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Assessing Critical Thinking Using a Talk-Aloud Protocol

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Abstract

This article presents the results of a research study that addresses how entry-level nurses process information in order to answer multiple-choice items versus a paired item that uses an alternate format. A talk-aloud protocol was used to assist in the identification of the cognitive processing that was required by entry-level nurses as they responded to items. A purposeful sample was used to select the participants: seven registered nurses and five practical nurses licensed for less than a year. Results of the study suggest that some items that use alternate formats require participants to use higher cognitive processing than a paired multiple-choice item. With the importance placed on the ability of the entry-level practitioners to think critically, regulators may want to consider the use of alternate format items in addition to multiple-choice items to assess higher order thinking skills.

Effective clinical decision-making is one of the most important contributions made by health care professionals (White, 2003). A large component of effective clinical decision-making, and thus of the successful practitioner, centers on the ability to understand complex issues and to think critically. Using items from the National Council Licensure Examinations for Registered and Practical Nurses (NCLEX-RN® and NCLEX-PN®), a study was undertaken to determine whether different levels of cognitive processing, such as the higher order skills of critical thinking and clinical decision-making, were used by entry-level nurses to answer examination items of varying formats and content areas. A qualitative method using a talk-aloud protocol was used to investigate how entry-level nurses process information in order to answer a question posed to them. The results of this study may provide insight into ways regulators can assess critical thinking and

clinical decision-making as part of their licensure process.

Cognitive Processing

Many methods of evaluating an individual's skills and abilities in a domain of knowledge involve evaluating that individual's cognition—often referred to as cognitive processing ability. Various taxonomies have been developed in an attempt to categorize the different levels of cognitive processing that are used to answer test items. Probably the most well known taxonomy used to categorize educational objectives and then test items is Bloom's taxonomy (Bloom, 1956).

Bloom's taxonomy contains six major classes from lowest level of cognitive processing to highest level of cognitive processing: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation (Bloom, 1956). Bloom's taxonomy is a cumulative hierarchy. This taxonomy assumes that the more complex cognitive behaviors include the simpler cognitive behaviors. Items categorized at successively higher levels of the taxonomy require more cognitive processing to answer a question. Several research studies provide evidence that supports this cumulative hierarchy and thus the ordering of the less complex categories of Knowledge/Recall, Comprehension, and Application. (Anderson & Krathwohl, 2001; Miller, et al., 1991; Buckwalter, et al., 1981). However, when the higher levels of cognitive processing are considered, there seems to be weaker empirical evidence for the hierarchical model (Anderson & Krathwohl, 2001). Indeed, some well-known authors have

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revised Bloom's taxonomy as can be seen in Figure 1.
(Anderson, et al., 2001, p. 310)

Figure 1. Comparison of Bloom's Framework to Revised Framework

In exploring this revision to the taxonomy, cognitive complexity appeared to be the ordering principle for Bloom's taxonomy and Create, which uses inductive reasoning, is inherently a more complex process than Evaluate, which uses deductive reasoning. In Create, the examinee gathers information and views it in light of personal knowledge and experience. The cognitive process used in Create involves putting elements together to form a coherent or functional whole by reorganizing elements into a new pattern or structure. In using deductive reasoning for the Evaluate category, the examinee provides assertions that predictably lead to a conclusion measuring soundness; makes judgments based on criteria and standards.

In general there seems to be evidence to support the use of

be taught and therefore assessed within the confines of test development. Evaluating and predicting are two aspects of critical thinking for which we can prepare test items (Haladyna, 1997).

Many test developers propose that multiple-choice items can be used to evaluate critical thinking, as long as the items are focused on measuring higher-order thinking ability. McDonald (2002) proposes that such an assessment consists of the ability to use item information in a unique situation—moving away from recall or comprehension-level questions that require only rote memorization skills. This unique situation is considered to be enhancement of a recall question into an application or analysis type of question. While there is agreement that item development at the application and analysis level is fundamental to the measurement of critical thinking, there appears to be increased evidence of the use of higher-order thinking when examinees answer constructed-response items. Items not limited to a single correct answer encourage the examinee to move from recall to application/analysis and therefore demonstrate cognitive processes that can be identified as critical thinking (McDonald, 2002).

