083

*Table 5 Correlations table- second part*

	<i>USA residence (years)</i>	<i>UCCS residence (years)</i>	<i>Estimated success</i>
Listening and understanding			
Participating and expressing ideas			
Writing			
Reading			
Communication effectiveness			
Educational background			
Degree			
USA residence (years)	1		
UCCS residence (years)	0.360	1	
estimated success	0.083	-0.034	1

*Table 6 Correlations table- third part*

We can identify the predictors of the dependent variable (estimated success) by looking to the significant correlations between the dependent variable and each one of the independent variables. From the previous tables we can see that there are significant correlations between estimated success and each of the following independent variables: listening and understanding lectures, participating and expressing ideas, writing, reading, communication effectiveness, and educational background. Also, correlation tables show that there are no correlations between

estimated success and each of the following independent variables: degree, the length of staying in the USA, and the length of staying at the university.

After obtaining the correlation results, it is good to see if the correlations are significant or just caused by other factors, such as having correlation with other independent variables. To do so, we did regression analysis on the dependent variable and the independent variables that have significant correlation with it. Then, we inspected the resulted p-value of each independent variable. P-value refers to the probability of having an observed value occurred by a chance or random error. Setting the level of significant to 0.05 means that we should consider independent variables that have p-values equal to 0.05 or less as significant predictors of our dependent variable (estimated success); and we are at least 95% confidence of data. The following table shows the regression analysis results of the dependent variable (estimated success), and each of the following independent variables: listening and understanding lectures, participating and expressing ideas, writing, reading, communication effectiveness, and educational background.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0.132	0.741	0.178	0.862
listening and understanding participating and expressing ideas	0.154	0.185	0.832	0.422
writing	0.306	0.131	2.335	0.038
reading	0.486	0.195	2.491	0.028
communication effectiveness	-0.096	0.144	-0.668	0.516
educational background	-0.101	0.189	-0.536	0.602
	0.207	0.150	1.378	0.193

*Table 7 First regression table*

The previous table shows that we have a significant p-values for writing, and participating and expressing ideas, which makes them good predictors of students'

estimated success.

Finally, we repeated the regression analysis including only independent variables that have a p-value equal to 0.05 or less to see the real predictors and write the prediction equation. The following table shows the regression analysis results of the dependent variable (estimated success), and the following independent variables: participating and expressing ideas, and writing.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0.466	0.514	0.907	0.378
participating and expressing ideas	0.344	0.096	3.586	0.002
writing	0.531	0.163	3.256	0.005

*Table 8 Final regression analysis*

The above table shows that doing the regression analysis considering only: participating and expressing ideas, and writing as independent variables provides much better p-values for those two variables and makes them highly significant. For writing skill, the p-value of 0.005 means that the probability of having a difference occurred by chance is equal to 0.5%. For participating and expressing ideas, the p-value of 0.002 means that the probability of having a difference occurred by chance is equal to 0.2%, and we are 99.8% confident that the observation is not due to chance. Also, it is known that the smaller the standard deviation, the greater confidence we have in the data. The standard deviation for writing is equal to 0.78, which means that 68% of the observations within 0.78 of the mean; the standard deviation for participating and expressing ideas is equal to 1.3, which means that the observations are spread out around the mean by 1.3. Thus, the real predictors of international Computer Science students' success are writing skills and the ability to participate

and express ideas.

That means international Computer Science students who have higher writing skills and higher ability to participate and express ideas tend to have greater success. It is worthy to note here that those predictors can also be considered predictors of international students' success in other fields of studies. This is because writing skills and the ability to participate and express ideas are not necessary to only Computer Science students. The prediction equation is as follows:

Prediction of International Computer Science students' success=  
 $0.466 + 0.344 * (\text{participating and expressing ideas}) + 0.531 * (\text{writing})$

### **Validation of Results:**

We discuss two types of validation, external validation and internal validation. The external validation refers to the extent to which results can be generalized to other populations. The studied sample well represents the international Computer Science students' population for the many reasons:

First, the participants in this study were selected from international Computer Science students in UCCS, and the sample contains males and females from 7 different countries.

Second, in the interviews nearly all students were asked the same questions to help investigate the same independent variables. In addition, for each mentioned difficulty, students were asked to state whether that difficulty is present or overcome

to help assigning a precise scale to each independent variable later. Then in the analysis stage, independent variables were scaled using definite criteria to ensure objective evaluation. The evaluation table in Appendix V contains details of how we assigned the Likert scale to each category of difficulties, and each criterion of demographic data.

Third, in order to validate the prediction equation, we calculate the predicted success for three random students. Then, if we get predicted success scores close to the real estimated success<sup>2</sup>, that means the equation can be used to predict success for any random student.

After applying the prediction equation on the third, eighth, and nineteenth students, we got the following predicted success scores: 2.89, 3.42, 4.31. Comparing them to the students' real estimated success<sup>3</sup> scores – 3, 3, 5, respectively- we found them close to the real values. This validates the resulted regression equation and makes it applicable to any random international student.

The internal validity refers to the extent to which data can provide conclusion about causal relationships. It is worthy to mention here that we might have internal threats to validity. The cultural differences may bias the interview process. Men may not respond well to a female interviewer. Cultures may assume that certain kinds of difficulties are normal. However, each identified difficulty was mentioned by all or nearly all subjects, which trusts the collected data and minimizes this kind of threats.

The regression analysis cannot be done if there is at least one missing value of a certain variable. Since there were two missing values in the independent variable

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<sup>2</sup> See estimated success column in the matrix of variables in Appendix VI

<sup>3</sup> See real estimated success for case no: 3, 8, 19 in the matrix of variables in Appendix VI

(reading), the missing values were replaced by the median of the remaining values for reading. However, that effect of the replacement process is very minimal since it is only done for 2 values of one independent variable.

Also, the values of the dependent variable (estimated success) were assigned by the researcher based on the Likert scale defined at appendix V. This may subjectively make the dependent variable more correlate with the independent variables. Students' grades would more accurately represent the dependent variable. However, since we did not have access to students' grades, we used the information available to analyze data. It is worthy to note here that the estimated success of each student (our dependent variable) does not depend at all on how well a student did on the other criteria. Values of estimated success were assigned without even looking to what students did on the other independent variables, which minimizes the effect of the assignment process.

## **Second: Evidence from Student Interviews on the Identified Issues**

This section contains evidence from students' data. Even though students' data has already been analyzed statistically, anecdotal evidence from student narratives can reveal richer context. This section gives evidence of what students said about the issues identified in Appendix IV.

### **Listening and Understanding Lectures:**

The ability to listen and understand lectures is one of the difficulties that concerned most new students. One student expressed that because this is the first semester for her in the university, she could not understand everything in classes.

On the other side, experienced international students suffer from understanding foreign instructors, who usually have different accents. A student said that he has a problem understanding foreign instructors even if they speak English very well. Three other students conveyed that understanding foreign instructors is an issue only for the first couple of weeks, then after that students formed patterns of commonly used phrases and accents. One of those students mentioned that he was able to overcome the difficulty of understanding foreign people after he had relationships with people from different countries. He also suggested that students pick friends from other countries to learn about their cultures, and to overcome the barrier of understanding their accents.

Other issues that may affect the ability of international students to understand lectures are when instructors use unclarified idioms and abbreviations, or when they go off topic and talk about something related to the American culture. A student said that he feels lost whenever instructors use idioms or abbreviations without clarification, or when they go off topic and talk about things that foreign students do not know about.

### **Participating and Expressing Ideas in Classes:**

Participating and asking questions in front of class seems to be the international students' biggest fear, even if sharing ideas and having class discussions are very essential in American classes and especially in the graduate ones. The fear is to have a break in speaking while students are expressing ideas, or that others will not understand the accent or words. One student said that he never asks questions during class because of the fear of making mistakes, and especially if the instructor does not give enough time to deliver the ideas. Another student expressed that for her to

participate in a class discussion depends strongly on the instructor's personality and whether s/he encourages and tries to ask and clarify what the student meant, if needed. A first semester student said, as she could not express her thoughts clearly, she never asks questions even if she needs to.

One student conveyed that the culture back home requires over respecting teachers, which reduces students' chances to ask or to discuss things openly. Interestingly, the same issue has been mentioned also by one of the instructors. He discovered that international students over respect him, which makes them uncomfortable to ask or to challenge him even if he says something wrong. Another student spoke of the fear of having class discussion due to the educational background in her country. She said, back home we are not used to having class discussions as instructors are supposed to say everything and we listen all the time. It is good to point out here that most eastern cultures emphasize the rote learning method.

