Expertise

Author: David Feldon
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The notion of expertise underlies many facets of the educational process. Educators look to subject matter experts to inform the selection of content and establish levels of optimal performance against which student performance can be compared. Expert teachers are highly valued and actively sought out to serve as mentors and master teachers for those who are less experienced in the classroom. It is also hoped that students acquire expertise in some area so that they may be successful in their future academic and professional endeavors. Despite the central-ity expertise in education, however, there are substantial challenges that exist in defining it.

DEFINITIONS OF EXPERTISE

Expertise is difficult to define with precision. Generally, experts are expected to outperform non-experts consistently on tasks in a specific domain. However, scholars disagree about the most effective means by which to identify these individuals. K. Anders Ericsson (1948–) argues that experts are those individuals who reliably excel on specific key tasks that are central to performance in a domain (Ericsson & Smith, 1991). In contrast, Robert Sternberg (1949–) suggests that such narrowly bounded criteria are inauthentic and do not represent expertise as it occurs in professional settings (Sternberg & Horvath, 1995, 1998; Sternberg, Gigorenko, & Ferrari, 2002). Rather than relying on a static list of necessary and sufficient characteristics for expertise, he advocates a “family resemblance” approach in which the central tendencies of expertise (proficiency, experience, etc.) may manifest differently among different experts within and across domains.

It is also an open question in some domains whether or not it is possible to be an expert. James Shanteau (1943–) reports that the reliability of expert evaluations and predictions varies significantly by domain. For example, expert weather forecasters are almost perfectly consistent (r=0.98) in their predictions when presented with the same information on different occasions (Shanteau, 2000; Shanteau, Weiss, Thomas, & Pounds, 2002). In contrast, expert stockbrokers (r=0.40) and expert pathol-ogists (r=0.50) are fairly inconsistent. Similarly, the level of agreement between experts in a field varies between domains and is closely related to rates of internal consistency. Shanteau suggests that evidence of unreliability in expert judgment does not inherently invalidate claims of expertise. In some cases, experts may discern multiple valid paths to reach a desired goal and evaluate the information at hand in that context. In other cases, the scientific knowledge base that supports experts' decision-making may itself be underdeveloped—as is the case in social sciences such as economics, psychology, and education. Experts in these domains may apply the best available knowledge of the field consistently and effectively but need to fill knowledge gaps with personal judgments that are less reliable.

In contrast, Robyn Dawes (1936–) argues that expertise can exist only in fields for which advanced training and accumulated experience lead to higher reliability and success rates. His 1994 book, *House of Cards*, analyzed the fields of clinical psychology and psychotherapy and found that licensed practitioners were no more successful in helping their clients than laypeople with minimal training. Further, supposed experts in the field were no more accurate than novices when interpreting the results of psychological tests (e.g., Rorschach and sentence completion tests) or predicting the future behaviors of the individuals whom they evaluated. His conclusion was that expertise could not exist in the domain.

The problem of defining expertise increases for fields in which there is little agreement on desired outcomes or best practices. In the field of education, for example, identifying and expert teachers and training novices to become experts are considered to be crucial. The early work of David Berliner (1938–) and others observed that teachers considered to be experts typically had a superior understanding of relevant factors impacting classroom dynamics, were better able to improvise during lessons to adapt to their students' abilities, and more successfully managed competing demands for their limited attentional resources (Berliner, 1986, 1987; Carter, Sabers, Cushing, Pinnegar, & Berliner, 1987; Carter, Cushing, Sabers, Stein, & Berliner, 1988; Sabers, Cushing, & Berliner, 1991).

However, in his recent work, Berliner (2005) suggests that two major issues prevent an adequate understanding of expertise in teaching. First, there are multiple standards of "good teaching" that are dependent upon cultural norms. Second, there is persistent disagreement on the desired outcomes of public education and appropriate ways to measure student success in relation to them. Thus, an expert teacher would need to be both a "good" teacher in a cultural sense by implementing commonly embraced practices and an "effective" teacher in terms of measured student learning outcomes (Berliner, 1987, 2005). The fact that teaching effectiveness must be evaluated on the basis of students' achievement rather than the actions of the teachers themselves further problematizes the concept of the expert pedagogue, because cultural, contextual, and personal factors impact student performance and are beyond the control and/or professional responsibility of an individual teacher.

