Team Models in the Generalized Intelligent Framework for Tutoring: 2018 Update

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INTRODUCTION

The Generalized Intelligent Framework for Tutoring (GIFT) is a domain-independent intelligent tutoring system (ITS) framework that has many features and applications that can be used by ITS authors (Sottilare, Brawner, Sinatra & Johnston, 2017). The research and development associated with GIFT is divided into a number of different research vectors including, architecture, individual learner modeling, team modeling, instructional management, domain modeling, and training effectiveness. Many of the research projects that have been associated with GIFT have focused on developing new features and tools that ITS authors can use to create their courses. An ultimate goal of GIFT is being able to provide tutoring to teams. Examples of teams that GIFT plans to support are at the Squad level (9 people) and higher. An initial summary of the work in the team modeling vector through May 2017 was provided in the GIFT Symposium 5 proceedings (Sinatra, 2017). The current paper provides an update in the progress and work that has been done in team models in GIFT.

TEAM MODELING IN GIFT

Theoretical Background

Work in the area of team modeling in GIFT has been separated into two different divisions: theoretical and applied. The theoretical basis for the work in team modeling in GIFT was done as part of a large scale meta-analysis that covered the relevant team literature from 2003 to 2013. The results of this meta-analysis were recently published in the Journal of Artificial Intelligence in Education (Sottilare, Burke, Salas, Sinatra, Johnston & Gilbert, 2017). As part of this project, behavioral markers were also identified. These behavioral markers provided ways of assessing team performance during a session. Many of the markers are heavily communication focused, and are traditionally assessed in person by a human observer. Future work is planned in which these behavioral markers will be specifically selected and operationalized in the context of real-time team intelligent tutoring.

Applications of Team Modeling and Team Tutoring in GIFT

Surveillance Tasks

Team tutoring has been successfully demonstrated within the GIFT architecture in the form of a Surveillance Tutor. This tutor was developed using GIFT 4.0, and involved tracking both individual performance and team performance in real-time. This was initially implemented in the form of an experiment, which had two players who were working together to surveil an area in the Virtual Battlespace 2 (VBS2) software. The initial version had two team members who each surveilled an 180 degree area and communicated to their teammate when they saw a threat (OPFOR) crossing into the other person's sector. The lessons learned and information about the creation of this tutor was documented in a recently published article (Gilbert, et al., 2017). Depending on the condition that the team was in, feedback was either provided at the individual level, the team level, or not at all. The GIFT system was adapted to support individual assessment files

(Domain Knowledge Files; DKFs) and a team assessment file. Each of the team members had his or her own DKF which tracked their individual actions and performances, and there was an overall team DKF which assessed team performance. The team DKF assessed the team tasks as a whole, and was unable to discern which team member engaged in which action.

As a follow up to the initial implementation, the task was extended such that there were three individuals who worked together as a team to perform the surveillance task. While in the first implementation of the task there were two individuals who each performed the same role (spotters), in the expanded version there were the two spotters and an additional role, a sniper. The spotters surveilled their 180 degrees and instead of telling their partner when they saw a threat passing to the other sector, they communicated this information to the sniper. The sniper then was tasked with acknowledging that the information was received, locating the possible threat and identifying the threat level associated with the spotted individual. The sniper would determine if it was a civilian, a potential threat, or an imminent threat. This implementation used a similar DKF structure in GIFT, where each of the spotters had their own task specific DKF, and another DKF was generated for the sniper and provided assessment that was associated with that role. Finally, there was an overall team DKF that examined the team actions and could provide feedback based on them. In this version of the experiment, feedback was provided in one of two ways: at the individual level or at the team level. Lessons learned from this approach included that this particular approach to assessing team tutoring in GIFT would result in an increasing number of DKFs as the number of team members and roles were increased. Further, the overlap and reassessment in the team DKF required additional authoring and duplication of efforts. While not the ideal scalable approach to team tutoring in GIFT, this implementation was an important step forward, as it demonstrated the simultaneous assessment/tutoring of three individuals, and the ability to assess individuals in different roles.

Search and Rescue Task

The next implementation of team tutoring in GIFT will be in the Search and Rescue domain using the Virtual Battlespace 3 (VBS3) software. This work is still in initial development and the implementation is in progress (McCormack et al., in press). As part of this project, there will be effort made to operationalize previously identified behavioral markers (e.g., cohesion and cooperation), and create a task that will elicit appropriate team behaviors that are associated with them. The search and rescue task is being developed in such a way that it is military relevant, and subject matter experts are being consulted in order to ensure that the tasks within the scenario are as realistic as possible. The focus for this implementation is on the team performance overall, with less focus on the individual. The actions that the team members perform will ultimately be assessed in one team DKF, and feedback will be provided at the team level. This reduces some of the complications of using multiple DKFs as was done in previous work using GIFT. Additionally, as this scenario is expected to be made up of 9 people, and include subteams within the structure, providing assessment/feedback in this manner will reduce complications and allow for focus to be on developing a rich relevant scenario. While this project is ongoing, the GIFT team will be developing a scalable solution to the GIFT team architecture, which can both be merged with this scenario and used for future implementations in GIFT.

TEAM MODELING WORKSHOPS AND OUTPUT

Team Workshop, March 2016

As part of the meta-analysis project, a workshop titled “Building Intelligent Tutoring Systems for Teams: What Matters” was conducted in March 2016. This workshop focused on teamwork as it applied to ITSs.