Students' strategies to overcome the fear of asking questions or participating are to either avoid doing it in class, or to challenge it in order to use to it. One said, every time she participates in class discussion, she feels more comfort than before. Another said, all kinds of difficulties that international students have start out big, and then shrink after practicing things and getting use to them. Others prefer not to expose themselves to the possibility of making mistakes in front of class. A student expressed that she usually asks questions after class because she is afraid that instructors may not understand her.

**Writing:**

Writing skill is one of the predictors of Computer Science international students' success as the statistical analysis in the first part of this chapter found. The

barriers that international students face in writing mainly fall into either grammar difficulty or, delivering ideas using the right vocabulary. This is especially true for students coming from non-English speaking schools. One student said, grammar is not a problem for foreign students who got their previous degrees from English-speaking schools. Another student conveyed that she has problems delivering her ideas, and instructors always told her that they cannot understand her writing.

A different student said, international students have critical thinking skills and different kind of thoughts, but they mostly find it difficult to deliver their ideas. She continued, what they mean is not necessarily what others understand, and this is true for speaking and writing.

Students' strategies to fix writing issues are basically to write and have others review. While the writing center is the main resource for students to review their papers, many students are not satisfied by the quality of the given services. A student said that not all reviewers in the writing center are good. She continued, the writing center cannot help with the major issue that most international students have, which is ensuring that they delivered the desired ideas.

Another expressed that he benefits from having friends from other cultures to review his papers. He continued, some of his friends have British English which is very formal. He said that he learned a lot of his friends in writing and reviewing papers.

### **Reading:**

Reading is an essential skill for students who are pursuing higher education, and especially for the graduate ones. The thing that graduate students most do is to reading and writing. They have to read a lot of scientific papers and books, and get

the knowledge as fast as they can. The biggest barrier that foreign students have in reading is spending more than the expected time to read a certain part of a paper or a book. A student said that the time that she takes to finish reading a chapter of a book usually takes double the intended time. This might be explained by having extra time for foreign speakers to translate the new vocabularies and then understand the whole structure of sentences.

The most useful strategy to improve reading skills is to read more books and scientific papers, and pay attention to the used vocabulary and structures. Two of the students, who score high estimated success, conveyed that reading a lot is the best recipe to improve both reading and writing.

### **Communication Effectiveness:**

Communication effectiveness is the ability of students to communicate well in both written and verbal communication. In other words, the extent to which students are able to understand others, and make others able to understand them. Many students expressed that sometimes they experience a gap between what they say or write, and what others understand. And this becomes specifically true for the new students.

A student said, that when she started studying here, she lost the idea after talking for a certain amount of time. That might be explained by a fact mentioned by another student. The student said that when she speaks or listens, she tries to process things in the background of her mind. The processing time of speech consumes foreign students' energy and slows the communication down. A different student expressed that this problem slows the communication down when speaking or

writing, when he tries to find the precise vocabulary which better describe the situation.

One of the students mentioned a wining strategy to overcome this problem. The student said that he was able to overcome the communication problem after he had had a group study with some friends, as he got greater chance to practice speaking English with them.

### **Dealing with Tools:**

Dealing with advanced software tools is one of the barriers that was disclosed frequently by the interviewed students, even if we did not intend to ask about it specifically. It has been mentioned by 7 students. Unfortunately, we do not have enough data to include dealing with tools as a variable in the statistical analysis that we have shown in the first part of this chapter. As in order to include a variable in correlation or regression analysis, we need to have data for every single participant, which we did not get. However, this should not suppress the voices of students, who revealed the difficulty of dealing with tools.

A student expressed that the educational system back home is theoretical, that does not give students chances to practice real life projects. She continued, the most problem that international Computer Science students have is dealing with tools because of not having enough technical background. She said, only international students who have work experience are able to manage the technical difficulty. Another student also conveyed that the technical knowledge can be developed only from having industry work experience.

A first semester student said, in each class she faces a bunch of new tools that she has to deal with, which she had not used in her previous school. The best strategy

that helps dealing with tools, as mentioned by one of the students, is to have conversations with instructors, or to seek help from math center's tutors.

### **Educational Background:**

The expressed difficulties that international Computer Science students have because of studying in a different educational system mainly fall under three dimensions: class discussion, research, and dealing with tools.

A student conveyed that international students came from different educational systems, and need time to adapt to the American system that values research, and class discussion. Another said, back home students are not used to researching or having class discussion. He continued, back home instructors are talking all the time while students are listening.

A different student expressed that there is a gap between instructors' expectations here, and the educational background that international Computer Science students have. Many other students conveyed that they have difficulties dealing with tools, because the educational systems in their countries are theoretical based and do not give students enough chances to practice real life things.

### **English Proficiency Test's Scores:**

In student interviews, we asked students about their English proficiency scores in an effort to correlate students' demonstrated language abilities with English test scores. Unfortunately, that was impossible for the following reasons. First, the fact that many students, for some reason, are waived from having English proficiency tests creates many missing values. Also, the issue of having multiple types of English

proficiency tests makes it difficult to do correlation without having a safe way to unify scores.

Although, from anecdotal data we notice that there is little correlation between students' English test scores and the demonstrated language abilities. One of the interviewed students scored 6 in IELTS, and got only 2 in the communication effectiveness which was evaluated by a third party native speaker. See the definition of communication effectiveness in the matrix of definition at appendix IV. Another student scored only 5.5 in IELTS, and got 4 in the communication effectiveness. This might be explained by the fact that the first student has been in the USA for one year while the second student has been in the USA for six years. The correlation analysis shows that there is correlation of 0.33 between the length of staying at the USA and students' communication effectiveness. That means that students who stay longer at the USA tend to have better communication effectiveness scores. However, more data is needed to compare the correlation between students' communication effectiveness and the length of staying at the USA, and the correlation between students' communication effectiveness and students' English test scores.

#### **Other Communication Based Issues:**

Students have mentioned different other issues that are commonly communication based related either to the communication with the department, or to the communication with other students. Many students conveyed that there is a lack of communication from the department side, as they do not know about the available resources, or the rules. More than two students expressed that they have no idea that there is a writing center, a math center, or computer help center services. Also, one of the PhD candidates said that some instructor advisors do not reply to students' emails,

which really causes problems and delays. It is worth noting that this might be American students' problems too.

A first semester student expressed that he needs to find old students to have an overview and ask about advice, but he was not able. Also, he noted that American students prefer to work individually, which makes it difficult to form group studies with them.

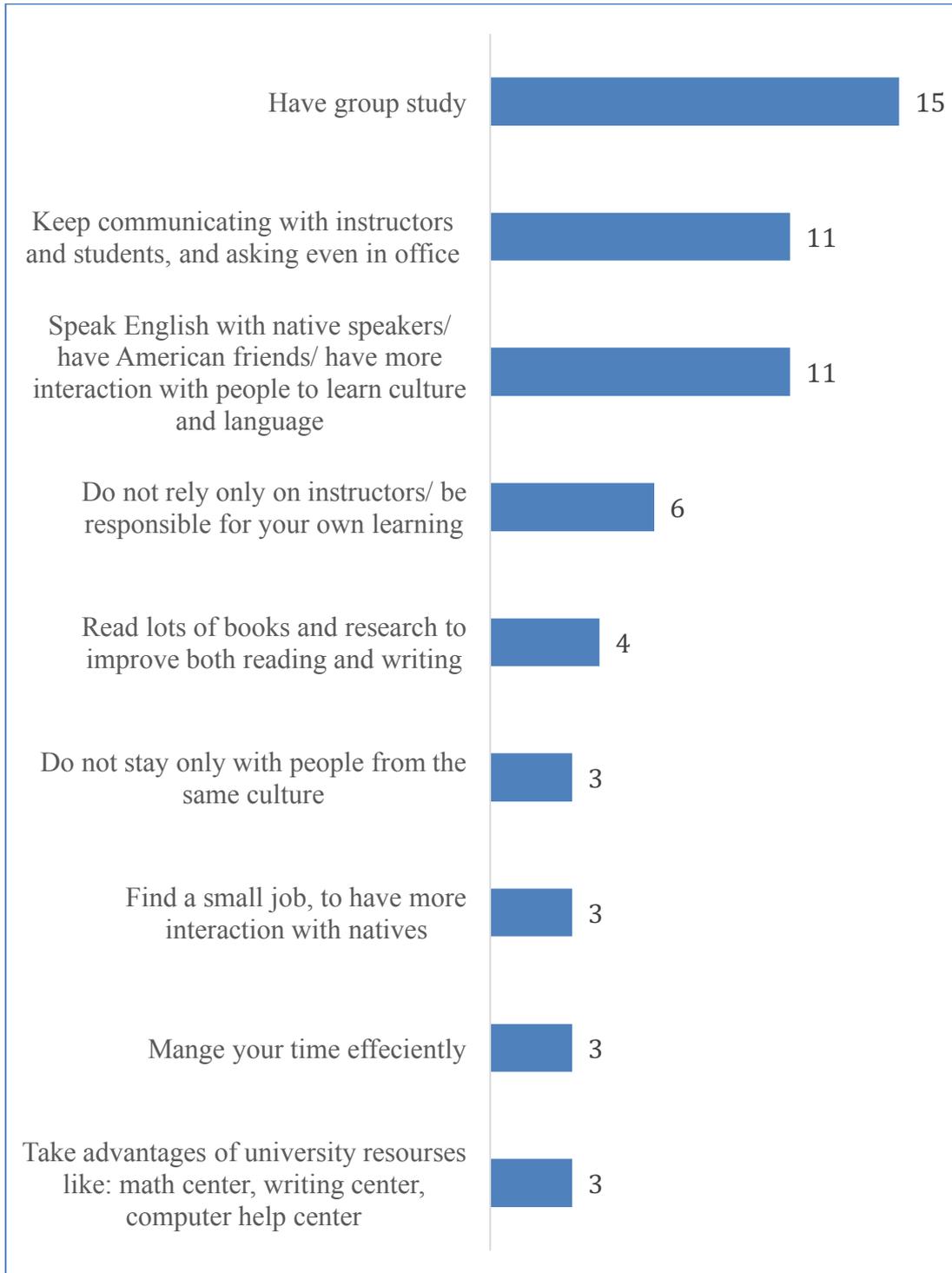
### **Third: Information that Cannot Be Measured**

