

Measuring Students' Beliefs about Physics in Saudi Arabia

H. Alhadlaq¹, F. Alshaya¹, S. Alabdulkareem¹, K. K. Perkins², W. K. Adams², and C.E. Wieman^{2,3}

¹ *The Excellence Center of Science and Mathematics Education, King Saud University, PO BOX 2458 Riyadh, Saudi Arabia*

² *Department of Physics, University of Colorado, Boulder, Colorado 80309, USA*

³ *Carl Wieman Science Education Initiative, Univ of British Columbia, Vancouver, BC V6T1Z3, Canada*

Abstract. Over the last decade, science education researchers in the US have studied students' beliefs about science and learning science and measured how these beliefs change in response to classroom instruction in science. In this paper, we present an Arabic version of the Colorado Learning Attitudes about Science Survey (CLASS) which was developed to measure students' beliefs about physics at King Saud University (KSU) in Riyadh, Saudi Arabia. We describe the translation process, which included review by four experts in physics and science education and ten student interviews to ensure that the statements remained valid after translation. We have administered the Arabic CLASS to over 300 students in introductory physics courses at KSU's men's and women's campuses. We present a summary of students' beliefs about physics at KSU and compare these results to similar students in the US.

Keywords: Beliefs, Attitude, CLASS, Science education, Learning, Undergraduate research, Physics.

PACS: 01.40.-d, 01.40.Fk.

INTRODUCTION

In recent years, students' belief studies have gained considerable interest in physics education research. Several studies have looked at how various populations of undergraduate students view physics as they enroll in their first course in college and how they change their attitude and beliefs afterwards [1, 2, 3]. Research studies in the US have shown that most undergraduate students in their introductory physics courses have relatively novice-like views regarding physics and learning physics and that students enrolled in algebra-based physics courses are more novice on average than those enrolled in calculus-based courses [3, 4, 5].

Such studies are important as research has shown that key educational outcomes, such as interest in physics, choice of major, and science learning correlate with students' beliefs and attitudes [3, 4, 6]. Furthermore, instructional methods and in-class activities can have a role in improving [7, 8] or regressing students' views [3, 4]. The ability to probe students' views, to identify where students are particularly novice-like, and to compare across populations or track changes provides valuable guidance to faculty wanting to implement teaching practices that support improvement towards expert-like beliefs and to measure key educational decisions like choice of major and interest in science [6].

The Colorado Learning Attitudes about Science Survey (CLASS) is an instrument that has been developed and validated at the University of Colorado, Boulder (CU) over the past several years [3, 9]. It consists of forty two statements that cover various categories, such as real world connection, problem solving and conceptual understanding. In this work, an Arabic version of CLASS was developed to probe students' beliefs about physics at King Saud University (KSU) in Riyadh, Saudi Arabia. Here, we report on the translation process and present results from students entering the introductory courses at KSU. We compare these results to the results from two US populations.

TRANSLATION PROCESS

The English language is used to some degree in science classes at KSU, and some students seem to have a relatively good background in English, particularly those majoring in engineering and health sciences. However, when the English-version of the CLASS was administered to 40 freshmen engineering students, most students had difficulty answering its statements without help. This experience highlighted the need to translate the CLASS into the Arabic language. A critical feature of the CLASS is that the statements be as clear as possible to students and in language they commonly use so students don't struggle interpreting the statement.

A draft translation was completed by a bilingual instructor in physics, who is involved in teaching courses for undergraduate students. Just like with the original CLASS, the translator focused on writing clear statements in natural student language. Words like ‘concepts’ and ‘intuition’ were avoided. Four bilingual experts, two in science education and two physics instructors who are involved in teaching physics for undergraduate students reviewed the Arabic version of the CLASS to make sure that the statements were clear and reflected the meaning from the English version. To test their validity with students, we interviewed ten engineering and science majors from KSU men's campus.

In the interviews, students were given the Arabic version of the survey and were asked to answer the statements. Students were then asked questions about what they thought of the statements. Most students seemed to interpret the word ‘physics’ as the science describing nature. However, a few students thought of it as ‘the subject of physics that is being taught in class’ in some of the statements, but not all. Some students could not understand the words ‘reasoning skills’ so it was described further as ‘matching, making connections and logic processing’. Some rewording was done based on these expert reviews and student interviews.

