Decoding group activities in interactive teaching

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ABSTRACT: We report on the analysis of a decoding interview which aims at identifying students' bottlenecks related to group activities. The interview allows making transparent the subtle sequence of individual and collaborative parts in such activities and to describe the mental operations that students have to perform in order to get started with problem solving in group tasks. We also report on metaphors which the interviewed instructor created in order to illustrate what he himself would and would not be doing in group work. These metaphors when communicated to students have the potential to support them in passing their difficulties related to group activities.

1 INTRODUCTION

Over the past decades, Discipline Based Educational Research [1] contributed substantially to the understanding of students' conceptual difficulties with subject matter that obstruct learning. Depending on focus and research community conceptual difficulties are variously referred to as bottlenecks, threshold concepts, or misconceptions. There is plenty of evidence showing that teaching strategies that acknowledge such difficulties successfully promote students' construction and understanding of concepts and thus prove valuable in overcoming conceptual difficulties. A distinguishing characteristic of these strategies is the engagement of students in activities which provide immediate feedback through meaningful interactions among peers and with instructors [2], e.g. in form of group activities during class time.

Despite their success the implementation of such teaching strategies entails new challenges. For instance, in class activities might yield their own bottlenecks if students are strongly accustomed to traditional teaching styles. In this contribution, we report on bottlenecks elicited via a decoding interview [3,4] with an instructor who noticed characteristic student difficulties with group activities in his interactively taught computer science course.

A decoding interview identifies bottlenecks to learning and reconstructs mental actions of experts that they themselves perform intuitively when facing related difficulties. Often faculty consider concepts or processes as intuitive which prove daunting for novices. In order for students to effectively master these concepts or processes it is helpful for instructors to become aware of their own way of thinking as experts. This in turn enables them to model professional expertise explicitly which typically yields insights beyond the scope of raw subject matter. Consequently, instructors can create specific opportunities for their students to practise and engage in concept application and thinking processes for which they receive feedback about their success.

1.1 Information on course and teaching philosophy

At the time of the interview the instructor taught a numerical computation course for graduate students in computer science in a Just-in-Time Teaching (JiTT) framework. JiTT [5] is a teaching philosophy akin to flipped classroom and characterised by a strong focus on promoting conceptual understanding and diagnosing students' difficulties with subject matter. Students prepare for class by reading sections of the assigned textbook and by answering reading questions and short quizzes [6] provided via a course management system. Instructors "just in time", i.e. prior to class, analyse these answers to identify their students' bottlenecks with the current subject matter and design targeted in class activities. Such activities often take the form of peer instruction [7] and group exercises combined with classroom discussions. In case of the numerical computation course under consideration here group activities typically involved algorithmic design, programming and computation tasks and were expected to be completed within ten minutes to one hour. Some activities built on and required work results from previous activities; none of the activities was designed to require literature research beyond course materials.

In the eyes of the interviewed instructor, however, group activities are more than a mere pedagogical means. He had made the competency to work in groups as one of the learning goals of his class.

The instructor noticed that many of his students showed a recurring characteristic behaviour at the beginning of an activity which he referred to as "falling in some kind of hibernation" and he has been considerably concerned by this. These concerns gave rise to the interview underlying this paper aiming at understanding this "hibernation". The interview was conducted by two interviewers. It was transcribed and coded afterwards.

1.2 Focus of this work

This paper presents bottlenecks that might result in what the instructor termed hibernation of his students. The bottlenecks are elaborated in a decoding interview carried out by two of the authors with the instructor. Thereby we aim at improving teaching and learning not restricted to the interviewee's class. Challenges, as is frequently the case in teaching, are not specific to one course but often generic. As instructors, all three of the authors, not only the one interviewed, have observed students being blocked by group activities and thus impeded in their learning.

The paper further aims at decoding these bottlenecks, i.e. to identify what students need to master in order to participate successfully in group activities, that intentionally are designed to resolve conceptual difficulties. In this way, we also intend to contribute to the research body on group work. Particularly, we have noticed that the students' difficulties to be reported here not only transcend the course in terms of subject matter, but also in terms of group work itself. That is to say, these difficulties are at least in part beyond social and psychological interactions among the members of the groups which seem to be at the focus of research on group work up to date [8].

