**Primary vs. secondary knowledge as a way to present logical problem solving.**

Florence Lespiau - Cognition, Langues, Langage, Ergonomie, Laboratoire Travail et Cognition, Université Toulouse 2 Jean
Jean-François Bonnefon - Toulouse School of Economics, Institute of Advanced Study in Toulouse, Center for Research in Management, Centre National de la Recherche Scientifique, Université Toulouse 1 Capitole, France
André Tricot - Cognition, Langues, Langage, Ergonomie, Laboratoire Travail et Cognition, Université Toulouse 2 Jean Jaurès, France

Learning in school demands conscious efforts, motivation (often extrinsic) and time. The main aim of schools is to teach culturally important knowledge which would be very difficult to learn by oneself or by simple social interactions: biologically secondary knowledge (e.g. reading, written language). Following recent theories in evolutionary educational psychology (Geary, 2008), human beings have evolved to learn primary knowledge (e.g. speech, food) easily, unconsciously and quickly. Basically, secondary knowledge is built on primary knowledge: For example, in logical reasoning, the use of secondary knowledge (formal logic) is based on the possibility to inhibit primary knowledge (heuristics) (De Neys & Bonnefon, 2013). Many studies also showed that the way a logical problem is presented has an important effect of performances and engagement. Therefore, in this paper, we investigate the influence of primary vs. secondary knowledge as a way to present logical problem solving. Our hypothesis is that problem presentation based on primary knowledge should increase performance and engagement.

We conducted seven studies with university and high school students in France (n = 1182). Participants were asked to solve different types of logical problems. We varied the problem content (primary or secondary knowledge; e.g. problem involving food vs. problem involving grammatical rule) and their presentation order (primary knowledge presented first vs. secondary knowledge presented first). We also studied the influence of cognitive load (low vs. high, with an additional cognitive task) on the two knowledge types. Analyses evaluated performance and perceived cognitive load as well as participants' perceived feeling of enjoying answering questions, to what extend they wanted to find the correct answer and participants' confidence in given responses.

Findings show a strong effect of knowledge type in logical problems. Compared with secondary knowledge content, primary knowledge content increases performance, emotional investment and confidence in given responses and decreases participants' perceived cognitive load. Primary knowledge increases motivation. In contrast, secondary knowledge decreases motivation and generates a spurious feeling of conflict (whose effect can be compared but not limited to cognitive load). Presenting primary knowledge problems first reduces the deleterious effects of secondary knowledge problems for every observed variable. Indeed, when primary knowledge is presented first, participants have higher performance, motivation and confidence as well as lower perceived cognitive load regarding secondary knowledge problems. Primary knowledge thus seems to facilitate and support secondary knowledge learning, suggesting that primary knowledge should be taken into account in learning situations and not left aside because it is something "already learned".