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**BLOOM WITH A BLOOM
(A COMPUTER MODEL OF A LOOM)**

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This article describes a computer model of a loom and a case study of a 10-year old child using the model to weave a real rug. The application of the model for weaving a real rug, the accompanying experiments and the involvement of the participants: the child, the master weaver, the parent and the teacher, show how technology can be used in such a manner as to make learning by doing and sharing its results happen in harmony with the ideas behind the STEAM education.

1. Introduction. The problem of how computers should be used in the process of education dates back to the early ages of the computer itself. Back in 1971 Seymour Papert (MIT) writes *When people talk about computers in education they do not all have the same image in mind. Some think of using the computer to program the kid; others think of using the kid to program the computer.* [1] And later he adds *But there is a world of difference between what computers can do and what society will choose to do with them* [2]. Today this question remains relevant. What should we choose to do with computers in education – use them to present content, improve communication, learn a skill? Or *help students build, evaluate and improve their ideas* [3]?

The goal of this article is to show one possible application of technologies in education demonstrating the computer as a tool for empowering students to develop their ideas.

One of the computer's main *skills* is to give almost immediate feedback to our actions and thoughts. This makes it an appropriate tool for experiments and research. When these experiments help us rediscover our surrounding then technology is in harmony with human reality and, in particular, with the process of education.

We illustrate these ideas by the development of a computer model of a horizontal four-treadle loom, applied to *weave* a rug on the screen together with a 10-year-old child. We weave a real rug with the help of the digital one.

The results so far: a computer model of a rug (by means of visual block programming), the joy of experimenting with various features (parameters) of the model, the creation of an *entity (product) to be shared* (the part of the rug which has been woven) and the involvement of the child. All this comes to show that when computer modeling is a tool for creation and exploration and is interlaced with key ideas of science and art, then joy and learning go hand in hand. In such a case, learning by doing, making and sharing its results

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happens naturally. Our experiment is an educational scenario, which demonstrates a natural weaving of all the STEAM components – **S**cience (predicting the modeling results, based on observation and experimentation), **T**echnology (the functioning of the loom and its computer model), **E**ngineering (implementing the program to model a real part of a rug), **A**rt (the design of the rug patterns), **M**ath (the geometrical properties of the rug patterns).

2. Background. Learning by doing and sharing the results is the basis of Papert’s Logo philosophy of education known as constructionism where the *learner is consciously engaged in constructing a public entity which could be shared* [2, 3]. In Bulgaria, this philosophy was adopted by the Research Group on Education (RGE) [4, 5] from 1978 to 1999 and later on by the Mathematics and Informatics Education Department of the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences. Their years of experience with teaching programming and especially with inquiry-based learning by programming have proven that key ideas of mathematics and informatics are much more efficiently learnt when the principles of this philosophy are applied [6, 7, 8].

The experience gained in the frames of seminars for teachers and students, dealing with constructionism ideas in action [9], and a recent participation in a rug weaving course are the foundation of the educational scenario we are presenting below.

3. General information on the loom. To be able to model the surrounding world successfully we need have a basic knowledge of it. We need to have spent enough time observing and experimenting *live*. That is how computer modeling becomes a way to enrich our human reality helping us rediscover it.

Therefore, before children start to learn computer modeling, they need to gain sufficient experience. Then they can be inspired to explore by using appropriate computer models. With this spirit, it becomes easy to learn methods of creating such models.



Fig. 1. Horizontal four-treadle loom adapted for children

To better understand the computer model described in this article here is a brief information about the loom (of course, making the model *tangible* as the real one, was the biggest challenge even for a professional programmer).

In general, a rug or a carpet is made of colorful threads (usually yarn threads) interwoven in the warp made of parallel threads which are strong enough (usually made of cotton). The loom frame holds the threads of the warp parallel and straight and the treadles make weaving easier. When pressing the treadle, the threads of the warp change position: some go down while others go up. This gives the necessary room for the yarn threads – guided by a shuttle – to pass. It is the scheme of the loom that determines which threads go up.

The looms being subject to our computer model are based on a special tie-up scheme (in Bulgarian *varhovat kepar*).

Different combinations of treadle movements and colors of the weaving thread form repeated patterns which are called *splitka* in Bulgarian (or a colorful horizontally symmetrical weaving pattern).

