Comparison between the use of different traditional tools and EM as a complement for teaching matrix multiplication

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Abstract

The goal of this paper is to analyse an Empirical Modelling (EM) model as a possible tool to teach matrix multiplication. First it will take out a basic summary of the EM definition and its connection to Education Technology (ET) and the day-to-day learning. Secondly it describes 4 of the most used traditional methods to teach. Following by a compassion with the EM artefact suggested in the first section and the other tools mentioned. To finalize the most relevant conclusions accompanied with recommendations to achieve suggested by using the EM model are exposed.

1 Introduction

Empirical Modeling (EM) is a research tool used by Warwick University with the goal of developing artefacts to support human thinking by interacting with computer technology, enabling to think with computers, instead of letting it, do it alone.

One of the areas of EM application is Education Technology (ET). This paper analyses the possibility of applying EM, a significant tool from ET, as a support for teaching matrix multiplication with the support of realizing a comparison with other methods.

Nevertheless in order to realize the above-described goal, an understanding from EM, ET and its connection to day-to-day learning has to be done. For that reason this paper begins by illustrating the significance of EM and its similarities to the traditional education. Followed by a description of 4 alternatives methods for teaching matrix multiplication. To finalize, a basic comparison of the 5 exposed examples is portrayed and the main conclusions are brought out.

2. EM and its connection to education technology

Section 1 attempts to explore the main idea about Empirical modeling and its connection to education technology. In order to do that, the first subsection defines what is understood under Education Technology (ET), the second one describes the idea of Empirical modeling (EM) and links it with ET. To finalize a model for explaining Matrix multiplication is described as a concrete idea to develop the concepts defined in the first to subsections.

2.1 Education Technology (ET)

According to Harfield Education Technology (ET) or e learning describes a very wide range of “computer-related technology that support teaching or learning”(Harfield08). The use of CD, DVD, web-based teaching materials, email, chats, and other similar examples are included in the concept.
There are several activities in which computers can be used as tools to improve traditional teaching methods, such as power point presentations, development of models, providing online information, etc.

Some potential properties of ET are:

-Information can be accessed from everywhere at every any time.

-Communication can be more effective. (By using the internet)

-“Learning material and support can extend the potential of traditional learning environments”(Harfield08).

The benefits of ET are remarkable, however it does not mean that they will provide better communication and understanding than the traditional technology.

Researchers found out that in order for ET to provide meaningful education the 8 significant characteristics of learning that occur in

the take out the word the everyday learning should be analysed.

These 8 characteristics are separated into 3 main stands: experimental, flexible and meaningful. In the next subsection the similarity from this characteristics and the ones from EM will be analysed.

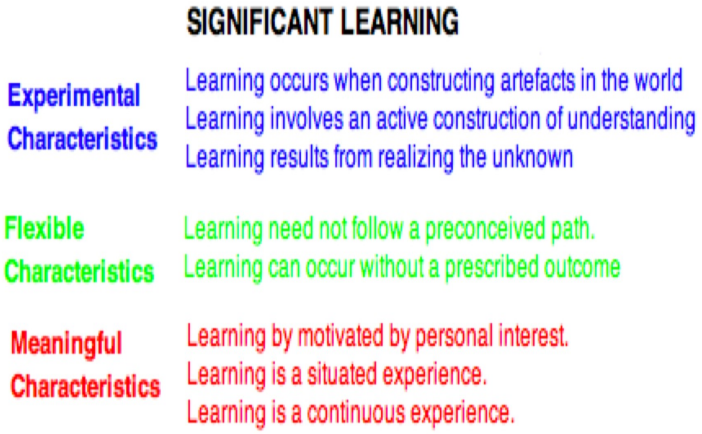

Figure 2.1: Significant Learning (Harfield 2008)

Figure 2.1 exhibits the 8 significant characteristics of learning divided in the following strands:
- Experimental Characteristics: Is the part of the learning where you implement the "learning by doing" method. However it can rarely be done without having a theoretical background.
- Flexible Characteristics: Learning should be flexible, endless and without any predefined order.
- Meaningful Characteristics: The most important one in the everyday learning: a human being needs a motivation or a reason to be able to learn a new topic.

These three strands together form a strong argument that ET can lead to learning in an informal everyday sense in the following way:

-Experimental Characteristic: is an important aspect in ET because it offers an environment where the users can explore and experiment with different activities.

-Flexible Characteristic: ET is as flexible as the learner wants it to be.

-Meaningful Characteristic: This strand is in ET already satisfied because ET is searched because of own motivation.

As is shown above ET supports these characteristics meaning that it satisfies the significance of learning. Meaning that ET is a suitable tool to teach.
The next subsection analyses Empirical Modelling as an appropriate ET that supports the traditional learning.

2.2 Empirical Modelling (EM)

Empirical Modelling is a type of ET. The main propose in this section is first to explain what is meant with EM and describe the strong connections from EM with the eight significant characteristics of learning described in the last section.

