

# Modality and Timing of Team Feedback: Implications for GIFT

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## Introduction

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This paper discusses considerations relevant to the design of team feedback in intelligent tutoring systems (ITSs). While team tutoring is a goal for the Generalized Intelligent Framework for Tutoring (GIFT), further research must be done to explore the focus, modalities, and timing of feedback for teams. Although there have been a number of studies on feedback, there are a limited number of studies on feedback for teams. This theoretical paper leverages previous research on ITSs, training, individual feedback, and teamwork models to inform appropriate decisions about the most effective feedback mechanisms for teams. Finally, the implications of team feedback on the design of GIFT are discussed.

Teams have the ability to achieve goals that are unobtainable by individuals alone. It is important to implement effective training for teams to support performance effectiveness. An important element of training is feedback. Feedback has the function of guiding or motivating individuals based on their past performance. The purpose of guiding feedback is to direct an individual to a desired behavior. The purpose of motivational feedback is to motivate the individual by mentioning future rewards (Ilgen, Fisher & Taylor, 1979). Although there have been a number of studies on feedback, there are a limited number of studies on feedback for teams. A common theme among these studies is determining whether feedback should be given at an individual or team level (Tindale, 1989). Some studies for teams suggest that team performance is influenced by feedback on an individual level (Berkowitz & Levy, 1956) and some studies suggest that groups outperform individuals when feedback is given to the entire team after each decision is made (Tindale, 1989). The purpose of the current paper is to characterize the range of modalities of feedback, timing of feedback, focus level of feedback, and who should receive feedback (i.e., individual vs. feedback) for teams to assist in the design of feedback for ITSs for teams. Finally, the implications of team feedback on the design of GIFT is discussed.

## Related Work and Implications for Team Feedback

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There are several aspects that are relevant to a discussion of team feedback. A definition and description of feedback is given in the next subsection. Feedback itself has several considerations, including 1) the type, or focus, of the feedback given, 2) the timing of feedback, and 3) to whom feedback is given. Previous work related to these aspects are discussed in the following subsections, as well as some initial discussion of the implications towards effective feedback for teams.

### Taxonomy of teams

Feedback is an important aspect of team tutors. In addition to feedback there are other aspects to consider in team tutors: Teams, tasks, and tutoring approach. A companion paper in this symposium (Bonner et al.,

2014) presents a taxonomy of team tutoring, of which feedback is one element, and serves as the basis for design decisions on the interaction between team variables and tutor decisions for team feedback.

## **Feedback**

There are a number of studies that have been conducted on feedback. DeShon, Kozlowski, Schmidt, Milner & Wiechmann (2004) present a model of how feedback on goals and performance influences learning and performance. Dominick et al. (1997) studied the influence of behavioral-based peer feedback on team behavior that occurs in a team-based task. Ilgen et al. (1979) provided a process-orientated review of how feedback influences behavior of individuals in organizations. Kluger and Denisi (1996) sought to show that the assumption that feedback intervention consistently improves performance is a result of the disregarded fact that the influence of feedback on performance varies.

Ilgen et al. (1979) describes feedback as a unique case of a communication process where a source conveys a message to a receiver. Ilgen et al. (1979) defines three different sources of feedback: 1) individuals who are in a position to evaluate a recipient's behavior, 2) task environment, and 3) self-evaluation from recipients. The information in feedback that an individual receives from any source deals with his or her past performance.

## **Focus level of feedback**

Hattie and Timperley (2007) make the claim that there are four levels of focus for feedback: 1) feedback can focus on the task at hand and whether or not it is correct, 2) feedback can focus on the process used to complete a task, 3) feedback can focus on the user's ability to self-regulate (e.g., self-evaluate), and 4) feedback can focus on the "self". They argue that the levels of feedback that focus on how a user processes a task and the level that focuses on the user's self-regulation are both powerful with respects to the deep processing and mastery of tasks. This suggests that if an ITS should give feedback that focuses on the user's process of task completion and the user's self-regulation ability.

## **Individual vs. team feedback**

Feedback for a team is different from feedback for an individual because of the information and the ability of a team member to act on the information. The three types of feedback are individual feedback, individual feedback in groups, and group feedback (Nadler, 1979). A study conducted by Zander and Wolfe (1964) concluded that the teams that received both individual feedback and group feedback had the greatest individual performance increase. This conclusion suggests that a tutor needs to provide individual and group feedback in order to effectively train a team. This method of mixed individual and group feedback has been implemented in existing training systems such as the Advanced Embedded Training System (AETS). Zachary et al. (1999) found the traditional feedback approach with ITSs difficult to apply to teams. The traditional feedback approach is difficult to apply because all the members of a team are collaboratively and simultaneously working together during the simulation. As a result, it was not possible for one team member to stop the simulation without hindering the mental flow the whole problem-solving process for the other members of the team.

