Groups can do IT

A Model for Cooperative Work in Information Technology

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Abstract. As the Information Technology (IT) professionals of the future, learners of programming need to master skills with regard to learning together and sharing knowledge. The research question that will serve to focus this paper is: "How can we integrate cooperative group work meaningfully into the teaching and learning of programming skills?" In answer, this paper presents a new model for cooperative learning environments in IT classrooms that emphasizes the importance of structuring cooperative groups for effectiveness. Learning from the past, we base the model on literature and previous research done by the authors. Appropriate implementation of the model requires the basic elements of positive interdependence, individual accountability, promotive interaction, interpersonal and small-group skills, and group processing.

1. Introduction

These days, programming projects are growing in size and complexity [1]. Large groups of programmers therefore need to work together to solve problems and develop solutions. Most companies are increasingly requiring members of their work force to be well equipped with essential cooperative and communication skills [2].

In order for Information Technology (IT) learners to be responsive to these changing requirements of the workplace, while learning programming, they must also develop the necessary social skills. "Cooperative learning techniques have been applied with a wide variety of subject matter and a broad spectrum of populations" to teach introductory computer programming [3]. These educational techniques produce increases in learning skills, improve learner motivation and have significant positive effects on learner performance and attitudes towards instructional content [4]. [3]

also refer to evidence accumulated from existing educational research that "suggests that cooperative learning results in higher student achievement, more positive attitudes toward the subject, (and) improved student retention". Many of these advantages are also transferable skills that influence both the ways in which learners learn cooperatively, and when they learn individually.

Cooperative work contributes to conceptual learning and the knowledge construction process when they consider alternative viewpoints on problem solution, thus creating possibilities for the re-construction of their own perceptions and answers [5] [1] believe that during the process of actively thinking and working together to construct problem solutions, cooperative projects provide learners with opportunities to share and explore ideas, learn new concepts, expose different points of view, and experience the satisfaction and challenges of working with others. Working cooperatively not only nurtures and develops these skills, "but also promotes deep learning through interaction, problem solving and dialogue" [6]. Exposure to these kinds of opportunities encourages cooperation between learners, considered one of the attributes of good teaching practice.

It is, however, crucial to understand that teachers' contributions are of key importance in making cooperative learning encounters constructive for all learners. Teachers need to promote interactions between learners during cooperative work that lead to the type of thinking and problem solving that is necessary to involve them in the learning process [4]. Another review of research by [7] "demonstrates that the benefits of cooperative learning are enhanced when … teachers have been trained in how to implement this pedagogical strategy." Such training not only adds to the advantages of this instructional approach, but also empowers teachers to help their learners in the IT classroom to utilize cooperative skills effectively. The research question that will therefore serve to focus this paper is: "How can we integrate cooperative group work meaningfully into the teaching and learning of programming skills?"

2. Key Elements of Effective Cooperative Action

Those experienced in the use of cooperative groups know that promoting successful cooperative learning "does not just happen" [6] - you cannot simply put learners in a group and hope that they will work together well [7]. Literature [see e.g. 9] emphasizes the importance of structuring cooperative work for effectiveness, by ensuring that the following key elements are evident:

1. Positive interdependence: Link group members so that they believe that they cannot individually succeed unless they all do,
2. Individual accountability: Expect each group member to be responsible for making their own personal contributions to the group and learning,
3. Interpersonal and social skills: Group members are expected to use interpersonal and small-group skills that would facilitate learning when helping each other as they work on their task, such as assuming a leadership role and effective communication ,
4. Face-to-face interaction ought be exhibited, and

5. Group processing: The group needs to reflect about how it is functioning).

3. Model for Group Work

3.1 Positive Independence

According to [7], "(e)xplicitly structuring positive… interdependence in groups… appears to be critical for successful cooperative learning." Interdependent group members realize that they cannot achieve success unless all the members of the group achieve success. Teachers need to establish mutuality in terms of common goals and "benefits from achieving goals" [9]. Having the completion of the project as a common goal should serve as one of the main factors in uniting group members in a joint effort. This mutual goal should be relevant and convincing enough to overcome learners' possible competing agendas and any conflict that might arise within the group. Because the learners in these projects are in high school, peer pressure plays an important role in encouraging good work ethics and commitment to the project.

Benefits received from achieving the common goal (in this case marks for the project) are usually distributed equally among group members, as this highlights the common fate of group members. Results in a study by [11] confirm that the majority of respondents preferred a division of the majority of marks equally among group members, with only a small portion allocated based on individual contributions. Teachers can also strengthen positive interdependence in a group by ensuring that each group member is able to complete a part of the total project [9].