M. Beynon defined EM as "a body of principles and tools concerned with computing activity that is based on observation and experiment (hence 'empirical')" (Beynon/Russ10). In other words EM are tools and principles that are specially concerned with a modelling state and dependencies.

EM designs are focused in capturing a state-as-experience (Beynon10). Meaning the artefacts usually offer the flexibility of human interaction in the world. These try to imitate in a predefined way any kind of activity presented in the everyday world.

To achieve this flexibility EM models are a collection of observations, called observables that define different states of the artefact. These are defined in the following way:

$$v \text{ is } f(x1,\ldots..xN).$$

Being x1….xN the different observations and v the actual state of the model that can be updated. In order for the models to make sense their set of definitions need to have a

solid and unique interpretation to the status to be reflected.

Now that the main idea of EM is defined, the writer will like to stress the strong relationship from EM with the eight significant characteristics of learning discussed in the first subsection of the chapter. Figure 1.2 emphasizes the ideas of EM between the different strands mentioned above.

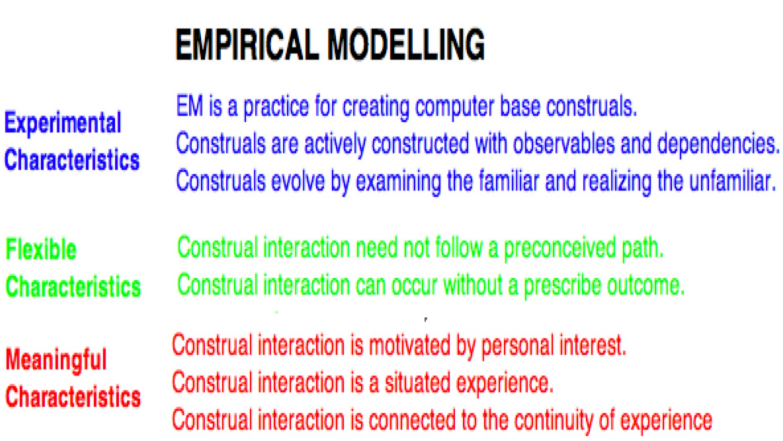

Figure 2.2: Empirical Modelling (Harfield 2008)

The comparison of Figure 1.1 and 2.2 clearly illustrates the similarities between EM and the everyday learning. That converts EM in a very interesting and innovative learning tool that can be used as a support for explaining any topic.

The last subsection of this chapter, expose an idea how EM can be used as a tool to teach Matrix Multiplication.

2.3 EM model as a tool to teach Matrix Multiplication

This subsection wants describe a model that can be used as a support to teach Matrix Multiplication. This new method should define clear and simple information of the advantages of using EM, for example the ability of modifying the model for its convenience without any programming knowledge. It will also introduce the teacher to a new experience and the student a new way of learning by modelling.

The framework appearance is a type of calculator where the result is provided by a dependence of the following parameters: numbers of the first matrix, an operator (multiplication or addition) and variables of the second one, where each combination with the solution is an observable. The dependencies are marked with yellow and the current number of each matrix with blue. After exploring the model the user will be able to combine the three factors as he desires and get a solution.

To facilitate the use of the framework, the following buttons will be provided:
- "load example", a given example will be showed
- "Multiply Matrices", shows the final result of the multiplication.
- "clear current parameter", erases the current parameter in the solution Matrix.
- "clear solution", erases all parameter in the solution Matrix
- "Clear model", restarts of the model.
- "+", adds the current square from C with the multiplication of current parameter from matrix A and the one from matrix B and displays its solution in the current square from matrix C.
- "*", multiples the current parameter from the matrix A and the one from the matrix B and displays its solution in the current square from matrix C.

Note: All the parameters are accumulative, so in order to start again, any of the 3 clear buttons can be used.

The main idea of the artefact is to evaluate the user's acceptance for empirical modelling as a tool for ET and show them how simple the modifying can be. Nevertheless there are still several functions than can be add to the above described model in the future.

The next chapter aims to describe different traditional teaching methods in order to realize a comparison in the third section of the potential of the model explained above of being a useful teaching tool.

3 Other teaching methods

As explained above this chapter aims to describe other teaching methods. Although there are endless tools to teach, the paper will consider 4 of the more significant methods for learning. After describing each method, a specific example is described in order to specify and facilitate the compassion in section 3.

3.1 Classroom teaching

Teaching in a classroom is the most traditional way of learning. However it definitely has several conditions that depend on the level of the success. The writer considers the following statements as the key variables:

-*Teacher motivation:* the more the teacher enjoys the topic and explaining it, the more enthusiastic is he is.

-*Student motivation:* the greater the interest of the student, the higher his attention.

-*Time of the lecture:* The longer the lecture the lower the student's attention.

