# CONTEMPORARY DATABASE TOPICS: LEARNING BY TEACHING

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## ABSTRACT

*Passive learning is generally believed to be ineffectual in that it leads to a generally impoverished student experience manifested by poor attendance, engagement and motivation alike. A shift towards a more pro-active learning experience was therefore the main motivator for the proposed method outlined in this paper. The method adopted was applied to a single module for a cohort of postgraduate, mainly international students. In our method, each student is charged with delivering a specialist database topic as part of an allocated group. They self-organise their group into two sub-groups for lecture and tutorial delivery respectively. Staff support the process by delivering the teaching in the first half of the module. The second, student-led phase is staff-supported using preparatory meetings to discuss content and presentation issues prior to delivery. Feedback overall indicates that the method is effective, particularly in confidence building. We believe that the latter more than compensates for the one or two concerns raised about the quality of information being received. We conclude by discussing a number of changes based on two years' experience and student feedback.*

**Keywords**

*Teaching paradigms, active learning, assessment, international students.*

## 1. INTRODUCTION

The main aim of the module is to allow students to gain in-depth knowledge of one specific application area of Contemporary Database Topics. The main assessment for the module consists of a literature review in a specific topic selected by the student and agreed with the tutors, e.g. "Enhancing the Efficiency of Location Dependent Queries in Mobile Databases". This type of assessment has been used successfully for many years, fulfilling the purpose of introducing students to postgraduate research methods in preparation for their masters project. However, most students used a large proportion of their allowed word count to provide too general an introduction, e.g. of Geographic Information Systems. Students have to learn about the more general subject area as part of the preparation of the literature review. Asking them to teach what they have learnt provides a suitable outlet for their achievement while clarifying the role of the literature review in demonstrating depth of knowledge.

The concept of students as teachers is not new. [4] lists five possible roles:

i) Students teaching regular lessons in their classes;

ii) Students serving as teaching assistants;

iii) Students partnering with teachers or peers to deliver curriculum;

iv) Students teaching students in lower grade levels;

v) Students teaching adults and facilitating professional development.

Published literature (e.g. [2]) generally relates to Peer Tutoring (i.e. iv, where more experienced students mentor and support less experienced ones) or to Supplemental Instruction (i.e. ii, where students act as classroom assistants helping others in their class understand material introduced by the teacher or lecturer). By contrast, our approach combines (i), (iii) and (v) and requires students not only to deliver the teaching itself, but also to select appropriate materials and teaching approaches within a given framework.

The module typically has around 60 students from all over the world, with approximately 40% from China, 30% from the Indian Subcontinent, 20% from Poland and Eastern Europe, and the remaining 10% from the rest of the world, including one or two UK students. One of the main issues arising from this mix is that many students

are unfamiliar with UK Higher Education teaching styles. Chinese students in particular tend to be very passive in class and shy away from contributing in tutorials. Taking the role of teachers for a week has helped combat passive behaviour in class, an effect also reported by [3]. One reason for this is the confidence-building effect, which will also benefit these students once they graduate, with typical jobs requiring professional presentations.

In a larger educational context, learning through teaching focuses on the higher levels of the cognitive domain in Bloom's taxonomy (See Fig. 1a): In order to prepare and deliver a lecture and set of seminars/tutorials, students need to apply their knowledge and understanding of the subject area to create suitable teaching materials, having evaluated a number of textbooks and other sources and analysed the appropriateness for the context of this module and the background of its students.