This section contains data that cannot be measured quantitatively, but does reveal information that is useful and helpful, and should not be ignored. This information includes the following: recommendations for international students, needs that ought to be addressed by schools and instructors, the most common difficulties that are seen among other international students, and whether students have experienced any kind of discrimination because of being foreign. Information in this section is analyzed by categorizing similar mentioned terms, and then counting them and calculating the frequencies of occurrence as well as citing what students said.

#### **Recommendations for international students:**

This section includes recommendations from the interviewed international students to the coming international students. Those recommendations come after facing different barriers, and struggling for a certain amount of time to figure out how to better deal with the common issues, easing the experience, and speeding up things. The first part of this section shows the frequency diagram of the recommendations that have been mentioned by students. The next part gives evidence from students' recommendations.

**Frequency Diagram of Recommendations:**



*Figure 1 Frequency diagram of recommendations*

**Having Group Study:**

Group study is the most frequent mentioned recommendation among interviewed students. It has been recommended by 15 out of 19 students. It is worthy to note that this confirmed the finding of (Kingston, 2008), that found that group work gives foreign students opportunities to exchange ideas and speak English with natives.

One of the students expressed that, group study gives different perspectives, and helps creating relationships with other students to exchange information, share ideas, and know about the available resources and rules. Another said, studying in groups helps learning Americans' skills, and culture. A third student conveyed that students in group studies can benefit from being in a multicultural environment, and can earn skills from people of each single culture. One of the students said that he extremely benefits from studying in groups, and specifically in practicing speaking English, and reviewing papers.

**Keeping Communication with Instructors and Other Students, and Asking About Missed Information:**

Keeping communication with instructors and students and asking questions is the second most frequent recommendation. It has been recommended by 11 out of 19 students. Most students conveyed that asking and communicating with others helps to gather the missed information and fill the gap of knowledge, if any. This confirmed the finding of (Tran, 2008), that concluded that students' interactions and having conversation with instructors play a significant roles in students' success.

One of the students said, even if some students are too shy to ask in front of class, they should not miss asking questions during instructors' office hours. Another

student expressed in order to adapt to the new educational system students should interact well with instructors and other students.

**Speaking English with Natives/ Having American friends/ Having More Interaction with People to Learn the Culture and Language:**

This recommendation is also the second more frequent recommendation, which is recommended by 11 students. One of the students recommended forming clubs that involve American students and international students as well to help building more interactions and communications. One said, that having more interaction with Americans really can improve English skills. Another mentioned that students should be more involved in public events and activities to learn about the culture and to meet more people. Many students conveyed the importance of having American friends.

**Not Relying Only on Instructors/ being Independent/ being Responsible/ Searching and Watching videos:**

Being independent is the third recommended strategy. This was suggested by 6 students. One said, students should trust themselves and be independent because they can find the missed information faster by searching the Internet or watching videos. Another conveyed that students should be responsible for their own learning and should not expect to have spoon feeding. It is good to note here that this student has no difficulties at all in English, and has really good interaction with students, and in the campus in general.

### **Reading Lots of Books and Research to Improve Both Reading and Writing**

#### **Skills:**

Reading a lot has been advised by 4 students; two of them are actually PhD students, and have high estimated success scores. One said when you read a lot of research papers you can acquire more vocabulary, see how the structures of papers are organized, and learn how others wrote things. So by reading a lot you can improve both your writing and reading skills.

#### **Not Staying Only with People from the Same Culture:**

This recommendation has been suggested by 3 students. International students usually prefer having groups with people from the same country or culture. Even if this may help students feel more comfort because of having the same language and experience, but in turn students will not learn what they are here for, the language, the skills, and the culture.

#### **Finding a Small Job to Have More Interaction with Natives:**

Finding a small job has been suggested by three students. Students conveyed that having a small job even on-campus gives students greater chance to communicate and interact with people, and to learn the language and culture.

#### **Managing Your Time Effectively:**

Managing time effectively is advised by three students. Students strongly suggest to manage time in efficient way. International students usually have more duties to do than native students, due to studying in an educational system that they

are not familiar with, and having some language barriers. Because they have more duties, they ought to have organized plans and timetables.

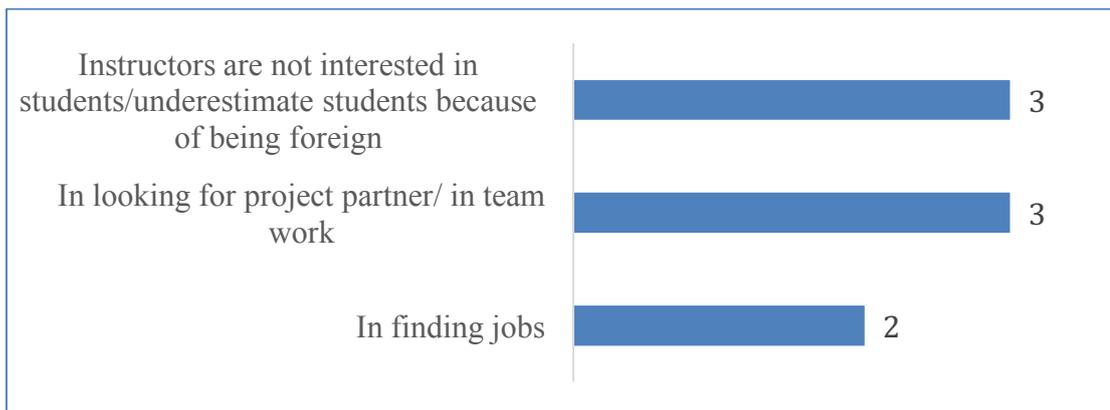
### **Taking Advantages of the Available University Recourses such as, Writing Center, Math Center, Computer Help Center, etc.**

Taking advantages of the available university resources has been mentioned by 3 students. Most universities' campuses provide students with amazing resources and even for free, but few students benefit from them. In fact, when we asked students if they know about writing center, math center, or computer help center, a large portion of students do not know at all about them or know about services very late in their school career.

### **Discriminations that Some Students Face Because of Being Foreign:**

This section includes what students said when they are asked about if they have experienced any discrimination because of being foreign. The first part of this section shows the frequency diagram of discriminations that have been experienced by students. The next part gives evidence from what students said about discrimination.

### Frequency Diagram of Discrimination:



*Figure 2 Discriminations frequencies*

### **Instructors are not Interested in International Students / Underestimate Students Because they are Foreign:**

This kind of discrimination has been experienced by 3 students. It is also found by (Robertson, 2000) that some faculty members are not interested in international students.

One of the student said, that one of her instructors always underestimates her and tells her verbally that she would not be able to finish a project, while she already had finished a large part of it. Another student, who has high estimated success score, said that she wants to tell instructors to please stop underestimating international students. She continued, we have critical thinking skills but sometimes we find it difficult to deliver our ideas.

