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The Impact of Cooperative Learning on Numerical Methods Course

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Abstract**—**Numerical Methods is a course that can be conducted using workshops and group discussion. This study has been implemented on undergraduate students of level two at the Faculty of Engineering, International Islamic University Malaysia. The Numerical Method course has been delivered to two Sections 1 and 2 with 44 and 22 students in each section, respectively. Systematic steps have been followed to apply the student centered learning approach in teaching Numerical Method course. Initially, the instructor has chosen the topic which was Euler's Method to solve Ordinary Differential Equations (ODE) to be learned. The students were then divided into groups with five members in each group. Initial instructions have been given to the group members to prepare their subtopics before meeting members from other groups to discuss the subtopics in an expert group inside the classroom. For the time assigned for the classroom discussion, the setting of the classroom was rearranged to accommodate the student centered learning approach. Teacher strength was by monitoring the process of learning inside and outside the class. The students have been assessed during the migrating to the expert groups, recording of a video explanation outside the classroom and during the final examination. Euler's Method to solve the ODE was set as part of Question 3(b) in the final exam. It is observed that none of the students from both sections obtained a zero grade in Q3(b), compared to Q3(a) and Q3(c). Also, for Section 1(44 students), 29 students obtained the full mark of 7/7, while only 10 obtained 7/7 for Q3(a) and no students obtained 6/6 for Q3(c). Finally, we can recommend that the Numerical Method course be moved toward more student-centered Learning classrooms where the students will be engaged in group discussion rather than having a teacher one man show.

Keywords**—**Teacher centered learning, student centered learning, mathematic, numerical methods.

I. Introduction

IN Malaysia, and specifically at the university level, Mathematics is taught in a traditional way. Usually, lectures are delivered by lecturers with little interaction with students. Teachers spend much efforts and time on explaining theories, concepts and mathematical problem-solving techniques, with little consideration to practical problems. Students have to do a lot of study, exercises and problem solving, and are rarely given real-world problems. Overall, students are not actively involved in the discussion but passively follow their teacher. At the International Islamic University Malaysia (IIUM), Faculty of Engineering, five Mathematics courses given to students from level 1 to level 3. This study is conducted on Mathematic course, code MTH2313 (Complex Analysis and Numerical Methods) for Mechatronics students in study level 2. Usually for this course, lectures are delivered in the Teacher-centered Learning (TCL) method. Many numerical methods are given as structure processes rather than theorems. For example: interpolation polynomials, iteration methods for solving ODE. Therefore, a constructive way for teaching makes more sense for students. Hence, for such topics, the lectures can be replaced by a workshop where the students will collaborate to construct the methods rather than the teacher showing them how to get the formulae [1]. Therefore, in this paper a Student-Centered Learning (SCL) method has been applied on the Numerical Methods course. There were two Sections 1 and 2 with 44 and 22 Students in each section, respectively. The assessment has taken place in a form of mini project during the course work and one question during the final exam. The rest of the paper explains the details of the study and its impact on the learning process of teaching Numerical Methods using SCL approach.

A. Types of Learning

In 1930s, Americans have used the terms "teacher-centered" and "student-centered" to describe two distinct approaches to instruction [2].

TCL

Teacher-centered refers to the learning condition where the teacher has control over the material that students study and how they study it. Where they study it, when and at what pace they absorb it [3].

SCL

In contrast, student-centered refers to forms of instruction that allow the students to control the learning activities. They should participate more actively in discussions and design their own learning projects. Exploring topics that interest them is highly encouraged and generally contributes to the structure of their own course of study.

B. SCL Methods Applied in Classroom

There are many approaches of teaching that are adequate for student-centered learning. The developers of these approaches have shaped names for their approaches. As a result, there are many named approaches, which includes Active Learning [4], Collaborative Learning [5], Inquiry-based Learning, Cooperative Learning [6], Problem-based Learning, Peer-led Team Learning [7], Team-based Learning [8], Peer Instruction [9], Inquiry Guided Learning, Just-in-

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Time Teaching, Small Group Learning and Project-based Learning

Cooper and Robinson suggested strategies for using informal (students working in small groups for short periods of time) small-groups in large classes [10]. Strategies include: think-pair-share [11], peer instruction [9], Quick-thinks [12], and minute papers [13]. After faculty member are comfortable with informal strategies, they might consider moving to formal strategies described by [14]. Implementation of these methods requires more forward-thinking groundwork which will help the students to accept more of the responsibility for their learning and lead to the development of better learning.

III. SCL to Teach Numerical Methods in IIUM

To perform a SCL mechanism in the class rooms, there are few steps to be followed which are:

A. Prepare the Topic and Assign the Learning Groups

The biggest task during the SCL is the preparation of the material for the student to learn. In this study, Euler's Method to Solve an Ordinary Differential Equation (ODE) has been chosen. The topic has been divided into five subtopics based on number of members in each group. The subtopics were introduction methodology, error, and example solution and error calculation. Each student in a home group has to master the subtopic assigned to him/her prior to the discussion with the other members from other group who have to master the same subtopic.

