MULTILEVEL ALTERNATING TEACHING AND ASSESSMENT IN WEB-ENHANCED ENVIRONMENT

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Teaching and assessment are non-separable components of education process. Alternating these two elements is especially important in mathematics where each consecutive step is strongly dependent on the previous ones. Permanent assessment in mathematics should become an integral part of everyday teaching. But the problem arises regarding the time consuming nature of assessment process. It usually takes a lot of time to think through and prepare an appropriate set of questions or problems of increasing complexity, help students to solve the problems, grade the answers, and keep records of the grades in a grade book. Web enhancement of mathematics courses allows resolving these problems and thus making teaching and learning processes more efficient. In this paper a recursive multi-level scheme combining teaching and assessment is suggested, and the ways of its implementation are considered.

In what follows we use a regular hierarchical course structure: course - section - topic - lesson. Example is this. Course: Precalculus. Sections: Equations and inequalities, Functions and graphs, Exponential and logarithmic functions, and Trigonometry. Topics for the section Trigonometry: Angles and their measures, Trigonometric functions and graphs, Trigonometric identities, Trigonometric equations, and Applications.

The simplest structure is "one comprehensive final examination". It is referred to below as *TA*. More developed scheme includes, for example, "four partial examinations

and a comprehensive final examination". This approach may be presented schematically as *T(TA-TA-TA-TA)A*, where inner *T*s and *A*s stand for teaching and assessment (partial examinations) for the sections of the course, respectively.

What is supposed in this paper is deepening of the *TA*-nesting, or, in other words, making teaching and assessment alternating more frequently, potentially, each class session. An important issue is that by using web-enhanced environment this approach does not increase instructor's load. Moreover, it allows saving time by sharing the resources of all instructors teaching a particular course.

The following *teaching tools* are available in web-enhanced environment:

- contact lecturing (L_C);
- video classes (L_V);
- contact supervised or independent practice (P_C);
- online supervised or independent practice (P_O).

Video classes and online supervised practice are now standard components of all mathematics textbooks issued by the main publishers. We found it useful to assign watching a video at home before giving a lecture in the topic or to assign a brief written reflection in the beginning of a class. Such written assignments were given no more than five minutes to complete, and were required to be 0.5 - 1 page long. They were counted towards the 20% component of final grade titled "Participation and homework". The problem that we faced was reading handwritten text, commenting, and grading it.

Online supervised practice proved to be a useful component in getting students prepared for tests and final examination. It comprised recitations provided by publisher on CDs or DVDs that students could follow up for practice.

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Assessment tools in the web-enhanced environment include the following:

Quizzes at the beginning of a class (Q_C). We suggested 5-minute quizzes comprising several multiple-choice questions. When doing so without technology, we experienced problems with encouraging students to stop working on the quiz on time, to submit their answers, and to move on with new material. Also, it took time to grade quizzes, especially when there were up to 40 students in a class. Using clickers may potentially resolve these problems because in this case grading would be done automatically, and computer would not receive students' answers after the assigned time is over. But at present time availability of clickers in each classroom and their safekeeping cause a problem and require instructors' additional time an efforts. Web – enhanced learning environment allows for more efficient solution to the problem: tests may be performed on laptops or desktops directly.

Written homework (H_W). This assignment comprises usually one or two comprehensive problems that students should solve in-depth and submit after a topic is over. Solutions to the problems are briefly considered before the next topic begins. Written homework turned out to be a very useful component of assessment, but grading homework took much time and their use was limited.

Online homework (H_O). This assignment contains a collection of problems suggested at the end of the corresponding topic. Problems were generated algorithmically. They were made available online with multiple attempts allowable.

Online projects (P_O). This assignment contains more complex and comprehensive problems that cover the whole section. Projects were due by the date of a section test. Our usual practice was assigning 3 - 4 projects, 10 problems each. The problems were

algorithmically generated and allowed 1 – 3 attempts. Completion was not forced: students could start the project, then suspend it and continue later.

Reflections in the topic (***R***). This assignment includes a comprehensive story problem with several long-answer questions. It is similar to the writing across the curriculum assignment and turned out to be very useful for student preparation. Grading reflections is a very time consuming component, so that it can hardly be used frequently. Posting textual part of assignment online and making questions multiple-choice facilitates grading process.

Tests in classroom and/or online (T_C/T_O). This is a usual assessment component. In the web-enhanced environment it is possible to combine on-site and online components of the tests. They can be combined in different ways. For example, tests may be suggested online or in class in an alternating way. Another possibility is dividing one test into on-site and online components with a resulting grade formed as 50%-50% or in another proportion. Tests assigned online did not allow for multiple attempts, questions were given one at a time in random order, and completion was forced. The last meant that a student could suspend taking the test if he or she started it and had to finish it by a predefined time.

