Socio-Cognitive Factors in the Acquisition and Transfer of Knowledge

M. D. McNeese

Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio, USA

Abstract: Within cooperative learning great emphasis is placed on the benefits of two heads being greater than one. However, further examination of this adage reveals that the value of learning groups can often be overstated and taken for granted for different types of problems. When groups are required to solve ill-defined and complex problems under real world constraints, different socio-cognitive factors (e.g., metacognition, collective induction, and perceptual experience) are expected to determine the extent to which cooperative learning is successful. Another facet of cooperative learning, the extent to which groups enhance the use of knowledge from one situation to another, is frequently ignored in determining the value of cooperative learning. This paper examines the role and functions of cooperative learning groups in contrast to individual learning conditions, for both an acquisition and transfer task. Results for acquisition show groups perform better overall than individuals by solving more elements of the Jasper problem as measured by their overall score in problem space analysis. For transfer, individuals do better overall than groups in the overall amount of problem elements transferred from Jasper. This paradox is explained by closer examination of the data analysis. Groups spend more time engaged with each other in metacognitive activities (during acquisition) whereas individuals spend more time using the computer to explore details of the perceptually based Jasper macrocontext. Hence, results show that individuals increase their perceptual learning during acquisition whereas groups enhance their metacognitive strategies. These investments show different pay-offs for the transfer problem. Individuals transfer more overall problem elements (as they explored the context more) but problem solvers who had the benefit of metacognition in a learning group did better at solving the most complex elements of the transfer problem. Results also show that collective induction groups (ones that freely share) – in comparison to groups composed of dominant members – enhance certain kinds of transfer problem solving (e.g., generating subgoals). The results are portrayed as the active interplay of socio-cognitive elements that impact the outcomes (and therein success) of cooperative learning.

Keywords: Cooperative learning; Knowledge acquisition; Perpetual context; Situated cognition; Social processes; Transfer of knowledge

INTRODUCTION

As the US Air Force encounters new domains with hard challenges it is increasingly recognised that multidisciplinary teams are a primary means for generating meaning in complex situations, acquiring and sharing knowledge, coordinating resources, making decisions, solving problems and executing actions. Conventional wisdom suggests that in some cases 'many hands make light work' while in others 'too many cooks spoil the broth'. Determining whether teamwork is effective and efficient requires an understanding of the social and cognitive foundations of teamwork. Inherent in teamwork is how individual and team cognition affect learning. The remainder of the paper uses the term learning to specifically refer to: (a) the acquisition of the knowledge and (b) the transfer of knowledge from one situation to another.

Research in this area can be an important consideration in the design of emerging collaborative technologies (e.g., datawalls, groupware computing).

This paper's objective is to examine individual and cooperative learning through the lens of socio-cognitive factors. Socio-cognitive factors help team members make sense of a situation, converge multiple perspectives towards a solution, and transfer knowledge from one context to another. The study of socio-cognitive factors in learning is inextricably tied to: (a) understanding context, (b) defining and knowing what the team cognitive demands are for a given context (as represented by specific experimental tasks/scaled world simulations), (c) operational definition of what a team consists of in terms of levels of experience, role interdependencies, type of subjects used and joint actions required for specified tasks, (d) requirements emerging through the interaction of teamwork, taskwork and context and (e) the methods and measures used to assess items a–d. Cooperative learning may be approached from various directions inclusive of historical, theoretical, methodological and practical significance. Given these constraints this paper looks at three research questions:

1. Do cooperative learning groups do better than individuals at solving complex problems?
2. How do cooperative and individual learning processes differentially affect transfer to similar problems?

Theoretical Perspectives on Cooperative Learning

In many cases there is a historical basis for success in cooperative learning (CL). When problem solvers cooperate as a group, many positive benefits can accrue (e.g., Dansereau 1988; Fletcher 1985; Gabbert et al 1986; Johnson et al 1986; Slavin 1983). The underlying rationale of having people work in groups is that in some cases groups do no worse than individuals (with the added benefit that there are social advantages of members getting to know one another), but in most cases groups do better than individuals. This is reinforced by many past reviews of cooperative learning (Johnson and Johnson 1985; Johnson et al 1983; Slavin 1983). However, there is disagreement as to the underlying reasons accounting for success. Many researchers in the social psychology/team literature account for success by looking at different variables, methodological, constraints and measures. Integrated views are typically cast as general team theories or frameworks (e.g., see Davis 1969; Hackman and Morris 1975; Kelley and Thibaut 1969; McGrath 1984; Roby 1968). More recently, theories exploring team cognition have been posed (e.g., Cannon-Bowers et al 1993; Hinz et al 1997; Klismoski and Mohammed 1994; Rentsch and Hall 1994). Some focus on schema for shared cognition (e.g., Rentsch and Hall 1994); others on group memory (Moreland et al 1996) and group information processes (Hinzs et al 1997), while others emphasise the role of meaning and the social construction of knowledge (Nosek and McNeese 1997).

This paper takes the position that cognitive benefits accrue when individual team members share knowledge through cooperative processes. Hence, team cognition theories that highlight group schema, information processes, memory and meaning are salient for distilling the socio-cognitive factors that determine learning success. Three basic-level processes are predicted to form the basis for acquiring, constructing, transferring and remembering knowledge: collective induction, generative learning and metacognition.

Collective Induction

One theoretical position – collective induction (Laughlin 1989) – is useful to consider for comparing individual and team cognition when it comes to learning. Collective induction is a group cognitive process that reinforces synergistic interaction among group members such that ideas, knowledge and strategies are disseminated to each member. Inherently, one member learns through collective participation with other members above and beyond what they could have learned by themselves. Laughlin describes the process as a collective search for descriptive, predictive or explanatory generalisations, rules or principles. Inherent within this theory is the idea that group problem solving consists of individual responses being mapped into a collective response through social combination processes (e.g., majority, minority, truth wins). Collective induction is specified for a continuum of problem-solving/decision-making activities that are anchored by intellective and judgement tasks. An intellective task contains a correct solution wherein verbal or quantitative arguments can enact agreement in the form of a collective response. Judgemental tasks involve evaluation, behaviour or consensus for which there is no demonstrably correct solution. In many complex requirements involving Air Force teamwork (e.g., command and control) both a mixture of intellective and judgement tasks exist.

Collective induction may be viewed as a form of generative learning as members engage in active discussions and explanations rather than just passively receive information. Each member's generative learning affords him or her additional insights that are consequently integrated into cooperative activities to increase overall understanding. Hence, the give and take among members causes a synergism to transpire. Alternatively, this is described in other arenas as the social construction of knowledge (Bereiter and Scardamalia 1989) resulting in group sensemaking (Weick 1995).

A key concept within collective induction that needs to be assessed is the level of synergy experienced among group members. For example, some group members freely share and are equivalent in their contributions. In other situations, a dominant member may lead the group. The dominant member is typically defined as the one who talks the most during learning activities. The dominant group classification for the studies reported in this paper is defined as when one member generates more than or equal to 66% of the total words in the team's transcript; whereas if neither member generates more than or equal to 66% of the total words they are classified as shared groups. For borderline cases, secondary criteria consisted of using subjective ratings of the video observation data to assign teams to either category.

When a dominant member is present it is hypothesised that collective induction is less likely to occur. Cooperative learning without collective induction may not be very effective especially when it comes to group members transferring knowledge to similar situations. In contrast, certain cooperative learning/group problem-solving tasks may benefit more from a strong leadership component in the group (assuming that a leader has the requisite skills, knowledge, context to lead). Hence, it is possible that a dominant member may actually help a team more than