### **Discrimination in Looking for Project Partner/ Team Work:**

Three students said that they have experienced discrimination in looking for a project partner, or in team work. One student expressed, most native students work only with natives, maybe because they are easier to communicate with and

understand. Another expressed that her instructor directed her to partner with a native student, but she noticed that the native student did not prefer or did not want to be partners with her. A third student conveyed that native students hate helping foreign students because they are not easy to understand.

### **Discrimination in Finding Jobs:**

Two students expressed that they have experienced discrimination in finding jobs. It is worth noting that (Lee, 2007) found that international students have this kind of discrimination. One student said, he really needs to find a job to help him and his family surviving here. He continued, the on-campus jobs' positions such as, teacher assistant or researcher assistant are difficult to reach. It is likely that the discrimination because of the language barrier.

### **Needs that Should Be Considered by School and Instructors:**

This section includes needs that the interviewed students disclosed as good to be addressed by schools and instructors. The first part of this section shows the frequency diagram of different needs that have been mentioned by students. The next part gives evidence of what students have said about the unfulfilled needs.

### Frequency Diagram of Students' Needs:

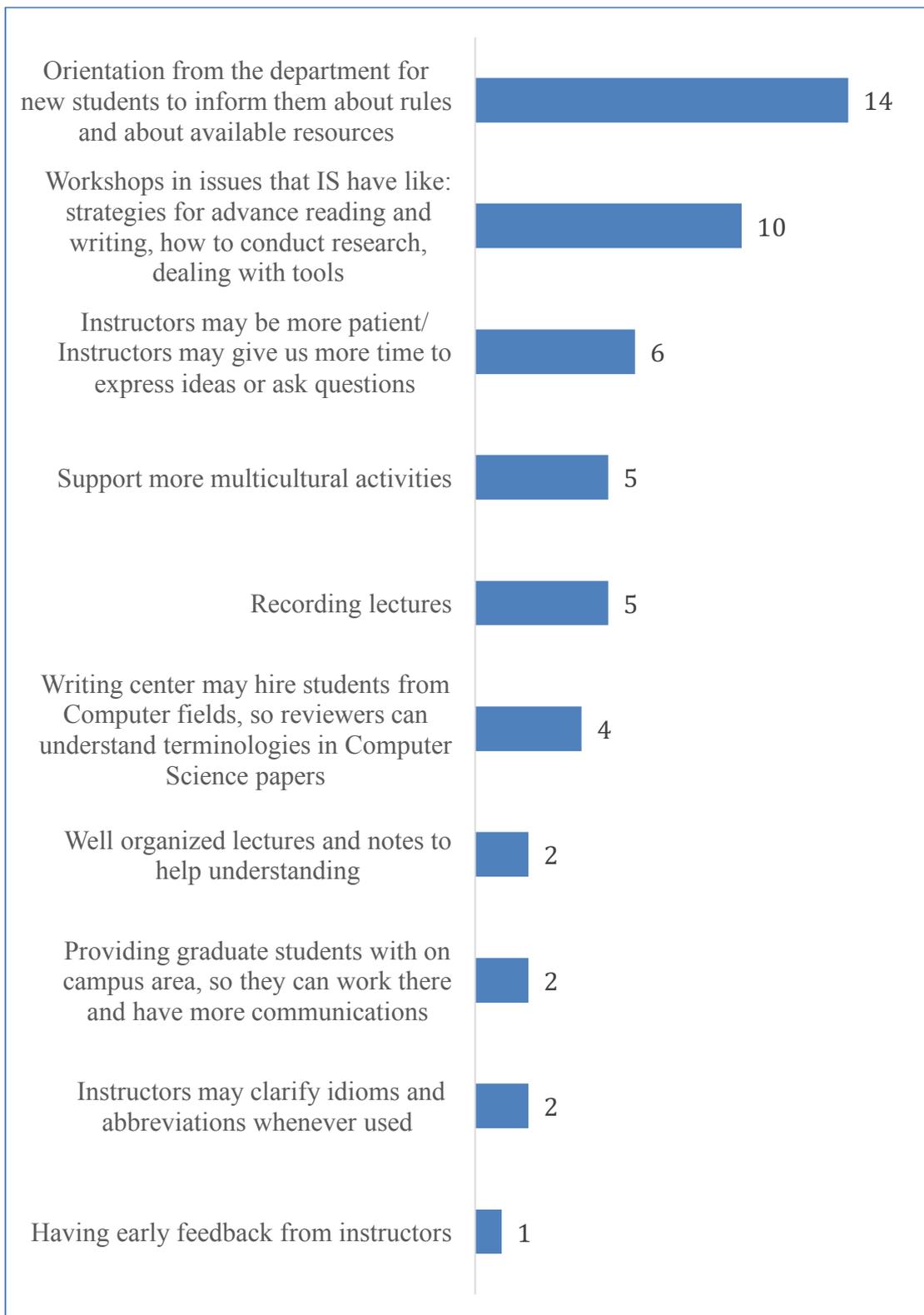


Figure 3 Frequency diagram of students' needs

**Orientation from the Department for New Students:**

Having orientation organized by the department for new coming students is the most frequent need disclosed by students. This was expressed by 14 out of 19 students. One student said, orientation is necessary to guide students, inform them about rules and available resources, and how to choose courses. Another expressed, in his previous university in New Mexico, the department provides students with orientation at the first week of each semester, and also arranges a pizza party at the end of each semester. He continued, it can be extremely helpful as students have chances to ask, gather together, and build relationships. Another PhD student suggested having different orientations for students in different programs, as information that should be said to undergraduate students are different from information that should be given to master or PhD students.

**Workshop in Issues that International Students Have:**

Offering frequent workshops is the second most frequently revealed need. It has been recommended by 10 out of 19 students. International students are thirsty for workshops, specifically the ones in issues that international students have such as, strategies to develop writing and reading skills, how to deal with advanced tools, and how to conduct research.

**Instructors may Give International Students More Time to Express Ideas and Ask Questions/ Instructors may be More Patient:**

Having instructors be more patient, and give more time to expresses thoughts and ask questions has been mentioned by 6 students. One student said, instructors should give us more time to express our ideas and should not underestimate us

because of the language difficulty. She continued, we have critical thinking skills and different kind of contributions but we need extra time to deliver it. Another student mentioned having more office hours to increase students' chances to ask and gather the missed information. Many other students conveyed that instructors ought to be more patient with international students as they have more to learn and work on.

### **Recording Lectures:**

Recording lectures has been asked by 5 students. It is worth noting that this is also suggested by (Arkoudis, 2006). Many students see that having lectures available online is really helpful as students can comeback to them and repeat them as many times as they need to collect the missed information. In addition, more than two students see that this becomes increasingly important in case if the instructor has a foreign accent too. It is worthy to note here that this might be a need for native students also.

### **Supporting More Multicultural Activities:**

Supporting multicultural activities has been recommended by 5 students. Multicultural activities are very important to students either being internationals or natives to meet the objectives of having international education. Students conveyed the importance of supporting multicultural activities and events in terms of number and quality, and not to only consider foreign cultures as the American culture is what international students are here for.

**Writing Center May Hire Students from Computer Science Department, so the Reviewers Can Understand Terminologies in Computer Science Papers:**

This need has been asked by 4 students, 2 of them are PhD candidates. It also has been suggested by one of the Computer Science instructors. They all conveyed that the reviewers at the Writing Center can help fixing the grammar and structures issues, but they cannot understand the field's terminologies, which can really affect the quality of the given review. Two students expressed that the quality of the reviewing services given by the writing center depends on the person who you will sit with, and whether s/he is familiar with your field. So if the writing center hires students from different fields to review different fields' papers, that would be extremely helpful, and especially for graduate students who need frequent reviewing services for their thesis and dissertations.

**Providing Graduate Students with On-Campus Area so they can Work there and Have More Interaction Together:**

This need has been addressed by 2 students and 1 instructor. They conveyed that having master and PhD students working at the same place will help them knowing each other and building relationships, and increase their chances to ask questions and fix problems.

**Instructors May Clarify Idioms and Abbreviations Whenever Used:**

Clarifying idioms and abbreviations has been suggested by 2 students. One student said, he feels lost whenever instructors use idioms or abbreviations without clarifications, and when instructors go out of the topic or talk about something that happened in history.

**Giving Well Organized Lectures and Notes:**

Providing students with well organized lectures and notes has been addressed by 2 students. One said that having lectures well structured really helps understanding especially in the case of foreign students, who have listening and understanding difficulties.