This paper, however, does not aim at coming up with solutions to the challenges the interviewed instructor has been facing. In fact this also has not been of primary importance to the instructor as uttered by him in the course of the interview:

> "I am looking for an explanation. More in the sense of a theory to explain what I observe. […] I am not looking for a solution in the sense of "here is the result" and that changes the whole situation. I am looking for a solution in the sense of, it provides me with a theory that explains what's going on and how I can deal with these things."

While solutions are necessary to improve teaching and student learning we deliberately restrict ourselves here to identifying underlying bottlenecks and decoding how experts overcome these bottlenecks. From a Decoding the Disciplines perspective these steps serve as prerequisites on a structured path towards improved teaching and learning [3,4]. From a Discipline Based Educational Research perspective they serve as indications of latent draw-backs, that need to be addressed as they restrain the efficacy of interactive teaching.

2 BOTTLENECKS IN GROUP ACTIVITIES / PROBLEM SOLVING IN GROUPS

2.1 Organizing the sequence of individual and collaborative work

The decoding interview had been triggered by the instructors' in class observation that in group activities many students are not effectively working as groups and his concerns about this issue. Being asked to envisage what he would do in such an activity - being a member of a group of people like him - he progressively outlined a sequence of consecutive phases that commences group work:

1. Individually ensure the assignment is clear to oneself; come up with an initial understanding of the problem at hand; explore possible connections to subject matter.
2. An initial coming together as a group "to clarify certain things about the problem".
3. Individually reading and further understanding the problem, identifying tasks and connecting it to what one knows and to the context of the course; looking up information and asking questions as necessary.
4. Individually coming up with a plan of "how to attack the problem".
5. Drawing individual plans together in the group; consolidating a single plan for the group; distributing work among group members.

It is important to note that it would not be before phase 5 that individuals would considerably function as members of a group. The instructor emphasized that group work essentially ought to start with individual effort that puts little attention to possible group synergies.

It is interesting to note that in identifying the bottleneck of organizing the sequence of individual and group phases, the instructor does not address potential issues related to social interactions among group members. In fact, one can argue that this bottleneck is closer related to problem solving in general than to group issues in a social or psychological sense. The instructor realised this quite early in the course of the decoding interview. Initially, when being asked whether his observations are related to problem solving he stated that he is pretty sure that this is not the case. When being asked what might change if he gave group activities as individual assignments he rapidly replied, however:

> "Well, I think the problem is with problem solving. In the sense of the art of problem solving."

Later on he explicitly related to the work of Pólya [9] on problem solving:

> "Well, Pólya comes to my mind. Have I solved a similar problem in the past? Do I know about a similar context where problems like this have been solved? Can I frame my problem with this context?"

2.2 Connecting to concepts and context and students' surrogate of problem solving

Apart from connecting to previously solved similar problems the instructor identified the operation of connecting the problem laid out in the group activity to the context of the course and to concepts taught in class as essential:

> "I would start reading the problems - the problem text. Make up some concept in my mind about the problem. What is it dealing with? And then try - well maybe, I am not sure if I really would do that, but - I think I would try to connect the information that I had gotten from the lecturer about the problem […]. I would try to connect this information to the problem and also the context we have talked about [in class]."

Essentially this is the third phase in the sequence of individual and collaborative work outlined above. Note that it entails a possible dilemma: While group activities are intended to foster learning of concepts they also require to a certain degree the prior interiorisation of the concepts to be learned in order to being able to connect to them. In contrast to his own approach, the instructor observed that students quite often start by "[taking] that literal problem and put it into Google".

The instructor frequently used the phrases "modelling the problem" and "picturing the problem in my head" when referring to the third phase. However, in the course of the interview he became aware that it is most often at this point when students

> "fall in some kind of hibernation. […] they don't do anything. I don't know what happens in this situation. And I regularly ask in class "Then take out your textbook - look it up." And then they start to move. […] Or at this point they look it up on Google.
>
> What I dislike in when they look it up on Google - I don't think Google is evil or I don't know, but they should in my opinion connect to their own material, to their textbook, to their notes to strengthen the connections they already have. Because when they look it up on Google and come to Wikipedia for example there are usually lots of new things and different formulations and that brings in some type of uncertainty."

