

Research Card #1:

Conversations to Make Thinking Visible

Human thinking is shaped by the social activities and use of the materials and symbols invented by culture, which in turn are temporally and geographically influenced (Schauble, Leinhardt, & Martin, 1997, p. 4). It is argued that higher mental functions have social origins that are first expressed between individuals before they are internalized within the individual (Vygotsky, 1978). In other words, meanings are rehearsed and made explicit as a result of conversations and interactions between people before becoming internalized by the individual. Thus, learning relies on conversation.

For learners, engaging in conversations can foster more generative thinking and enable them to practice dialogic skills, such as asking questions and communicating ideas in an effective manner. It is a way for them to process information and make social connections. These thinking and dialogic skills form the basis of active, analytic, individual thought, and allow individuals to develop their ability to communicate their ideas.

- Externalization and articulation is the process of expressing one's unformed ideas and still developing understanding, and continuing to do so throughout the process of learning (Sawyer, 2006). Such expression may involve *talking, writing, or drawing*. This support stems from the notion that higher mental functions have social origins that are first expressed between individuals before they are internalized within the individual (Vygotsky, 1978).
- Articulating to others what one thinks, reasons, predicts, and assumes about (scientific) concepts and ideas is helpful for learners as they formulate and refine their understanding (Collins, 2006). In particular, talk forces learners to think about and articulate their ideas. Talk can also provide an impetus for learners to reflect on what they do—and do not—understand (Michaels, Shouse, & Schweingruber, 2007, p. 88).

It is believed that the construction of an explanation requires the integration of old and new knowledge (elaboration), which requires a great deal of active, in-depth processing of the material so that its presentation can be coherent and understood better (Chi, et al., 1994). Elaboration is a form of higher-order thinking. It involves clarifying and specifying the relationship between information to-be-learned and related information from learner's prior knowledge and experience or contiguously presented information (Hamilton, 1997). "Essentially, elaboration is encoding the original content in a different but related way." (Hamilton, 1997, p. 299). "Elaboration leads to deep levels of information processing, and is assumed to inhibit forgetting, because it produces a richer, more redundant memory structure" (van Blankenstein, 2011, p. 190).

For educators, talk from learners offers a glimpse into what learners think and how they make sense of new experiences in light of what they already know (Scott, 1998).

Research Card #2:

Learning to talk science

Every specialized kind of human activity, every subject area and field, has its own special language (Lemke, 1990, p. 130). Whether it is dealing drugs or designing handbags, there are ways of talking and idiosyncratic terms and meanings. Similarly, the language of science is specialized; not just due to specialized science definitions but also due to the way science is spoken and written. For instance, in science the word “theory” is understood to mean “a well-elaborated body of scientific knowledge that explains a large group of phenomena.” In common parlance, the word “theory” is often used to refer to a guess or a hunch (Michaels et al., 2007, p. 88). Additionally, scientific language has a preference for passive voice (e.g., “the earth was uplifted” not “pressure lifted the earth up”; or “what element is being represented” not “what element are we representing”). One effect of this grammar is that people disappear from science as actors or agents (Lemke, 1990, p. 130).

“Learning science, therefore, is seen to involve more than the individual making sense of his or her personal experiences but also being initiated into the 'ways of seeing' which have been established and found to be fruitful by the scientific community.” (Driver, 1989, p. 482). Thus, in teaching science, there is often tension between directing the conversation to communicate the views of science and ensuring participants are equal contributors to the conversation to encourage everyone to voice their views.

It is important that learners have the opportunity both to make explicit their everyday ideas and to apply and explore newly learned scientific ideas through talk and other actions for themselves (Scott, Mortimer, & Aguiar, 2006).

Peer-to-Peer Discourse

Peer talk unfolds in pairs or groups of learners unhindered by the inherent asymmetry of teacher-learner interaction. The more equal participant structure of peer groups may be conducive to both cognitive and pragmatic development. Opportunities to talk are important for learners to share, clarify, and distribute knowledge among peers. Peer discussions exhibit the following characteristics: asking questions, hypothesizing, explaining, and formulating ideas. (Rivard & Straw, 2000).

However, there is a power dynamic between educator and learners. The educator has the responsibility of introducing students to a particular way of knowing about the content. But there is an imbalance of power in this relationship: the educator determines the topics, pace, grades, etc. The more knowledgeable educator is in a position of authority. This imbalance occurs in conversations between children and adults as well. Children’s discussions with adults are less conducive to cognitive development than their discussions with equals (Rogoff, 1995). While the superiority of adults might intimidate children from freely expressing their ideas, other children can provide the opportunity for discussion and reciprocal exchanges, thus promoting the types of social interaction conducive to cognitive development.

Facilitation Approaches

1. Giving Information

It is a lecture, an educator monologue. The educator is giving information. The educator may: provide a series of logical connections between various ideas, terms, and tasks; give a narrative account of a set of events and actions that establishes chronological and causal relations among them; and selectively summarize the essential ideas and items from prior discussion (Edwards & Mercer, 1987; Lemke, 1990).

This approach is perceived as an efficient way of communicating scientific knowledge. The educator transmits the information and reports how the ideas evolve and are connected and important. In particular, selective summaries are argued to be crucial for students, as they may not know, while the dialogue progresses, what ideas will be important. The educator monologue is criticized for expressing only one viewpoint and not allowing students to articulate their understanding of the ideas.

2. Checking for Understanding

The educator poses a sequence of interrelated questions that deliberately link the ideas, terms, and tasks for the topic or concept being discussed. The educator knows the answer to the questions, and thus is checking for understanding. It is described as a transposition of an educator's lecture into a dialogue format, and is viewed as a way of expressing and connecting ideas, so long as the students respond to the cues and provide the correct answers (Edwards & Mercer, 1987; Lemke, 1990; Mehan, 1979; Scott, 1998). If learners provide the wrong answer, the educator: continues to solicit responses until the correct answer is provided; modifies the learner's response to fit the topic; elaborates on the learner's response to situate it in a different context and thus retrospectively change its meaning (Scott, 1998).

A distinct 3-part pattern emerges in conversations facilitated in this way: educator **initiates** the discussion with a question, learners **respond**, and then the educator **evaluates** students' responses. This approach serves as a way to extend the learner's answer, to draw on its significance, or to make connections with other parts of the learner's total learning experience (Wells, 1999). However, it fails to provide learners with an opportunity to articulate their own understanding and express themselves in the language of the discipline (Alexander, 2005 ; Wellington & Osborne, 2001).

3. Thinking Out Loud

The educator aims to develop shared understandings with learners through a process of negotiation, rather than transmitting information or confronting misconceptions. Learners are prompted to think out loud by expressing their own thoughts, comments, questions, and connections. The exchange also requires learners to try to understand one another's thinking (van Zee & Minstrell, 1997). The educator: acknowledges and restates learners' comments in a neutral manner; asks questions that encourage learners to think about and elaborate on their ideas; acknowledges and encourages learners to be conversational partners; and is silent to offer learners time to think.

The pattern in these conversations is a longer chain: learners or educator **initiates** the discussion, learner **responds**, educator **prompts** for further clarification, explanation, evidence, learner **responds**, educator **prompts** for other viewpoints, agreement/disagreement, same or different learner **responds**, etc. Thus, learners voice their everyday views of the world in common language; educators helps to make connections between everyday views and scientific views (Scott et al., 2006; van Zee & Minstrell, 1997).

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