# WHAT SHOULD BE KNOWN FOR AN EFFECTIVE MATHEMATICS TEACHING

Gülhan Can[1]

Bilkent University

M. Sencer Corlu

Bilkent University

**Abstract**

In this paper, I explained my understanding of the curriculum models, STEM education and what was important to implement a course of study according to my readings. Then I construct my own ideas about these topics and expressed them also. I mentioned about Turkey's situation for each topic. Which of the curriculum models was appropriate for different situations in Turkey classes? Why was STEM Education so important for the future and where did the mathematics education take place in this education? Why it was important to learn mathematics? I tried to answer these questions in this article.

*Key Words:* curriculum models, the crossover model, enrichment model, differentiated model, STEM education, goals and objectives.

[1]Correspondence concerning this article should be addressed to gulhan.can@bilkent.edu.tr

## Introduction

The purpose of this article was to explain my understanding of curricular models which were suggested by Meiring et al (1992). These were the crossover, enrichment and differentiated curriculum models. After that I explored about STEM Education and expressed my ideas. Additionally I read about implementing a course of study and I decided on a high school topic then according to my understanding, I tried to write two goals and eight objectives for this topic.

## What Is Necessary Before Implementing A Course Of Study

### The Crossover Model, Enrichment Model and Differentiated Model

The crossover model includes two parallel sequences. One of them is for college-intending students and the other one is for not intend to go to a college. It covers a three-year course with same topics in both sequences. However the college-intended students had the topics in an advanced level while the others not planning to go to a college had the same topics in a more concrete level. Additionally at the end of the three-year core curriculum program, a fourth-year advanced course is suggested for college-intending students (Meiring et al., 1992).

The crossover model does not force students to decide at the beginning and go on in that way. For example if a student changes his/her mind after one or two year and decide to go to a college, he/she can switch to the other sequence. Here the advantage of this model is that there is continuity between topics for such students. But it could be forceful for a student who decided to switch from *not planning to go to a college sequence* to *a college-intending sequence* to move from concrete level to abstract level.

In Turkey, for high school students, there had been some fields to choose one of them such as *mathematics and science, mathematics and literature, social sciences* and *foreign language.* After the first year of the high school every student had to decide on one of these fields. It was so important to decide on your department and relatively your potential future job

at the age of 16 or 17. Because for example first you wanted to be a doctor and you were good at mathematics and science lessons, so you attended *mathematics and science field*. But then at the last year of the high school you decided that you were afraid of the idea of morgue and changed your mind and wanted to be an English teacher this time. Here a big problem occurred because you had not had a two-year English courses and the time was not enough to cover all gaps. Assume that you managed it but this time the system would decrease your mark since you chose a department that was not in your own field. Such these situations forced lots of people to choose wrong jobs for themselves. If a crossover model suggested for such situations it would be more appropriate, I think. Because people have education to be happy at all, not to be frustrated about their decisions at age 17.

In the new MoNE curriculum, there is a distinction for grade $11^{th}$ and $12^{th}$ as standard level and high level, similar to IB DP and IGCSE's core and extended level (MoNE, 2013). It is similar to crossover model since the model also makes two sequences for college-intending and not intending students. However the topics are not exactly same for standard and high level so it is not democratic I think. All students should have the same chance to reach all topics as a principle of *equity* (NCTM,2000).

The second curricular model is the enrichment model. It is similar to the crossover model since it is a three-year core curriculum program with same topics for all students. However there are no sequences for college-intending and the other students. Differently, there are small groups of students at the beginning of each unit and if a group of students complete the core content early from the class, they could have some activities, explorations, looking at historical or new approaches etc. on the same topic again. I think it is like an extension part in 5E Model.

In Turkey, according to new MoNE Curriculum the students have the same topics until the $10^{th}$ grade. Particularly in middle schools the classes include mixed group of students at

different level. After the 8th grade the students have an examination to enter some well-qualified high schools such as Anatolian High Schools, Science High Schools etc. So, in middle school I think groups are more heterogeneously.

In the middle school grades teachers face some gifted and struggling students in the same group and I think enrichment model can be suitable for such groups. For example the gifted students can study some topics with the whole class and for some topics the teacher could want them to explore a new thing or to practice a deeper activity. This helps the teacher to deal some gifted students more easily and also students are not isolated the rest of the class. But I am not sure how this model could be adjusted for struggling students such as *kaynaştırma öğrencileri*. I think it depends on the topic and these students' special manners. If a teacher can prepare some extension activities for gifted students, I think it could be prepare more special (sometimes easier and sometimes more challenging) activities for these children. I agree this idea at all: "Unlike tracking practices; neither gifted nor struggling students are isolated from one another so that the diversity of thinking can enhance learning for all students" (Winebrenner & Devlin, 2011).

The differentiated model is similar to both crossover and enrichment model with some aspects of it. It is a three-year core curriculum program with a possible fourth-year as in the crossover and enrichment models. The differentiated model organizes classes in a heterogeneous manner similar to the enrichment model but structures the work of each group by depth of coverage as the crossover model does (Brahier, 2013, p. 89).

In Turkey the new MoNE curriculum should give the same chance to students to reach any topics as it is stated in differentiated model. I think without dividing the students into parts that such saying as if "you are at standard level and you are at high level", it could be implemented a differentiated model in Turkish curriculum. However I think this model and its success depends according to teachers' abilities to manage such a classroom environment with

mixed groups, their needs/interests/levels and the same topic. It could be challenging especially some crowded Turkish classes. Additionally this model should be well-defined and have clear explanations for teachers and maybe a training program should be provided for teachers.

