Assessment of Collaborative Methods in Learning Principles of Programming

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ABSTRACT

Learning a computer programming language has been observed to be a difficult task. Failure and drop rates are high among sophomore students in their introductory programming courses. Many methodologies are used to enhance learning and collaborative or cooperative methods are widely implemented even within online environments. This paper describes the collaborative and cooperative methods and the assessment paradigm. A study was conducted and showed that the collaborative methods may not be adequate for learning basic programming principles.

KEYWORDS
Collaborative learning; cooperative learning; programming; concept learning;

1 INTRODUCTION

It has become a trend to adopt new methods, new behaviors new products without a lot of reasoning or inspection. After the emergence of certain observations, the significance of the adoption of new techniques simply for newness sake has been questioned. This approach is happening also in education. As an example we find many attempts to use collaborative learning or cooperative learning in almost all fields of study and computer programming for beginners is not an exception. In this paper a study about learning basic computer concepts in sophomore class using a collaborative method is assessed. The first section describes the collaborative and cooperative learning methods and the difference between them. Next, the different assessment paradigms are exposed in order to choose the appropriate method for the study. Section 4 tackles the difference between the types of tasks to be learnt and section 5 discusses the study and is followed by the conclusion.

2 COLLABORATIVE AND COOPERATIVE LEARNING

A major challenge for researchers and practitioners is to develop teaching practices that encourage high-level interactions among learners. A high-level learning procedure requires that learners are engaged in reasoning activities, development, questioning, explanation, arguments and criticism.

In cooperative learning, there will be a clear partition of the work to achieve; a clear task will be assigned to each student. Thereafter, individual output from each student are gathered to constitute the final work. In this case, the student will be accountable for his own production but he will nevertheless learn to interact with other learners to produce a final consistent work. The cooperation is the result of a negotiated division, a priori task for an equity to be allocated between individuals who will act relatively independently. The interactions are constrained by the organization, the coordination and the monitoring of progress (often under the responsibility of a member to monitor the individual performance of each learner). Everyone's liability is limited to ensure the implementation of his assigned actions. The progression and the coordinated concatenation of each member output achieve the objective of the group (e.g., building a house).

On the other hand, in collaborative work, there is no division of tasks among learners. Everybody works together at every stage of the development. It is therefore not possible, to identify the work
done by each participant. In the case of collaborative work, there is no a priori distribution of roles. Members subsume a group that gradually becomes an entity. The responsibility is global and collective. All group members remain in regular contact, each one may bring to the group an action that everyone can contribute to increase the performance. Collective work consistency achieves the objective (e.g., winning a football game).

The key participants and the elements of a collaborative environment based on the most often currently encountered literature are described below [1].

2.1 The Participants

a) The tutor

The tutor is the one who carries an accompanying feature of all the teams during their training. He plays a role at different levels, with different functions in the design and in the development of the content, in the correction, where he makes the link between the content and the learner and builds an assessment from the latter productions.

The tutor is a mediator between the learner and the material and he provides the basic tools (method, work rules) necessary for any task. The tutor is also an agent between the learner and the course content, meaning he must be attentive to the terms of the learner and drive him slowly to autonomous intellectual activity. He helps the learner to act and decide and guides him to find the keys to the situation [1].

b) The Learner

As part of the collaborative work, the student’s role is no longer to memorize the knowledge imparted by the teacher for a refund on the day of the examination, but he governs his learning process by transforming knowledge into information and creating interactions with other group members. During the communication, the learner can be a transmitter to be listened to and to be understood. He expresses himself as succinctly as possible to avoid encroaching on the time of expression of other members of the team, and speaks clearly and accurately. He must also be a receiver who listens and understands the transmitter, communicates and adopts a sympathetic attitude. He lets the other speak until the end, to ensure a good understanding of the ideas from the transmitter. He may ask questions or reformulate ideas already issued [1].

c) The moderator

The moderator is a person responsible, among other things, to coordinate tasks and allocate duties. He has the power to influence the members of his team by his personal characteristics, talents, previous experience, and beliefs to which he adheres. He maintains a positive attitude towards the group members and participates in the task and tries to maintain a good atmosphere within the group. He seeks to remove tension when existing and brings examples related to the purpose of the work and puts effort to reconcile two members who adopt different points of view [2].