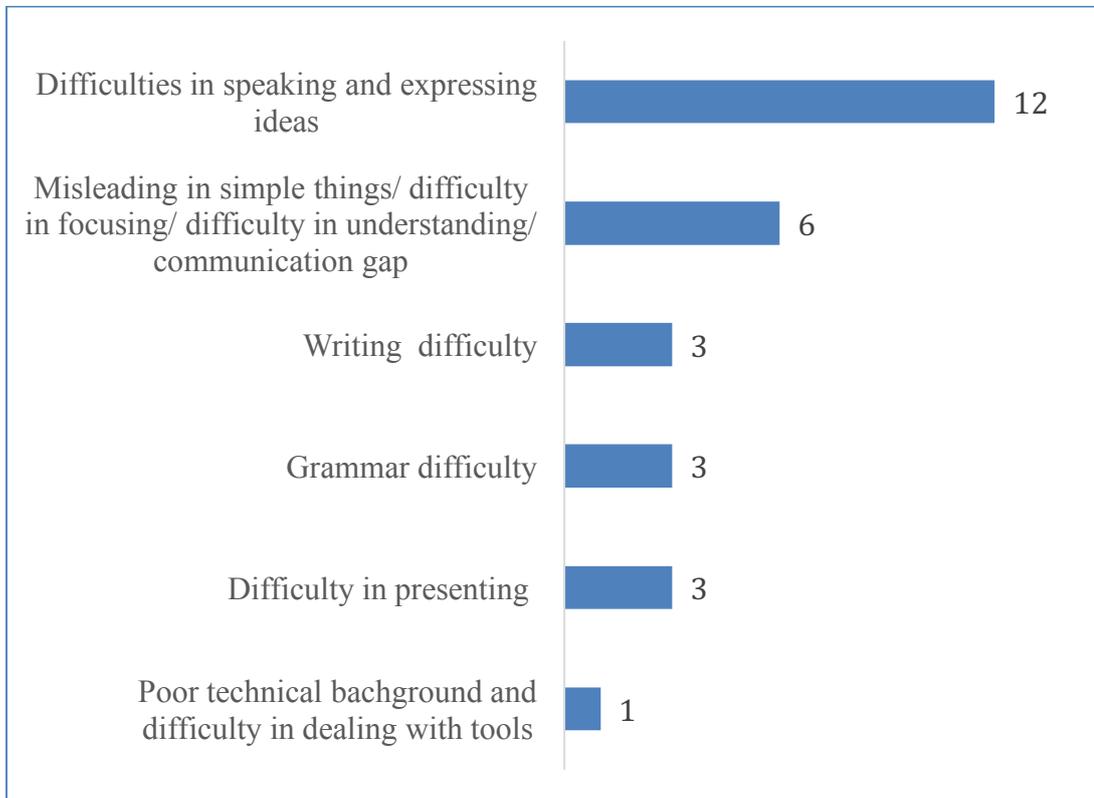
### **Providing Early Feedback:**

One student addressed the importance of having early feedback from instructors. He said, providing students with early feedback helps students avoiding their mistakes in the future.

### **The Most Common Difficulties that are Seen Among International Students by Other International Students' Eyes**

This section includes the most common difficulties that are seen among other international students. The first part of this section shows the frequency diagram of the most popular seen difficulties. The next part gives evidence of what students said about the struggles that other international students face.

**Frequency Diagram of the Most Seen Difficulties Among International Students  
by Other International Students' Eyes:**



*Figure 4 The frequency diagram of the most seen difficulties among international students*

The diagram shows that the most seen difficulties among foreign students are speaking and the ability to deliver ideas. This is also what the statistical analysis shows, in the first part of this chapter. However, only 3 students are able to see the writing difficulties, and other 3 students expressed it as grammar difficulty. However, writing is the most prominent barrier as found by the statistical analysis of students' data. That might be explained by the fact that writing skills cannot easily be seen by other students.

Others saw international students misleading in simple things and having communication gap, which means that what students say are not necessary what

others understand. Also, one student mentioned the poor technical background and having difficulties dealing with tools.

## **Second: Instructor Interviews**

We have interviewed five Computer Science instructors, who have taught international students. Three of them were previous international students for some time of their lives and lived the experience, while the other two instructors were not. Instructors were asked about the following: general opinions about international students, the difficulties that they face when teaching foreign students, needs that international students seem to have but have not been met, and the effort, if any, that instructors made to help international students overcome the barriers.

This section details evidence from instructor interviews organized mainly under four criteria: instructors' opinions, difficulties when teaching foreign students, needs that have not been met, and instructors' efforts to help international students.

### **Instructors' Opinions about International Students:**

Instructors' opinions about international students are varied among no specific opinion, very positive pictures, and negative thoughts. One said he has no general opinion. He continued, some are good and some are bad students. Another answered, the average international students are good and most of them have better math skills than American students. He elaborated that, on other dimension American students are better than the international ones.

Another instructor saw international students as lazy and poorly prepared. She expressed, "foreign students are poorly prepared, and not good enough programmers.

They are less able to struggle in order to solve a problem. They are missing problem solving skills.”

On the other hand, another foreign instructor, who also had been an international student, sees international students in a very bright picture. He said that international students are more open-minded than native students. They understand different cultures and different ways of thinking. Even if their English skills are not perfect, he continued they are enough to communicate.

When instructors have been asked whether international students have been succeeding or not, their answers strongly point to the understanding of the culture, and working hard. An instructor said, “If someone goes to another culture, he is probably better served the more he knows about the culture.” He expressed that international students can succeed even if they do not know about the culture, but they probably would have difficulties of which he would not be aware. Another conveyed that foreign students are capable of succeeding if they work hard, but the cultures and the educational systems of some countries do not prepare students to do that.

Nevertheless, one of the instructors notes that international students are not as competitive as American students. He expressed that American students are raised to be creative, they had more practice, and they can think out of the box. He continued, while students from eastern cultures treat teachers as gods, which makes students always have to follow without practice.

In the long term, instructors see foreign students as winners in term of skills and number of publications. An instructor said, “Across the country international students are dominating in graduate programs in term of graduation and publication records.” Another expressed that international students succeed more than native

students. He continued, all foreign students finish their degrees, and they publish more papers than the American students. He said that one of his international students became a professor. A third instructor conveyed that international students would win in the long term because of learning from two different educational systems and having two different ways of thinking even if they have to work harder

### **Difficulties that Instructors Face when Teaching Foreign Students:**

The issues that instructors note when teaching international students fall along three dimensions, English barriers and communication gaps, difficulties because of the educational systems' differences, and cultural differences. An instructor said that the main difficulty that international students have is the language barrier, and mostly the ability for him to understand what they are saying and for them to understand him. Another instructor conveyed that if students have language difficulties, they would probably have different interpretations of what he is saying.

A third instructor elaborated that the language barrier is the international students' biggest difficulty and especially writing and reading. He said that it takes him three to four times as long to understand their writing. Interestingly, this is what the statistical analysis of students' data found. Writing skills and the ability to express ideas are significant predictors of international Computer Science students' success.

A different instructor expressed that most international students have listening and understanding problems, and the cultural differences increase the miscommunication. Another instructor listed the issues that international students have as, they seem to be resistant to face to face conversation, they are difficult to communicate with, and sometimes their choices of words is garbled and not clear. She continued by saying that having international students participate in class discussions

is difficult because their processing of English is weaker and slower than the native ones. A different instructor also conveyed that students who are more fluent are also more resistant to engage in discussion in classes.

An instructor said that sometimes cultural issues cause different interpretations and misunderstandings. He said that a student from China in a multiple choice exam, chose as many answers as possible because this is what multiple choices questions meant in her culture. This caused the student to lose a significant number of points.

An instructor expressed that students from eastern countries tend to have more difficulties adapting to the American system and culture than students from European countries. She elaborated that European cultures are closer to the American culture and their languages are mostly of the Roman root just like English.

An instructor disclosed that educational systems in most eastern cultures are very driven toward memorization. She said, students are not encouraged to be creative or to think outside the box. Another instructor also pointed to the issue of educational systems differences. He expressed that foreign students came from different educational systems, and most international students are used to following instructions given by teachers. He elaborated, they expect instructors to tell them explicitly what to do while graduate schools require students to figure out what to do, which international students are struggling with.

### **Needs that International Students Have but Not Have Been Met:**

Instructors revealed different kinds of needs that it would be helpful to meet. The disclosed needs are, to talk openly with instructors if students have missing skills, to give graduate students on campus an area to facilitate more interaction among students, to provide international students with introductory courses to ease adaptation

to the culture and educational system, and to have Computer Science reviewers in the writing center.

