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***Essay** (Open Access)*

THE TEACHING OF SCIENCE TO UNDERGRADUATE SCIENCE MAJORS

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INTRODUCTION

There is great controversy in the teaching of science to undergraduate science majors. There are three major areas of controversy, namely, (a) Lecture time, (b) Teaching Style-Lecturing or Discussion, and (c) Laboratory Teaching-hands on or not hands on. Additionally, there are problems associated with the use of technology in teaching methods. This article outlines the problems of teaching science in mo0dern times, the use and abuse of technology in the classroom-Lecture and Laboratory. It also explains the best strategy for teaching science to science majors and minors.

CONTROVERSIES AND SOLUTIONS

Lecturing should be the first option in teaching theory rather than discussion. Lecturing can be 3 hour sessions or 1 hour sessions. In 1 hour sessions Instructors/Professors should aim to achieve 45-50 minutes of straight lecturing. Questions asked by students during the lectures should be answered immediately if the answer is short or referred to the tutorial session if the answer requires a lengthy explanation. For 3 hour lecture sessions the aim is to have two and a half hours of lecture time with a 10 minute break after every hour. For 3 hour sessions all questions from students could be answered immediately. There should be mandatory tutorial 1 hour sessions for each science course. The tutorials should be in the care of the instructor/professor for the course. The tutorial class size should be 10-15 students. Discussions are the better methods for tutorials since the explanations of the students' problems are normally associated with lecture topics. The tutorials should be time tabled in a similar manner to lectures and laboratory sessions. Tutorials run by the instructor/professor of the course gives students a better understanding as he/she will from the lectures know which sections of the lecture needs further discussion and analysis, in addition to addressing the students' problems. The more contact time students have with their instructors/professors the more comfortable they become in approaching and questioning their professors/instructors. The maximum class size for science should be 45 students per class. This is important because most laboratories cannot accommodate 45 students and different laboratory sessions have to be used. There should be no university administered tutoring sessions that involves tutors other than the course professor or instructor.
The controversy of laboratory teaching involves, hands on with full laboratory experiments, demonstrations-with or without laboratory kits, exercise theory labs, computer simulations, television simulations. All laboratory teaching for undergraduate science students should involve a lab report. Lab times should be 3-6 hours. Some labs may be of a shorter duration and some of a longer duration and may require 2 lab sessions to complete. This accommodation for lab time should be done by the professor/lecturer/instructor for the course. Lab manuals containing the experiments for the course should be prepared before the beginning of the course. Each student should write an individual lab report regardless to whether they perform the experiments in groups or individually.
All lab reports should have the following:

1. Title
2. Purpose of the lab
3. Method
4. Results

5. Questions (Optional-but must help with the discussion and conclusion)
6. Discussion and conclusion

The Rubric for the Lab Report should be addressed as following.

(a) Participation……. 30%
(b) Results……...30%
(c) Discussion and Conclusion……30%
(d) Neatness…….10%

100%

NB### No student should ever fail a lab course if correctly administered. The above explains the hands on situation.

In Demonstrations without kits one individual performs the procedure while explaining theory and all others (students) watching and sometimes asking questions. The demonstration is usually done by the instructor or the lab technician. It is normally a 2 hour session-1 hour to complete the demonstration and 1 hour for questioning. There is no write up from the students.

Demonstrations with kits involve simple preparations and a quick conclusion /end of experiment to give the desired results. The demonstration is normally done by the instructor or lab technician and analyses are normally done the same day. There is normally a theory talk with no writing. Questioning, discussion, and explanations are normally based on theory as outline in the kit notes. There is no student write up or lab report. The time limit is normally 1-2hours.

Exercise theory labs involves questions in a book. Students answer simple questions similar to what would be attained from most common labs. They read a summary at the beginning and then answer questions pertaining to the summary-similar to an open book exercise. Some institutions do not sell or pass out Exercise Theory Lab. Books. They are used in the lab only. Students work in groups or individually.

In computer simulations there are pictorials and explanations, all with written steps and guidelines. Sometimes there is questioning from step to step. There is normally one student per computer. There are simulations in all disciplines of science experimental work. Even medicine has simulations in surgery. There is normally no demonstrator, instructor or scientifically aware personnel and very often the computer technician is in charge. The time period is normally 2 hours and there is no write but sometimes questions are answered on the computer.

In television simulations there are pictorials, and explanations, all with written steps and guidelines. There is questioning from step to step and explanations afterwards. The entire class watch the television. Some lectures and professors leave the supervision to the lab technician or IT crew. There is no written lab report, but sometimes questions are answered at the end of the television program and submitted as lab work, corrected and posted on transcripts as course labs. The time line for television simulations sessions is normally one and a half to two hours.