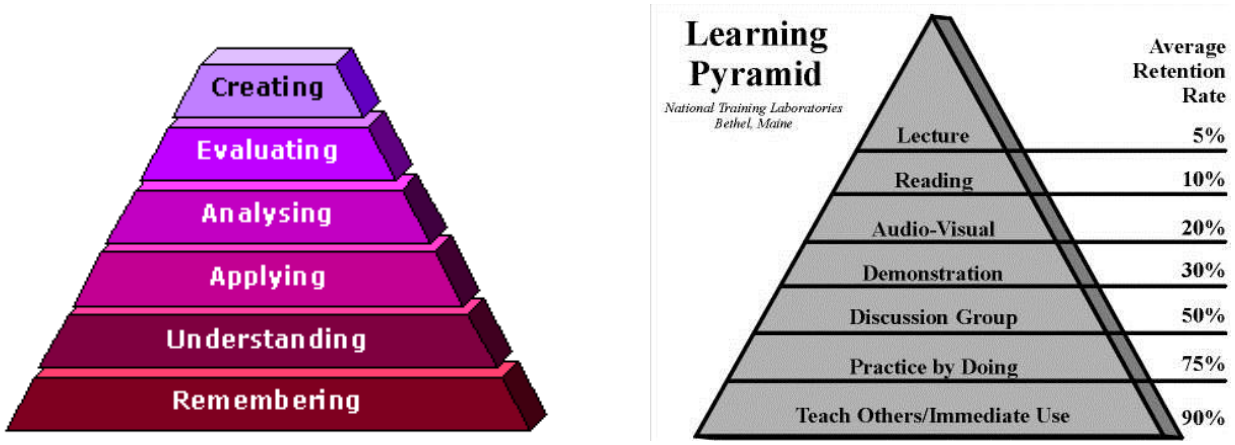


**Fig. 1. (a) Bloom's Taxonomy (modified by Anderson and Krathwohl (2001), quoted in [1]). (b) The Learning Pyramid (attributed to National Training Laboratories, Bethel, Maine).**

Secondly, "Learning by Doing" is known to be an effective learning method (see e.g. [5], [6]). Asking students to teach others allows us to introduce this principle into a module that focuses on theory and intentionally does not include practical classes. The Learning Pyramid shown in Fig.1b underpins this approach; it shows the effectiveness in promoting student retention of the material taught for a range of learning activities. Teaching others is shown to have the highest retention rate.

The following sections outline the structure and organisation of the module, a discussion of group teaching delivery, an overall strategy of assessment and dissemination before reporting on the perspectives of students and staff.

## 2. MODULE ORGANISATION

The module is at post-graduate level, delivered in semester 2 and forms part of the MSc Information Technology and the MSc Bioinformatics. Titled "Contemporary Database Topics", the module adopts a research focus in contrast to its precursor in semester 1, which delivers the more conceptual and technical aspects of standard relational modelling and SQL respectively. Delivery is scheduled over a twelve week period using a 1 hour lecture and 1 hour tutorial per student per week. Staff members teach through the first half of the semester, leading the teaching and learning strategy by example, and allowing time for the allocation of students to their teaching groups and for preparation of the student-led topics in the second half of the semester. The full delivery schedule is outlined in Fig. 2.

Allocation of students into groups begins in the first week with a lecture introducing the five specialist teaching topics. This is followed up in the second week by a topic bidding process conducted in a laboratory. Each student is given the task of pitching for a preferred topic (with two backup choices). A librarian contributes to this session to give a brief overview of literature searching methods such as ebrary and online journals and to support the initial search. The outcome of the pitch is to present a title and give a brief description of the priority topic complete with key supporting references. The pitches are used as a mechanism to allocate students in equal numbers to each teaching group. For example, where a topic is over-subscribed, some students may be allocated their second choice; the deciding factor being the quality of the pitch.

After allocation, students are responsible for self-organisation into lecturing and tutorial sub-groups. As each group of 10-12 students needs to cover one lecture and four repeated tutorials, lectures are invariably delivered by 3 students and tutorials in pairs.

| *Week* | *Preliminary meeting* | *Lecture* | *Tutorial/lab* |
|---|---|---|---|
| **1** | Introduction to module methods | Advanced topics overview | |
| **2** | | Concurrency | 2 hour lab: finding your topic area and specialist topic |
| **3** | | Distributed Databases | Concurrency |
| **4** | | Physical Database Design | Distributed Databases |
| **5** | | XML | Physical Database Design |
| **6** | **Data Mining** | XML | XML |
| **7** | **Text and Web Mining** | **Data Mining** | XML |
| **8** | **GIS** | **Text and Web Mining** | **Data Mining** |
| **9** | **Biometrics** | **GIS** | **Text and Web Mining** |
| **10** | **Bio Databases** | **Biometrics** | **GIS** |
| **11** | | **Bio Databases** | **Biometrics** |
| **12** | | | **Bio Databases** |

**Fig. 2: The module schedule. Shaded areas indicate the student-led programme.**

## 3. GROUP DELIVERY

Lecture slides are submitted to the module leaders shortly before the day of delivery for uploading to the WebCT VLE. During the lecture a printed tutorial sheet is issued to all students in attendance; they are required to prepare answers for the tutorial in the following week. Each lecture is recorded as a podcast, which is uploaded to WebCT for future support. One noticeable fact is that the number of slides presented tends to be much higher than the module deliverers would expect for a 50 minute lecture, ranging from 39-64 with an average of 50. Despite this, no group ran out of time and seemed relatively well prepared to the time constraint.