RESEARCH FINDINGS ON EXPERTISE

Research stemming from the field of cognitive psychology in the 1970s and 1980s has yielded a sizeable body of evidence for common traits across domains of expertise. The seminal book by Michelene Chi, Robert Glaser, and Marshall Farr, The *Nature of Expertise* (1988), compiled examinations of data from typewriting, restaurant orders, mental arithmetic, computer programming, judicial decision-making, and medicine. The overview chapter listed seven primary attributes that characterize the performance of most experts across domains. These observations have helped to shape the development of the field:

1. Experts excel mainly in their own domains;
2. Experts perceive large meaningful patterns in their domain;
3. Experts are fast; they are faster than novices at performing the skills of their domain, and they quickly solve problems with little error;
4. Experts have superior short-term and long-term memory;
5. Experts see and represent a problem in their domain at a deeper (more principled) level than novices; novices tend to represent a problem at a superficial level;
6. Experts spend a great deal of time analyzing a problem qualitatively;

7. Experts have strong self-monitoring skills.

When performing in their domains, experts rely on their highly refined mental models to represent and solve the problems they encounter. These schemas allow experts to identify the problem type and respond using efficient and effective strategies that leverage their deep understanding of the problem structure (Chi, Feltovich, & Glaser, 1981). Using known strategies, they are able to proceed directly toward the desired outcome. Referred to as "forward reasoning," this process differs sharply from novices' approaches to problem solving, which typically involve reasoning backward from the desired outcome to identify appropriate intermediate steps (Chi, Glaser, & Rees, 1982).

In addition to these characteristics, studies from various domains suggest that experts typically have at least 10 years of experience in their fields. In a major review of the research, Ericsson and his colleagues (Ericsson, Krampe, & Tesch-Römer, 1993) analyzed many studies of training outcomes across a wide range of tasks (e.g., Morse Code operation, musical performance, Olympic sporting events) and found strong evidence that years of experience alone was not sufficient for explaining performance outcomes. Replicating these findings, their own study demonstrated that in some cases expert professional pianists had up to six fewer years of experience than their less-skilled amateur counterparts.

To explain this discrepancy, Ericsson proposes that those individuals who become experts engage in focused and intensive training during their years of experience known as *deliberate practice* that is qualitatively different than other types of experience within the domain. Defined as "the individualized training activities especially designed by a coach or teacher to improve specific aspects of an individual's performance through repetition and successive refinement [that includes] monitor[ing] their training with full concentration, which is effortful and limits the duration of daily training" (Ericsson & Lehmann, 1996, pp. 278–279), deliberate practice is not considered to be inherently motivating. It is specifically intended to refine performance and remediate any facet of relevant skills in which there is room for improvement (Ericsson & Charness, 1994).

Ericsson characterizes experts' performance as demonstrating maximal adaptation to task constraints. In simpler terms, this means that experts have shaped their skills to maximize the efficiency of their actions within the structural context of their domains as they solve relevant problems. Such adaptations can take the form of "shortcuts" that would not be feasible for non-experts but produce superior results when employed appropriately. For example, expert athletes learn to anticipate changing conditions rapidly and respond effectively before the new condition has actually formed (e.g., anticipating the gunshot that starts a race). Likewise, chess masters can visualize the ways in which a particular move may prevent or allow an opening several moves later in a game and make preemptive decisions on that basis.

