Acquisition of Tacit Knowledge in a Research Laboratory

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Introduction

The novice to expert transformation in chemistry as in any field is a complex phenomenon. It is intimately linked to action within a community and hence cannot be acquired by an individual in isolation. Polanyi (1969), the physical chemist and philosopher, wrote that "the tacit" and "the practical" aspects of knowledge were often found combined.

Theoretical Background

Cognition in science-as-practice is based on situated learning as a social process that occurs within a proficient community of practice. Novices progress from peripheral to full participation as they acquire the tacit understanding or "street smarts" of that community. The facets of cognitive apprenticeship afford immersion and continuous opportunities for practice, reflection and discussion while solving community problems (Lave & Wenger, l991).

Methodology

We used an ethnographic approach to study a research group (Klahr & Simon, 1999) synthesizing novel organic molecules for drug design. The learning environment was composed of laboratories and an office area. Data were selected from audio videos of group meetings and interview transcripts. First, one graduate student's progress from the end of the first year to the last year of graduate school was examined at three intervals to ascertain the features of tacit knowledge gain through daily work in the laboratory. Secondly, transcripts of the undergraduates (UG) researchers were compared against those of the graduate student to see what critical features of tacit knowledge were acquired in 10 weeks. Each was initially paired with an experienced graduate mentor but was also mentored by other researchers as well.

Results

TK acquisition was judged to have occurred based upon the following emergent features from study of the graduate student: (1) A notable increase in independence; (2) A decrease in the mentoring needed from detailed to suggestive; (3) Use of the language of the research community in routine communication.; (4) Growth in the ability to "fix" or assemble mechanical systems; (5) A reduction in the number of predictable difficulties; (6) Ability to relate molecular-level ideas to macro-scale lab work; (7) Increased skills in interpretation of data; (8) A marked ability to make progress on more complex aspects of the project; and (9) Becoming a source of research help for others.

One of the UG researchers showed no evidence of growth in TK over 10 weeks except that of item (3), use of the group's scientific vocabulary. The two other UGs showed evidence of gains in TK items 1-8. Their group presentations showed increased confidence, appropriate language, molecular level thinking and the ability to hold their own under questioning from group members. In the laboratory they made gains in problem solving, and independence. Important actions became automatic, such as running a chromatography column. Automatic actions, mentioned by other researchers as occurring in the gain of expertise, are clearly a tacit gain.

In summary, novice researchers progress to a higher quality level of participation as they acquire the tacit understanding or "street smarts" of the organic synthesis community. Cognitive apprenticeship here uses immersion in solving research problems to guide understanding of the norms of practice and standards of work. Continuous opportunities transpire or are suggested to guide work progress. The progress is also dependent on the researcher's personal reflection on the work and his/her interactions with more knowledgeable researchers.

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