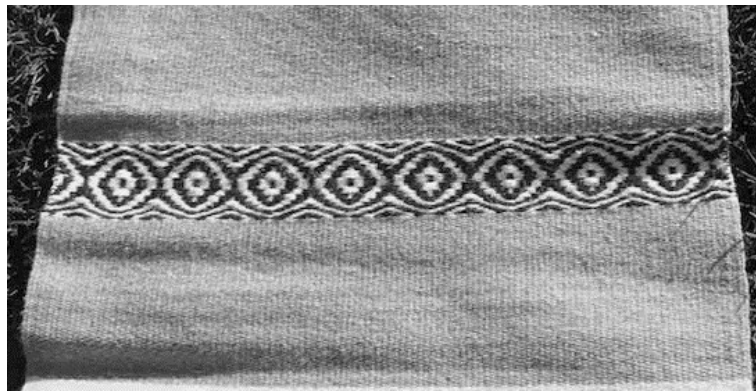


Fig. 2. Splitka – a colorful horizontally symmetrical weaving pattern

4. A computer model of a loom.

4.1. Turtle graphics. The computer model of a loom (called BLOOM) was created by means of the so-called Turtle graphics [3] using the block-based visual programming environment called *Snap!* [10, 11]. *Snap!* was developed by Jens Mönig and Brian Harvey under the umbrella of the University of California at Berkeley, with the objective of bringing the power of the Scheme programming language and its computer science concepts into a Scratch-like environment.

The main character in our model is the turtle which *weaves* on the screen in the role of a shuttle. When moving on the screen, it can leave a trace by means of a small pen attached to its tail. We can guide the movements of the turtle by using the following commands: MOVE (forward by a certain distance) and TURN RIGHT (at a certain angle). We can determine whether the turtle leaves a trace of its movements on the screen by using the commands PEN DOWN and PEN UP.

4.2. Basic weaving commands. The above-mentioned four commands are the basis of BLOOM and of the following weaving commands on the screen.

4.2.1. *ROW, NEXT ROW, PLAIN WEAVE.* With the ROW command, the turtle weaves one rug row with a particular color and by *pressing* a particular treadle combination. The block command accepts as input a list of treadles and colors for the trace



Fig. 3. ROW block command that *weaves* one rug row with orange weaving thread

which the turtle will leave. A list containing the number of the first two treadles, used as an input for the command, makes the turtle *pass the thread over every uneven line of the warp and below every even one*. In this way an interrupted line is formed:



Fig. 4. Result from executing the ROW command (Fig. 3)

Whenever the trace is interrupted, *the yarn remains below the lines of the warp with white color*.



Fig. 5. NEXT ROW command

The NEXT ROW command makes the turtle turn in the opposite direction and prepare to weave the next row.

We can weave the next row by *pressing* the other two treadles: the third and the fourth one.



Fig. 6. ROW command using the alternative (to Figure 3) treadles

In this way we will *cover this part of the warp which has been left visible from the previous row* and will obtain a fully woven cloth.



Fig. 7. Result after executing the second ROW command (Fig. 6)

This type of weaving technique is called *plain weave*. The equivalent in BLOOM is the PLAIN WEAVE command which accepts as input the yarn color. The REPEAT block (built in Snap!) can be used to repeat the command:

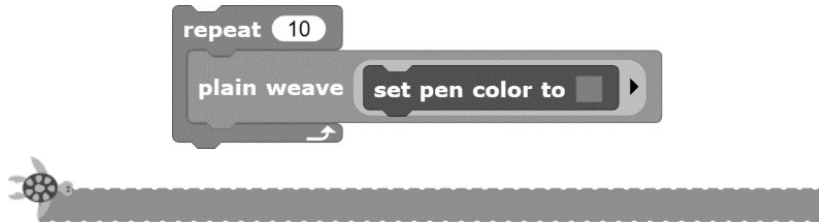


Fig. 8. Block commands to repeat 10 times *plain weave* and their outcome

4.2.2. *SPLITKA*. The splitkas (the colorful weaving patterns) are made when using various repeated combinations of colors and different treadles in the processing of weaving. These combinations form the design of the splitka. In most cases the design is repeated as a mirror image once it has been woven.

For ease of reference, we can use the *SPLITKA* command which requires a scheme and background color. The scheme consists of rows each of which determines the treadles, number of repeats and color.

The scheme in the figure below provides:

- First line – two double rows each of which has the following single rows: a purple-colored row using the first and the fourth treadle and a row of background color and using the alternative treadles – the second and the third ones.
- Second line – the same as the first row but using the first and the third treadle when weaving with the purple color.
- Third and fourth line – at this point four double rows are woven.