The Arabic version of the CLASS, just like the original CLASS, has 42 statements to which students respond on a 5-point Likert scale (strongly agree to strongly disagree). Thirty-six of these statements are used to determine each student's 'Overall' % favorable score – which measures the percent of responses for which the student agrees with the experts’ response. Further details about the categorization, validation, and scoring of the CLASS is described elsewhere [3].

STUDY DESIGN AND POPULATION

KSU is the largest and oldest public university in Saudi Arabia with two main campuses in Riyadh, a men's campus and a women's campus, and several branches outside Riyadh. It offers undergraduate and graduate degrees in a wide variety of disciplines and has a highly competitive admissions process in the

region, particularly for engineering and health science majors. As summarized in Table 1, a total of 15 sections across 3 introductory physics courses were surveyed in the first and second week of the winter semester of 2009 (referred to as the ‘pre’ survey). Over 300 student responses were collected from the men’s and women’s campuses.

The CLASS in Arabic was administered in class in a paper-and-pencil format. Students were given clear instructions that the survey was for research purposes and their responses would not affect their grades. Most students took an average of 12 minutes to finish with a minimum of 10 minutes as compared to an average of 8 minutes for US students. Relative to the experience of U.S. students, KSU students have little experience with surveys in class and they seemed to be reading statements carefully. When the same students took the survey at the end of the semester, the average time was 7-8 minutes, less than at the beginning of the semester.

The KSU freshmen in the three different introductory courses surveyed had different majors (Table 1). Pre-medical (Premed) students intend to enroll in one of four colleges: college of medicine, college of dentistry, college of pharmacy, and college of applied medical sciences. These students have gone through a very competitive admissions process and most of them received good grades in high school math and science. Engineering (Eng) and computer sciences (CS) students are enrolled in either the college of engineering or college of computer and information sciences. Science major students are enrolled in the college of sciences and are intending to major in physics, mathematics, or chemistry. Most Premed students had no prior university physics course and are required to take only one physics course, which covers mechanics, E&M, and modern physics, but most Eng and science major students had taken a university physics course in the previous semester as they are required to take two physics courses, one is mechanics and the other is E&M. When scoring responses, fewer than 6% of the surveys were identified as invalid and dropped (see [3] for criteria).

To compare KSU results to similar students in the US, results of pre-course surveys of US students from

TABLE 1. Introductory courses surveyed at KSU.

	# of sections surveyed ¹	# of students enrolled	# of scored responses
Men’s campus/Physics for Eng and CS majors ²	5	137	87
Men’s campus/Physics for Pre-medical majors	4	90	62
Women’s campus/ Physics for Pre-medical majors	4*	280	127 **
Women’s campus/ Physics for Science majors	2	50	29

¹ Each section has about 20-30 students. Faculty members each teach between 1 and 3 sections.

² 85% engineering majors (Eng) and 15% computer sciences (CS) majors.

* Each section has about 70-80 students.

** Out of random selection of some lab sessions.

CU and the University of Northern Colorado (UNC) were used, including representative semesters of: CU calculus-based physics I course (CU Phys I Calc; men: $n=361$, women: $n=135$) in the fall semester of 2008, CU algebra-based physics I course (CU Phys I Alg; men: $n=134$, women: $n=234$) in the fall semester of 2007, UNC calculus-based physics I (UNC Phys I Calc; men: $n=43$, women: $n=22$), and UNC algebra-based physics I course (UNC Phys I Alg; men: $n=14$, women: $n=32$) in the fall semester of 2007.

RESULTS AND DISCUSSION

Figure 1 shows overall favorable score (%) of KSU students' responses in comparison to results of US students from CU and UNC. In general, we observe that KSU students majoring in engineering, computer sciences, and science tend to express more novice-like beliefs about physics than their peers in CU and UNC. When comparing KSU to CU, the overall favorable score is significantly different ($p<0.001$) except among the women premed group. Most KSU students majoring in engineering, computer sciences, and science had a prior university physics course and, given the typical regression to more novice-like beliefs found in first-term college courses, this experience could have contributed to their novice-like responses.