Brainstorming and discussion happened during the workshop about best practices in ITSs and what is relevant in order to conduct team tutoring. The discussion lead to the output of an edited book volume. Individuals who attended the workshop, in addition to others who were experts in the field were invited to contribute chapters. The book was recently completed and is in the editing process. The final book titled *Building Intelligent Tutoring Systems for Teams: What Matters, Volume 19*, with editors Joan Johnston, Robert Sottilare, Anne M. Sinatra, and C. Shawn Burke is scheduled to be released in September 2018.

Team Taskwork Expert Workshop, June 2017 and Design Recommendations Book Volume

In June 2017 a Team Taskwork Expert Workshop was held at Iowa State University in Ames, Iowa. This workshop was held as part of the ARL-University of Memphis cooperative agreement, and one of the goals was bringing together a group of experts in different areas of team research (including collaborative learning, team performance, and team tutoring) to discuss their work and how it is applicable to team taskwork in ITSs. The focus of the workshop was specifically on taskwork, or ways that intelligent tutors could be applied for specific tasks or domain areas. There were a wide range of presentations that included discussions about applications in the medical field, in military domains, in analyzing the content of team messages, and more. In addition to the discussions, the formal output of the expert workshop is in the form of an edited volume. The book, tentatively titled: *Design Recommendations for Intelligent Tutoring Systems: Team Taskwork*, includes four focuses areas about team taskwork: modeling, socio-cultural applications, system design and assessment. The editors of the book are Robert Sottilare, Art Graesser, Xiangen Hu, and Anne M. Sinatra. The book is expected to be released in summer 2018.

Assessment and Intervention during Team Tutoring Workshop, Artificial Intelligence and Education Conference, June 2018

The GIFT team has an accepted workshop at the Artificial Intelligence and Education (AIED) Conference in June 2018 in London. Papers have been accepted to the workshop that highlight different areas and applications of team tutoring in ITSs. Areas of focus include collaborative problem solving, demonstration of team tutoring in action, and communication during team tutoring. During the workshop there will be a discussion of the commonalities in the different approaches to team tutoring and a discussion of gaps and steps forward overall in the problem area. The output of this workshop will be proceedings papers that will be available online and the information gathered from the workshop will impact the way forward for team tutoring in GIFT.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The lessons learned from the surveillance tutor and the recommendations for both intelligent team tutoring systems and GIFT in particular that have come out of the team workshops will be taken into consideration while developing the team architecture in GIFT. Providing real-time feedback and assessment for not only individual team members, but a team as a whole is a difficult challenge. As was demonstrated in the initial surveillance tutor, it can be difficult to interrupt individuals in the middle of a scenario to provide real-time feedback, and it may result in them either reducing performance, or not being able to attend to the feedback. As a result of this, initial implementations in the future may use the approach of focusing on after action reviews that occur at the team level after the completion of subtasks within a scenario. By engaging in this manner it will not interrupt the event that is occurring and will ensure that the feedback is viewed by the team members. Additionally, as authoring multiple DKFs would be cumbersome, work should continue to be done in order to implement a scalable team architecture that lessons the authoring burden but still provides relevant assessment and feedback during tutoring sessions.

Research into team modeling in GIFT should continue to be actively developed, and careful thought should be given into the implementation of the team architecture in GIFT. Additionally, work should continue to be done to use the theoretical foundation that was identified in order to implement successful team tutoring in GIFT. By operationalizing the behavioral markers and determining which can be generalized it will provide a powerful theory driven approach to team tutoring that tutor authors will be able to implement. Through the development of scenarios and the architecture, the initial plans for a team tutor authoring tool can be put into place. Ultimately, as GIFT is adapted for use with teams it will lead to it becoming more powerful and incorporating many additional relevant features that can be authored. Similar to the other authoring tools in GIFT, it is expected that the team tutor author will not need to be heavily versed in the team literature, but can use the tools, prompts, and recommended pedagogy within GIFT to construct a highly relevant team tutor that is pedagogically sound. GIFT continues to be developed in order to support team tutoring, with future work including demonstration of a Squad level team tutor, and approaches to assessing teams in real-time.

REFERENCES

Gilbert, S. B., Slavina, A., Dorneich, M. C., Sinatra, A. M., Bonner, D., Johnston, J., ... & Winer, E. (2017). Creating a team tutor using GIFT. *International Journal of Artificial Intelligence in Education*, 1-28.

McCormack, R., Kilcullen, T., Sinatra, A.M., Brown, T., & Beaubian, J. (in press). Scenarios for Training Teamwork Skills in Virtual Environments with GIFT. In Proceedings of the 6th Annual Generalized Intelligent Framework for Tutoring (GIFT) Users Symposium (GIFTSym6).

Sinatra, A. M. (2017, July). Team Tutoring in the Generalized Intelligent Framework for Tutoring: Current and Future Directions. In Proceedings of the 5th Annual Generalized Intelligent Framework for Tutoring (GIFT) Users Symposium (GIFTSym5), p.123.

Sottilare, R. A., Burke, C. S., Salas, E., Sinatra, A. M., Johnston, J. H., & Gilbert, S. B. (2017). Designing adaptive instruction for teams: A meta-analysis. *International Journal of Artificial Intelligence in Education*, 1-40.

Sottilare, R. A., Brawner, K. W., Sinatra, A. M., & Johnston, J. H. (2017). An updated concept for a Generalized Intelligent Framework for Tutoring (GIFT). *GIFTtutoring. org*.

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