-*Number of students:* the lower the number of students, the higher the personal attention from the teacher

As the statements explained above showed, the quality and success of a lecture can be really variable. In order to be able to compare this method with the other ones, the variables will be defined as followed:

- *Teacher and student motivation level* (From 1-10, 10 highest): 7
- *Topic:* Matrix Multiplication
- *Time of the lecture:* 50min
- *Nr. Students:* 30

3.2 Online Video

Learning by looking interactive videos is another significant method of learning. Again because the success depends on the quality of the video, in order to compare it, a specific video (http://www.youtube.com/watch?v=aKhhYguY0DQ) will be analysed.
The tape explains first with the help of two examples the way matrix multiplication is done. To finish, the "teacher" proofs with the last example the following statement:

MatrixA x MatrixB <> MatrixB x MatrixA.

The way that the person talks with a clear and understandable voice in the tape and the using of different colours assists the listener to successfully understand the topic.

3.3 Self-study

Self-study is another common method of learning. The most traditional way of realizing it, is by reading books or researching online about the wanted topic. Here again it depends on a total subjective opinion to decision if the book is understandable or not.
To facilitate a comparison between the methods the following explanation, a link found on-line by typing "matrix multiplication" in google.com, is going to be considered:

http://www.mathwarehouse.com/algebra/matrix/multiply-matrix.php

The webpage explains 2 types of matrix multiplication. The first one is the multiplication of a matrix with a single number, described in a specific example. The second one is the multiplication from two matrices. It begins with a specific example, followed by a general explanation and rules for definition, finishing with a step-by-step description.
In comparison with other sources, the writer personally finds the web page very useful and easily explained.

3.4 Assignment

Another way of understanding a topic is by completing an assignment about it. However in order to be capable of developing an example successfully the student must have

some particular knowledge. For that reason this method must always be combined with one of the other 3 methods described.
Every assignment demands a different level in order to be solved successfully. This paper will analyse the following assignment found on-line:

http://www.math.utep.edu/Faculty/mabry/web/matrixmult.pdf

The example offers 10 different exercises with a solution. In order to be solved the student has to have a basic knowledge of matrix multiplication. To acquire that ability any of the methods described above must be utilized. is to be realized. The goal is applying the theoretical lectures into practical and specific examples in order to understand it better.

4 Matrix Multiplication Teaching Method Comparison

METHOD	PRO	CONTRA
EM as a teaching tool	- **Supports the eight characteristics of learning.** - "Learning by doing it" - Helps to understand from a structure how it works. - The student is more motivated for learning in a new method. - Can be used everywhere at any time. - Demands fully understanding of take out the word of the topic. - Motivated by personal interest. - "Learning by **modelling**"	- Learning a new language. - Understanding idea of EM first and then Matrix multiplication. - Difficult to understand it without the teachers help. - Lack of a defined timetable
Teaching in a classroom	- Most "effective" way, almost always has a positive effect. - Student reserves specific day and time to concentrate on a topic with an expert's support.	- Mainly does not involve student's thoughts. (Depends in the teacher). - Not always supports the 8 characteristics of learning. (Not always conceived by a personal interest or follows a preconceived path.)
Video	- Motivated by personal interest. - Can be seen everywhere and at any time. - Can be done by your self. - Gives a "lecture feeling" without being physically in one.	- Demands self discipline. - It depends of the quality. - Does not involve practice.
Self-study	- Motivated by personal interest. - Demands student's total concentration in the topic. - Can be seen everywhere and at any time.	- Books, WebPages can be confusing. - Information is not 100% viable. - The learner does not know if the topic is correctly understood. - Lack of defined timetable. - Demands more discipline than any other method.
Assignment	- Motivated by personal interest - "Learning by doing" - Way of putting in practices the theory. - Can be seen everywhere and at any time.	- Lack of defined timetable (unless there exists a deadline) - Some assignments do not demand full understanding of the topic.

5 Conclusions

After analysing the 5 exposed methods you can come to the conclusion that EM can be a very promising teaching tool for matrix multiplication. However it can be too challenging to replace completely a lecture or even the self-study method, because it demands learning 2 new objects.

Nevertheless it can be a very powerful tool for the teacher to present it in a lecture or as a student to substitute the assignment method. It would be even more successful as realizing examples, because first as it was proved in the first section, EM has a very close connection with the 8 characteristics of learning and secondly it demands a higher level of understanding than only following a predefined sequence to solve a problem.

Still there exists a need to motivate the teacher to use a different teaching tool and the student to learn with a new method. In order to achieve that, the writer suggests taking the following considerations:
- Show the users the connection from EM with the day-to-day learning to convince them that it is worth it trying something new.
- Provide a nice and easy to understand manual to avoid confusions and frustration.
- Create an attractive framework that gives the users curiosity to learn how it works

With all the above mentioned motivation EM has a great potential to be a successful tool for teaching.

References

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- Online Video: *http://www.youtube.com/watch?v=aKhhY-guY0DQ*

- Self-Study: *http://www.mathwarehouse.-com/algebra/matrix/multiply-matrix.php*

- Assignment: *http://www.math.utep.edu/Faculty/mabry/web/matrixmult.pdf*