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Development and Validation of an Instrument to Measure Teacher Knowledge of Inquiry

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Introduction

A 19-item multiple-choice instrument was developed to measure elementary teacher knowledge of a) scientific inquiry, b) classroom inquiry, and c) inquiry pedagogical content knowledge. The scientific inquiry questions address scientists' practice of inquiry and the nature of science; the classroom inquiry questions focus on the essential features of classroom inquiry (NRC, 2000), and the pedagogical content knowledge questions use brief teaching scenarios as a context for teachers to identify appropriate inquiry-based teaching approaches.

Development Process

The development process began with a comprehensive review of existing teacher inquiry knowledge instruments, with the intention of using an existing assessment. When a suitable questionnaire could not be located, the decision was made to develop a new instrument. However, we used questions from two federally funded projects[1] in addition to developing new questions. [1]

To guide the development process, a table of specifications was developed identifying underlying constructs and concepts for the initial 23-question assessment (Table 1).

The instrument was first tested with pre-service teachers enrolled in a science education methods course. Nineteen pre-service teachers completed the assessment and participated in a focus group session to identify confusing questions. Based on this input, wording of questions and response choices were revised.

Psychometric Analysis

The revised instrument was pilot tested with 164 teachers from two Midwestern states. Classical test theory and item response theory analyses (using BILOG-MG) were used to guide selection of items. Classical discrimination was calculated as the difference between the top and bottom 25% of participants in proportion of correct responses to each item. IRT difficulty/item location was calculated as the "b" parameter from a 2-parameter logistic model. IRT discrimination is the "a" parameter from a 2-parameter logistic model.

Results and Discussion

Selection of a final set of items required balancing content coverage as specified in the table of specifications, potential cognitive load on teachers, and psychometric properties. In order to reduce the length of the test several items had to be omitted, which in turn negatively impacted the alpha level. Table 2 shows key statistics for the final 19 items. These retained items yielded moderate internal consistency (alpha = .54) with wide variability in item difficulty (.09 - .91).

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[1]Pedagogical content knowledge questions were drawn from Schuster, Cobern, Schwartz, Velom, & Applegate. *Assessing Pedagogical Content Knowledge of Inquiry Science Teaching,* NSF Award 0512596. Other questions were drawn from Doll, Bruning, Horn, & PytlikZillig. *Evolving Inquiry: An Experimental Test of a Science Instruction Model for Teachers in Rural, Culturally Diverse Schools.* U. S. Department of Education grant R305M050309.

The item analysis and deletion process resulted in changing the appropriateness of the instrument from 2 standard deviations (SD) below average to 1.5 SD below average knowledge/ability and increased the breadth of applicability (Figure 1). It is important to note, however, that some questions were revised for the final version of the instrument and these statistics do not reflect the impact of these changes.

Use of Instrument

The instrument has been used in a national survey of elementary school teachers as a means of assessing teacher knowledge of inquiry. Results show that teachers (n = 142) scored 56% correct on the entire instrument, with 48% correct on the scientific inquiry questions; 63% correct on the classroom inquiry questions, and 55% on the pedagogical content knowledge questions. The difficulty level ranged from .05 to .91. Teacher knowledge is also being used in path analyses investigating the potential influence of various characteristics of professional development (e.g. contact hours, delivery format, training strategies, and level of collaborative participation) on teachers' inquiry knowledge, perceptions, and instructional practice and moderating effects of context and teacher variables (Glover & Nugent, 2013).

References

National Research Council (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning.* Washington DC: National Academy Press.

Glover, T., & Nugent, G. (2013, April). The influence of rural professional development characteristics on teacher-perceived knowledge and practice. Presentation at Connect-Inform-Advance Conference of the National Center for Research on Rural Education, Omaha, NE.

Table 1

Table of Specifications and Items

Topic	Question #
What is scientific inquiry?	4, 8, 16, 18, 20, 22
What is classroom inquiry?	1, 9, 10, 6
Engaging in scientifically oriented questions	17, 14a
Giving priority to evidence	2, 14b, 14c
Formulating explanations based on evidence	14d, 19
Connecting explanations to scientific knowledge	3
Inquiry pedagogy: What should teachers do in an inquiry-based classroom?	5, 7, 11, 12, 13, 15, 21, 23

Table 2

Psychometric Statistics for Retained Items

Science Inquiry Instructional Knowledge Measure (N = 164)					
	Difficulty/Item Location		Discrimination		
Item	Mean	IRT	Classical Discrimination	IRT	Corrected Item-Total Correlation
1	.683	-1.060	.071	0.494	.213
2	.592	-0.622	.093	0.389	.198
4	.524	-0.477	.128	0.327	.180
5	.561	-0.766	.109	0.433	.108
7	.622	3.288	.078	0.473	.209
8	.762	0.295	.064	0.366	-.060
10	.085	-2.366	.357	0.465	.098
11	.457	-1.775	.160	0.664	.143
12	.524	-3.054	.163	0.444	.268
14a	.842	-1.421	.022	0.438	.154
14c	.835	-2.420	.037	0.675	.238
14d	.890	-0.387	.027	0.424	.095
15	.592	-0.728	.113	0.347	.278
18	.720	-0.766	.042	0.433	.149
19	.689	-2.694	.123	0.265	.278
20	.909	3.288	.014	0.473	.163
21	.561	0.295	.142	0.366	.209
22	.598	-0.134	.061	0.558	.115
23	.842	-2.366	.029	0.465	.317

Figure 1. *IRT scale information function*