B. Make Your Classroom Student-Centered

Student-centered classrooms are prepared for teamwork where desks or tables are organized in a way that allows the students to collaborate and learn (rather than listening to lectures) [15]. Therefore, during the day of discussion with other students inside the classroom, students were asked to pre-prepare their materials. Each member in the home group has to discuss his/her topic with other members from other groups. Thus, expert subgroups for each topic including introduction, methodology, etc., have been formed inside the classroom to discuss and clarify any unclear issue through peer learning. During that time, the teacher strength is by giving up absolute control to the students. The teacher becomes a participant and co-learner in discussion, asking questions and perhaps correcting misconceptions, but not telling the learners what they need to know. Surprisingly, students who were not active during the TCL time inside the classroom were leading the discussion during the SCL time.

C. Ways to Make Students Learn Outside the Classroom

After all the members of each subtopic have learned from the expert group and have corrected the misconceptions, they were asked to go back to their home group to teach the other members of the group in a professional way outside the class. This is to ensure the continuity of learning outside the classroom.

III. Assessing the Students

The strength of the teacher during the SCL assessing process is by valuing student engagement over convenience. It is easier for the facilitator to use a common assessment methodology such as bubble test. But these assessments do not reflect exactly the students' progress and cannot show much about the critical thinking involved. Therefore, generating, developing and completing meaningful assessments, is tough work for the teacher and students, but worthy [15].

In this work, assessment has taken place through three stages:

i. During the student's migration to the expert group.
ii. During teaching the members in the home group.
iii. During the Final Semester examination.

A. Assessment during the Student Migration to the Expert Group

The facilitator has directed the students to prepare the subtopics prior to the classroom discussion on their own way after giving them some points of study. While the students were discussing the subtopics with other members, the lecturer was evaluating each member in the expert subgroups. They have been asked questions individually and the rubrics set were very simple such as knowledge, confidence, communication, leadership and engagement with others. The time that facilitator consumed with each subgroup is about 3 minutes.

The main observation is that all the students were involved in discussion with the other members, alert and engaged in the process of learning. The lecturer task was not easy to keep the control inside the classroom in terms of the voice and time. They were given 20 minutes to do the discussion inside the classroom. But moving the table setting and settling in themselves in the expert group takes around 5 minutes.

B. Assessment during Teachings Members in the Home Group

To ensure that the process of teaching the home group continues outside the classroom, the lecturer asked the students in each group to go back to their home group with their verified knowledge and materials and teach his/her home group members. Then, they have to shoot a video in the form of screen snapshots to explain their understanding of each subtopic. That means, every member must explain his part and the video flow must follow the topic content starting from the introduction, and followed by methodology, error calculation and solution. The submission has been presented on a CD and the best two videos chosen by the lecturer have been uploaded for other students to use as a reference in i-Ta'leem (a system used in IIUM as a platform of communication between students and lecturers in terms of materials, quizzes, announcements, etc.).

C. Assessment during the Final Semester Examination

The final examination of the course Numerical Methods has been divided into two sections. Section A contained three compulsory questions (1, 2, and 3), Section B also contains three questions (4, 5, and 6), but here, the students have to

choose two questions to answer. Question 3 was divided into (a, b and c). Question 3(a) and 3(b) are marked a total out of seven, while Question 3(c) has a total mark of six. The Euler's Method to solve ODE was given as (b) sub question in Question 3. Tables I, II and Figs. 1, 2 describe the statistics obtained from Question 3(a), 3(b) and 3(c) for Section 1 and 2. It is clear from Table I that none of the students scored zero for Q3(b) compared to Q3(a) and Q3(c), where eight students and four students from Section 1 and 2 obtained zero marks, respectively.

TABLE I
SECTION 1 (44 STUDENTS) PERFORMANCE IN QUESTION 3

Marks for Q3	Q3(a)	Q3(b)	Q3(c)
0	8	0	4
1	4	0	4
2	5	2	10
3	5	5	3
4	1	4	5
5	7	1	5
6	4	3	13
7	10	29	0
Total	44	44	44

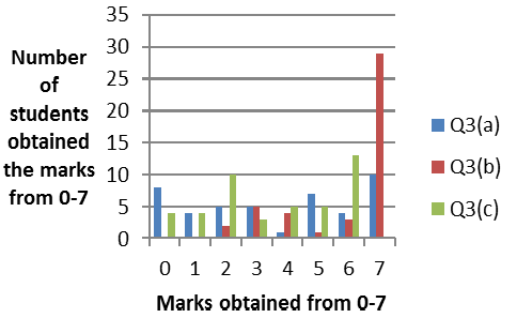

Fig. 1 Section 1 Performance in Question 3 during the Final Exam

IV. FINDINGS: BENEFIT INCREASE WITH SCL IN NUMERICAL METHOD COURSE

The results obtained from the Numerical Method exam conducted using SCL is illustrated in Figs. 1 and 2 for Sections 1 and 2, respectively. In Question 3(b), the students of Section 2 were tested to use Euler's Method to solve ODE, and a total of 29 students out of 44 obtained the full mark of 7/7. Meanwhile for Question 3(a), only 10 students out of 44 obtained 7/7. In Q3(c), 13 students obtained the full mark 6/6.

