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Application of QUEST Model of Questioning in the Classroom: Action Research Methodology in High School Education

Nadira Pardo[1] and Patrick Bakes[2]

1. Behavioral Sciences Faculty at the California Southern University, 930 Roosevelt, Irvine, CA 92620, USA

2. *Principal of the Circular Head Christian School, 48 Nelson St., Smithton, TAS 7330, Australia*

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Abstract: It is well known that humans learn through a process of assimilation, incorporating new concepts into existing cognitive structures and forming revised representations in their mental lexicon. The study examines the application of the theories underlying Graesser's QUEST model to the high school classroom, to determine if the framing of new concepts into question-asking protocols and cognitive rehearsal regimes allows for increased and enhanced learning in high school students. Mandler's seminal work in Cognitive Psychology, Learning, and Memory are well known (1967) as is the work of one of his former graduate students, now Professor Emeritus, Dr. Arthur C Graesser from the University of Memphis (USA) who developed the QUEST model with his own graduate students, including Dr. Pardo, in the AI and Cognitive Science Laboratories at the University of Memphis. A pre-test/post-test quasi-experimental design was applied to two different levels of math and science classes, and overall performance was measured by how many questions they could answer before and after the classroom instruction.

Key words: LTM, cognitive processing, teaching methods.

1. Introduction

Although the use of questioning has long been used as a teaching method, for example, in the Grecian Socratic method, the specific mechanics of the cognitive processes have only been explored for the last 50 years as published research in Psychology, beginning with Mandler's [1] work in memory, and following on with his graduate student, Graesser [2] in the area of psycholinguistics [3-9]. However, the authors have yet to see this implemented in the classroom in mainstream education. The purpose of the study was to see if the theories presented in the QUEST model would have any impact on overall learning of high school science and math students in a private school K-12 in rural community in the state of Tasmania in Australia.

1.1 Memory and Learning

George Mandler is a well known Cognitive Psychologist from the USA who conducted work in the organization of memory in the 1960's [1]. His work was the beginning of many years of research in the area of learning and memory. His work in category-recall relation was first presented in October 1964 at Niagra Falls, Ontario, Canada, then his general model was presented in January 1965 in LaJolla, California, and presented to Colloquia at the Center for Cognitive Studies at Harvard University in February 1965. Finally, the model was presented to the Psychonomic Society in October 1965 before being published in the Psychology of Learning and Motivation book in 1967. The main concepts of his model were: a) the organization of verbal material is hierarchical, with words organised in successively higher order

Corresponding author: Nadira Pardo, Ph.D., professor, research field: psychology. E-mail: Npardo@calsouthern.edu, nadira.pardo@my.calsouthern.edu.

categories, b) that organisation is a necessary condition for memory, and c) that the storage capacity within each category or sub-category is limited. Therefore, memorisation or learning depends on the organisation and organisational variables. His doctoral students, including one Arthur C. Graesser, [2] carried on his work and developed their own models in the areas of Cognitive Psychology and Cognitive Science.

1.2 Quest Model

The QUEST model was developed by Professor Emeritus Arthur C. Graesser in the Institute for Intelligent Systems Laboratories at the University of Memphis, USA in the 1980's [2]. The model examines open-ended questions such as Why, How, When, Where and What are the consequences, and predicts 1) types of knowledge structures, 2) causal networks, 3) goal structures, 4) taxonomic hierarchies, and 5) spatial networks when examining written or verbal discourse in the areas of learning and memory and cognitive structures and processes involved in learning and memory. The convergence mechanism in the model identifies the subset of statement nodes within an information source, which can predict good answers to a particular question. For example, arc-search procedures for each question category, constraint propagation, pragmatic considerations such as common ground and goals of the participants involved in the discourse and the identification of intersection nodes from different information sources. This model, to the best of knowledge, has not been applied in a high school educational setting to determine if question asking as a framework can enhance overall learning and memory for better retention of material presented in the classroom. The study aims to rectify this gap, and seeks to apply the model in a high school setting.