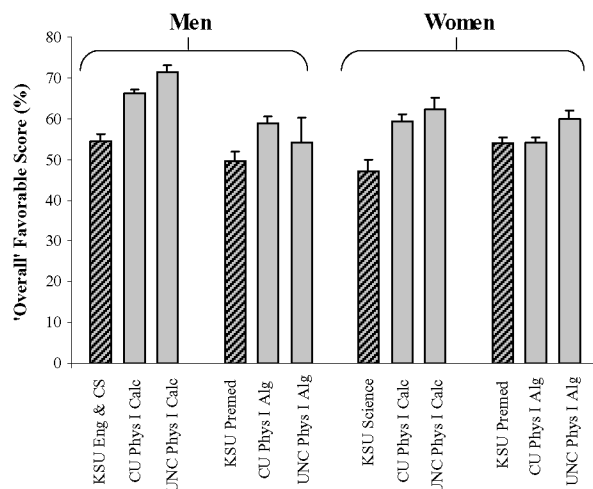


FIGURE 1. CLASS survey 'overall' favorable scores at the start (pre) of physics courses in (KSU, CU, and UNC) for different majors (most KSU students majoring in engineering, computer sciences, and science had a prior university physics course in the previous semester).

Comparing students' responses in various categories, rather than the 'overall' scores, provides more insight into how their beliefs about physics and physics learning differ. Out of eight categories, two categories showed significant differences ($p<0.05$) between KSU and CU for all comparable groups.

These categories were conceptual understanding, and applied conceptual understanding. The KSU Eng & CS students had the largest differences from their comparable group (CU Phys I Calc), with significantly lower scores across all categories except the "sense making/effort" category. We find the sense making/effort category is not significantly different between the corresponding KSU-CU groups except among women premeds where the KSU women premed were significantly more expert-like than their peers in CU.

Figure 2 shows students' responses in two related categories: personal interest and real world connection. These two categories involve statements that describe students' interest in and connection to physics.

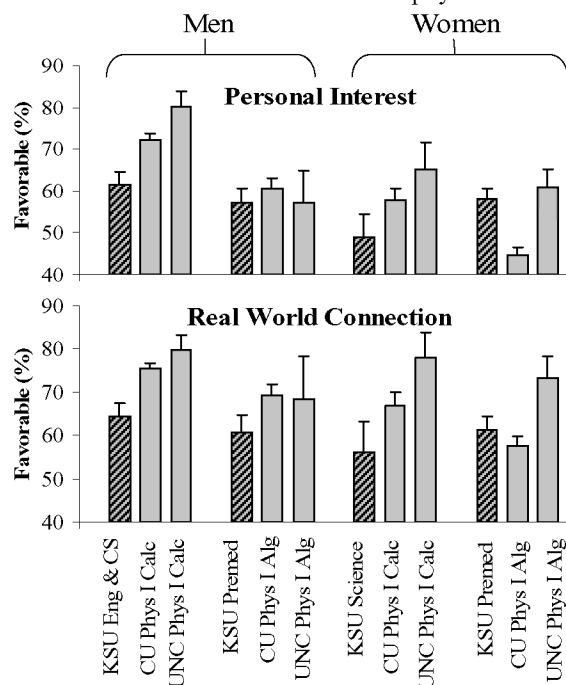


FIGURE 2. CLASS survey favorable scores in two categories: personal interest and real world connection at the start (pre) of physics courses in (KSU, CU, and UNC) for different majors.

In these two categories, it is interesting to notice that among men, while there is a noticeable difference between Phys I Calc and Phys I Alg in the US samples, within the KSU sample, there is no significant difference between Eng & CS and premed. One would think that engineering and science majors would have more expert-like beliefs in their interest in physics, and in fact, this correlation has been observed consistently in US students. Among the women, premed students tend to score the same or better within the KSU sample in personal interest, and score significantly better than the sample of CU population (with a margin of 12%).

We notice striking differences between KSU responses and responses from CU and UNC in two categories: conceptual understanding, and applied conceptual understanding (Figure 3). In conceptual understanding, KSU students scored in the range of 46-30% favorable score in comparison to 62-53% for CU students and 71-48% for UNC students. In applied conceptual understanding, KSU students scored in the range of 35-24 % favorable score in comparison to 52-41% for CU students and 54-38% for UNC students. We believe that this result is consistent with prior experiences of students before entering physics courses at KSU. In Saudi Arabia, high-school teaching commonly involves students memorizing equations and following recipes to solve problems. Noticeably, the differences in these two categories are less profound in the women's premed group.