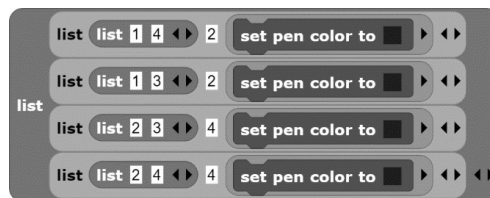


Fig. 9. Sample scheme of a splitka

With the *SPLITKA* command, the above-mentioned scheme is applied as follows:

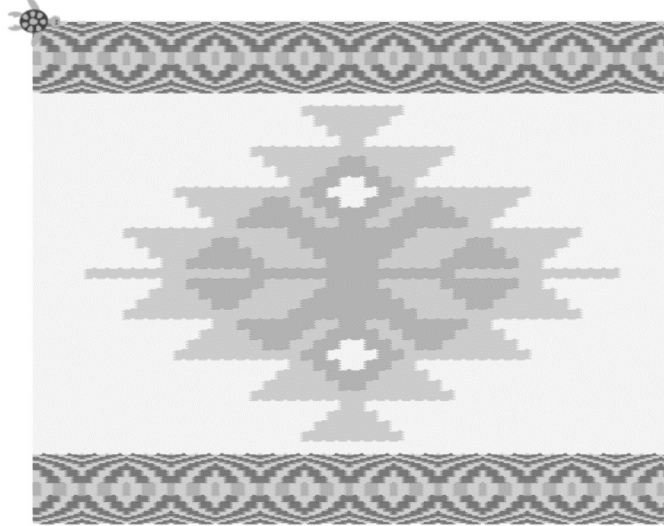


Fig. 12. Rug with two splitkas and the *kanatitza* figure created with the carpet technique

Inspired by the results that were accomplished (we assisted in weaving a rug for sale), we created the BLOOM computer model and the child got motivated to create her first *real rug* for a present to a friend whose name starts with the Bulgarian letter И .

Having discussed the design of the rug and checked the available yarn colors, the child took a decision to use a rainbow-like color pattern as a beginning and an end of the rug and put the letter И in the middle.

There were two main obstacles which made us start using BLOOM to model the rug before starting to weave it: it was not clear what the scheme for the letter should be and how to set the proportions of the different parts so that we can weave a rug which was long enough. To get a better approximation (in terms of colors in the model), we took a photo of the selected yarns and imported it into the *Snap!* environment where we were able to extract the colors.

The introduction to BLOOM followed the same steps as described in this article. Instead of a demonstration led by an instructor we used an online video-like interactive lesson created with the *SnapReplay* system [12], part of the *iSnap* tutoring system [13]. This helped verify a recording of a clear instructions that can be used remotely at later stage [14]. The child had previous experience with the *Scratch* environment [15] – the predecessor of *Snap!* – and started working with BLOOM right after the instructions. During the model creation there were few experiments with the order of the rainbow colors and the letter’s color and background. The most challenging task at this stage was creating the scheme of the letter. We started with a very simple model with 4 rows in the scheme. The child wanted it to be more prominent so we stretched the scheme to 22 rows. Then it turned out not to be thick enough so we doubled the color lines and filled some extra slots here and there for aesthetic purposes:

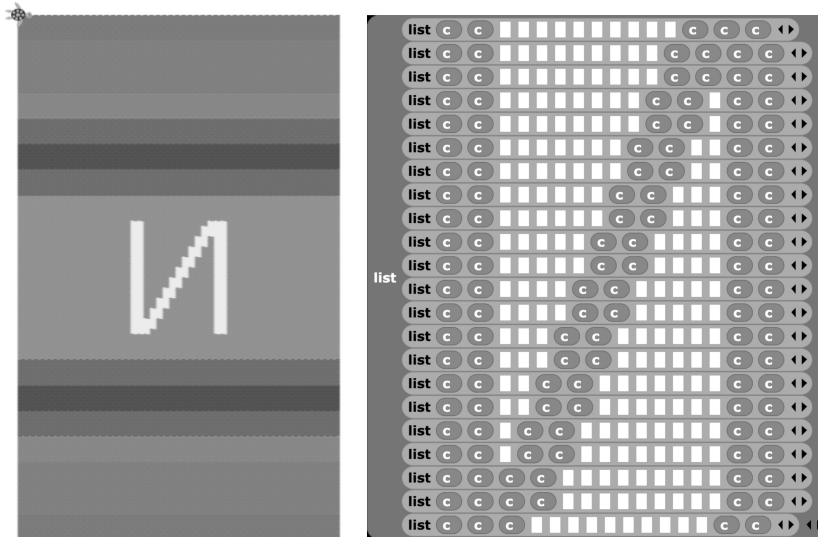


Fig. 13. Model of a rug made with BLOOM. Scheme of the letter И in BLOOM

We downloaded it as a picture which – by counting the spaces and making calculations – is to be used on the real loom.

