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Paper Title: SCIENTIFIC MISCONCEPTIONS AND CARTOONS: ESTABLISHING A CAUSE AND EFFECT RELATIONSHIP
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Several causal agents are postulated to include insufficient perceptual knowledge, insufficient conceptual knowledge, misperceptions and misconception in an attempt to explain individuals' responses to cartoons. Those responses are categorized as follows: Can not laugh; Do not laugh; and Do not get the joke.

Preliminary results indicate that an association exists between those causal agents and response types. Further results indicate that sufficient knowledge, as well as a correct view of the knowledge (i.e., perception) or a correct organization of the knowledge (i.e., conception) are preconditions for an individual who are categorized as follows: get the joke. Data as well as a demonstration of the design and the methodology are presented in the paper.

In conclusion, cartoons are a reliable assessment measure, which includes data collection and decision making, for determining the state of a learner's prior knowledge. Cartoons are also an effective instructional tool.

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SCIENTIFIC MISCONCEPTIONS AND CARTOONS: ESTABLISHING A CAUSE AND EFFECT RELATIONSHIP

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ABSTRACT

Scientific communities are expressing concerns about the "knowledge gap" that exists between experts and the voting citizenry. Linn (1986) described the components of metacognition as perceptions, conceptions, beliefs, etc. Kuhn (1970) described declarative knowledge as facts, concepts, theories, etc. and procedural knowledge as computing, graphing, reasoning, etc. Foci of this paper are metacognition, prior declarative knowledge, prior procedural knowledge and effects those variables have on knowledge acquisition and knowledge transfer as depicted by misperceptions and misconceptions that are imbedded in cartoons.

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THEORETICAL AND CONCEPTUAL PROBLEMS

Once again a crisis exists in areas of mathematics education, science education and technology education. This crisis is described in reports by the National Science Board (1983); the National Assessment of Excellence in Education (1983); the National Science Teachers Association (1984); the American Association for the Advancement of Science (1986); the National Academy of Science (1987); the Office of Technical Assessment (1988); the National Council of Teachers of Mathematics (1989); and by President Bush (1990). These are a few authorities, in an ever growing list of leaders, who acknowledge that once again the United States is a "Nation at Risk."

Those concerns are not new, as implied by the author's first words. One needs to look back to the literature a mere thirty years to hear similar concerns. In some respect the nation is at a point in time which could be referred to as the "Second Genesis of Sputnik." Although government, industrial, and educational leaders differ with respect to the nature of the crisis, as well as the solution, there exists two issues which are common to all perceptions of the crises. The first issue is the problem of knowledge acquisition. The second issue is the problem on knowledge transfer.

Mathematical, scientific, and technological communities have expressed concern about the apparent "knowledge gap" that exists between experts and the voting citizenry. This does not imply that the public is less capable than thirty years ago. Rather, the proliferation of knowledge in those areas, in part, is offered as an explanation for the apparent "knowledge gap." Fensham and Kornhauser (1982) reported that

the initial million entries in Chemical Abstracts required thirty-two years, whereas the second million entries accumulated in just two years. Although knowledge acquisition is more complex than thirty years ago due to a proliferation of available knowledge, there also exists today both a more sophisticated understanding of how to facilitate knowledge acquisition and a more sophisticated understanding of what impedes knowledge acquisition.

Cognitive psychologists such as Jean Piaget had a major impact both on science education and on mathematics education during the 1970's. Central to that impact were issues of the nature of knowledge (i.e., declarative and procedural types); how knowledge should be transmitted (i.e. through inquiry teaching); how knowledge should be acquired (i.e., through discovery learning); and how knowledge should be transferred.

Two variables to emerge from the work of early cognitive psychologists are: the nature of the knowledge to be learned; and the nature of the learner. A basic operational definition of cognition involves the classification of knowledge as either declarative (i.e., content) or procedural (i.e., process) and an individual's perception (i.e., the view of the knowledge) and conception (i.e., the ordering of new knowledge into an existing cognitive structure). Concept Map 1 is provided to concretize those classifications and constituent parts.