**STEM Education**

STEM Education looks Science, Technology, Engineering and Mathematics as an integrated parts of a realistic and contemporary education system. It is stated that STEM Education is so important for nations' future in such an information age. For example, American administrators think "STEM education will determine whether the United States will remain a leader among nations and whether we will be able to solve immense challenges in such areas as energy, health, environmental protection, and national security" (President's Council of Advisors on Science and Technology, 2010). Additionally, it is also stated in the innovation strategy of America to secure their economic growth and prosperity with these words: "Working with a coalition of private sector leaders called Change the Equation, the Administration is encouraging public-private partnerships that inspire more students – including girls and other currently underrepresented groups – to excel in science, technology, engineering, and mathematics (STEM). The Administration will also work to prepare 100,000 STEM teachers over the next decade with a down payment in the FY 2012 Budget to recruit STEM teachers and improve teacher training." (National Economic Council, Council of Economic Advisers, & Office of Science and Technology Policy, 2011).

In Turkey there are also some studying/researches etc. about STEM Education. For example it was explored about Turkey's population, future needs, strong and weak parts in education and things to do to place among developed countries in *Vision 2023: A Technology Prevision Project* (Serbest, A. H., 2005). It is explained that each person could be educated to have their own ideas and be capable to query any information/idea in a scientific way; the

abilities to collect and conduct data, analyzing/synthesizing, interpreting, cooperation and produce original products. Since the 21st century is an information age, it is important to think in a creativity way and have problem-solving abilities in lots of professions/fields/economics etc.

The economic structure of the information age inquires not only individual abilities of employers, but also their performances in a group. So, to obtain this, education must be interdisciplinary (Serbest, A. H., 2005). So mathematics education can/should be integrated into other subject areas. Particularly it is trivial from researches that science-conceptualized exercises/problems affects mathematics lessons in a positive way (Corlu, Capraro, & Corlu, 2011). And also a good mathematical knowledge makes science lessons richer and easier. As a conclusion at all, in any field, people need a lifelong process on problem solving, reasoning and proof, communication, connections and representations abilities as NCTM stated (2000).

**A Topic From High School Mathematics: The Interpretation of Tables and Graphics**

This topic places in the 12th grade standard level of the new MoNE curriculum (MoNE, 2013). Here are two goals and eight objectives for this topic:

Table 1.

| Goals |
|---|
| The student will understand the connection between graphics/tables and daily life situations. |
| The student will develop a positive disposition toward the study of mathematics. |

Table 2.

| | | |
|---|---|---|
| Objective 1 | The student will display interest and curiosity in interpreting daily life situations. | Affective Objective |
| Objective 2 | The student will use a graph calculator by exploring graphics exercises. | Psychomotor Objective |

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|---|---|---|
| Objective 3 | Given a graphics, the student will define what is on the x-axis and y-axis and given a table, what is the meaning of the valuables on the columns and rows. | Knowledge |
| Objective 4 | Given a graphic or table, the student will read and interpret the data. | Comprehension |
| Objective 5 | Given a table, the student will interpret it and make comments/predictions about expectations in the future and write an appropriate scenario according the table and its data. | Application |
| Objective 6 | Given linear graphics, the student will make predictions about future and will discuss the expectations. | Analysis |
| Objective 7 | Given linear and quadratic graphics, the student will determine about intersection points and discuss/interpret their meaning. | Synthesis |
| Objective 8 | The student will determine which graphics/tables are most suitable for daily life situations such as velocity-time, profit and loss, increasing population, increasing/decreasing the air pollution etc. | Evaluation |

The objectives above were divided into three main parts. The first one was affective, the second one was psychomotor and the last six were cognitive objectives. The cognitive objectives were divided into six parts according to Bloom's Taxonomy (Bloom & Krathwohl, 1956).

The different types of objectives provide different ways to approach the goals. For example the affective objective above affects both the two goals for this topic. It could be considered such a first step to stimulate interest. If a teacher manages this, it will affect the rest of the topic in a positive way and help the student to develop a positive disposition toward the study of mathematics.

On the other hand to use a graph calculator can make students more adopted and integrated about topic and it is also relevant with the two goals. I think, it could be thought as psychomotor objective to use the calculator effectively.

Additionally, cognitive objectives help students to construct a general understanding of the topic by using their knowledge in a meaningful way. The students can apply their learning of the topic, analyze different parts of the topic and synthesis so be able to evaluate the topic according to his/her own experiences/learning/understanding.

## Conclusion

The purpose of this article was to express my understanding of curriculum models, STEM Education and writing goals and objectives in a course of study. I learned about curriculum models which were crossover, enrichment and differentiated models and considered their appropriateness in Turkish mathematics education. I observed each model could be suitable for different situations and built up my own ideas. Also I read about STEM education and compared it in America and Turkey and decided on this subject was one of the most contemporary issues for nations' future plans. And finally I read about writing goals and objectives. Then I considered on a topic's goals, and wrote affective, psychomotor and cognitive objectives to foster the goals as a whole. It provided me useful knowledge for my teaching profession.

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"A Bilkent student does not lie, cheat, or steal or tolerate those who do. On my honor, as a Bilkent student, I have neither given nor received unauthorized aid on this academic work."

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Gülhan Can