Integrating TBL and PBL into College Mathematics Courses

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Introduction

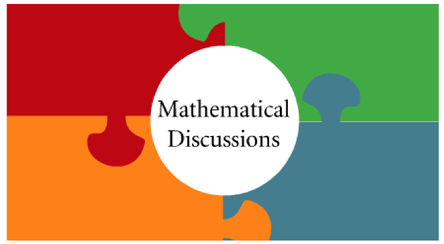
Traditional methods of teaching math in college level often lack team-based learning and problem-based learning approaches.

- **Limited Collaboration**: Traditional teaching in mathematics often focuses on individual learning, leaving little room for team-based activities. This approach misses the benefits of collaborative learning, where students can share different perspectives, learn from one another, and develop teamwork skills.
- **Reduced Problem-Solving Skills**: Without problem-based learning, students may miss opportunities to apply mathematical techniques in real-world problems. This gap can result in students knowing how to follow procedures that have been taught but struggling to think critically or apply their knowledge to solve complex problems.

Team-Based Learning (TBL) in College Math Courses

Approach: Students collaborate on homework and classwork but write their individual solutions in their own words.

- **Pre-discussion:** Students submit a preliminary version of homework.
- **Collaboration:** Students work together to discuss problems, brainstorm solutions, and share key ideas.
- **Final version:** Each student is encouraged to submit a revised version in their own words, promoting ownership and individual understanding.



Benefits of Team-Based Learning

Benefits of TBL in College Mathematics: Team-based learning allows students to discuss concepts with peers, leading to a deeper insights of the material. Explaining ideas to others can enhance one's own understanding.

- **Development of Communication Skills**: Working in teams requires clear communication. Students practice their ability to explain complex mathematical ideas and listen to others' input, skills valuable in both academic and professional settings.
- **Greater Motivation and Engagement**: Team-based learning can be more engaging than traditional lectures. Working with peers often increases motivation to complete assignments and participate in class discussions.
- **Supportive Learning Environment**: Teams can provide support, reducing stress and creating a sense of community. This support can be particularly beneficial in challenging math courses.

Problem-Based Learning (PBL) in College Math Courses

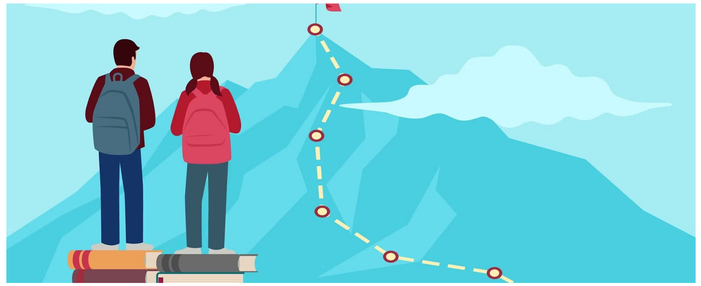
Problem-Based Learning (PBL) is centered around complex, open-ended problems that require some innovative applications of complicated mathematical concepts and theorems. This approach encourages critical thinking, creativity, and problem-solving skills.

Implementation Ideas:

1. **Real-World Problems in lower division courses:** Design assignments or projects that involve real-world applications. In calculus, consider problems involving rates of change, optimization, or area/volume calculations; in linear algebra, focus on applications like applications to data analysis; in probability, propose problems connecting to engineering/science/finance.
2. **Project-Based Learning in upper division courses:** Assign reading projects that require research and deep understadning of mathematical concepts and new theorems. This could involve understanding proofs for complicated theorems, modeling real-world systems, or analyzing large data sets.
3. **Presentation and Reflection:** Have teams present their solutions to the class and reflect on the problem-solving process. This promotes communication skills and deeper understanding of mathematical concepts.

Benefits of Problem-Based Learning

When students work on an open-ended mathematics problem, they are required to try a variety of different techniques and utilize theorems they have learned. The PBL can stimulate students' interests and enhance critical thinking skills.



- **Real-World Applications**: PBL connects abstract mathematical theories to real-world scenarios, demonstrating the practical use of mathematics. This relevance can increase student interest and engagement, showing them the value of mathematics in everyday life and various professions.
- **Development of Research Skills**: PBL encourages students to research, gather information, and use a variety of resources to solve new and complex problems. This process helps them develop research skills that are valuable in their future studies in mathematics as well as other academic and professional settings.
- **Promoting Collaboration and Communication**: PBL often involves teamwork, encouraging students to collaborate, share ideas, and communicate effectively. This collaborative aspect helps build essential soft skills, such as teamwork and interpersonal communication. This is often missing in traditional mathematics classes.

TBL and PBL in Math3200 Mathematical Analysis I

Objective:

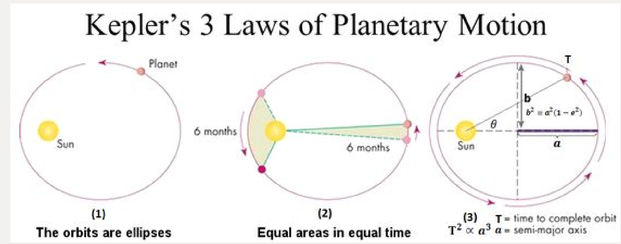
- Developing skills in mathematical prooofs and logic.
- Master rigrous mathematical arguments for theorems in calculus.
- Enhancing understanding concepts and theorems in calculus.

Philosophy:

- Utilizing concret examples and connections with real-life applications.
- Balancing rigrous arguments and intuitive explaination.
- Encouraging questions and discusssions.

Case Study for TBL:

Using calculus to derive Newton's law of universal gravitation from Kepler's laws of planetary motion.



Case Study for PBL:

For each $n \in \mathbb{N}$, denote

$$\gamma_n = 1 + \frac{1}{2} + \cdots + \frac{1}{n} - \ln n.$$

Prove that the limit γ_n exists as $n \to \infty$.

Assessment

Individual Readiness Assurance Test (iRAT): In a calculus course, students take quizzes and answer questions on derivatives, integrals, limits, and other foundational topics.

Team Readiness Assurance Test (tRAT): After the iRAT, students work in teams and work with the instructor on questions together.

Feedbacks from students: The instructor will reach out the students for their ideas and suggestions on how TBL and PBL were integrated in a mathematics course.

References

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