There is also a controversy in the use of technology in the teaching of science to science majors. It was well intentioned when in some institutions for each science lab to be equipped with an internet and television set up as well as computers where students could perform research for their necessary Laboratory Report-Discussions and Conclusions. However, the dual set up between the computerize T.V. screen and computers have become a widespread abuse of the technology. There is the use of the dual computerized TV screen in the presentation of topics in the syllabus that some professors or instructors do not feel competent in teaching. In this regard a readily available program is purchased and shown to students and the professor/instructor only occupies a sitting (listening and watching) position. The inclusion of the DVD with text books as teaching material is another example of the abuse of technology in teaching. The text book and its inclusive DVD is the student's reference and should not be extensively used by professors/instructors/lecturers for teaching. More than one text book should be used to prepare lecture notes for the introductory or advance students, and in the case of advance students research papers/articles should be used. The book chapters, content and titles give the professor/instructor the correct content for

students at different levels. It should be noted that in science different books are at different levels even though they might cover the same topic/title.

Some instructors/lecturers/ professors have all their lecture notes on computer power point in step wise words or phrases for discussion. This teaching method varies from lecturing to discussion. This type of teaching is best suited for tutorials. Students in this format do not take very good notes because they are continually looking at the screen and do not listen to the content of the lecture. Every human being have 5 senses of learning namely, sight, hearing, taste, touch and smell. Sight often moves you away from hearing especially when you start thinking about what you are seeing. Traditionally, evolved through dictation. Hence, students listen and write and look up when there is a pause, or they have a question about what they are hearing. In science touch, sight, hearing and smell are most important, but in the medical profession all five senses are needed particularly in patient examination. Power point presentations in science are suited to students' presentations of research and research projects. They are also good for conferences.

Far too often the student's reference is used in power point of the lecture's presentation and other references mentioned very slightly. Book references are mainly for upper level students- first and second years, whereas in the advance years-3rd and 4th years research papers should be included. Every student in the advance years should be given a comprehensive review article covering the lecture topics of the course.

Teaching Methods-Theory

All theory teaching in science should be done by the lecture method while writing on the board. Diagrams and illustrations should also done on the board. It is optional, the teaching time –one hour sessions or three hour sessions depending on the availability of the professor and time tabling. All tutorials should be one hour maximum and contains 10-15 students. Hence it may be necessary to have more than one tutorial session per week. To aid in teaching and create students interests in the topics it is desired that all students in science should write a research paper or project. Students can work in groups-a maximum of three or individually. All students have to prepare and present a power point presentation of their research paper or project.

For 1st and 2nd year students the research paper should be theoretical and involve book references and internet references. A minimum of 10 references should be used. For advance students -3rd and 4th years- there can either be a research paper-Theoretical or a laboratory experiment with a lab Report type write up and a power point presentation to present in class. For such students a minimum of 15 references should be used. Advance students can work individually or in groups no greater than 3 individuals. Journal references, books, and internet references should all be used. Every student should have for submission a research paper, or project lab report, and a power point presentation. The project lab report should be graded according to the normal lab report mentioned above and the theoretical research paper graded out of 100%. The rubric for the power point presentation is as followed.

Power Point Presentation
Knowledge and content…….30%
Presentation of Power point……30%
Discussion and Conclusion…….30%
References…….10%
Total……100%

All science students at the undergraduate level must present a research paper or project along with the power point except Physics and Chemistry students. Research projects based on experimentation should be allowed to scholarly students who might go to a higher level in science.

Teaching Methods- Laboratory

All laboratory exercises for science students should be hands on with students participating either individually or in groups-a maximum 3. Students should be trained to prepare laboratory materials, perform experiments, account for their results and explain their results regardless of theoretical differences. This training means that such students should have learned techniques that would afford the opportunity to work

in industry without further training, be competent school teachers in science, and be familiar of the experimental lives of career research. This hands on approach gives Doctors of Medicine the tactile skills required for examinations and surgery.

Demonstrations, Computer Simulations and Television simulations are very inadequate methods for teaching labs to science students. Visuals and Pictorials with explanations do not often discuss or show the problems that can occur while physically performing the experiments as shown in the simulations and demonstrations even with kits. These methods do not afford the students the opportunity to connect strong theory with the physical experiment. Demonstrations, computer and television simulations are often done with experiments and procedures that are proven to give the correct theory applications. This is not so with the hands on technique because some laboratory exercises require techniques adequate for the work place and theoretical applications may vary. In the laboratory situation that involves hands the experimental technique of the student can cause results to vary. Demonstrations, computer simulations, and television simulations do not train science to write scientific reports based on experiments. Demonstrations, computer simulations and television simulations can be considered aspects of theoretical teaching because there is no physical laboratory involvement. Demonstrations, computer simulations and television simulations are obstacles that prevent science students from generally reaching higher levels in science.