For tutorials most students deliver in pairs. Other members of the same teaching group occasionally attended the tutorials of their group to either support or learn from the experience in advance of their own delivery. It was noted that some quieter students came out of their shell more at the point of having to be heard. While the structure of the tutorial was the same for each pair, the style of delivery often exhibited strong contrasts. For example, some pairs showed good team teaching in that they listened to and supported each other, while others talked across each other or lacked agreed roles. Most pairings employed group work in the tutorial, resulting in much greater engagement from all students and avoiding both passive behaviour due to shyness and dominance by the most confident students.

To support the student-led teaching, a preparatory meeting with the module tutors is held a week before delivery (see Fig. 2). Discussion is centred around the draft lecture slides and tutorial questions. An additional opportunity to practice delivery and presentation is offered through a one hour workshop with the University's Student Academic Support team. This gives the students the chance to practice with an audience who are "lay" in the subject area but expert in general presentation skills. Attendance at the preparatory meeting is compulsory and contributes to the individual teaching grade (see below).

## 4. ASSESSMENT AND FEEDBACK

Students are assessed on this module as both a teacher and a learner. Overall, the assessment constitutes 50% of the module grade. This 50% is split threefold into a group teaching grade, an individual teaching grade and a learning grade in the ratio 3:2:5. Fig. 3 below shows the assessment criteria for each category.

| **Group Teaching** | **Individual Teaching** | **Individual Learning** |
|---|---|---|
| Selection of materials<br>Suitable images/diagrams<br>Slide content<br>Appropriate pitch<br>Timing and engagement<br>Questions/interactivity<br>Directed reading | Participation in teaching group and preparatory meeting.<br>Level of subject knowledge:<br>*Either:* Lecture fluency, explanations, interactivity, engaging and addressing audience.<br>*Or:* Tutorial facilitation, interactivity, group discussion, responding to questions | Attendance<br>Preparation<br>Contribution<br>Depth of knowledge<br>Interactivity |

**Fig. 3 : Assessment Criteria**

All assessment is made in real-time using the criteria above. The group is judged according to the materials they produce and their organisation of the group delivery, including how they have acted on advice from the preparatory meeting. Each member of the group is assessed individually on their teaching according to the depth of knowledge demonstrated and the delivery style as expressed in the attributes listed in the middle column of Fig. 3.

Assessment for the learning aspect of the module is made on a continuous basis within the tutorials. The essential criteria are that students attend, show evidence of preparation, knowledge and contribute to discussions in each tutorial. Tick sheets are used to keep detailed notes of each student's performance in each class.

When a teaching group has finished their delivery, the tutors meet to discuss the teaching grades for that group. Each tutor also assesses the students' individual learning outcome for that week. A database is used to record feedback and grades for each student and each group (Fig. 4). Email merge is used to disseminate the teaching feedback to each student immediately after completion of their group's teaching, creating a very rapid turn-around mechanism.

