Improving the Qualities of Teaching Ordinary Differential Equations in Local University

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Abstract: Ordinary differential equations (ODEs) is one of the compulsory courses for students of mathematics. In this paper, analyzed the status of ODEs teaching of our university, and proposed to active learning strategies in the ODEs teaching, which can enhance students study motivation, foster their self-esteem and develop their interpersonal skills. Furthermore, these methods are expected to improve the quality of ODEs teaching.
Keywords: Ordinary differential equations; Teaching methods; Assessment.

BACKGROUND

Ordinary differential equations (ODEs) arise in many contexts of mathematics and science, (social as well as natural). Mathematical descriptions of change use differentials and derivatives. Various differentials, derivatives, and functions become related to each other via equations, and thus a differential equation is a result that describes dynamically changing phenomena, evolution, and variation. Often, quantities are defined as the rate of change of other quantities (for example, derivatives of displacement with respect to time), or gradients of quantities, which is how they enter differential equations. Specific mathematical fields include geometry and analytical mechanics. Scientific fields include much of physics and astronomy (celestial mechanics), meteorology (weather modelling), chemistry (reaction rates), biology (infectious diseases, genetic variation), ecology and population modelling (population competition), economics (stock trends, interest rates and the market equilibrium price changes)[1].

Ordinary differential equations is one of the compulsory courses for second year students in the school of mathematics at my University in the second semester. The content of the teaching includes: first order differential equations, higher order differential equations, systems of linear equations, etc. In my university, ODEs course is usually taught in the traditional way. The current teaching approach is teacher-centered. Teachers carefully select texts, prepare and present lectures using old fashioned delivery technologies. Students are seen by their teachers as empty vessels to be efficiently filled with scientific knowledge. Students are asked to hand in their homework once a week. The primary ways students' learn ODEs is by attending lectures, taking notes, reading textbooks, doing homework and asking questions. Good students have time to read some reference books and do more difficult problems. Many students are so busy struggling with their homework that they only look up related content in the textbook when they encounter difficulties with their homework. So many students still have no idea about how to use ODEs to solve current real-life problems. There are problems that we face : 1) Each semester 30% of the students fail; 2) Quite a number of students are learning at a surface level. They are ready to accept passively rather than enquire actively. They do not gain a deep understanding of key concepts and theories and some of them forget what they have learned soon after the final examination. 3) Some students feel ODEs is too abstract and difficult to learn, and quickly lose interest.

Consequently they tend to 'learn' science by memorizing and understanding the body of facts in a discipline and reinforce their knowledge with many examples, exercises and tests, and then apply these facts to a task. This approach has served well in the past but requires that students have an interest in ODEs processes to begin with; being able to just remember those important facts and concepts that are probably not too useful for them. Deep quality learning should be student-centred, cooperative in nature rather than competitive, should emphasize critical thinking skills, problem based learning, inquiry-based study and be

personally challenging. Now, it is time that we make changes. And something must be changed; otherwise we will inevitably lose our students someday.

IMPROVEMENTS OF TEACHING METHODS
Collaborative Learning Group
A collaborative learning group is a successful way to learn different material for different classes[2]. It is where you assign students in groups of 4-6 people and they are given an assignment or task to work on together. This assignment could be either to answer a question to present to the entire class or a project. Make sure that the students in the group choose a leader and a note-taker to keep them on track with the process. This is a good example of active learning because it causes the students to review the work that is being required at an earlier time to participate.

According to the actual situation, more tasks can be given if necessary. The group work will create an active and interactive learning environment for students. In their own groups, students will work with each other, share their ideas, discuss, debate and convince each other. Discussions is typically more effective in collaborative learning group settings, it helps students explore a diversity of perspectives, it increases intellectual agility, it shows respect for students' voices and experiences. In this group work, students will be more fully engaged in the learning process. For example, separable differential equation that can be written in the form $y' = f(x)g(y)$ .If $g(y) \neq 0$, we can obtain $dy/g(y) = f(x)dx$, then it yields

$$\int \frac{dy}{g(y)} = \int f(x)dx .$$

If $g(y_0) = 0$, then $y(x) = y_0$ is solution. After I introduced this equation, I asked the students to think about the solution of the differential equation with separable variables. Some group of my students sum up as follow table 1,

Table 1: Separable equations

Separable equations		
Differential equation	Solution method	General solution
Separable in x (or y) $dy = f(x)dx$ ($dx = g(y)dy$)	Direct integration	$y = \int f(x)dx$ ($x = \int g(y)dy$)
Separable in x and y $g(y)dy + f(x)dx = 0$	Integrate throughout	$\int g(y)dy + \int f(x)dx = c$ Where c is a constant.
Separable in x and y $f_1(x)g_1(y)dx + f_2(x)g_2(y)dy = 0$	Divide by $f_2(x)g_1(y)$	$\int \frac{g_2(y)}{g_1(y)}dy + \int \frac{f_1(x)}{f_2(x)}dx = c$ Where c is a constant.