Alternate Item Types

In 1994 the NCLEX® examinations moved from a paper and pencil format of multiple-choice items to computer-adaptive technology using those same item formats. Innovations in computer-based testing include additional item types with features that include sound, graphics, animation and video integrated into the item stem, response options or both. The computer interface for items has moved from multiple-choice type items of selecting one answer from several response alternatives, to the ability to drag and drop objects in order to rank answer options, click on graphics, and choose multiple-correct responses. In addition, advances have been made in the scoring of fill-in-the-blank items and essays. The following pages describe the types of alternate item formats used in this study. These items were paired with multiple-choice items to determine the ability of alternate items to tap into higher-order thinking. Figure 2 contains a comparison of traditional item types and alternate item formats. A discussion of the various item types follows.

Figure 2. Comparison of Traditional and Alternate Item Formats

Traditional Item Type	Alternate Item Type
<u>Multiple Choice Item:</u>	

As has been discussed, there is a great deal of information on how individuals process information and learn. In addition, there are many taxonomies that can be used to categorize cognitive processing and with the categorization of cognitive processing, the manifestation of that processing for assessment purposes. In nursing and other professions, critical thinking has been identified as an important trait to develop. Measurement of that trait is difficult but is valued by educators and regulators. One method that has been identified as useful in identifying critical thinking is the use of alternate items. However, it remains uncertain as to whether it is possible to objectively measure critical thinking, and if the items that employ alternate formats actually require higher cognitive processing when compared to a paired multiple-choice item. This study is intended to determine if alternate items are assessing higher levels of cognitive processing.

Methodology

The design of this study uses a non-experimental research method involving a talk-aloud protocol to identify the cognitive processing required to answer alternate item formats paired to multiple-choice formats. Based on the work of Ericsson and Simon (1984) the assumption is that it is possible for subjects to report on their last cognitive processes based on information and cues retrieved from their short term memory. Talk-aloud protocols use the subject's verbal reports as data in determining the cognitive processes, with the addition of retrospective reporting to verify the data. Experts then evaluate the talk alouds and assign a cognitive level to the verbal report. The results of the experts rating the talk alouds are then analyzed using a multi-faceted variation of the Rasch measurement model, FACETS (Linacre, 2003). FACETS can be used to jointly measure people, items and raters. FACETS produces "measures" of persons and items. The "measures" of the participants' cognitive processing of items as defined by the experts' ratings are then used when comparing the item pairs.

In order to identify whether there was a difference between the cognitive processes of alternate items as compared to conventional multiple-choice items, it was necessary to employ the use of verbal reports. The 'think-aloud' theory devised by Newell & Simon (1972, in Taylor, 2000) proposes that it is possible to record and to identify the problem-solving strategies in use during exercises. Using this protocol, in which the examinee is asked to relate what is in his/her mind while working through the item, provides the ability to identify the actual cognitive processing taking place.

For the purpose of various talk-aloud research, text types may include reading paragraph comprehension, where easy

well-written texts may not provide suitable verbalization—but rather a reproduction of the text itself. When text becomes more difficult due to unfamiliar topics, poor organization or unfamiliar writing styles, talk aloud can produce more information than only the reproduction of text (Katalin, 2002). In this research reading has a specific purpose and the test question formats described earlier make the activity of reading and thinking in order to find the correct response suitable for talk-aloud research.

Talk Aloud Study

Nurses within a thirty-mile area of our offices (in Chicago, IL) who had successfully passed the NCLEX® examination and were within their first year of practice were asked to participate in this study. Participants signed a confidentiality agreement and were given a tutorial on the talk-aloud protocol methodology, asking them to talk-aloud constantly from the time a problem was presented until they had given their final answer. Finally, the participants were asked about their educational background, how many times they had taken the NCLEX® examination before passing, and their computer skills to assure a mix of skill levels.