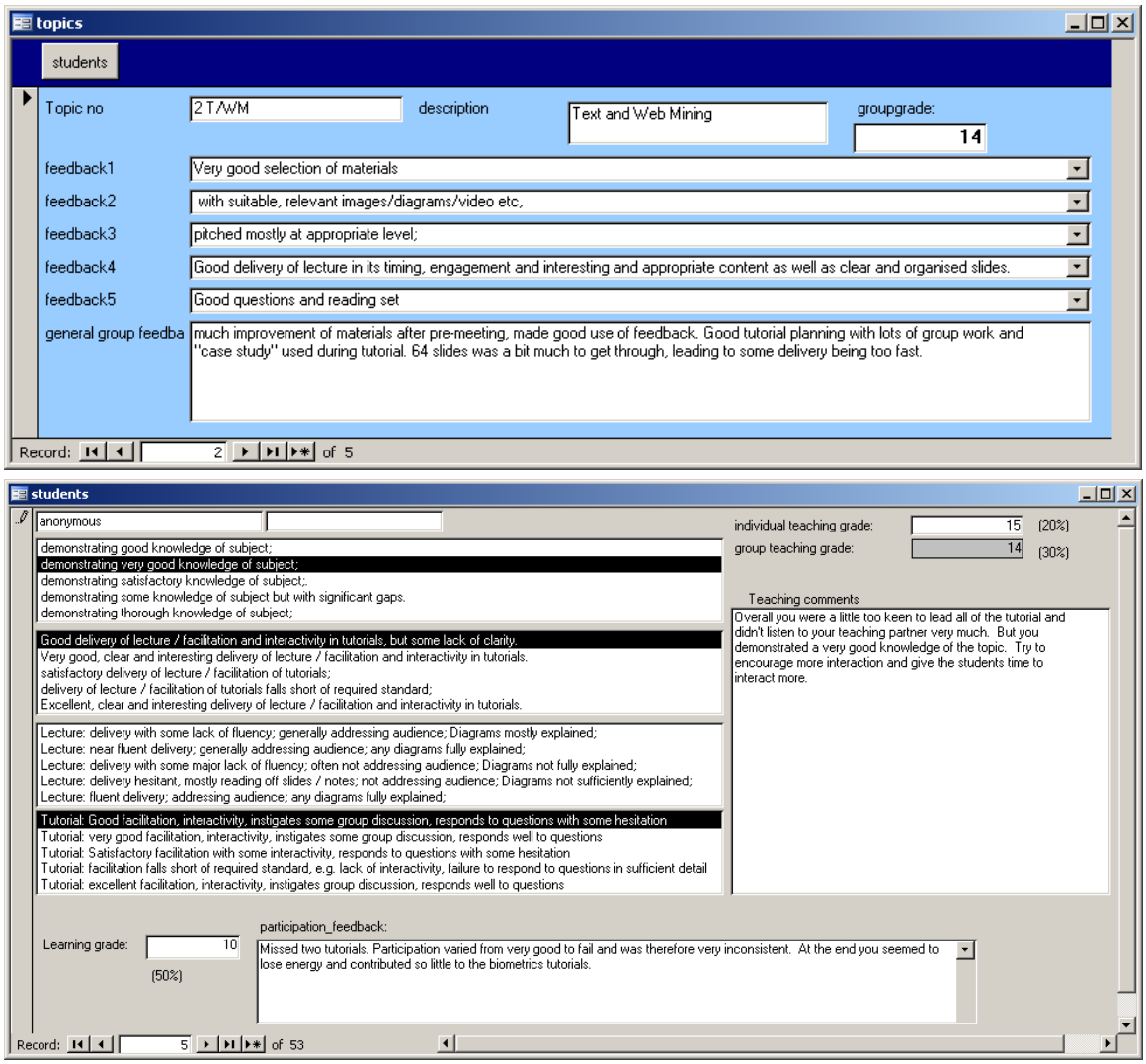


**Fig. 4: Examples of a) group feedback b) individual feedback for teaching and learning.**

## 5. THE STUDENT EXPERIENCE

At the end of the module, a questionnaire was placed on WebCT inviting feedback from the students on their experiences of the Learning by Teaching strategy. The questions asked were:

1. What were the best things about being the teacher?
2. What were the worst things about being the teacher?
3. How useful was the preliminary meeting (the week before your group's lecture)?
4. How useful was the presentation skills practice session before your group's lecture?

5. What did you learn from teaching that you might not have learnt without it?
6. How good were the student lectures?
7. How good were the student tutorials?
8. What were the best things about being taught by other students?
9. What were the worst things about being taught by other students?
10. Would you recommend that we use this method again next year? Why / Why not?
11. What changes, if any, do you suggest?

The results for the multiple choice questions (questions 3, 4, 6 and 7) are shown in Fig. 5. Typical sample comments for Questions 3,4,6,7 and questions 5 and 11 are shown in Fig. 6-8. For question 10, students were unanimously in favour of retaining this method.

| Answer | Q3 Preparatory Meeting | Q4 Practice Session |
|---|---|---|
| 1. * | 0 | 2 |
| 2. ** | 2 | 0 |
| 3. *** | 4 | 3 |
| 4. **** | 5 | 6 |
| 5. ***** | 12 | 3 |
| 6. not attended | 1 | 10 |

| | Q6. Lectures | Q7. Tutorials |
|---|---|---|
| not good | 0 | 0 |
| so-so | 0 | 3 |
| some were much better than others | 12 | 7 |
| mostly good | 10 | 13 |
| very good | 2 | 1 |