3.2 Individual Accountability

[12] stress the importance of assessing for individual accountability, to ensure that all group members participate. Individual accountability is important for group success, since some members tend to dominate and some to withdraw, unless mechanisms are in place forcing everyone to participate. Individual accountability is established when each group member understands that she/he is required in each cyclic meeting to briefly report what she/he has been working on and what progress has been made [7,2]. In this way, the meetings also motivate learners to make meaningful progress, so that they have something significant to report. By requiring groups to keep a record of their decisions at meetings, each group member can be held accountable for those parts of the project that the group had agreed was her/his responsibility. All group members are individually responsible for demonstrating their own knowledge and skills with regard to programming by applying these to their parts of the project [10]. Learners also write their class tests and examinations with regard to their programming knowledge and skills individually [13].

3.3 Interpersonal and Small Group Skills

It is necessary to train learners in the interpersonal and small-group skills that facilitate learning [7]. Learners need to be taught how to communicate with each other [2], incorporating the concepts of compromise, participation, interaction and cooperation. It is also important to teach group members how to "avoid negative comments, and to present their critiques in a positive light" [14].

During the first period allocated to the project, learners receive training in small group processes by participating in various activities and games. One of these illustrate the elements of good group organization, including having a clear purpose, how to define group goals, and planning the project well [15]. The actual "planning meeting" takes place in the second period allocated to the project. Teachers need to make sure that the time allocated for planning the group work (at least one period) is spent in appropriate discussion and thorough planning, as this planning is important in order for everyone to know exactly what they will be doing. Each group should provide an account of how they had planned their work, with details written down of things such as the division of tasks between various members. If they do not plan carefully, a group might take very long to really get started, and spend too long changing their minds about what to do. As a result, they might not have enough time to complete their projects to the extent that they would have preferred. During the planning meeting, learners are responsible themselves for developing appropriate ground rules through discussion within the group [7,13].

3.4 Face to Face Interactions

Face-to-face interaction is supposed to take place each time the groups meet. When they sit together in their groups while carrying on with their cyclic meetings, learners should communicate efficiently with each another, and cooperate in order to make orderly progress. They need to provide explanations and elaboration to help other group members understand key principles and concepts related to their responsibilities within the project. Teachers need to create a situation where learners realize that effective learning is a shared responsibility, and where they share their resources, provide mutual support and encourage each other to achieve success [12].

3.5 Group Processing

Teachers should structure group tasks to ensure that learners learn to work together and get the opportunity to assume more of the organization and management of their groups [15]. During group processing learners' mastery and application of group skills are monitored regularly through teacher observation, as well as by having learners submit detailed self and peer assessment reports, in a rubric format, at the end of each cycle [2]. The assessment instrument consists of items specifying positive contributions from different group members towards the project, possible weak spots displayed, and an indication of the global contribution level for each group member. Teachers then use these assessments to provide timely and appropriate feedback to learners reflecting "observations from their peers and the teacher about how they are doing as group members" [2].

Disruptive group members could at times appear to be bored and do not always interact well with their groups. Sometimes their effort and interest are minimal in comparison to other group members. Now and then, it could be difficult to get and then hold their attention. They might benefit from realizing that it is important for the good functioning of the group to be willing to listen to the other people in the group and find out what their ideas are. This kind of behavior reminds us that teachers should not only be trained in how to handle 'trouble-makers' in groups, but also how to teach their learners how to handle such group members themselves.

If the results of group processing show some group members acting disrespectfully or uncooperatively, it is important that teachers take swift action to correct such situations. Persistently disrespectful or uncooperative learners could eventually be required to work alone, or among themselves, "rather than be an undue burden to other learners' group experiences" [2]. We are convinced that we train teachers well in ensuring that they implement these elements successfully in their learners' groups, many of the problems experienced in IT classes when implementing groups, could disappear [8]. The presence of the basic elements of group work should enable groups to work effectively to bring in the required group projects according to specifications and initial planning. In order to maximize all learners' involvement in the project, it is important that the pitch of the project is just right: On the one hand, some of the tasks should provide a challenge to learners, while other tasks require the use of skills that they feel comfortably capable of using [10].