## **Timing of feedback**

The timing of feedback is important to consider. Feedback during task execution may interrupt task performance, interrupt the cognitive process of task execution, and prevent users from learning how to identify their own error (Corbett & Anderson, 2001). The timing of feedback given to a user can be influenced by the user's affect state. Common affect states that occur within students are confusion, frustration, engagement, and boredom (Calvo & D'Mello, 2012). For example, a user who is being trained on a topic, especially if the topic is novel, will most be confused as a result of irregularities, inconsistencies, and qualms in subject matter. (Calvo & D'Mello, 2012). Confusion, however, should not be avoided by an ITS, rather an ITS should adapt to the user's uncertainty. Studies have shown that the users overall learning is improved when an ITS is able to recognize and adapt to confusion or uncertainty (Forbes-Riley & Litman, 2011).

The timing of feedback for teams and individuals may differ. Some research suggest that delayed feedback for individuals is more beneficial to students' retention (Butler, Karpicke & Roediger, 2007) and learning (Walsh, Ling, Wang & Carnahan, 2009) when compared to immediate feedback. This finding suggests that an ITS should give feedback at the end of a given task (e.g., After Action Review). Delayed feedback would be most beneficial for tasks that are complex and fast-paced because it would allow a team to finish a task without interrupting the team member's flow. Once the team has completed the task, the ITS can identify problems and offer suggestions on how to address any problems that are identified. However, other research suggests that delayed feedback would decrease the group motivation as compared to receiving immediate feedback (Gabelica, Bossche, Segers & Gijsselaers, 2012). This suggests that individual feedback should be given immediately, or close to real time, to be most beneficial. This method may not be ideal for complex tasks but there are task that are more easily interrupted and could allow for real-time feedback without interrupting the flow of the task. Corbett and Anderson (Corbett & Anderson, 2001) identified two principles of immediate feedback from the results of their research. The first principle was that giving feedback on each problem-solving step is an effective form of tutor support for students attempting to understand a complex problem solving skill. The second principle was that although lessening of immediate feedback on tasks (e.g., coding) may be essential, it will not promote error detection and other process monitoring skills of individuals.

## **Teamwork**

Teams are becoming more important today as the complexity of tasks increase. Research on teamwork is sometimes difficult to generalize because different teams function differently depending on the task and the domain. Salas, Sims, and Burke (2005) proposed a model that is supported by empirical evidence and practically relevant. The authors described five important components of teamwork that they call the "big five." They argue that the big five are required to complete any team task. The big five include team leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation.

### ***Team Leadership***

Though some research concludes that team leadership is not important in most situations (Fransen, Weinberger & Kirschner, 2013), others contend that leadership of a team is an important contribution to the effectiveness of a team (Zaccaro, Rittman & Marks, 2001). There are certain functions that a team

leader must be capable of in order for a team to be successful. The team leadership needs to facilitate team problem solving through mental processes (e.g., shared mental models), coordinating the team, and keep the team motivated (Salas et al., 2005). The team leadership should receive feedback that shows how well they are facilitating the team. If the team leadership is in training and is learning how to properly facilitate a team then that would suggest real-time feedback should be used. Giving real-time feedback on each problem-solving step is an effective form of tutor support for users attempting to understand a complex problem solving skill (Corbett & Anderson, 2001). The feedback given to the leadership team and the timing of that feedback would change if the focus of the task at hand changes (e.g., if the team already had the knowledge to complete the task and was focus on efficiency).

### ***Mutual performance monitoring***

Mutual performance monitoring is the ability of each team member to keep track of other members' work while continuing to carry out tasks, make sure that everything is functioning as expected, and make sure the other members are following procedures (McIntyre & Salas, 1995). This component of the big five is important for a team throughout a team task but it becomes especially important when the task has a high stress level. However, it is difficult to give feedback on mutual performance monitoring because it is difficult to measure, due to a lack of an accepted method of detecting when is occurring (Salas et al., 2005). Feedback pertaining to the mutual performance monitoring of a team would most likely be focused on the team's process of the given task. If a team processes a task correctly then they will be able to determine when members need additional help. If members of the team do not give support to members then feedback should be given on how the team is processing the task at hand. If the purpose of the training is to teach members to recognize when another member needs additional help then feedback should be delayed. It is difficult to determine if members of a team exhibit successful mutual performance monitoring if no problem ever arises during a task.