1.3 Design

A two-by-two factorial quasi-experimental design was used to compare year 10 science and math students to year 11/12 science and math students at a high school in rural Tasmania Australia. In this way, levels and abilities of the students were matched, differences in curriculum content were matched, and with 2 difference subjects (math and science) the subject matter could also be matched across student conditions. Thus, the independent variables were academic year (10 or 11/12) and time of assessment (pre-test/post-test or post-test only), and the dependent variable was how well they performed on the Midyear Exam for material presented under those two conditions in Term 1 and Term 2.

2. Methods

2.1 Subjects

Science and Mathematics classes for years 10 through 12 from the Circular Head Christian School enrolled during 2014 academic year in Circular Head Tasmania Australia were included in the study.

2.2 Procedures

During Term 1 (February through April) of 2014 a pre-test/post-test design was used to present material from the Australian National Curriculum to all students for their specific required content and level of study. During Term 2, a post-test only design was used to deliver material from the Australian National Curriculum to all students for their specific required content and level of study. Midyear Exam content for each class was designed such that 50% of the content came from Term 1, and 50% came from Term 2 material presented to the students in class. Results from the Midyear Exam for each class were compared for differences between recall on material presented in Term 1 compared to Term 2. Additionally, the post-tests for Term 1 and Term 2 in the form of weekly quizzes were compared for Term 1 and Term 2.

2.3 Materials

Weekly quizzes were designed using Graesser's QUEST model for each of the classes at the Circular Head Christian School (CHCS). Specifically, questions

Table 1 Research design.

Academic Level	Term 1	Term 1	Term 2
Year 10 Math	Weekly Pre-test	Weekly Post Test	Weekly Post Test Only
Year 10 Science	Weekly Pre-test	Weekly Post Test	Weekly Post Test Only
Year 11/12 Math	Weekly Pre-test	Weekly Post Test	Weekly Post Test Only
Year 11/12 Science	Weekly Pre-test	Weekly Post Test	Weekly Post Test Only

using What, How, Why, were designed to allow for the maximum amount of taxonomic construction, elaboration, and organizational frameworks around the concepts being presented. Post-tests across both conditions (with and without the Pre-test) were similar in design in both the complexity of questions, and level of abstractness of the concepts being presented to ensure comparability.

3. Results

First, the Midyear Exams from each class were scrutinized for the similarities or differences between the Term 1 and Term 2 content responses. Qualitative analysis of these results indicates that first, the number of omissions (responses left blank) were significantly higher for the Term 2 content compared to the Term 1 content. Second, that the types of responses given were more accurate for Term 1 content compared to Term 2. Third, that the descriptions used to reply to the questions on the exam were better overall, with more complexity and clarity noted in responses to Term 1 content questions than Term 2 content questions. Finally, the taxonomic and organizational attributes of the information presented in response to Term 1 content was higher than to Term 2 content. When compared to the weekly quiz results, it was noted that the amount of information presented in the Post-test conditions in both Term 1 and Term 2 were higher overall compared to the content replies on the Midyear Exam. However, the replies to Term 1 (when the Pre-test was present) were significantly higher recall for information in terms of amount of information retained for a longer period of time compared to Term 2. Given the fact that the Midyear Exam was held at the end of Term 2, this finding is even more remarkable, since the time between initial presentation of the concepts and the Midyear Exam was longer for Term 1 than for Term 2 concepts. Thus, the application of Graesser's QUEST model to the teaching of Science and Mathematics in this study appears to support 1) better understanding or clarity of the concepts, 2) better retention of the concepts over time, 3) better taxonomic and organizational attribution over time and 4) more elaboration of related concepts when a pre-test is posed with a question-based framework to encode the information.

Table 1 Math-QUEST attributes present.