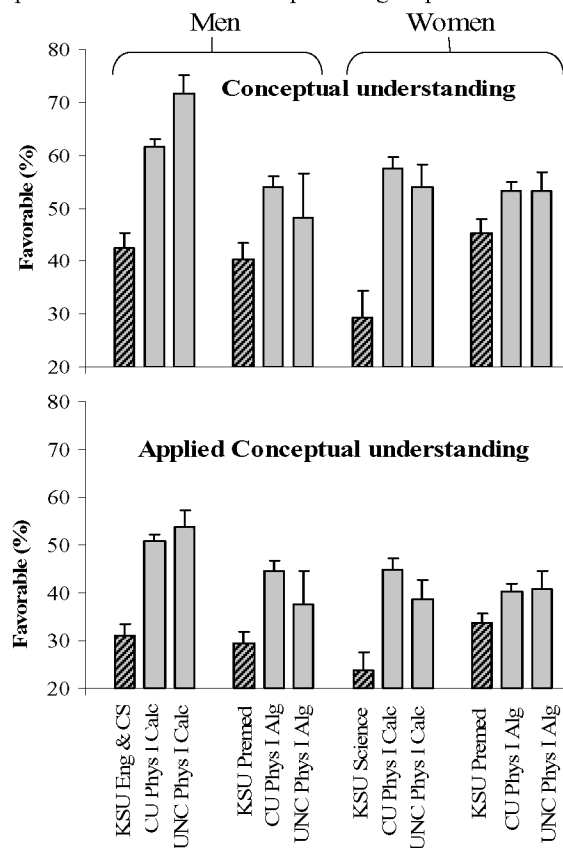


FIGURE 3. CLASS survey favorable scores in two categories: conceptual understanding and applied conceptual understanding at the start (pre) of physics courses in (KSU, CU, and UNC) for different majors.

One of the features in the KSU results that is worth further exploration is the gender difference in survey responses. For example, within the KSU premed sample, women tend to have similar or more expert-like beliefs about physics than men. Moreover, the

difference between KSU responses and US responses is less among the women premed group.

CONCLUSION

We have developed an Arabic version of the CLASS survey that can be used to measure students' beliefs about physics in Arabic-speaking countries. We have used expert reviews and student interviews to ensure that the statements are still valid and results can be compared to other students' population. We find that the KSU student population tends to be more novice-like than corresponding US populations, particularly in conceptual understanding and applied conceptual understanding categories. This information will help inform KSU faculty who are participating in a broader effort to transform teaching practices from traditional lecture instruction to incorporate interactive engagement techniques and assess conceptual understanding.

ACKNOWLEDGMENTS

The Excellence Center of Science and Mathematics Education (ECSME) [10] is funded by the Ministry of Higher Education in Riyadh, Saudi Arabia. We are grateful to the administration of King Saud University for their help and encouragement and to all of the faculty members at the department of Physics and Astronomy, King Saud University who generously agreed to administer the CLASS in their courses during winter semester of 2009. We also thank the CU and UNC faculty who agreed to give the CLASS in their courses, and we thank the CU PER group for useful discussion.

REFERENCES

1. D. Hammer, *American J. of Physics*, **68**, S52-S59 (2000).
2. E. F. Redish, *Teaching Physics with Physics Suite* (New York : John Wiley & Sons, 2003).
3. W.K. Adams, K.K. Perkins, N. Podolefsky, N.D. Finkelstein and C.E. Wieman *Phys. Rev. ST Phys. Educ. Res.* **2**, 010101 (2006).
4. K.K. Perkins, W.K. Adams, N.D. Finkelstein, S.J. Pollock, & C.E. Wieman, *PERC Proceedings 2004*.
5. Redish, E., Saul, J.M. and Steinberg, R.N. *American J. of Physics*, **66**, 212-224 (1998).
6. K.K. Perkins, M.M. Grady, W.K. Adams, N.D. Finkelstein and C.E. Wieman, *PERC Proceedings 2005*.
7. K.E Gray, W.K. Adams, C.E. Wieman and K.K. Perkins, *Phys. Rev. ST Phys. Educ. Res.* **4**, 020106 (2008).
8. E. Brewe, L. Kramer and G. O'Brien *Phys. Rev. ST Phys. Educ. Res.* **5**, 013102 (2009).
9. Latest version of CLASS (V.3) is available at: <http://class.colorado.edu>
10. The website: <http://ecsme.ksu.edu.sa>