They were instructed not to plan out what they were to say or try to explain their reasoning to the researcher. The participants were also told that if they were silent for a long period of time the researcher would remind them to talk. A series of warm-up exercises were presented including simple multiplication problems and anagrams until participants were comfortable with the talk-aloud procedures. For practice in retrospective reporting, the study participants were asked to talk aloud and identify the number of windows in their parent's house. Next they were asked to describe how they were thinking as they arrived at that number. The same type of practice was used to identify twenty animals. The practice sessions continued until the participants were comfortable with the protocol.

The method required that the verbalizations were recorded and the researchers did not interfere with the process. The tape recorder was placed to one side and the researcher sat behind and out of sight of the examinee, who was working at one laptop with the examination and with the audio recordings. The participant was given a tutorial on the alternate item types with samples of each question type and a full explanation of the specific operation of the computer being used. Throughout the recording session the researcher would prompt the subjects to "keep talking" whenever there was an extended period of silence.

Following completion of the research test, the participants were given a copy of the items just completed and asked to retrospectively state what they were thinking about when

they answered the item. They were instructed not to re-answer the question, but to review what they were thinking about when they originally answered. Ericsson and Simon, (1984) state that “even for cognitive processes of long duration, where we know that the retrospective report will be incomplete, it will be quite useful...it will more clearly convey the general structure of the process...” (p. 379)

Once completed, the recordings were transcribed verbatim. Three experts evaluated the talk aloud transcription and categorized the findings according to the six cognitive levels: knowledge, comprehension, application, analysis, evaluate and create. The decision to stop the talk alouds was based upon the determination by the experts as to whether or not new information was being obtained from the review. The experts were to evaluate the talk alouds of 5-10 entry level RNs and 5-10 entry level LPNs. Should there be no new information gained from the talk alouds after 5 cases, the talk alouds and transcriptions could be stopped. After analysis of the transcription of five LPNs and seven RNs it was determined that no new information would be gained.

Expert Rating

Three nursing experts were used to evaluate the cognitive processing of the participants talk aloud as they answered the items. The raters received information on the purpose of the study, training materials addressing talk-aloud protocol and cognitive processing, and background material. All of the raters had been involved with the NCSBN Examination Committee and were very familiar with cognitive processing and NCLEX® items. Prior to evaluating the transcriptions, the raters were oriented and a sample transcription was evaluated independently, and then discussed as a group to bring forward any issues regarding the scoring matrix that was developed. The experts were asked to evaluate the transcript independently, using the scoring matrix. They were asked to identify lines from the transcript that supported their rating of the cognitive processing of the items in the research test. The experts were “blinded” as to the sequencing of the items in the research test in order to prevent bias in their ratings of cognitive processing.

In developing the research test, care was taken to vary not only the item formats, but within formats to vary the nursing content as well as expected levels of item difficulty. In addition, to manage potential cueing and impact of cueing on cognitive processing levels, the positions of the alternate items and the multiple-choice items in the test were juxtaposed. All items used in the study were validated in nursing textbooks required by entry level nursing programs and were evaluated by item review panels who certified the correct answer and that the items are appropriate for entry level practitioners. This information can be used to determine if

the different nursing content areas and competencies being assessed impacted the item format and/or cognitive processing of the items. Thus, a variety of content areas including several items on the same content were used for the various item types. It was expected that the study would be able to determine that cognitive processing for item formats is not necessarily related to content of item. In working with calculation items, participants were provided with calculators

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examined, a very different picture emerges.