An instructor said that it is very important for international students and their instructors to know if there is a gap between the expectation of instructors and the educational background of students. She elaborated that this should be discussed openly. She continued, it is difficult for instructors to figure out whether a student is just lazy, or missing prerequisite skills unless the student comes and talks to the instructor.

Another instructor pointed to the importance of having on-campus space for graduate students. This would enable them to share their different ways of thinking, and solve problems together. Also two instructors suggested providing international students with introductory courses to help them adapt to the American culture and educational system, and to teach them how to do research. It is worthy to note here that many of the interviewed students talked about research and class discussion being the most unfamiliar practice when adapting to the American educational system.

One instructor suggested having people who are familiar with the Computer Science field to review Computer Science students' papers in the writing center. He said, most international students are graduate, who need to write theses and dissertations. He conveyed that they need frequent reviewing services for their papers, especially because they are second language writers. He recommended the writing center in the University hire graduate Computer Science students, who can better understand the technical terminologies and the context of Computer Science papers, and give better reviewing services.

### **Effort, if any, that Instructors Made to Help International Students Overcome the Barriers:**

Instructors' efforts to help foreign students overcome the difficulties are varied depending on the kind of barriers that instructors are aware of. One instructor said that he tries to work close to all students who have difficulties. He continued, instructors do not have enough time or resources to treat each group of people differently.

A foreign instructor expressed that he records his lectures because he has a foreign accent. He elaborated that students can come back to lectures and listen to them as many times as they need to obtain the information. He also said that he helps international students improve their writing and gives comments to make their papers more understandable.

Another instructor said that she tries to be more accessible to answer students' questions and to give help, as well as present materials as organized as possible to help eliminating misunderstanding. She also expressed that she communicates with students using the writing method because it is clearer and easier to both of them to understand.

An instructor mentioned that he tries to handle issues for all of his students. He continued, he knows that international students may have more issues regarding their visa status and family obligations. Thus he tries to make schedules more flexible.

### **Future Work**

A number of follow-on research opportunities present themselves. First would be to obtain consent to use students' grades and grade history as a dependent variable.

Second would to device assessments for various language and technical skills, and to validate remediation for deficiencies uncovered by the assessments.

The results of the regression analysis were validated by comparing the real estimated success scores and the calculated success scores using only three students. In future work, a more comprehensive evaluation could be done by automating the process of selecting all 3-student combinations and doing the same calculations.

Also, dealing with advanced software tools is one of the barriers that was mentioned frequently by the interviewed students, even if we did not intend to ask about it specifically. It was mentioned by 7 students. Unfortunately, we do not have enough data to include dealing with tools as a variable in the statistical analysis in the first part of this chapter. Thus, investigating how Computer Science students deal with advanced software tools is left for future work.

In addition, in student interviews we asked students about their English proficiency scores in effort to correlate students' demonstrated language abilities with English test scores. However, that was impossible for the following reasons. First, the fact that many students, for some reason, are waived from having English proficiency tests creates many missing values. Also, the issue of having multiple types of English proficiency tests makes it difficult to do correlation without finding a safe way to unify scores. Although, from anecdotal data we notice that there is a little correlation between students' English test scores and the demonstrated language abilities. Thus, figuring out how to deal with those issues, and investigating the correlation between English scores and students' demonstrated language abilities is a good candidate for future work.

## Conclusion

International students in their learning journeys face lots of difficulties and barriers due to the cultural differences. Hiding these difficulties may affect the students' academic achievement and the quality of their education.

The research question was: What are the difficulties that foreign computer science students face and what are their special needs? We conducted a qualitative study to reveal the barriers that international computer science students have, and to discover the needs that have not been yet met. The data was collected by interviewing 19 foreign computer science students and five of their instructors, as they are the only people who can tell us stories about the difficulties that international students face.

The study found that international Computer Science students have English barriers evaluated on the following dimensions: listening and understanding lectures, participating and expressing ideas, presenting, writing, and reading. Moreover, students have identified another set of difficulties, which is technical barriers evaluated on educational background and the ability to deal with advanced software tools.

The statistical analysis of participants' data found that the significant predictors of international Computer Science students' success are writing skills and the ability to participate and express ideas. That means international Computer Science students who have higher writing skills and higher ability to participate and express ideas tend to have greater success. It is worthy to note here that those predictors can also be considered predictors of international students' success in other fields of studies. This is because writing skills and the ability to participate and express ideas are not necessary to only Computer Science students.

Students give a number of recommendations for new international students to help overcome the identified difficulties. The recommendations in general emphasize having more interaction and communication with students, instructors, and native people to learn the language and culture.

Also, students identified a number of needs that should be considered by schools and instructors. Nearly all the identified needs were about educating international students about schools' rules and services, and giving them a more interactive environment to help them fill the information gaps and exchange the knowledge.

Some students mentioned that they experienced kinds of discrimination, including, underestimation from some instructors, discrimination in team work, and discrimination in finding jobs. It is likely that the discrimination arises from the language barrier.

Instructors recognized some obstacles when teaching international students including, English barriers and communication gap, difficulties because of the educational systems differences, and cultural differences. Instructors gave some suggestions to help international students overcome the barriers such as, providing international students with introductory courses to adapt to the culture and educational system, having Computer Science reviewers in the writing center to better understand the context of Computer Science papers, and giving graduate students on campus an area to help facilitate more interaction among students.

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## APPENDIX I

## IRB APPROVAL AND CONSENTS



University of Colorado  
Colorado Springs

Institutional Review Board (IRB) for the Protection of Human Subjects

Date: 9/3/2015

IRB Review

**APPROVED**

**IRB PROTOCOL NO.: 16-011**

**Protocol Title: Characterize the Difficulties that International Computer Science Students Face**

**Principal Investigator: Eman Alharbi**

**Faculty Advisor if Applicable: Albert Glock**

**Application: New Application**

**Type of Review: Expedited 7**

**Risk Level: No more than Minimal Risk**

**Renewal Review Level (If changed from original approval) if Applicable: N/A No Change**

**This Protocol involves a Vulnerable Population: N/A (No Vulnerable Population)**

**Expires: 2 September 2016**

\*Note, if exempt: If there are no major changes in the research, protocol does not require review on a continuing basis by the IRB. In addition, the protocol may match more than one review category not listed.

**Externally funded:  No  Yes**

**OSP #:            Sponsor:**

Thank you for submitting your Request for IRB Review. The protocol identified above has been reviewed according to the policies of this institution and the provisions of applicable federal regulations. The review category is noted above, along with the expiration date, if applicable.

Once human participant research has been approved, it is the Principal Investigator's (PI) responsibility to report any changes in research activity related to the project:

- The PI must provide the IRB with all protocol and consent form amendments and revisions.
  - The IRB must approve these changes prior to implementation.
- All advertisements recruiting study subjects must also receive prior approval by the IRB.
- The PI must promptly inform the IRB of all unanticipated serious adverse (within 24 hours). All unanticipated adverse events must be reported to the IRB within 1 week (see [45CFR46.103\(b\)\(5\)](#)). Failure to comply with these federally mandated responsibilities may result in suspension or termination of the project.
- Renew study with the IRB *prior to expiration*.
- Notify the IRB when the study is complete

If you have any questions, please contact Research Compliance Specialist in the Office of Sponsored Programs at 719-255-3903 or [irb@uccs.edu](mailto:irb@uccs.edu)

Thank you for your concern about human subject protection issues, and good luck with your research.

Sincerely yours,

Michele Okun, PhD  
IRB Reviewer

Protocol Number: 16-011

Version and Date Received: V3 –9/2/15

Valid through date: 9/1/2016

**University of Colorado  
Colorado Springs (UCCS)  
Consent to be a Research Subject**



**Title:** Characterize the difficulties that foreign Computer Science students face

**Principal Investigator:** Eman Alharbi

**Funding Source:** None

**Introduction**

You are being asked to be in a research study. This form is designed to tell you everything you need to think about before you decide to consent (agree) to be in the study or not to be in the study. A member of the research team will describe this study to you and answer any questions. **It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. You can skip any questions that you do not wish to answer.**

Before making your decision:

- Please carefully read this form or have it read to you.
- Please ask questions about anything that is not clear.

Feel free to take your time thinking about whether you would like to participate. By signing this form you will not give up any legal rights. If you are completing this consent form online, you may want to print a copy of the consent form for your records.

**Study Overview** This study plans to learn more about the unknown difficulties and barriers that foreign Computer Science students have and to discover their special needs.