Concept Map 1

Postulated Main Effects and Interactions

KNOWLEDGE TYPES		
Declarative (Content)	Prior (Metacognition)	Procedural (Process)
° facts	° perceptions	° computations
° concepts	° conceptions	° estimation
° theories	° beliefs	° reasoning
° etc.	° e t c .	

Metacognition or prior-knowledge has emerged from the earlier work in cognitive psychology as a determining factor for how knowledge is acquired and for how knowledge is transferred. Linn (1986) reported that metacognition or the prior-knowledge state of the learner, is as important to knowledge acquisition as Piaget's cognitive state of the learner. Billions of tax dollars were spent on developmentally appropriate K-12 mathematics and science curricula and teacher preservice and inservice training during the 1960's through the 1970's. The literature during that period of time is almost devoid of a linkage among the developmental state of the learner, the nature of knowledge to be acquired and the learners metacognitive state. This lack of association, in part, may account for the "Back to Basics" movement and the "Nation at Risk" experienced during the 1980's.

Metacognition (i.e., prior knowledge) is a focus of current research in knowledge acquisition and knowledge transfer. The metacognitive state of the learner may facilitate knowledge acquisition if a positive association exists between an individual's prior-knowledge and an individual's perception of new information (i.e., conception is evident). However, the metacognitive state of the learner may impede knowledge acquisition if a negative association exists between the prior knowledge and an individual's perception of new information (i.e., a misconception is evident). Previous curriculum development and teacher training assumed that a positive association existed and emphasis was placed on developmentally appropriate materials.

In summary perceptions and conceptions of prior declarative and procedural knowledge must be determined as well as the cognitive development state of the learner. Failure to take the metacognitive state of the learner into account could have negative implications on knowledge acquisition and knowledge transfer. Individuals may be coming

to the learning environment with misperceptions and/or misconceptions.

DESIGN AND METHODOLOGY

Numerous teaching and learning theories are presented and analyzed in the literature both past and present. Although these theories have noted differences, common to all perceptions and conceptions of how knowledge is transmitted and of how knowledge is acquired is the need to establish a linkage between prior knowledge and new knowledge. Piaget recommends the use of concrete objects. Further articulation of his work revealed the need for objects to be both concrete and familiar to establish a linkage between prior knowledge and new knowledge and facilitate knowledge acquisition, as well as promote general cognitive development. What could be more familiar, as well as concrete in nature, than cartoons and jokes?

Research on learning is confounded by numerous intervening variables such as anxiety. Anxiety is a curvilinear phenomenon which affects knowledge acquisition and knowledge processing (Kermis, 1983). Test anxiety is a situational specific form of anxiety which affects knowledge recall (Kermis, 1984). What better way to control the debilitating affects of anxiety on declarative and procedural knowledge acquisition, processing and recall, than through the use of cartoons and jokes?

Research on humor is linked to metacognition in the following ways:

1. Individuals who can not laugh.
2. Individuals who do not laugh.
3. Individuals who do not get the joke.
4. Individuals who get the joke.

Individuals with the first type of response lack sufficient perceptual experiences (i.e., they lack prior declarative or procedural knowledge). Individuals with the second type of response have sufficient perceptual experiences but lack

sufficient conceptual experiences (i.e., lack processing knowledge). Individuals with the third type of response have either misperceptions, misconceptions or an intervening variable such as, high anxiety (i.e., they have either incorrect declarative knowledge and/or procedural knowledge or an inability to recall). Table 1 represents associations between the three theorized causal agents and response types, respectively.

Table 1

Theorized Causal Agents and Associated Responses to Cartoons

Causal Agents	Response Types
1.Lack of sufficient perceptual experiences (i.e., lack of prior declarative or procedural knowledge).	1.Individual who can not laugh.
2.Lack of sufficient conceptual experiences (i.e., lack of processing knowledge).	2.Individuals who do not laugh.
3.Evidence of misperceptions and/or misconceptions and/or high anxiety (i.e., incorrect declarative knowledge and/or procedural know-ledge or lack of the ability to recall).	3.Individuals who do not get the joke.
4.Evidence of appropriate perception and/or conception and low anxiety (i.e., correct declarative knowledge and/or procedural knowledge and the ability to recall).	4.Individuals who get the joke.