	Term 1	Term 2	Midyear Exam
Year 10	Pretest/posttest	Posttest only	
Types of Knowledge Structures	HIGH	LOW	T1 > T2
Causal Networks	HIGH	LOW	T1 > T2
Goal hierarchies	HIGH	LOW	T1 > T2
Taxonomic hierarchies	HIGH	LOW	T1 > T2
Spatial Networks	HIGH	LOW	T1 > T2
Year 11/12			
Types of Knowledge Structures	HIGH	LOW	T1 > T2
Causal Networks	HIGH	LOW	T1 > T2
Goal hierarchies	HIGH	LOW	T1 > T2
Taxonomic hierarchies	HIGH	LOW	T1 > T2
Spatial Networks	HIGH	LOW	T1 > T2

Table 2 Science-QUEST attributes present.

	Term 1	Term 2	Midyear Exam
Year 10			
Types of Knowledge Structures	HIGH	LOW	T1 > T2
Causal Networks	HIGH	LOW	T1 > T2
Goal hierarchies	HIGH	LOW	T1 > T2
Taxonomic hierarchies	HIGH	LOW	T1 > T2
Spatial Networks	HIGH	LOW	T1 > T2
Year 11/12			
Types of Knowledge Structures	HIGH	LOW	T1 > T2
Causal Networks	HIGH	LOW	T1 > T2
Goal hierarchies	HIGH	LOW	T1 > T2
Taxonomic hierarchies	HIGH	LOW	T1 > T2
Spatial Networks	HIGH	LOW	T1 > T2

4. Discussion

Although the use of questioning has long been used as a teaching method, for example in the Grecian Socratic method, the specific mechanics of the cognitive processes have only been explored for the last 50 years as published research in Psychology, beginning with Mandler's work in memory, and following on with his graduate student, Graesser in the area of psycholinguistics. However, we have yet to see this implemented in the classroom in mainstream education as a deliberate teaching strategy for improving overall learning and retention of concepts.

The purpose of this study was to see if the theories presented in the QUEST model would have any impact on overall learning of high school science and math students in a rural community in Tasmania. Results support the theories of both Graesser and Mandler, in that memory for concepts is increased and retained for longer periods of time when presented initially in a framework of questioning.

The next phase of this research is to perform detailed quantitative analysis of the results in Term 3 and 4, and to compare the overall year of teaching and learning for the same group of students in a more longitudinal design, comparing midyear exams to the final exams for the year. Also, a retest of the same material when the year 10 students get to year 11 would be a way to determine if longer term retention is possible with the use of the QUEST model.

References

[1] Mandler, G. 1967. "Organization and Memory." *Psychology of Learning and Motivation* 1: 327-72.

[2] Graesser, A. C. 1990. "QUEST: A Cognitive Model of Question Answering." *Discourse Processes* 13 (3): 279-303.

[3] Dowell, N. M., Cade, W. L., Tauscik, Y. R., Pennebaker, J. W., and Greasser, A. C. 2014. "What Works: Creating Adaptive and Intelligent Systems for Collaborative Learning Support." In *Proceedings of the 12th International Conference on Intelligent Tutoring Systems*, 24-33.

[4] Graesser, A. C., and McNamara, D. S. 2011. "Computational Analyses of Multilevel Discourse Comprehension." *Topics in Cognitive Science* 3 (2): 371-98

[5] Graesser, A. C., McNamara, D. S., and Kulikowich, J. M. 2011. "Coh-Metrix: Providing Multilevel Analyses of Text Characteristics." *Educational Researcher* 40 (5): 223-34

[6] Joksimovic, S., Dowell, N. M., Oleksandra, S., Kovanovic, V., Gasevic, D., Dawson, S., and Graesser, A. C. 2015. "How do you connect? Analysis of social capital accumulation in connectivist MOOCs." In *Proceedings of the 5th International Learning Analytics and Knowledge (LAK) Conference*.

[7] Kintch, W. 1998. *Comprehension: A Paradigm for Cognition.* UK: Cambridge University Press.

[8] McNamara, D. S., Graesser, A. C., McCarthy, P. M., and Cai, Z. 2014. *Automated evaluation of text and discourse with Coh-Mrtrix.* MA: Cambridge University Press.

[9] Snow, C. E. 2002. *Reading Understanding: Toward a Research and Development Program in Reading Comprehension.* CA: Rand Corporation.