

Promoting a Culture of Learning through Talking to Understand Mathematics

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Abstract

Over the last four decades, a lot of effort has been focused on the importance of problem-based learning (**PBL**) in collaborative and problem-solving based approaches as a medium to learning culture in mathematics and support for collaborative knowledge construction. PBL is a facilitator that enables students to transcend and improve their knowledge and capabilities. Talking to learn mathematics in classroom and groups can give students an enlightened experience and assist them to approach mathematics in an effective way. The results indicate major improvements in students' learning progresses and deeper understanding.

Background

Higher education institutions face challenges in keeping first year students active, engaged and motivated. Over the last 40 years, a significant amount of effort has been focused on the importance of problem-based learning (**PBL**) in collaborative (Hmelo-Silver, 2004; Barrows, 2000) and problem-solving approach (Schoenfeld, 1994) as a medium to learning culture in mathematics (Brown, Collins & Duguid, 1989) and a support for collaborative knowledge construction (Chernobilsky, E., Nagarajan, A., & Hmelo-Silver, C. E., 2005). PBL is a facilitator to enable students to transcend and improve their knowledge and capabilities.

The purpose of this case study is to understand the effect of discourse in classroom and in groups based on team-based problem solving (**TBPS**) to change the culture of learning and knowledge building in mathematics. Lecturer presents a new subject, lectures and students can make the subject their own by talking about and on the subject and explain to others in their small groups by answering questions and solving problems in order to understand the concepts and when and how the methods can be used. The method was adapted for Subsea and Marine Technology Engineering students at Bergen University College during the period from 2009 to 2015 and the experience revealed that students can build a better understanding of mathematics.

Method and Case Study

It is important that students know how to approach an effective learning process, and they can improve fellow students' learning and they are there to make that happen. Similar to a football team's success which depends on active and helpful team engagement by all players.

Examples, questions and problems I chose, are one of the important parts of the project. I used control questions, which reflected on theoretical aspects and definitions while control problems, which focused on when and how mathematics can be applied.

In this study I observed how effective first year students can progress their cognitive reflection abilities and decision-making capabilities which can assist them in other courses as well.

The math-talk classroom is one attempt to engage students and to raise the level of interaction and discussion which enables students to increase their level of comprehension.

The concept of "by talking about mathematics, make it your own" is a good description of how by thinking and trying to explain what we have learned to answer a question or solve a problem, can help students to progress informative knowledge to a higher and deeper understanding of mathematics. The more effort you expend, the better you will remember.

Teaching and learning by talking mathematics. Talking mathematics:

Part I: Why and How to Talk Mathematics

Many researchers have reflected on Pedagogics Mathematics in teaching and effective teaching mathematics under active learning in classroom. The studies encourage talking in the classroom and in groups as a powerful tool and explain talking mathematics:

- Can reveal understandings and misunderstandings;
- Supports robust and effective learning by boosting memory;
- Supports deeper reasoning;
- Supports language development and encourages students to be concise, consistent and accurate;
- Supports development of social skills;
- Contributes to meaningful, integrative learning environment.

Discourse in Classroom and Group Work

One of the methods used to integrate active learning techniques in classrooms is to assist students to reflect, what they have learned and what they should remember.

Moyer & Milewicz (2002) stated that “*effective questioning in mathematics actually requires well-developed oral-questioning skills including preparing important questions ahead of time, delivering questions clearly and concisely, posing questions that stimulate thought, and giving enough time to think about and prepare an answer.*” (Moyer, Milewicz, 2002).

The lecturer can ask the following types of questions to the whole classroom:

- What do you think about this approach?
- Do you agree or disagree?
- Does it sound logical to you?

The lecturer then has the responsibility to sequence the student responses that will be displayed in specific order and connect different students’ responses and connect the responses to key mathematical ideas. The lecturer’s role is also to:

- Provide a brief overview after presenting a new subject and its application and when and how it can be used – with a particular focus on the words ‘when and how’;
- Give students good and challenging mathematical tasks to give students the opportunity to reflect on important mathematical concepts and problems;
- Try to monitor student activities, in order to give comments to improve their ability;
- Select students to present their solution process and solution.

It is important that students learn it is important to be simple, short and precise when they try to explain the problem or they suggest solution method. Students can practise using the following statements in their group sessions:

- I agree as ...
- I like the proposal because ...
- I disagree because ...
- I do not believe ...
- I like your method because...

Part II: How to Math-Talk in Groups?

Students can further develop their group sessions by using the following methodology:

- Read the problem twice and make notes to understand the problem at hand.
- Each student is provided 2 minutes to explain the problem to their colleagues (this assists students to understand the problem better). Students then characterize the problem and suggest a solution method.
- Students take 5-7 minutes to solve the problem individually and if they think they have found a reasonable answer, they share the solution as well as the method. If several fellow students have the same answer, students share their method and let the others who have not solved the problem a few more minutes to answer.
- One of the students can solve the problem on the board in the group room and can discuss their views and ideas with their fellow students. Students explain the reasons for their choice of method and summarize their understanding.

Students should remember to:

- Talk using simple terms, be precise and be short
- Listen to others and their views, and suggestions in order learn from each other (active and reflective listening)
- Try to explain, verify, identify, justify, convincing, refuting the problems and methods by talking and try to recognize the connection between concepts and methods
- The purpose is to get insight and learn to learn, not just solving the problems.

Lecturers should remember to:

- Make good challenging tasks which lead students to understand definitions and theories with a stronger emphasis.
- Mistakes in class discussions are seen as useful, all students contribute and their suggestions are valued, being stuck is seen as honorable and students learn from shared discussion with the teacher,
- Listen to the students and try to give them guidance on how they can be more simple and effective, identify problems easier and assist them to avoid misunderstandings and using wrong methods.
- Ensure students understand the correct method to apply for certain problems.

Summary

The study provides a good basis for improving students' learning process. This has had positive effects on students' motivation and desire to attend teaching activities and learn effectively. The talking method can provide a forum for broader interpretations and an opportunity for students to clarify their understanding

Results

By talking mathematics:

- Students learn how to formulate their thoughts in a short and precise way.
- Students learn to use diagrams and simple figures to understand and present ideas.
- Students better absorb mathematics as their own knowledge and find ways to explain simply complicated problems
- Students' comfort levels in small groups increases as well as their knowledge base. It gives them greater confidence in their capacity to learn and make sense of mathematics.
- Students learn to listen to and respect each other's solutions and evaluate different viewpoints.

The failure rate for engineering students in first course mathematics is usually around 20-30%. This method has also been implemented in teaching students from various engineering disciplines. The mathematics talk application has contributed to reducing the failure rate to 5-10%. Students had a greater

enjoyment in attending classes and what could have been long and boring classes turned to be exciting and explorative discussion sessions.

During the project, I talked with students about the effect of the discourse in the classroom on their learning processes and understanding of mathematics. Conducting interviews with students is a valuable strategy as a component in qualitative research methods in education research.

The result of this case study over seven years indicates that verbal learning process can assist engineering students' knowledge to step from informative knowledge to integrative knowledge. The choice of questions and problems are essential. PBL and TBPS approaches are vital and effective methods to improve students' learning abilities and develop their educational identity and professional skills (Savin-Baden, 2014). The students' ability to gain and retain mathematics knowledge is a key factor for success in their studies. The study confirms the importance of student-to-student interaction for a deeper and more meaningful learning process. Future research on combining flipped-classroom approach in order to study the effects of flipping on students' abilities to learn to learn and investigating their improvements in mastering mathematics and their academic performance.

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