Summarizing, the set of teaching tools available in the web-enhanced environment may be presented as a 4-tuple $\mathbf{T} = \{\ L_C,\ L_V,\ P_C,\ P_O\ \}$, and the set of assessment tools, as a 7-tuple $\mathbf{A} = \{Q_C,\ H_W,\ H_O,\ P_O,\ R,\ T_C,\ T_O\}$. Taken together, they allow for suggestion of the following alternating recursive teaching - assessment scheme:

$\mathbf{TA}_{\text{Course}}(\mathbf{TA}_{\text{Section}}\ (\mathbf{TA}_{\text{Topic}}(\mathbf{TA}_{\text{Online}}\ (\mathbf{TA}_{\text{Classroom}}))))$.

This formula stresses that classroom contact (innermost term) is basic and crucial component for teaching and learning mathematics but the instructor - student communications are not restricted to the face-to-face contacts only. Web-enhancement allows for enrichment teaching tools and techniques and provides opportunities for alternating teaching and assignment at all hierarchical levels: from lesson to topic to section to course while preserving instructors from overloading by preparation, distribution, collection, and grading assignments of different types. Our observations show also that this also decreases the probability of mathematics anxiety.

This teaching – learning scheme was implemented by the author using MyMathLab educational system. It is referred to below as MARTA: Multilevel Alternating Recursive Teaching and Assessment. The functional scheme is given in fig. 1.

Leading publishers provide web - enhancing tools commercially. They suggest access to electronic editions of textbooks, after-chapter problems, problem sets (usually multiple choice only), multimedia resources, help in problem solving, grade books for instructors etc. But they condition these opportunities by purchase of a new textbook or additional payment. This payment usually causes complains of students who claim that technology fees that they pay should make them eligible for access to web-related resources free of charge. In our opinion, this claim is not baseless, especially for students of community colleges. It more often than not that they have limited or no extra support and need to work hard to make their living. Such students are reluctant to spend extra money. A solution to this problem may be an agreement between a college or university and a publisher that allows students free access to the publisher's resources that is paid by the

institution with a discount. Taking into consideration the bulk student body, such

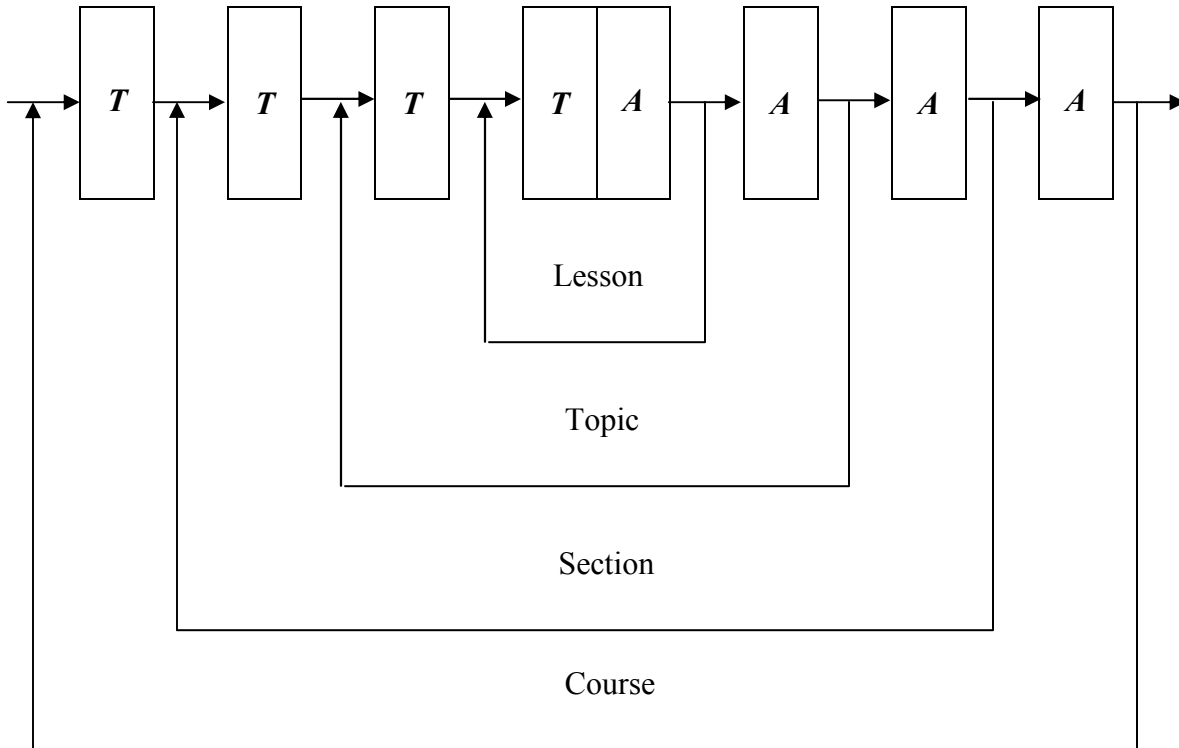agreement may be financially acceptable for both sides.

Figure 1. MARTA functional scheme.

T stands for teaching, *A* for assessment.