### ***Backup behavior***

Backup behavior is defined as providing resources and task-related efforts to another member when it is recognized by possible backup providers that there is a problem with the distribution of workload within the team (Porter et al., 2003). There are different ways that members of a team can provide backup behavior. For example, members of a team can provide verbal feedback and coaching to help improve performance (Marks, Mathieu & Zaccaro, 2001). Members of a team can go beyond providing feedback and coaching to other members by assisting a teammate in performing a task (Marks et al., 2001; Salas et al., 2005). Doing this will allow other members to observe a task conducted correctly and allow members to correctly complete the task themselves. Lastly, if assisting a team member is not enough to help improve team performance then members of a team can complete tasks for other team members when an overload is detected (Marks et al., 2001; Salas et al., 2005). Feedback pertaining to backup behavior depends on the goal of the task at hand. If the goal of task is teach members to identify and take action when other members need help, then feedback should be given in real time. However, if the task at hand is to give the team a chance to practice their skills, then feedback should be delayed until the end of the end of the task.

### ***Adaptability***

Teams need to be able to adapt to tasks that are continuously changing. A team is required to have the ability to utilize knowledge, skills, and attitudes that allow members to recognize deviations from anticipated actions and readjust actions accordingly to acquire the adaptability component of the big five (Priest, Burke, Munim & Salas, 2002). There are many different ways that adaptability can appear, depending on the task and the challenge the team face (Salas et al., 2005). For example, let's assume a football team (specifically the offensive line) was told to run an offensive play. A coach may first allow the team to run the play as if everything ran perfectly. Once a team has mastered that play, a coach may have the defensive line set up to defend against the offensive line. The coach may have the defense set up in a way where another play (modified from the play they plan to run) may be more successful. The Quarterback (QB) can change the play by calling an audible and changing the play. Feedback can be given on how well the QB handles the situation. The QB can be evaluated on whether or not an appropriate play was called or if an audible was called at all. Similarly, an ITS should be able to compare the actions of a team during a task to the expected action in order to understand adaptability.

### ***Team orientation***

Team orientation does not focus on that behavioral aspect of teams but rather the attitudinal. It has been found to improve satisfaction of individuals, individual effort, and performance (Salas et al., 2005); facilitate overall performance (Driskell & Salas, 1992; Eby & Dobbins, 1997), and influence team cooperation behaviors (Eby & Dobbins, 1997). Feedback pertaining to team orientation should be given no matter the focus of feedback. If the team orientation is not sufficient (i.e., if the members of negative attitudes toward the team) then the teams efficiency will suffer. Feedback that pertains to a teams' orientation, also called collectivistic orientation (Eby & Dobbins, 1997), can be gathered from members of a team using a desired data collection method (e.g., Wagner and Moch's (1986) individualism-collectivism measure).

### **Modality**

An issue to address when building an ITS is the modality of feedback. For instance, should the feedback given to a team be text, visual, verbal, or tactical? The domain of athletic sports teams can provide useful insight to team feedback because players are continuously receiving feedback from their coaches and teammates in order to improve their skill levels. Literature suggests that the combination of visual and vocal feedback is beneficial to performance. A study conducted on high school football athletes by Stokes et al. (2010) concluded that vocal and visual (and sometimes acoustical) performance feedback improved the players' pass-blocking skills. Another study conducted by Smith and Ward (2006) showed that performance was the best during the goal-setting condition where verbal feedback was given during practice. Smith and Ward also discovered, via a questionnaire, that players did not prefer individual goal setting intervention because it was missing the visual feedback. These conclusions suggest that an intelligent tutor should, at minimum, give visual and vocal forms of feedback.

## **Team Feedback and Implications for GIFT**

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There are several factors that are important to team feedback. The first factor is the how feedback is given to teams. In order to provide effective feedback in team training, there needs to be both individual and group feedback. Although both group and individual feedback should be administered to a group, Smith (1972) concluded that individual reinforcement feedback produced more satisfaction with the task than group reinforcement feedback. A feature that allows GIFT to give feedback to the individual members of teams and to the team as a whole should be added to the roadmap for GIFT. The second factor that is important to team feedback is the timing of the feedback. Literature suggests that individual and group feedback should be given at the end of a task. Real-time feedback is more difficult to apply to a team task, although the benefits can also be immediate. Often the timing of feedback is governed by the nature of the focus of the feedback. A feature that allows users to set parameters to tell GIFT when to give feedback to a team should be added to the roadmap for GIFT. The third important factor is feedback that describes how effectively a team completes a task. Salas et al. (2005) suggest that teamwork has five components that influence the effectiveness of task completion. These five elements are team leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation. Feedback about the different elements of the team should be given when feedback is given to the team. A feature that allows GIFT to determine if a team is effectively completing a task should be added to the roadmap for GIFT. Ultimately GIFT should be able to use different models for effective teams but the big five presented by Salas et al. (2005) could be used as a starting point. The fourth important factor of feedback is the modality of feedback. Research suggests that the mode of feedback that benefits performance the most is visual and vocal (Smith & Ward, 2006; Stokes et al., 2010).