Long Distance Teaching

The theory of teaching through the long distance method is done through discussions aided with power point presentations with or without a live instructor. This methods used are computer attachments-talk and see- and teleconferencing. The laboratory teaching of science through the long distant phenomenon involves computer simulations and teleconference both with pictorials and explanations and very seldom a write up is done by the students-even questions are sometimes questions are not asked. This method of teaching science is faulty, there is no direct lecturing, no time for tutorials or prompt explanations because the connection time is usually on hour. Students of science by this method do most of their work individually and one cannot be 100% sure that they are producing the assignments according to their own ability and not others. As mentioned earlier computer simulations are inadequacies. There is no hands on approach and students are unaware of the entire contents of the science laboratory. With the advance technology of teleconferencing live lectures can be taped/recorded or performed such that the professor/ lecture is shown only. This method is adequate for advance science students who after watching can go and perform their own hands on experimental research later. Teleconferencing from a laboratory perspective is weak, there is no hands on and students are unaware or not afforded a true laboratory experience. Again, this type of teaching hinder most students from advancing to higher levels in science.

Assessments

There should be two examinations along with Research Paper or Research Project grade and laboratory reports assessments for science courses other than physics and chemistry. One examination should be mid-term and any format can be used, that is, multiple choice, short answers or essays. The final examination in all science courses including physics and chemistry should include combinations of two examination papers outlined as followed.

PAPER 1

Multiple choice-Part A
Short answers-Part B

Paper 2

Essays- Part C

Paper 3

Laboratory exercise-Part D (optional)

For students of chemistry and physics though opted out of research projects they must have hands on laboratory exercises in the appropriate laboratories with instrumentation where possible to augment their

theory teaching. The other assessments should be as outlined for science in the mid-term and final exams for all science students.

CONCLUSION

The teaching of science in the laboratory using the hands on technique is an expensive ordeal and some institutions (universities and colleges) charges lab fees to purchase glass ware and minor chemicals. This in the long run is cheaper than purchasing kits which have to be purchased yearly, whereas with the purchasing of regular laboratory materials and preparations a time comes where there is no need to purchase glassware and some minor chemicals because they will be left overs. Hence annually it should become cheaper to use hands on techniques rather than kits.

The controversies in the teaching of science would all be alleviated if minor colleges and universities would refrain from teaching it. Some of these institutions lack proper laboratories and very often do not possess laboratory materials, equipment or instruments. The teaching of science to undergraduate science majors and minors should involve straight live lecturing of all theoretical concepts. The lecture times are optional and can be either 1 hr. or 3 hrs. For 1st and 2nd year students, from an experience perspective the 1 hr. sessions are better. Where the option of 1 hr. or 3 hrs. Sessions are less of a burden is in the teaching of the 3rd and 4th year students.

The topics for the research project (experimentation) should be given within the first two weeks of the class to be finished before the final exams. All lecturing should be completed when the presentations begin. Rubrics as outlined above should be used. Long distant teaching is not a good option for science because the discussion method is not lecturing, tutorials are not normally used that would help students with their understanding of pertinent topics.

Computer simulations, television simulations, teleconferences and laboratory exercise books are inadequate methods because the laboratory exercise books are an extension of theory teaching, computer and television simulations cannot substitute for practical laboratory experience that would provide the tactile and textile techniques required for surgery in regard to medical students, taking care of glass ware, laboratory equipment, and instrumentation techniques afforded other science students. The knowledge of measurements, changes, dissections and other scientific phenomena that could be gained through hands on are lacking in such simulations. Additionally, the training of the correct methodology in reporting and writing scientific information based on experiments/research is lacking. Teleconferencing can afford the ability to teach long distance showing live individuals. However, it is not an adequate tool for laboratory experiments. Visualizing personnel performing experiments does not mean that such individuals can perform the experimental techniques since most scientific techniques require practice to become proficient. In reality all science majors and minors should be lectured to, and this means that dictation would be taught once more in elementary and early secondary schools so that students can become more proficient in note taking. Laboratory experiments are a must, through physical contact in regular labs, assessments as outlined above, including the relevant research papers and projects. Technology should normally be used to aid in the lecturing (teaching) and not as the teaching method alone, that is, one should not teach with technology alone.

Computers in the lab can be used by students to research while waiting on experimental data as well as research pertinent information for their lab report and typing. The internet connected to the television can be used to assess mellow listening music of the students' choice while waiting for experimental results and performing some experimental procedures. This music give a more relaxing situation to the students and reduces tension and anxiety.