**Fig. 5: multiple choice questions results**

| | BEST | WORST |
|---|---|---|
| TEACHING | power, knowledge, respect if the performance was good. confidence, that i know more about the topic than my students. possibility to share the knowledge. | the stress when speaking in front of the audience or a tutorial group. Being lost in your own material or when nerves start to kick in ! |
| | Good feeling and confidennce building ! Imparting knowledge to others. | finding easy to understand for everybody way of explaining and tutorial tasks |
| | different way of thinking about how to solve a problem. if i am a student, i only need to work it out. but if i am a teacher, i have to learn many ways of working the question out and how to solve different questions asked by students. | the feeling that people will not understand what i'm saying, because of my accent. and when a person is stressed, tends to speak faster, and the accent becames less understandable. as far as i know, when students do not understand at the begining, they will not listen at all. |
| | I had to know prepared material very well and it was perfect improvment of my genral knowledge. Moreover, nice experience to be a teacher for someone. | knowing but can not explaining. I knew that any moment someone could ask me a question and even I knew my topic very well I could not answer them. |
| | The best thing about being a teacher is how building confidence of what you are saying and delivering the course properly. | 1. Always be prepare for cross questions. 2. Whatever you are saying shall have proof. 3. Be sure that everyone gets the lecture properly. |
| LEARNING | students do not use so much terminology. I do not know why but I felt more confident. Also it was always full of fun and suprising | sometimes it was difficult to get the answer to the questions maybe because of the problems with the language. |
| | the classes was not so formal, a lot of fun | not professional enough |
| | be provided another way to have the lessons and their teaching is really very good. the students know what is more difficult for us. | sometimes i could not understand even a word because of the accent |
| | There was a scope for more interaction. The sense of informal teaching, fun watching friends perform well. | some parts of a lecture were borring because materials chosen were not of a high quality. |
| | The best part of it was the peer appraisal, the building of self awareness and being in the position to empathise with tutors about how much work they have to put in to deliver lectures. the best [p]art by far is being able to successfully deliver your lecture with the feeling that it has been recieved positively. | Having no experience in teaching made the session a bit slow because students tended to put all materials in presentation slides, so not all materials provided could be fully explained because of the time limit. For tutorial, the questions sometimes did not really correlate with the teaching materials. The mixing culture, language and point of view made the preparation harder. |

**Fig. 6: Representative example comments (quotes) for questions 1,2,8,9**

| |
|---|
| Having the courage to stand up in front of a group of people and present my part of the lecture. I had to research the subject more thourghly and try and ensure that I knew my part and was able to help and encourage others in the group. Fantastic feelings ! |
| how to attract others' attention - speak including real situations examples; moreover not to speak monotonously - by involving the audience; what's more - speak using slides or other material as the reminders of particular parts of speach instead of reading slides!! :) |
| how annoying it is when students are whispering.<br>how time consuming and complicated gathering information and materials might be. |
| the experience to be a teacher, it is wealthy. |
| working in a group is very difficult. Knowing is not always enough. Teaching is a skill. |
| team work, co-operation with classmates and commitment towards finishing the given task. |
| learn the new knowledge is far from can teach it to others, the second one is more complex, but in other hand we learn what we teached deeper and can learn from the members discussion in group meeting. I think all these cannot be got without teaching the web mining though it's only one week and two lessons for our group. |
| assertiveness skills, team building skills-involving being able to work with people bringing them together, dealing with those who are disruptive, personality clashes, those with agendas which work against the team. and being able to go through the forming storming and norming stages of team building with a working forward looking team still intact. This requires self discipline and measured or deliberate actions to keep the team together. leadership skills, knowledge about subject matter that you might not have known about, e.g. sources, brain storming sessions leading to knowledge discovery. self awareness. |

**Fig. 7: Representative comments (quotes) for question 5**

| |
|---|
| No changes (30% of students). |
| 1. log books 2. probably having one more meeting with students before they start teaching and speak with them one by one but not only with one or two students. |
| The changes what i shall suggest that every student shall make its own log book and submit at the end of the lecture so that evaluation can be easy that who have how much participate. On the base of that log book course teacher shall give marks. |
| more advice and control over the preparation for the tutorials. |
| give the students points which must be covered in order to direct them and make sure that the general understanding of the topic is presented. |
| More teaching of the subjects in first term, inform the students about the teaching in first term and recommend the subjects and books to read in first term ! So at least the will have some ideas ! |
| more writing on the board because some students get difficulties on listening. |
| I want we can have more chance be a teacher. |
| The topics can be more diverse and more practical |
| whether or not there could be more choice for the topic. |

**Fig. 8: Suggestions for change (Q11)**

## 6. DISCUSSION

Following last year's delivery we made several changes. Firstly, e-Commerce was removed as a specialist topic as it seemed to offer fewer "data" opportunities to align with the database theme. Security as a topic was replaced by Biometrics as this allowed the students to still pursue aspects of security but within a broader and more contemporary application area. The current topic set worked better and created a coherent whole.

