Using Knowledge Structure as a Diagnostic Tool with Students Taking Introductory Statistics

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Many students have expressed difficulties in learning statistical concepts. However, traditional approaches of assessment such as multiple-choice questions and word problems often fail to identify their misconceptions. The motivation for this study was to examine a different approach to assessing student's understanding of basic statistical concepts. This approach examines mental representations of the relationship among concepts, also called structure of knowledge (SOK), and allows teachers to identify misconceptions (Acton, Johnson, & Goldsmith, 1994, Gonzalvo, Canas, & Bajo, 1994). The focus of this study was to investigate whether misconceptions can be identified using the SOK approach. Several steps were carried out. First, the plausibility of creating a single "instructor" model was examined. Second, comparisons between student and instructor were performed; and lastly, the identification of misconceptions was conducted qualitatively.

1. Method

Following established approaches, we generated a list of 21 words based on class syllabi and reflective of important concepts in introductory statistics. Then, all possible word pairs were formed. Students (n=20) and instructors (n=5) were then asked to rate the relatedness of words in each pair on a scale from 1 to 7. The ratings were treated as indices of perceived inter-relationships between concepts. Subjects were drawn from those associated with a graduate level introductory statistics class at the University of Georgia, USA. These students should have already received instruction in the concepts used in this study.

Because the focus was to identify misconceptions, local relationships among concepts were of interest. The Pathfinder (Schvaneveldt, Durso, & Derahold, 1989) was used in creating SOK. A program written in SAS was used to calculate the C index representing the degree of match between pairs of SOKs. The C index ranges from 0 to 1 with 1 being a perfect match. Misconceptions and important linkages were identified subjectively using authors' knowledge on the concepts.

2. Results and Discussion

Instructor SOKs were generated. The C index was calculated for every instructor pair. Agreements among instructors were moderate, ranging from .21 to .40. Instructors seemed to have vastly different overall representations of the selected concepts. Thus, averaging instructors' ratings to create a single "model" instructor SOK did not appear to be reasonable. Attention was shifted to smaller sets of concepts that may have closer linkage. By carefully reviewing instructors' SOKs, certain linkages were consistently observed. Four sets were found classified as (a) measures of central tendency, (b) measures of dispersion, (c) sampling variability, and (d) hypothesis testing. Instructors agreed moderately to highly on these four sub-sets of concepts. Modal linkages were used to create "model" SOKs. Instructors showed moderate to high agreement on the model SOKs (see Table 1). Model SOKs were compared to those from each student.

Table 1. Means and Standard Deviations (in parentheses) of C Index for Instructor and Student.

	N	Central Tendency	Dispersion	Variability	Hypothesis Testing
Instructor	5	.67 (.41)	.65 (.35)	.68 (.34)	.67 (.14)
Student	7	.50 (.40)	.33 (.19)	.36 (.25)	.40 (.13)

Students' C index for the four model SOKs were calculated using each model SOK as a standard. Only students (N = 7) who rated all concept pairs were included in the analyses. Overall, students showed less agreement to the model SOKs than did the instructors (see Table 1); however, several had SOKs similar to the model SOK in hypothesis testing. This point is somewhat surprising as students usually have great difficulty grasping the concept of hypothesis testing. One possible explanation for this unexpected observation is that instructors tend to spend more time and effort explaining these concepts, so students have more exposure to them.

Generally insufficient or inefficient inter-relations among concepts were observed in many student SOKs. They tended to have either simpler structures with few connections among concepts or messy structures in which connections were not necessarily meaningful. This does not necessarily lead to the conclusion that students have misconceptions in their understanding of statistics. It may be more appropriate to say that students have not yet established a well-connected SOK due to their lack of experience in statistical reasoning. Student SOKs appeared to be useful in identifying areas in which instructors should provide more exposure and experience for students.

REFERENCES

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FRENCH RÉSUMÉ

Des structures d'étudiant de la connaissance ont été comparées aux structures modèles compilées des instructeurs des classes préliminaires de statistiques. Les structures de la connaissance ont permis à des instructeurs d'évaluer la compréhension d'étudiant des concepts statistiques et d'identifier les concepts qui ont dû être renforcés.