Capitalize the first letter of each word. Use a bold font.

2.2 The Elements of the Collaborative Work

According to [3], the three elements of collaborative work are: coordination, communication and sharing.

a) Coordination

Coordination is an effective arrangement of activities, persons and resources to achieve a goal. To have a good focus and coordinate the energies and activities of the group, three main variables should be controlled by the tutor, which are the task, the composition of the group and the medium.

To conduct a collaborative task, participants should work together and help everyone reach the goal that the group has set by negotiating and taking into account the expectations. The composition of the group, the size and the type of the group (homogeneous or heterogeneous), and the method used to divide learners into groups, are three fundamentals components that should be carried out carefully.

b) Communication

Communication helps the learner to express himself, to share with the group, to make
connections between the ideas, to allow the emergence of new ideas and structure processes to give them meaning and build knowledge. Coordination along with communication are the cornerstones of the collaboration procedure.

c) Sharing

Collaborative learning promotes students to share, build positive interdependencies and invest in mass production. The pedagogical sharing can take many forms: sharing ideas, activities (learning, education, learning evaluation), teaching materials or knowledge teaching.

3 ASSESSMENT METHOD

Evaluation is an important phase in any learning procedure. It takes many forms (written or oral examination, lab work, quizzes, internship, project implementation etc.) and it is quite common to measure the knowledge acquisition of students in a traditional way but the measurement of students’ reasoning is not always obvious. We cannot assess in isolation the student reasoning during his work to express his knowledge. The purpose of the assessment in an educational context is to contribute to successful teaching, and to assure that students have gained knowledge and skills [4]. Evaluation is indeed what enables learning systems to have interactivity with the learner [5].

In fact, assessment of knowledge and the learner’s problem solving skills remains a fundamental aspect of any learning or training system [6], as it enhances the learner’s training, allowing the tutor and the learner to assess strengths and weaknesses. Since the evaluation is a part of the learning procedure, introducing some categorization could facilitate the adaptation of the evaluation in regards to the required objectives.

There are many types of evaluation depending on when it is carried out, and according to the use made of it. In the following we distinguish four types of evaluation as listed in [7].

- Prognostic evaluation is whether the learner is capable or not to follow a specific curriculum, a suitable example might be an entrance examination in an institution.
- Diagnostic assessment identifies particular difficulties a learner or a group of learners is having. It is found especially in tests offered to pupils in schools.
- Formative assessment is not used to judge the student but rather for the teacher to adapt his course, or adopt another approach to the teaching content he wishes to transmit according to the results in terms of students’ appropriate knowledge acquisition.
- Summative assessment, which is the most frequent type. It is the evaluation of a specific student learning. It is typically a knowledge test with result materialized by a note, a qualification, for example the passing grade in the class, etc.

When writing programming code, common misunderstanding will be translated into common errors among students. The study of these errors, their classification and their types can give valuable information about the learners’ attitude in solving problems. This kind of work can be seen in some recent research such in [8]. Using multiple choice questions is easier and more convenient in the evaluation process because it reduces the answers to a small set of right/wrong that is followed by summing the correct points. Multiple choice questions obviously cannot be appropriate to meet the evaluation needs when using complex training systems. Thus, the multiple choice questions are a part of a summative evaluation that gives no information about learner’s critical thinking or learner’s cognitive processes and does not allow fine diagnostic of the skills and knowledge thereof. The practice of open questions in learning is essential to promote initiative taking and learners’ research approach. Practice, training, resolving open questions or open issues are essential to the acquisition of learners, and it is similar to the research approach that mobilizes knowledge and enhances imagination, assumptions and chaining steps of reasoning.
4 TARGETED CONTENT

The usefulness of collaboration depends on the learning content. Some tasks are more adequate and appropriate to be carried out with collaboration while others are not. Collaborative learning takes precedence over other learning methodologies in two thirds of case studies [9]. Assuming that collaborative methods have a very high success rate would lead to over-expectations which are not always justified [10].