**Procedures** You are being asked to be in this research study because you are a Computer Science foreign student. First you will be given a small survey about demographic data and your contact information. Then, we will schedule interview for 30 minute to be asked about your experience and the difficulties that you faced as a foreign student.

**Other people in this study:** Up to 100 people will participate in this study.

**Risks and Discomforts :** There is no expected risk in asking students or instructors about the difficulties that foreign students face. Students will not be asked to identify instructors, and instructors will not be asked to identify students. However, interviewing students may cause emotional reactions but that would probably be the rare exception.

**Benefits:** The aim of the study is to identify and articulate the difficulties that foreign Computer Science students face, and to discover their special needs, which will make instructors, international student organizations, and society in general aware of foreign students' needs, which will in turn provide international Computer Science students better services and will help them achieve greater success.

**Compensation** no compensation is provided.

**Confidentiality :** The privacy of participants will be protected by substituting their names with codes. and the confidentiality will be protected by using the data for this research only.

Protocol Number: 16-011

Version and Date Received: V3 – 9/2/15

Valid through date: 9/1/2016

Certain offices and people other than the researchers may have access to study records. Government agencies and UCCS employees overseeing proper study conduct may look at your study records. These offices include the UCCS Institutional Review Board, and the UCCS Office of Sponsored Programs and Research Integrity. UCCS will keep any research records confidential to the extent allowed by law. A study number rather than your name will be used on study records wherever possible. Study records may be subject to disclosure pursuant to a court order, subpoena, law or regulation.

#### **Voluntary Participation and Withdrawal from the Study**

Taking part in this study is voluntary. You have the right to leave a study at any time without penalty. You may refuse to do any procedures you do not feel comfortable with, or answer any questions that you do not wish to answer. If you withdraw from the study, you may request that your research information not be used by contacting the Principal Investigator listed above and below.

#### **Contact Information**

Contact (PI's info): ealharbi@uccs.edu

- if you have any questions about this study or your part in it,
- if you have questions, concerns or complaints about the research, or
- if you would like information about the survey results when they are prepared.

Contact the Research Integrity Specialist at 719-255-3903 or via email at [irb@uccs.edu](mailto:irb@uccs.edu):

- if you have questions about your rights as a research participant, or
- if you have questions, concerns or complaints about the research.

#### **Consent**

A copy of this consent form will be provided to you.

I understand the above information and voluntarily consent to participate in the research. By signing this consent, I am confirming that I am 18 years of age or older.

Signature of Participant \_\_\_\_\_ Date \_\_\_\_\_

I agree to record my interview by the audio recorder:

Signature of Participant: \_\_\_\_\_ Date: \_\_\_\_\_

Protocol Number: 16-011

Version and Date Received: V3 – 9/2/15

Valid through date: 9/1/2016

**University of Colorado  
Colorado Springs (UCCS)  
Consent to be a Research Subject**



**Title:** Characterize the difficulties that foreign Computer Science students face

**Principal Investigator:** Eman Alharbi

**Funding Source:** None

**Introduction**

You are being asked to be in a research study. This form is designed to tell you everything you need to think about before you decide to consent (agree) to be in the study or not to be in the study. A member of the research team will describe this study to you and answer any questions. **It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study. You can skip any questions that you do not wish to answer.**

Before making your decision:

- Please carefully read this form or have it read to you.
- Please ask questions about anything that is not clear.

Feel free to take your time thinking about whether you would like to participate. By signing this form you will not give up any legal rights. If you are completing this consent form online, you may want to print a copy of the consent form for your records.

**Study Overview** This study plans to learn more about the unknown difficulties and barriers that foreign Computer Science students have and to discover their special needs.

**Procedures** You are being asked to be in this research study because you are a Computer Science instructor, who have taught foreign students. We will schedule a 30-minute interview to ask you about your experience about teaching foreign students and the barriers that foreign students face.

**Other people in this study:** Up to 100 people will participate in this study.

**Risks and Discomforts:** There is no expected risk in asking students or instructors about the difficulties that foreign students face. Students will not be asked to identify instructors, and instructors will not be asked to identify students. However, interviewing students may cause emotional reactions but that would probably be the rare exception.

**Benefits** The aim of the study is to identify and articulate the difficulties that foreign Computer Science students face, and to discover their special needs, which will make instructors, international student organizations, and society in general aware of foreign students' needs, which will in turn provide international Computer Science students better services and will help them achieve greater success.

**Compensation** no compensation is provided.

**Confidentiality:** The privacy of participants will be protected by substituting their names with codes. and the confidentiality will be protected by using the data for this research only.

Protocol Number: 16-011

Version and Date Received: V3 – 9/2/15

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Certain offices and people other than the researchers may have access to study records. Government agencies and UCCS employees overseeing proper study conduct may look at your study records. These offices include the UCCS Institutional Review Board, and the UCCS Office of Sponsored Programs and Research Integrity. UCCS will keep any research records confidential to the extent allowed by law. A study number rather than your name will be used on study records wherever possible. Study records may be subject to disclosure pursuant to a court order, subpoena, law or regulation.

**Voluntary Participation and Withdrawal from the Study**

Taking part in this study is voluntary. You have the right to leave a study at any time without penalty. You may refuse to do any procedures you do not feel comfortable with, or answer any questions that you do not wish to answer. If you withdraw from the study, you may request that your research information not be used by contacting the Principal Investigator listed above and below.

**Contact Information**

Contact (PI's info): ealharbi@uccs.edu

- if you have any questions about this study or your part in it,
- if you have questions, concerns or complaints about the research, or
- if you would like information about the survey results when they are prepared.

Contact the Research Integrity Specialist at 719-255-3903 or via email at [irb@uccs.edu](mailto:irb@uccs.edu):

- if you have questions about your rights as a research participant, or
- if you have questions, concerns or complaints about the research.

**Consent**

A copy of this consent form will be provided to you.

I understand the above information and voluntarily consent to participate in the research. By signing this consent, I am confirming that I am 18 years of age or older,

Signature of Participant \_\_\_\_\_ Date \_\_\_\_\_

I agree to record my interview by the audio recorder:

Signature of Participant: \_\_\_\_\_ Date: \_\_\_\_\_

## APPENDIX II:

### STUDENT DEMOGRAPHIC SURVEY

**Study name:** Master Thesis about “Characterize the difficulties that international Computer Science students face”

**Principle investigator:** Eman Alharbi  
ealharbi@uccs.edu

**Study Overview** This study plans to learn more about the difficulties and barriers that foreign Computer Science students have and to discover their special needs.

**Risks and Discomforts** There is no expected risk in asking students about the difficulties that foreign students face. Students will not be asked to identify instructors. However, interviewing students may cause emotional reactions but that would probably be the rare exception. In the case of a participant having an emotional reaction, we will talk with her/him to reduce the stress and to explain that all foreign students have difficulties and this is very normal. If the reaction is severe, we will refer her to the University Health Center .

**Benefits:** This study is designed for the researcher to learn more about the difficulties and the barriers that cause the foreign students to have bad education experience or to reduce their learning achievement. Discovering these barriers will help the future foreign students to deal better with the difficulties, and will make instructors and society in general aware of foreign students’ needs.

The privacy of participants will be protected by substituting their names with codes. and the confidentiality will be protected by using the data for this research only.

**Procedure:** This is a screening survey. You will be asked some demographic questions, and then we will schedule a 30 minute interview with you at your convenience.

1. What is your gender?
  - Male
  - Female
2. What is the degree that you are pursuing?
  - Undergraduate
  - Master
  - PhD
3. What is your native Language?
4. From what country did you receive your last degree?
5. How long have you been in the U.S.A?
6. How long have you been at UCCS?
7. Your contact information to schedule the interview:
  - Email:
  - Phone:

## APPENDIX III:

### INTERVIEW QUESTIONS

Foreign Computer Science students' interviews:

- 1- What are the difficulties that you have faced?
  - a. If you have passed them, tell me how?
  - b. Tell me about the difficulties that you are not able to overcome.
  - c. Do you see the difficulties that other international students have, that you do not have?
- 2- Do you have problems participating in classes and expressing your ideas, and listening to and understanding the lectures? Why?
- 3- Have you experienced discrimination in the University in general, or during teamwork projects?
- 4- What do you think about the needs that international students have and not have been met?
- 5- Do you think that the knowledge that you learn in your previous degree in your country is enough to make success in your higher education here in U.S? For example to make success in your homework, projects, and papers.
- 6- Do you have any recommendations for international students affair, instructors, or students to help international students passing the difficulties?

