Implementation and Assessment of Teamwork in Computer Science Education

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Introduction

Teamwork has been agreed upon as a necessary and vital skill in the field of computer science. Effective teamwork involves the following traits: shared team goals and values, equal commitment to team success, motivation, interpersonal skills, open and effective communication, constructive feedback, ideal team composition, leadership, accountability, interdependence, and adherence to team process and performance (Chowdhury & Murzi, 2019). Because teamwork is a necessity in the professional realm of computer science, the need for teamwork training in computer science education has become increasingly apparent. As a result, numerous studies have been conducted to determine best practices for introducing and endorsing teamwork in classroom settings. Despite the large amount of research being done in this area, there are still no universal methods for measuring teamwork, teamwork effectiveness, and team compatibility.

In this preliminary literature review, we analyzed several research papers to identify the various ways by which teamwork is measured. Since our goal was to begin exploring existing research, we did not complete a systematic review, but are saving this for future work. In order to find the articles used in our review, we searched several article databases, using ‘teamwork’, ‘computer science,’ and ‘engineering’ as keywords. Our search returned six articles and we included three in this review that focused on the following ideas: measuring teamwork by its social attributes and measuring teamwork by the quality of the artifacts produced by the team. Some researchers have also taken to combining these two methods, measuring both the social and academic aspects of teamwork.

Findings

Measuring Teamwork through Artifacts

Whilst many researchers attempt to measure teamwork on its own, many researchers have claimed that teamwork effectiveness can be assessed based upon the quality of the artifacts produced by the specific team. One such example of this is found in Lingard and Barkataki’s (2011) “Teaching Teamwork in Engineering and Computer Science.” In this study, Lingard and

Barkataki analyzed the students in their own classrooms, using a variety of methods to measure teamwork efficacy. One of these was the analysis of intra-team emails. The authors of this paper claimed that this method helped "faculty easily monitor the degree and quality of student collaboration during a team project" (Lingard, 2011). The authors of this paper had faculty evaluate the quality of the emails in real time, a measure which the authors claimed to curb procrastination and poor teamwork. Additionally, these evaluations were used in the team's final grade. Unfortunately, the paper did not mention any of the criteria that the evaluators used in their analysis. Ultimately, I believe that this particular method has many areas for improvement. Whilst emails are definitely an artifact, they may not represent the entirety of the team's interactions. Additionally, the evaluation of intra-group emails may cause team emails to become less personal. Because this method utilizes email evaluation as a part of students' final grades, students may become more focused on sending emails that appeal to the evaluators simply to obtain a certain grade rather than for promoting intra-team communication. This method is also highly subjective. Whilst the authors claimed that this method made teamwork assessment more objective, it seems that this method would only serve to make this process even more subjective. Because there was no singular evaluation criteria that was used across all teams, this evaluation method relies heavily on the opinion and perspective of the evaluator. Overall, this method definitely has several strengths, but needs to be improved in several key ways before it can reliably measure teamwork efficacy.

Measuring the Social Attributes of Teamwork

Researchers have also used surveys to measure the quality of teamwork. In our review, we read a paper by Martínez, Martín, and Alonso (2014). In this study, the researchers sought to find which methods worked best for improving teamwork. They used the Team Work Behaviour Questionnaire (TWBQ) and the Achievement Goal Questionnaire (AGQ) to measure teamwork. The TWBQ is a survey consisting of twenty-two Likert-style questions. Each question is answered on a scale from 1 to 7, where a '1' represents 'Not At All' and '7' represents 'Very Much.' The questions ask about teammates' behavior and overall team compatibility. I found this survey to be very good, but somewhat limited in scope. While it can measure teamwork and can be a very efficient solution, the TWBQ's linear nature makes it somewhat rigid. While a survey composed of close-ended items can measure teamwork and be administered easily, the survey lacks the emotion that open response items might provide. Nevertheless, this is a very good solution to measuring teamwork directly and is extremely concise as compared with other similar surveys, many of which are over thirty questions in length. The second tool mentioned - the AGQ - is also measured on a 7-point scale, with the same numerical values. The AGQ differs from the TWBQ in its focus on goals and completion of those goals. In some ways, this could be argued to be measuring teamwork efficacy, but the AGQ focuses heavily on how each member contributed to those goals, making it more about the teamwork than about the results of the teamwork. The researchers noted that they were not able to conclude anything in their study using the AGQ. This could have been for a couple reasons. One reason is that the AGQ may not

be a valid measure of teamwork. Another reason could be that the AGQ did not accurately measure what they were trying to measure. I strongly believe that the AGQ's focus on goals makes it far more susceptible to error because teams were not made to agree upon common team goals prior to starting the project. Because of this, the student's reviews would be based solely on their own goals for the team, which may be starkly different from other students in the group.

Measure Multiple Aspects of Teamwork

Other studies combined measuring teamwork along with teamwork efficacy, as in Britton, et al. (2017) In this study, the researchers first tested TeamUp and CATME, existing frameworks for measuring teamwork and teamwork effectiveness. The researchers found two major faults with the two surveys. Firstly, the surveys were not sustainable as there were too many questions for students to complete in a reasonable amount of time. Additionally, the researchers questioned the accuracy of these two surveys, as they seemed to not take several important factors into account. Recognizing the weaknesses of the current measurement techniques, the researchers created their own rubric, Team-Q. Team-Q consists of five separate areas that the researchers felt created a good teammate: contributing to team project, facilitating contributions of others, planning and management, fostering a team climate, and managing potential conflict. Students rated themselves and their teammates in each of these sections on a five-point scale from zero to four, where '0' represented 'Never' while '4' represented 'Always.' Unlike other surveys that are only given at the end of every project, this method was tested across many different classrooms and was administered every four weeks. The researchers found that Team-Q resolved the issues that were identified with the TeamUp and CATME tests. Ultimately, the Team-Q is a very versatile survey that is sustainable and is highly efficient. The number of questions are significantly lower than that of other surveys, but the survey does not lose any depth nor accuracy. However, the Team-Q has some room for improvement. For example, the 'fosters a team climate' section overlaps with the 'manages potential conflict.' Although these two sections have different connotations, the survey's description of these two areas are very similar and can potentially cause confusion to respondents.

Summary

Teamwork is an incredibly complex field of study. In our review, we looked at three methods for measuring teamwork: measuring teamwork through artifacts, through social attributes, and through multiple aspects. Ultimately, no one way is absolutely perfect. Each method has different strengths and weaknesses and works better in different environments. Obviously, this review is by no means exhaustive. There are a plethora of other techniques being used to measure teamwork, many of which we did not cover in this review. Being fairly limited in the number of papers we reviewed, our study only used papers from computer science and engineering education. We also did not review all of the literature available within the scope of computer science education. In the future, we hope to expand upon this review by conducting a more exhaustive literature review, using more papers across more disciplines. We also hope to study

the effectiveness of these teamwork measurement methods in classrooms to develop more personalized measurement techniques.

References

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