If the content is quite simple and reduced to a single task there will be no room for disagreement or explanations or misunderstanding among the participants, therefore the communication is reduced to the minimum or it may not be present at a certain degree. According to Gagné, a concrete concept is a concept relying on classification of physical features. Zentall et al., also called it a perceptual concept [11]. The discrimination between objects is the first step in a concept formation. The higher level is the defined concept which requires a level of abstraction beyond the classification. It is also being called relational and associated concept since it examines the functional properties of the objects after being classified. Complex concepts are those concepts which require more critical thinking, analysis and synthesis. They can be divided into smaller parts and require more processing [12], [13]. The abstraction needed to resolve basic concepts is already acquainted by students at a young age. In this respect the memory concept in programming can be considered a simple concept for sophomore students and needs some individual practice to be assimilated. In a collaborative environment, the dominating student will draw from his weaker peers their chance to figure out the concept by themselves. If the task relies on perception which is not open to introspection, subsequently there will be no planning, no sharing and no interaction among members [14]. Collaborative learning takes place when learners have to resolve a complex problem or to develop together complex knowledge [15]. Collaborative learning may not be a magical method that can be implemented in all cases.

5 CASE STUDY

Based on the synthesis of the above sections, two groups of 20 sophomore students each, enrolled in the introductory programming course were asked to work collectively in a class setting to solve elementary programming exercises. The memory concept, one of the first basic concepts was chosen to be the target of the study. The average GPA of the students was almost equivalent in all groups. The average was based on the SAT exams since the students were sophomore and their GPA didn’t reflect their academic level.

After the material explanation, students were divided into 8 groups of 5 and were given an exercise that will assess uniquely their assimilation of the memory concept. No other interfering programming concepts and no prior expertise are needed to come up with the solution. The assessment method chosen was open ended question (e.g. a swapping the values of two declared variable) which shows the students’ principle comprehension. The groups were supervised closely to identify the moderator in each group and to assure the presence of collaboration and communication among the participants. Among the 8 groups only 5 finished the task within the given time. The procedure was repeated but with another exercise and 6 groups among the 8 finished in the given time. In both tasks the moderators of the groups remained the same. Each group submitted one solution and was graded to the entire group. Table 1 shows the results of the 2 procedures. The diagnostic assessment was used to reveal the difficulties but it didn’t affect the students’ official evaluation. The groups who tried to write some code but didn’t get to the correct final result were judged accordingly and therefore awarded a grade to reflect their knowledge, while 100 was awarded to the group with a correct answer since the exercises were quite simple. The grades of each group are shown in table 1.
The same students sat later for a post quiz in order to assess individually this time each student for the same concept as above. The results of the post quiz revealed that only 5 students could finish the task. Four of them were from the groups who gave correct solutions and also were identified as moderators of their group. Table 2 shows the results of the post quiz.

<table>
<thead>
<tr>
<th>Number of students</th>
<th>Grade</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>17</td>
<td>0</td>
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</table>

The fact that 42% of the students couldn’t write any correct code reveals that they didn’t get any help during the previous collaborative work. Also 37% of students showed a very weak assimilation of the subject. If added to the 42% we can conclude that almost 80% had a major problem and didn’t benefit from their previous collaborative experience. Fig. 1 shows the correlation between the group average in the two collaborative exercises and the grade of each group member in the individual quiz. For example, in group 1 with average 100, only student s1 was able to show knowledge of the concept. In the groups with a low average (group 5, 6, 7) no members have shown acceptable knowledge. The leaders of the groups were behind the groups’ high average while their peers did not have major input and couldn’t write alone any code sufficient to indicate a good acquisition of the concept.

6 CONCLUSION

Collaborative work should not be confused with cooperative work since the latter is cooperation among many members interacting for a common goal and sharing the tasks, while collaborative work is done in collaboration from beginning to end without dividing the tasks. Collaboration methods are promising to implement in course learning. The material has great impact on the decision whether a collaborative method should be used or not. If the task is reduced to a simple concept like a basic programming principle, individual practice may be more appropriate while collaborative procedures are more conducive for learning in the case of complex activities which mobilize high-level strategies. The rightful choice of assessment process and diagnostic techniques points out the effectiveness of the learning methods.

7 REFERENCES