Table 1: Comparison of RN Alternate and Multiple Choice Items

As can be seen from Table 1, Pairs of RN Alternate and Multiple-Choice Items by Type, the RN participants used higher ordering thinking skills (as evaluated by raters based on their talk alouds) more often for the ordered response, multiple response, clinical scenario/chart, and hot spot items as compared to the paired multiple-choice items. (Larger “measures” reflect increased levels of cognitive processing. The measure reflects a scaled score centered at 10). There were some items within the item types mentioned where the difference was not significant and could be considered the same level of cognitive processing. However, on average

for every item type for RNs, except audio, there was a significant difference in cognitive processing as noted by increased measures for those items. For the audio items there was no difference from the paired multiple-choice

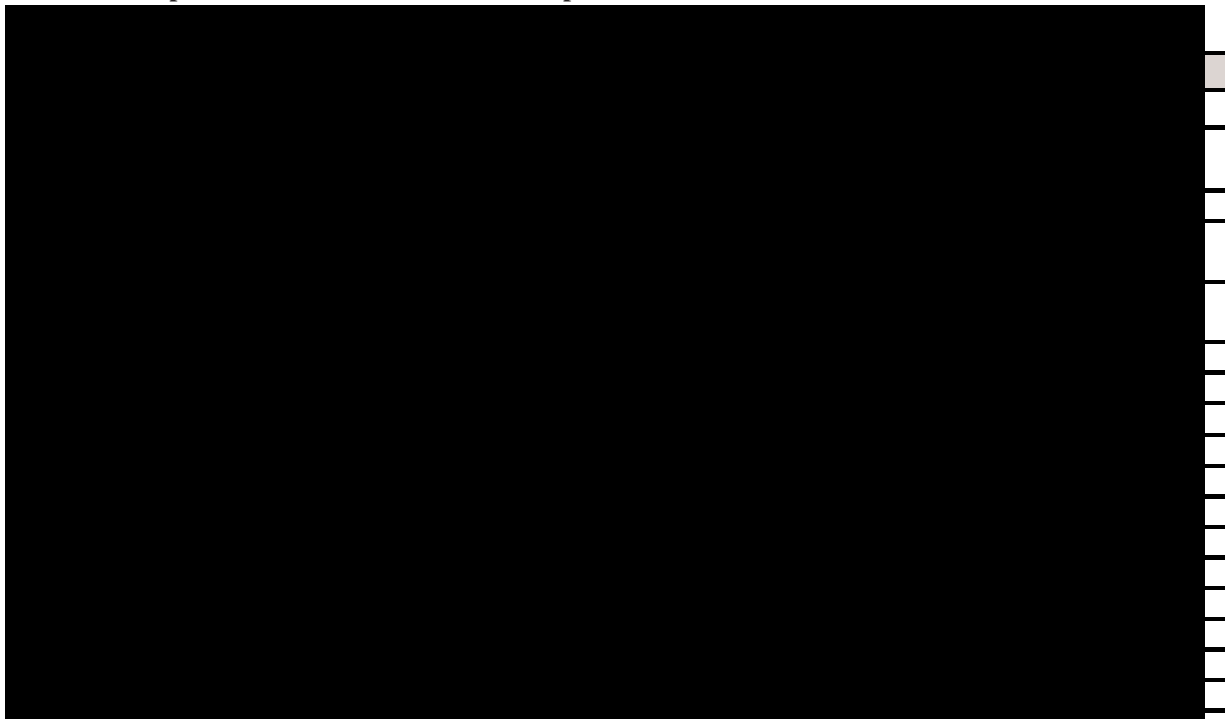
talk alouds. It should be noted that the computer interface for Ordered Response item may add a level of complexity to the task of responding. That is, the necessity to track and “type in” the answer rather than ‘drag and drop’ to achieve sequencing may be making the item unnecessarily difficult either in terms of cognitive processing or item difficulty.

Figure 3. Cognitive Processing RN

It seems that if higher levels of cognitive processing can be equated with critical thinking, then the use of the alternate items—especially the clinical situation/chart format—may provide increased opportunity to assess this aspect of nursing competence.