3.6 Allocating Specific Roles in the Group

Learners need to experience that they need to effectively implement several member roles in order to successfully maximize their group's interaction and accomplishments. The main aim of these roles is the assignment of different responsibilities to group members and determining how group members are to act and/or function with-in the group [1]. In this way "poor drivers" can be avoided - they usually have domineering personalities, leading to them not knowing how to delegate responsibilities, but instead want to do everything themselves. The opposite would be learners who become "free riders", avoiding responsibility and/or contributing by letting others handle all the work [5]. As the only role that teachers often assign to group members when working in groups is that of group leader [8], learners are exposed to some of the common pitfalls that could occur when leading groups and how to take up responsibility. Since teachers generally do not know other different roles that can be assigned to learners when working in groups [8], this aspect needs specific attention during training workshops.

Learners are required to rotate between different roles what can be assumed within the group, and to record this information as part of their cyclic meeting, e.g. who the leader, scribe etc. was for a specific cycle [2]. The scribe/recorder/secretary is responsible for documenting the group conversation and providing the group consensus solution for the problem. Other positions in a group are the speaker/presenter, who presents the group's answer to the class, and the facilitator, in charge of encouraging everyone to participate. The role of a planner, to outline where and how the group is proceeding through the assignment can be added.

3.7 Assessment in Group Context

Many arguments put forward why teachers do not often use groups when teaching IT centre on perceptions that assessment in group context and the administration of group work is difficult [8,12]. Teachers need access to techniques that they can implement in order to obtain information for the assessment of individual learners in the group project situation. One of the queries most often encountered with regard to group work (that teachers need to be trained in extensively) is the issue of assessing individuals' involvement when the product of the group work is a single project [11]. This aspect is intricately tied into the elements of positive interdependence and individual accountability mentioned in previous sections. A final cumulative peer assessment instrument is used that explicitly asks "each student to rate each group member on" [2] group skills such as communication and cooperation. A principle suggested by [14] is used when marking group projects: All group members start with the same grade, but that grade is then adjusted for each member, in accordance with their individual contributions as reflected in their peer assessments [4].

We now implement and test this model for cooperative groups in South African IT classes, by piloting it in selected schools, to determine the effectiveness of the model when teaching programming, as well as to identify possible shortcomings.

4 Piloting the Model

4.1 Training Workshops

In order to pilot the model, we train selected teachers in the effective use of group strategies for implementation in the teaching and learning of programming skills in the IT class. This training is in accordance with the model as described in the previous section of this paper, and takes place in a workshop setting. We follow a pre-test - post-test approach, with teachers involved completing a questionnaire before the training workshop to determine their base knowledge, skills, attitudes and perceptions of group teaching and learning in the IT class. After the training workshop, teachers again complete a questionnaire in order to determine the impact of the training on the same. Due to the small number of participants, mainly descriptive statistical analysis is used.

Workshops consist of a solid theoretical framework for using group learning in computer programming, as well as clear practical applications of knowledge and skills gained. Theoretical and practical work are intertwined in the workshop to ensure that the necessary knowledge, skills and attitudes are acquired in such a way that teachers are able to implement it effectively in their own IT classrooms. Responses in a study by [8] indicated that current IT teachers lack theoretical knowledge of group work. Not only were teachers uninformed, but they did not seem to appreciate the dynamics of group work and the contribution that group work could make to effective learning and teaching in the IT class. Ignorance of the possible advantages of group learning strategies could be one of the important reasons why

teachers generally do not use it for teaching programming skills. If such teachers were to undergo training, one needs to query them to establish whether this is in fact the case; if so, we need to make them aware of this potential.

4.2 Teaching the Model

The selected teachers then proceed to teach programming skills in accordance with their training in cooperative strategies. During this implementation of the model in their classrooms, we ask teachers to complete a short journal entry for each implementation opportunity, detailing their experiences of cooperative teaching and learning. These provide rich qualitative information towards evaluation of the model. Researchers visit teachers on a regular basis to determine problems that they might be experiencing. During these visits, the journals form the basis for semi-structured interviews. The researchers also provide teachers with advice, information and emotional support to help teachers keep up their spirits and efforts. At the conclusion of the pilot study in schools, teachers complete a final questionnaire. We hold a focus group discussion as a debriefing session for teachers, to gain assistance from teachers to interpret results and provide a versatile, dynamic source of data directly from participants [13] - we analyze this qualitatively.

6. Conclusion

Learners need to master the basic knowledge and skills regarding group work, assume various roles within the group, resolve conflict constructively when it arises, and should be able to put these into practice successfully while working together in a group. In light of the scenario as described in the introduction to this paper, empowering learners in this way represents a valuable investment in each of these learners' futures. We are convinced that this model should enable teachers to understand the dynamics of group work and the contribution that group work could make to effective learning and teaching in the IT class.

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