That is using the internet, on one hand might result in more mental work than is needed for solving the problem and on the other hand, keeps students from building and strengthening mental connections between concepts they have seen before. Internet usage might produce more details than the students need and requires them to discriminate between the essentials and the details – another operation that inherently necessitates expertise. Hence, students' surrogate for problem solving skills, that the group activity is intended to promote, backfires in that it not only increases the complexity of the problem at hand, but it also puts the whole activity at risk to change course and lose its intended focus. It is often the case in these situations, that students perceive activities as inadequate and too difficult.

2.3 Significance of asking questions

To elicit how the instructor connects a given problem to concepts and context of the course one of the interviewers asked what the instructor would do before going to Google. The instructor emphasized that he would come up with specific questions he would like answered and added

> "I think one of our goals should be to get questions into students' heads."

The further conversation identified as a potential bottleneck that students do not perceive the importance of asking (self-generated) questions. Instead they value answers that quite often seem to satisfy criteria that appear superficial to an expert. Experts seem to contemplate relevant questions while novices tend to start with producing answers immediately. Reflecting on his classroom observations the instructor further noticed

> "Well, my observations showed me that some of them asked questions that are related to building a model of this problem."

and that these students generally were more successful in completing the activity as a group.

3 METAPHORS

During the interview the instructor developed several metaphors to illustrate his thoughts to the interviewers. We feel that these metaphors also serve well to illustrate to students what is expected from them and what is necessary to engage successfully in activities.

3.1 Building a house

As analysed in Section 2.2 the instructor is concerned with students' direct consultation of web resources and consequently getting swamped by potentially irrelevant information. In order to exemplify the detriments of such behaviour he likens the situation to that of building a house:

> "For example if you would like to build a house - a wooden house. I would expect that you have some idea in your mind. You need some beams here and some wooden plates there. You would start and would come up with a house. It wouldn't be perfect. But you have an idea. On the other hand when you think about the idea of building a house and look it up on Google you suddenly start to think about certain kinds of woods, certain kinds of connections, certain kinds these things. Lots of new problems you need to solve. And that's I think not really a starting point to learn something. I think you need to build your house or whatever from your first ideas and then continuously improve on this first one."

3.2 Jigsaw puzzle

The instructor considers connecting concepts among each other and to the problem as important steps in problem solving and learning in general. He further explicated that this is assisted by asking questions. At this point the interviewers facilitated the decoding process by elaborating on what kind of questions he would ask. In his answer the instructor came up with the following metaphor that likens problem solving to solving a jigsaw puzzle:

> "To make it explicit: I would ask questions that help me figure out the shape of the problem. […] The metaphor doesn't really fit. But something like a puzzle. What does the piece look like? And how does it fit into the remaining puzzle […]?"

Subsequently he explained that he looks for clues in the problem that help him to connect the different pieces. Like in solving a jigsaw puzzle he is looking at individual pieces, fitting those together that appear relevant to the problem or puzzle, respectively, while discarding the irrelevant ones.

4 SUMMARY AND CONCLUSIONS

The decoding interview analysed in this paper allowed the interviewed instructor to make transparent the subtle sequence of individual and collaborative phases in group work and to identify mental operations that are expected of students to get started with such activities. A great deal of these operations requires individual rather than collaborative effort. Hence, they do not relate to skills commonly considered essential for group work including leadership, decision-making, trust-building, communication, and conflict-management skills [8]. We conclude that preparing students for group activities must involve both social and problem solving issues.

Some of the identified bottlenecks are related to the difference in approaches to problem solving by experts and novices [10], such as asking self-generated questions and connecting the objective of group activity to the concepts of the course. Some bottlenecks seem to be intensified by detrimental use of information technology.

While this work does not intend to come up with teaching methods that help students to overcome the identified bottlenecks the metaphors created by the instructor might serve this purpose. When communicated to students they have the potential to support them in recognising and passing their bottlenecks related to group activities.

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