Meanwhile, students of Section 1 has obtained slightly different results where for Q3(b), a total of 10 students out of 23 obtained 7/7. As well, a total of 10 students out of 23 obtained 7/7 and five students out of 23 obtained a 6/6 for Q3(c). On the other hand, for the students of Section 2, it has been noticed that none of the students has obtained a zero mark for Q3(b), while a total of five students in Q3(a) and four students in Q3(c) obtained zero mark. This confirms that the SCL method ensures that the students will have the ability to perceive the minimum knowledge without failure.

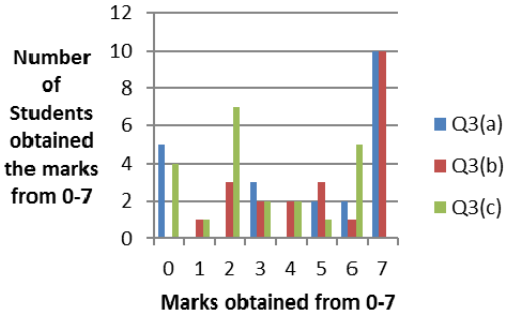

Fig. 2 Section 2 Performance in Question 3 during the Final Exam

TABLE II
SECTION 2 (22 STUDENTS) PERFORMANCE IN QUESTION 3

Marks for Q3	Q3(a)	Q3(b)	Q3(c)
0	5	0	4
1	0	1	1
2	0	3	7
3	3	2	2
4	0	2	2
5	2	3	1
6	2	1	5
7	10	10	0
Total	22	22	22

V. CONCLUSION

Nowadays, students in the classroom are no longer engaged with traditional methods of teaching. It is important for the instructor to engage with students in order to discuss (and, whenever possible, research) how they perceive their teaching/learning environments. In this work, the SCL method has been applied in teaching Numerical Methods to students of Level 2. Discussion has taken place inside the expert group and home group inside and outside the classroom, respectively. After assessment, it has been obvious that group work enhances student understanding. Students learn from each other and benefit from the group discussion. Group work provides an opportunity for students to clarify and enhance their understanding of concepts through discussion with peers. In conclusion, many, but not all, students have recognized the value to their personal development of group work and of being assessed as a member of a group, even if they did not distinguish how knowledgeable they become in Euler's Method to solve ODE compared to other Numerical Methods Topics.

REFERENCES

[1] Weiwei Wang, Student-centred teaching of *Numerical Analysis*, The China's paper, Xidian University.
[2] Hidden curriculum (2014, August 26). In S. Abbott (Ed.), The glossary of education reform. Retrieved from http://edglossary.org/hidden-curriculum
[3] What is a Student Centered Learning? Educational Initiative Centre, University of Westminster (2004).
[4] Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom.* Washington, DC: George Washington University Press.
[5] Bruffee, K. A. (1984). Collaborative Learning and the "Conversation of Mankind". *College English, 46*(7), 635-652.

[6] Johnson, D. W., Johnson, R. T., & Smith, K. A. (1991). *Active Learning: Cooperation in the College Classroom*. Edina, MN: Interaction Book Company.
[7] L. T., Roth, V., & Kampmeier, J. A. (2001). Implementation of a peer-led team learning instructional approach in an undergraduate organic chemistry course. *Journal of Research in Science Teaching, 39*(7).
[8] Michaelson, L. K., Knight, A. B., & Fink, L. D. (2004). *Team-Based Learning: A Transformative Use of Small Groups in College Teaching*. Sterling, VA: Stylus Publishing.
[9] Mazur, E. (1997). *Peer Instruction: A User's Manual*. Englewood Cliffs, NJ: Prentice Hall.
[10] MacGregor, J., Cooper, J. L., Smith, K. A., & Robinson, P. (2000). Strategies for Energizing Large Classes: From Small Groups to Learning Communities. The Jossey-Bass Higher and Adult Education Series. *New Directions for Teaching and Learning*.
[11] Lyman, F. (1987). Think-pair-share: An expanding teaching technique. *MAA-CIE Cooperative News*, *1*(1), 1-2.
[12] Johnston, S., & Cooper, J. (1997). Quick-thinks: Active-thinking tasks in lecture classes and televised instruction. *Cooperative Learning and College Teaching*, *8*(1), 2-7.
[13] Angelo, T. A., & Cross, K. P. (1993). Minute paper. *Classroom assessment techniques: A handbook for college teachers*,, 148-153.
[14] Shu-Hui, H. C., & Smith, R. A. (2008). Effectiveness of interaction in a learner- centered paradigm distance education class based on student satisfaction. *Journal of Research on Technology in Education*, *40*(4), 407-426.
[15] 5 Ways to Make Your Classroom Student-Centered, Posted by Marcia Powell on Tuesday, 12/24/2013, http://www.teachingquality.org/content/5-ways-make-your-classroom-student-centered