Interview for instructors who have taught foreign Computer Science students:

1. What is your opinion about international students? tell me a story?
2. Can you tell me about a time you have had difficulties teaching international students?
  - a. How often does this happen?
3. What do you think about the needs that international students have which have not been met?
4. What effort have you made to help international students pass their challenges?
5. Do you think that international students have the same abilities to succeed as American students?
  - a. Do they succeed as well as American students?
6. Have you ever been an international student, and know about international students experiences?

## APPENDIX IV:

### Definitions of Difficulties/ Criteria that Mentioned in Student Interviews, and Collected from Demographic Data Survey

no	criterion	Description
1	listening and understanding lectures	The ability for student to listen and understand verbal communication in English
2	participating and expressing ideas	The ability for student to participate in class and express ideas
3	writing	The ability for student to write academic papers
4	reading	The ability for student to read books and research paper
5	presenting	The ability for student to present
6	dealing with tools	The ability for student to deal with advanced software tools
7	communication effectiveness	The ability for student to speak and understand others efficiently, and the ability for others to understand them. Note: We had a third party native speaker to listen to interviews and evaluate the communication effectiveness of students.
8	educational background	The extend to which the student's educational background, that student got from previous degrees, is enough to make success in studying Computer Science in USA
9	gender	Student's gender
10	degree	The degree that student is pursuing
11	USA residence (years)	The length of staying in USA
12	UCCS residence (years)	The length of staying in University of Colorado at Colorado Springs
13	country of previous degree	The country that student got previous degree from
14	language	Student's native language
15	English proficiency score	English proficiency score that students meet to enroll school. For example, TOEFL, and IELTS
16	estimated success	The estimated student success based on what student said in interview, and it does not depend on how well student did on the other criteria

*Table 9 table of definitions*

## APPENDIX V:

### Evaluation of Difficulties/ Criteria that Mentioned in Student Interviews, and Collected from Demographic Data Survey

no	Evaluation criterion	Scale
1	listening and understanding lectures	1- Student cannot understand anything. 2- Student understands things with major difficulties and confusing. 3- Ok, student has difficulties in understanding but s/he can overcome them e.g., by asking questions and writing notes. 4- Student had difficulties in listening and understanding only at the beginning of program. 5- Student has no problem at all in listening and understanding.
2	participating and expressing ideas	1- Student cannot participate and express ideas at all. 2- Student participates and expresses ideas with major difficulties and confusing. 3- Ok, student has difficulties in participating and expressing ideas but s/he can overcome them. e.g. by asking for clarification. 4- Student had difficulties in participating and expressing ideas only at the beginning of program. 5- Student has no problem at all in participating and expressing ideas.
3	writing	1- Student cannot write at all. 2- Student writes with major difficulties and confusing. 3- Ok, student has difficulties in writing but s/he can overcome them e.g. asking for reviewing from writing center or friends. 4- Student had difficulties in writing only at the beginning of program. 5- Student has no problem at all in writing.
4	reading	1- Student cannot read at all. 2- Student reads with major difficulties and confusing. 3- Ok, student has difficulties in reading but s/he can overcome them e.g. by translating or by skimming words first etc. 4- Student had difficulties in reading only at the beginning of program. 5- Student has no problem at all in reading.
5	presenting	1- Student cannot present at all. 2- Student presents with major difficulties and

		<p>confusing.</p> <p>3- Ok, student has difficulties in presenting but s/he can overcome them e.g. by careful preparations etc.</p> <p>4- Student had difficulties in presenting only at the beginning of program.</p> <p>5- Student has no problem at all in presenting.</p>
6	dealing with tools	<p>1- Student cannot deal with software tools at all.</p> <p>2- Student deals with tools with major difficulties and confusing.</p> <p>3- Ok, student has difficulties in dealing with tools but s/he can overcome them e.g. by seeking help from computer help center or others, or by searching, etc.</p> <p>4- Student had difficulties in dealing with tools only at the beginning of program.</p> <p>5- Student has no problem at all in dealing with tools.</p>
7	communication effectiveness	<p>Note: This criterion had been evaluated by a third party native speaker.</p> <p>1- Student cannot communicate effectively at all.</p> <p>2- Student has difficulty in expression, needs prompt from interviewer.</p> <p>3- Student has slight hesitation and difficulty in expression, not fluent.</p> <p>4- Student is fluent, accented.</p> <p>5- Student is educated native speaker.</p>
8	educational background	<p>1- Student has no educational background at all.</p> <p>2- Student has educational background but it is not enough at all, student has major lack of knowledge.</p> <p>3- Ok, student's educational background is not up to the required level, but s/he can overcome it e.g. by searching, or asking, etc.</p> <p>4- Student finds her/his educational background is not enough only at the beginning of program e.g. because of studying in different educational system.</p> <p>5- Student has enough educational background.</p>
9	gender	<p>1- Female</p> <p>2- Male</p>
10	degree	<p>1- Bachelor</p> <p>2- Master</p> <p>3- PhD</p>
11	USA residence (years)	<p>1- 1m-1y</p> <p>2- 1y 1m- 2y</p> <p>3- 2y 1m- 3 y</p> <p>4- 3y 1- 4y</p> <p>5- 4y 1m- 5y</p> <p>6- 5y 1m- 6y</p>

		<p>7- 6y 1m- 7y  8- 7y 1m - 8y  9- 8y 1m- 9y  10-9y 1m- 10  11- 10 y 1m- 11y  12- 11y 1m- 12  13- 12y 1m- 13y  14- 13 1m- 14 y  15- 14y 1m- 15 y  16- 15 y 1m- 16 y  17- 16y 1m - 17 y  18- 17 y 1m -18y  19- 18y 1m -19 y  20- 19 y1m- 20 y</p>
12	UCCS residence (years)	<p>1- 1m-1y  2- 1y 1m- 2y  3- 2y 1m- 3 y  4- 3y 1- 4y  5- 4y 1m- 5y  6- 5y 1m- 6y  7- 6y 1m- 7y  8- 7y 1m - 8y  9- 8y 1m- 9y  10-9y 1m- 10  11- 10 y 1m- 11y  12- 11y 1m- 12  13- 12y 1m- 13y  14- 13 1m- 14 y  15- 14y 1m- 15 y  16- 15 y 1m- 16 y  17- 16y 1m - 17 y  18- 17 y 1m -18y  19- 18y 1m -19 y  20- 19 y1m- 20 y</p>
13	estimated success	<p>1- Student cannot proceed at all, no chance to have success.  2- Student proceeds with major difficulties.  3- Ok, student has problems but, s/he knows how to figure them out.  4- Students had difficulties only at the beginning program.  5- Student does not have any kind of difficulties at all.</p>

*Table 10 evaluation criteria*

## APPENDIX VI

## DATA SHEET

case no	listening and understanding	participating and expressing ideas	writing	reading	communication effectiveness	English proficiency score
1	4	3	3	2	4	IELTS 5.5
2	5	5	3	5	4	TOEFL 88
3	3	3	2	5	3	IELTS 5.5
4	2	2	2	2	2	IELTS 6
5	5	4	3	5	3	waived
6	3	3	3	3	4	waived
7	3	1	3	2	3	UCCS AST 272
8	3	3	3	3	5	TOEFL 115
9	4	2	2	4	4	IELTS 6
10	4	3	4	4	4	TOEFL 85
11	4	1	4	4	4	IELTS 6
12	5	5	5	5	4	TOEFL 109
13	4	4	3	4	3	NA
14	5	5	3	4	5	waived
15	4	3	2	2	3	waived
16	4	2	3	3	4	waived
17	3	5	3	5	4	IELTS 6
18	5	3	3	5	4	TOEFL 550
19	5	5	4	5	5	IELTS 6.5

Table 11 data sheet- part 1

case no	dealing with tools	educational background	gender	degree	USA	UCCS	estimated success
1	NA	3	1	3	6	5	3
2	3	3	1	2	4	3	3
3	3	3	1	2	2	1	3
4	3	2	1	2	1	1	2
5	NA	4	1	2	10	1	4
6	NA	5	2	2	20	3	3
7	NA	3	2	2	1	1	3
8	3	3	1	2	4	2	3
9	3	3	1	2	6	1	2
10	5	5	1	2	4	3	4
11	2	2	2	2	2	2	2
12	NA	5	1	2	1	1	5
13	NA	3	2	2	2	2	3
14	NA	5	2	1	20	3	4
15	NA	4	2	1	6	3	3
16	NA	4	1	1	6	4	3
17	NA	4	2	3	8	3	3
18	NA	4	2	3	8	5	3
19	NA	3	2	3	2	2	5

*Table 12 data sheet- part 2*