Individuals with the fourth type of response have both sufficient and correct perceptual, and/or conceptual experiences and are, for example, low anxious (i.e., they have sufficient and correct declarative knowledge and/or procedural knowledge and an ability to process and to recall that knowledge).

RESULTS AND CONCLUSIONS

Assess yourself by recording your response to the five jokes which follow:

Joke 1

A beaker is setting on a chemistry lab bench with a vapor hand holding a club. A person with a lump on his/her head is standing next to the beaker on the lab bench. The individual says, "My aren't you a violent reaction."

Joke 2

A child is pouring a liquid out of a can with one hole. An adult notices the child having trouble and suggests that the child punch two holes in the can to make the liquid come out. The child proceeds to place the second hole next to the first hole with little results.

Joke 3

Two bank robbers are coming out of a vault while three policemen wait outside the vault. The one robber sees the policemen and turns to the others and states that they will need to divide up two more shares.

Joke 4

Two students are walking down the hall. The first student asks, "Do you think science and mathematics are more important than history and literature?" The second student responds, "Seven of one and half dozen of another."

Joke 5

A child watches his/her parent with great affection. The child is anxious about the thought of the parent leaving the room. You know what they say, out of sight, out of mind.

Individuals who can not laugh at Joke 1 lack sufficient perceptual experiences (i.e., lack of prior knowledge). The specific declarative knowledge required to get the joke is factual information about a violent reaction. Individuals who do not laugh at Joke 2 have sufficient perceptual experiences but lack sufficient conceptual experiences (i.e., lack of processing knowledge). The specific declarative knowledge required to get the joke is conceptual information about a partial vacuum. Individuals who do not get Joke 3 bring to

the learning situation a misperception (i.e., incorrect prior knowledge). The specific procedural knowledge required to get the joke is the ability to count single digit numbers. Individuals who do not get Joke 4 bring to the learning situation a misconception or perhaps high anxiety (i.e., incorrect processing knowledge or an inability to recall). The specific procedural and declarative knowledge required to get the joke is the ability to make a comparison between computational skills and units. A learner may bring to this situation correct perceptual experiences of computation and units of measurement, but may bring to the learning situation incorrect conceptual knowledge of the association between procedural and declarative knowledge. Finally, individuals who get Joke 5 have sufficient perceptual and conceptual experiences and are, for example, low anxious (i.e., sufficient procedural and declarative knowledge, processing, and recall are evident). The specific procedural and declarative knowledge required to get the joke is experience with Piaget's stages of cognitive development.

Practical uses of cartoons and jokes in K through post-graduate studies are about as finite as the number of cartoons and jokes which are available. Cartoons and jokes may be used to detect misperceptions and misconceptions in situations that involve advanced organizers, anticipatory sets, discovery learning, extended practice, mastery listing, formative evaluation, summative evaluation, etc.

Teachers who use cartoons as an instructional tool should ask themselves these questions. What is the declarative knowledge (e.g., fact, concept, etc.) and/or procedural knowledge (e.g., measurement, estimation, reasoning, etc.) that is important? What metacognition (i.e., prior knowledge) is necessary? What pedagogy, to include assessment, is being stressed (i.e., what association exists among instructional strategy, learning modality, data collection and evaluation of outcomes)?

Cartoons and jokes are like Gremlins. They are all pleasant and powerful. As with Gremlins, who come with certain conditions for their use, to include: no food after midnight, no contact with water, and no exposure to bright light; cartoons and jokes come with certain conditions for their use. Proper use of cartoons and jokes require the user to ask these three questions in instructional and assessment situations. They are: What is the cartoon or joke to be used for? How is the cartoon or joke to be used? Why is the cartoon or joke being used?

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