The last phase – the actual weaving based on the model – was the most difficult and exciting one. Although we had the rug model – the number of rows for each color and the letter’s scheme – we faced few challenges with the implementation of the letter. One of them was the number of shuttles and yarn balls we needed to use which made the weaving harder and at some point affected the motivation of the child. Secondly – the way the carpet technique works for longer vertical lines in the scheme. It leaves a vertical gap where the colors change. If there is a longer vertical line (as is the case on both sides of the letter) there will be a big hole in the rug. We were able to see the issue after weaving approximately 1/3 of the letter, so we decided to do some additional stitching to fix the gap.

So far we have woven the following:

6. Conclusions and future work. The overall feedback about BLOOM is positive. During the modeling, the child said that she liked BLOOM very much impressed by how quickly changes in the rug model affect the rug on the screen. The child worked with BLOOM to create the rug model and used it to weave the real one, counting the scheme’s squares and making calculations. All this took place without openly mentioning notions such as symmetry, matrix transformation, multiplication table although the concepts behind them were used to create the model of the rug and to weave the real one.

Our weaving teacher and some of his students were impressed by the realistic splitkas made with the BLOOM and asked for training so that they can use it in their work (to experiment primarily with the carpet technique).

While this experiment represents an initial phase of a greater study, it revealed several challenges which remain. Firstly, to refine BLOOM, the instructions and the scenario we need more experiments similar to the one described above. Here is an example. Another



Fig. 14. Real rug weaving in progress

child's idea for a rug modeled with BLOOM showed that basic knowledge of computer modeling can help in creating more *natural* weaving schemes. In that case we wanted to model the Swiss flag using the carpet technique. We orally described it as 18 repeats of the first row (18 blue squares, 6 yellow squares and 26 blue squares), then 6 rows with yellow squares only, then 18 rows more identical to the first row. The description naturally suggests using the *Snap!'s repeat* block to repeat one row 18 times instead of defining 18 equal rows in the scheme. In this way the scheme is closer to the verbal description and easier to read and modify.

Secondly, professional weavers need further assistance in learning to use BLOOM. In that case their technical equipment doesn't meet the requirements to run BLOOM and their computer skills need to be improved.

Last but not least, the scenario needs to be adjusted and implemented in environments similar to those in the STE(A)M education centers and public schools to prove compatibility with their curricula.

Despite the challenges, there is strong motivation for taking part in the experiment. There were multiple exchanges of experience and ideas which brought together children, parents, teachers and master weavers in order to create a rug blooming with the colors of the rainbow.

7. Further ideas for explorations. Although BLOOM seems to cover our needs in this particular scenario we must not leave the impression that it is complete [16]. Here are some ideas for further explorations. How BLOOM can be changed to enable new kind of experiments and results? Which parameters and algorithms can be changed to make traditional rugs more fancy? Can new parameters be added? For example, try to imagine what it would be like if the weaving thread formed a bend or if we could change the thickness of the thread.

Weaving is not the only activity that can *weave* naturally the constructionism prin-

ciples in the education [17, 18]. What other scenarios and activities can have similar results?

Weaving as a traditional craft and the loom itself as a hand-operated device provide opportunities for interdisciplinary connections. For example between computer modeling and history. What other connections can be made? How should those connections be integrated in the educational scenario?

We invite all STE(A)M education centers to continue the process exploration and share their discoveries.

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КАК СТАНА МОДЕЛЪТ НА СТАНА

Цветелин Андреев

Статията описва компютърен модел на тъкачен стан и образователен сценарий с десет годишно дете, което използва компютърния модел, за да изтъче истинска черга. Използването на модела за тъкането на истинската черга, съпътстващите експерименти и ангажираността на участниците: детето, майсторът-тъкач, родителят и учителят, показват как технологиите могат да се използват така, че ученето чрез правене и споделянето на резултатите от това стават в хармония с основните идеи на STEAM образованието.

Ключови думи: тъкачен стан, компютърно моделиране, Костенуркова геометрия, конструционизъм, блоково програмиране, STEAM