Classroom summary
The summary is an important part of classroom teaching, which plays an important role in the process of teaching. Classroom summary can help students clarify the appropriate knowledge structure, grasp the internal relations, to promote the students to construct their own knowledge system. Concept mapping, which is derived from a constructivist approach to teaching and learning, is a technique used for representing knowledge graphically, where the knowledge graphs represent related concepts that are interconnected. Usually, a concept map consists of nodes and links. Some of the processes related to the concept of solution of an ODES are shown in the following diagram. Also, the concept of the direction field associated with an ODES involves two related tasks that we can differentiate from a cognitive point of view: its representation and its interpretation.
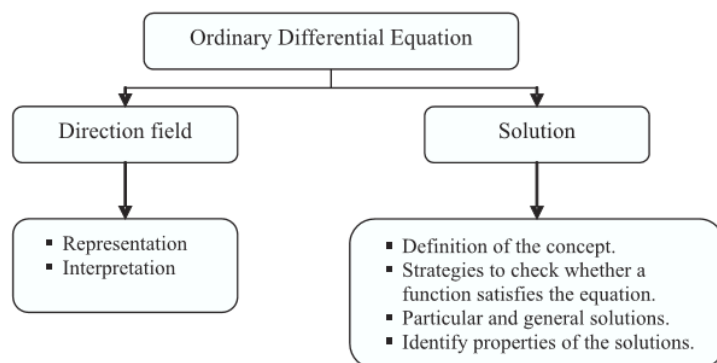
Relevant concepts and processes associated with the study of ODEs[3]

Mathematical modelling

Problem-solving activities are essential to develop mathematical proficiency and involve the use of different representations in order to explore connections among mathematical relations. Suitable representation of mathematical objects provides a clearer vision of the intrinsic properties of these objects, which will lead students to develop a deep understanding of the concepts and to their use in problem solving situations.

Mathematical modelling plays a very important role in the history of ODEs. The most successful example is the mathematical models of Newton's laws in mechanics that changed the history of science. So letting students realize the importance of modelling, and encouraging them to find some basic skills about modelling by themselves, should be considered in the course ODEs. The mathematical modelling approach to problem as follow steps[4]:
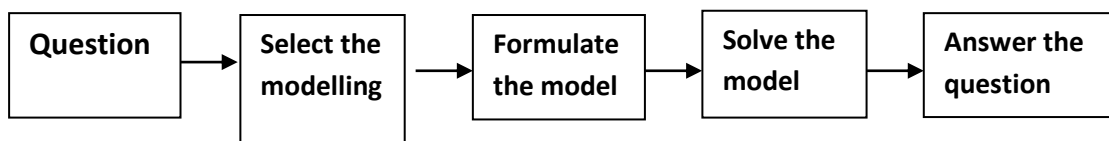
Matlab is a very powerful technical computing program. It integrates computation, visualization, and programming in an easy-to-use environment. So it is a convenient aid in the teaching and learning of ODEs. We can use Matlab to draw the picture of solution curve and orientation field about ODEs, to depict the geometric meaning of odd solution about ODEs. Students can use Matlab as a tool for exploring with various concepts in ODEs. The use of MATLAB also allows some simple mathematical modeling to be included.

Improve Assessment

As we know, assessment has a great impact on how the students learn. In the past, the final closed-book examination at the end of each semester contributed 80% to the assessment. Some students study very hard in the last few weeks for the examination. Some of students successfully pass the examination, but they forget most of the knowledge when they have completed the examination. This assessment does not evaluate students properly. So we should modify the traditional assessment as following Table 2

Table 2 Original and new assessment of numerical compare

Original assessment	New assessment
Homework 20%	Homework 10%
	student's ordinary performance 20%
	Group report and group presentation 10%
Final examination 80%	Final examination 60%

Acknowledgment

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