When task constraints change, however, some experts are unable to adapt successfully to the new situation while others retain their high levels of performance. Giyoo Hatano (1936–2006) characterized members of these respective groups as *adaptive and routine* experts (Hatano, 1982). Adaptive experts typically understand why their skills are effective under normal circumstances and successfully modify them to fit the new situation or invent new procedures as necessary (Hatano & Inagaki, 1986, 2000). However, it is challenging to reliably identify adaptive experts. Studies of expert bridge players, electronics troubleshooters, and others have found that changing task constraints (e.g., point values in bridge) or introducing highly unusual situations often leads to weak performance by individuals who typically demonstrate high levels of expertise in their domains under routine conditions.

EXPERTISE AND IQ

Expertise is often attributed to high levels of intelligence. However, studies of expertise consistently find that there is no correlation between IQ and experts' performance. Ericsson (1998; Ericsson & Charness, 1994;

Ericsson & Lehmann, 1996) investigated reports of child prodigies who are reputed to perform feats rivaling top experts' abilities. However, in instances where these abilities have been sufficiently documented to permit independent validation, the prodigies consistently have approximately 10 years of deliberate practice that was initiated and supported by parents, tutors, or coaches as young as 18 months old. The available evidence indicates that even those abilities typically attributed to innate talent (e.g., perfect pitch, exceptional memory, reflexes, muscle strength and endurance, etc.) can be fostered through environmental factors and training experiences for children who are highly motivated to succeed in these tasks.

DIFFERENT PERSPECTIVES ON THE DEVELOPMENT OF EXPERTISE

As discussed above, Ericsson's findings across domains indicate that world-class performers tend to require about 10 years of deliberate practice prior to attaining that status. However, other research from various fields suggests that other factors may also play a role. Dean Keith Simonton (1948–) argues that those experts who demonstrate adaptive expertise through creative innovations in their respective fields typically score higher on personality measures of nonconformity, independence, openness to experience, ego strength, introversion, and aggressiveness. They are also significantly more willing to take risks than routine experts in their fields (Simonton, 1999, 2000). Additional research also suggests that highly creative experts tend to have broader interests than their less creative counterparts (Simonton, 1976).

Simonton's analyses also indicate that several assumptions of the deliberate practice hypothesis are not borne out with regard to experts in creative fields like music composition and scientific discovery. He argues that if deliberate practice were the sole factor affecting the development of expertise, then the best experts ought to be those with the most years of deliberate practice. However, his (1991a, 1991b) studies of 120 classical composers and 2,026 scientists and inventors indicated that those who were most productive and considered to be most eminent in their respective fields trained for fewer years and made major contributions sooner after their first accomplishments than those considered to be less important contributors. Further, the career trajectories of creative experts tend to peak and then decline, despite ongoing deliberate practice, and the odds of generating a creative success do not change significantly over the course of a career (Simonton, 1985, 1986, 1997).

Ericsson (1998, 2004) suggests that practice which becomes rote rather than deliberate may limit the development of expertise in this way. Research in cognitive skill development indicates that as people practice new skills, they typically require less and less conscious attention directed to their actions while maintaining a consistent level of performance. For example, learning to read or drive a car is typically highly effortful, slow, and halting when it is first learned. However, with continued practice, performance becomes fluent with little or no attention directed to the component skills (e.g., pronunciation or word recognition during reading; shifting gears or stepping on the brake pedal while driving). This automaticity of skills results in performance that is very fast and consistent. It may also lead to people being unaware of how they perform those skills—and even whether or not the skills were used in a particular situation. As skills automate, they demand fewer cognitive resources, so attention can be redirected to other tasks.

What is done with surplus attention during practice and performance is likely a critical factor in the development of advanced and creative expertise. In deliberate practice, this attention is reinvested to continually monitor and improve performance. However, when spare attention is allocated to unrelated activities (e.g., talking on a cellular phone while driving), skill development plateaus.

For this reason, Ericsson argues that automaticity should be avoided as individuals seek to become experts. However, research on skill acquisition and expertise from cognitive science indicates that automaticity in fundamental domain skills is necessary to make available the attentional resources required to develop and execute more sophisticated strategies. Spare attention during performance is especially important for adaptive experts, because they must allocate their cognitive resources to recognizing and understanding novel or unusual aspects of a task and the implications of resulting atypical constraints. Therefore, those routine skills that are directly applicable to the new task must not demand conscious attention that would compete with these needs.