There are several implications for GIFT functional requirements in order achieve effective team training: 1) GIFT should be able to differentiate different members of the team, 2) GIFT should collect data to support different metrics to evaluate team performance, 3) GIFT should have the ability to collect and evaluate data in real-time, and 4) GIFT should be able to understand the goal of the training and the current state of the team as a whole.

GIFT needs to be able to track different members of the team in order to provide individualized feedback. Team members may have the same role but tracking of team members increases in complexity if team members have different roles. If the members have different roles then the members are more likely to need feedback that is unique to their assigned role. GIFT would need to be able to track the members, differentiate each member, understand that member's role within the team, and then understand how that member's role relates to the task at hand. Tracking the different members will look different depending on the task. For example, if the members are in the same room then GIFT will need to track the member's different locations and know where they are in relation to the task space. If GIFT cannot track team members then the feedback that GIFT gives will be limited. Furthermore, tracking the team members will allow GIFT to evaluate how the members interact with one another.

GIFT also needs to have the ability to collect data to support different metrics to evaluate team performance. It is difficult to tell which metrics are important for determining team performance because little research has been conducted in that area. Further research is needed to understand the different metrics

that are domain independent indicators of team performance. Once these metrics are identified then research will need to be conducted to better understand how those metrics connect to the different elements (i.e., the big five) of teams.

Once these metrics are explored then the understanding of those metrics will need to be translated so that GIFT can accurately interpret the data input. For example, the way that members respond when a member experiences a very high workload during a team task can indicate how well a team shows backup behavior. If a tutor notices that a lot of time passes before any assistance is given to the team member with a high workload then that may indicate that the team, as a whole, lacks backup behavior. On the other hand, if little time passes before the team member with the high workload receives assistance from the other team members then that team may be able to effectively show backup assistance. This example may also indicate something about mutual performance monitoring as well since backup behavior and mutual performance monitoring are closely related. The resulting backup behavior that a team exhibits may be a result of good mutual performance monitoring.

Research indicates that it would benefit a team member's performance to give feedback to a team after the task (e.g., After Action Review) but ultimately GIFT should have the ability to collect and evaluate data in real-time. This ability may not be used to give feedback to the student participating in the task but it may be used to give feedback to the instructors that are overseeing the task. For example, imagine a team conducting a task in a virtual world. During that task in the virtual world there is a scenario where GIFT notices that the team is currently lacking in team leadership. If GIFT were to notify the instructor about the team's lacking leadership, then that instructor can throw in an unexpected task to the virtual world that exploits the team's lack of team leadership. However, further research needs to be done in order to evaluate if the previously mentioned scenario is achievable and the impact it would have on student and team learning.

In order for GIFT to have the ability to give influential feedback it needs to be able to understand the goal of the training and the current state of the team as a whole (Ilgen et al., 1979). If GIFT is unable to understand the current state of the team as a whole then it will not be able to determine what the team needs to do in order to reach the goal. Further research is needed to better understand the different independent elements of team that will allow the evaluation of a team. Once these elements are identified then those elements need to be translated into empirical data that can be automatically tracked by GIFT. The better GIFT understands the current state of a team the better feedback it will be able to give teams.

## **Conclusion**

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While feedback to teams in tutoring contexts has many implications for GIFT, there are still many areas that warrant further research. For example, research needs to explore the different empirical data that will allow us to evaluate a team's effectiveness relative to a given task. Further research is also needed to explore the different types of feedback (e.g., immediate vs. delayed) and provide evidence of how the feedback influences the team and its members. For GIFT, the next step is to develop different modules that allow GIFT to handle giving and receiving information from multiple team members simultaneously. GIFT modules to support team evaluations need to be developed. As the modules are incrementally and

iteratively developed they should be tested and evaluated to better understand the accuracy of the module. The ultimate goal is to develop GIFT's ability to support evaluation of a team in real time and to provide effective feedback to positively influence team learning.

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