During a number of preparatory meetings, a small group of students dominated proceedings, invariably these were the ones giving the lecture. Further consideration is required here to ensure wider participation. For example, a better approach might be to focus the initial part of the meeting on the tutorial questions and to discuss the knowledge required to address them, potentially resulting in a more focused lecture with fewer slides and a deeper learning experience. Student feedback does support the need to give the quieter students a greater opportunity to contribute to the preparatory meeting (see Fig. 8).

All lectures were of a good to excellent standard. Unsurprisingly, the best speakers combined confident, clear speaking with a deep knowledge of their chosen subject and an ability to engage with the audience. It is noticeable that only a single Chinese student volunteered for the lecture slot. The generally quieter, less confident students appeared to perceive tutorial delivery as a 'safer bet' than lecturing, perhaps as they are conducted in a less intimidating space. Despite this, these students performed reasonably well when having to

teach. The style of tutorial delivery varied widely across pairs. Those who organized sub-group activities and invited short feedback sessions from those sub-groups generated the best responses because every student was forced to engage and address their peers. This worked particularly well where case studies or additional questions were introduced. However, more standard delivery methods inviting any answers from the whole class were often met with silence as students found it possible to remain passive and 'hide'. Alternatively, this teaching style could result in competitive crossfire.

The best topic groups paired members well, i.e. matching students with complementary styles and skills that allowed each to play to their strengths. Although some students did revert to reading from a pre-prepared script, there was a noticeable gain in confidence overall.

A potential danger with the student-led teaching approach is that student groups may fail to cover essential aspects of a topic or misunderstand underlying theories, leading to errors in their materials and/or presentation. The preparatory meeting has been successful in avoiding this. For example, the GIS group came to the preparatory meeting with a draft lecture that failed to even mention raster/vector models, spatial querying and spatial indexing! All of these issues were rectified prior to the lecture with the group acting on the specific advice given by the tutors. Another teaching topic, Biometrics, while very engaging, focused largely on physiological, sociological and psychological aspects rather than on issues related more closely to databases, such as data analysis, comparison methods etc. This persisted in the live lecture and tutorial, partly due to the tutors' lack of experience with the newly introduced topic.

A final point of discussion is that last year tutors adopted a purely observational role during the tutorials. This year, the emphasis was changed and tutors adopted the role of the learner during the student-led tutorials. It was found that staff participation seemed to empower the teachers and learners alike at points where facilitation needed a cue or discussion needed further injection.

For next year, we are planning to retain this teaching method, with a number of changes based on two years' experience and influenced by student feedback (see Table 4 above):

- Investigate how to make small changes to the semester 1 module to prepare students better;
- Introduce log books in which students reflect on their individual contributions;
- Use a checklist of key aspects of each topic in the preparatory meetings to ensure that the topic is covered appropriately and that the focus remains on the database issues of each topic.

## 7. REFERENCES


[1] Atherton, J. S., Learning and Teaching: Bloom's taxonomy. http://www.learningandteaching.info/learning/bloomtax.htm. (2005).

[2] Beasley, C., Students as teachers: The benefits of peer tutoring. In Pospisil, R. and Willcoxson, L. (Eds), Learning Through Teaching, p21-30. *Proceedings of the 6th Annual Teaching Learning Forum, Murdoch University*, http://lsn.curtin.edu.au/tlf/tlf1997/beasley.html (1997).

[3] Brems, B., Planning for a Substitute Was Never This Easy. *Education World*. http://www.education-world.com/a_curr/voice/voice110.shtml (2004).

[4] Sarason, S., Students as teachers. In: Teaching as a Performing Art. (Ch. 11). New York: Teachers College Press. (1998)

[5] Schank, R. C., Active Learning through Multimedia. IEEE Multimedia, Spring 1994, Pp. 69 – 78. http://csdl.computer.org/dl/mags/mu/1994/01/u1069.pdf (1994)

[6] Schank, R. C, Why learn by doing? (Video) http://www.socraticarts.com/schank/rcs3.htm (2008).