David Feldon (1975–) suggests that what differentiates adaptive experts who are able to leverage their automaticity from routine experts whose flexibility is limited by it is the number and relevance of the decision points in their procedures (Clark, Feldon, van Merriën-boer, Yates, & Early, 2008; Feldon, 2007a). As skills automate and basic skills combine to form more complex procedures, consciously mediated decision points remain where details of the specific situation determine which of several possible strategies will be the best to employ from an expert's repertoire in that instance. Thus, the training most likely to lead to adaptive expertise presents learners with a wide variety of practice scenarios to support the development of appropriately placed decision points and to avoid inappropriate automatization of requisite skills (Clark, Feldon, Howard, & Choi, 2006; Feldon, 2007b).

IMPLICATIONS OF RESEARCH ON EXPERTISE FOR INSTRUCTION

Conventional wisdom suggests that if a learner needs to know how to do something well, the best instructor would be an expert in the field. However, research indicates that this is not always the case. Trends in the findings on experts' instructional abilities indicate that, overall, experts are (1) inaccurate in their assessments of learners' knowledge and abilities relevant to learning procedures in an expert's field, and (2) inaccurate in their explanations of how they accomplish tasks within their domains.

Pamela Hinds' studies of experts as instructors demonstrate that experts are significantly worse than nonexperts in predicting the amount of time that it would take novices to learn presented material within the experts' domain of expertise. Further, debiasing techniques that are often effective in improving the accuracy of non-experts' preliminary assessments of novices did not improve their predictions (Hinds, 1999). In another study, Hinds compared the efficacy of one-on-one instruction between novices and experts with one-on-one peer instruction among novices. She found that when novices taught other novices how to perform a task, the students were better able to perform the procedure correctly than when experts provided the instruction. However, if the novice learners were asked to complete a task that required adjustments to the procedure that was taught, those who learned from the experts performed better (Hinds, Patterson, & Pfeffer, 2001).

These findings indicate that the explanations of experts offer an advantage, because their sophisticated mental models of their domains allowed them to structure the information that they provided to be broadly applicable. This differed from the overly specific explanations of novices, which were based solely on their experiences with the single task in the study. However, it seems that experts excluded specific information which would have been helpful to learners as they attempted to perform the task. This may have occurred (1) because the experts overestimated learners' pre-existing knowledge bases, (2) because they could not successfully explain the automated skills they themselves use, or (3) for a combination of both reasons.

Feldon's investigations of experts' self-report accuracy (2004, 2007a, 2007c) indicate that automaticity does play a role in limiting their abilities to fully describe their own problem-solving processes. Analysis of experts' explanations of their actions during a recorded task revealed that inaccuracies represented both omissions of relevant steps in their activities and statements that directly contradicted their actions. If the only reason for experts' inaccurate explanations was an overestimation of students' abilities, then only errors of omission would be expected. However, the presence of errors of commission indicates that experts' may lack an awareness of their own actions that would limit the accuracy and completeness of their explanations to others.

Research on ways to maximize the benefits of experts' knowledge for instruction has identified techniques that appear to avoid the limitations of experts' limited self-awareness within their domains. Collectively known as cognitive task analysis (CTA), these techniques involve intensive, highly structured interviews with multiple experts to identify and collectively validate complete explanations of effective ways to perform a specific task within the domain of expertise. Instructors then incorporate these protocols into their course materials to supplement or replace their own explanations of the skills to be learned. Controlled studies of CTA-based instruction consistently demonstrate dramatic effect sizes favoring its use over more traditional unscaffolded explanations by experts in diverse domains including medicine, electronic systems troubleshooting, and spreadsheet applications (Clark et al., 2008; Feldon, 2007a; Feldon & Clark, 2006).

See also:Expert-Novice Studies

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