For PN participants, a pattern similar to the RN results emerges. As can be seen by Table 2, Pairs of PN Alternate and Multiple-Choice Items by Type, when the level of cognitive processing as measured by raters evaluating talk aloud answers to paired alternate and multiple-choice items, there is a general increase in cognitive processing for the alternate items.

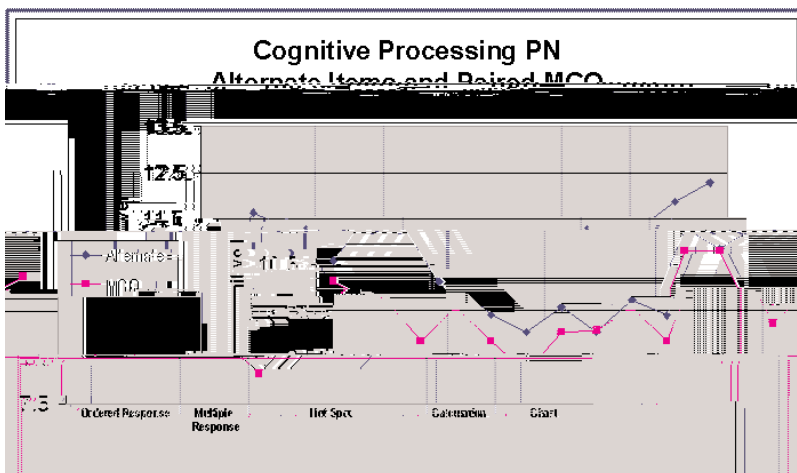
Table 2: Comparison of PN Alternate and Multiple Choice Items



As with the RN items, we note that within item types, some alternate items require the same amount of cognitive processing as multiple-choice items when the error associated with the measure for cognitive processing is considered. Thus for the hot spot and calculation items, some of the alternate items required the “same” level of processing as multiple-choice items. For the remainder of the items—ordered response, multiple response, and clinical scenario/chart—participants used more cognitive processing to answer the items.

In addition, for PNs in this study as seen in Figure 4, the clinical scenario/chart items are the most cognitively complex followed by the calculation, ordered response and multiple response items. The hot spot items were the least complex. It seems that if higher levels of cognitive processing can be equated with critical thinking, then the use of the alternate items—especially the clinical scenario/chart format—may be the wave of the future.

Figure 4. Cognitive Processing PN



Based on the results, raters are able to assess the cognitive processing that is used by participants to answer alternate and multiple-choice questions. In general, it appears that all of the alternate items except audio items require more complex cognitive processing when compared to a paired multiple-choice format items.

Conclusions

Experts are able to agree on ratings of examinees' cognitive processing based on the talk alouds of alternate and multiple-choice item types. Based on this study, experts should be able to categorize the cognitive processing that is used by candidates to answer examination items of various types. Historically, assumptions (based on the literature and expert judgment) have been made about how NCLEX® candidates process information in order to answer multiple-choice items. Now there is some empirical data to support the tax-

onomy used to categorize the cognitive processing of NCLEX items. It should be noted, however, that more research is needed to determine the cognitive processes and thus coding of the Create (synthesis) items since there were no items in this study that were targeted for the Create cognitive level. Additionally, results may not extend to other professions, and generalizability, even within nursing, may be an issue due to small sample size.

In this study, higher cognitive processing is required to answer many of the alternate item types when compared to the paired multiple-choice item. With the importance placed on these higher cognitive processes (i.e., critical thinking) by many educators, the use of alternate items may allow better assessment of the use of those higher cognitive levels. Perhaps the best strategy for assessing competence is to take advantage of a variety of item types to maximize the benefits of each item and thereby reduce the risk of using just one type of item on a high stakes examination. The results of this research provide test developers of high stakes examinations, whether they be educators or regulators, a

comparative framework for an alternate path of item development aiming for a negotiated middle ground somewhere between austere and efficient multiple choice items and the stimulus rich, yet often unattainable simulation testing environment.

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