# Teacher's Motivation for Applying the Unplugged MEMA Method for Early Programming Teaching

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***Abstract* - Teachers' motivation is crucial for the application of innovations in their teaching. Therefore, it is important to find out what factors promote teachers' intrinsic and/or extrinsic motivation so that the innovation is accepted and used in the classroom. This paper points out the need to understand the factors that motivate teachers to use the Unplugged MEMA method for early programming teaching. In this context, ways to motivate current and future teachers to use the MEMA method over time are identified, and possible motivating factors are explained using the existing conceptual model of educational innovation adoption. The results of this work may help create a teacher education model for the future application of the MEMA method and the implementation of similar innovations in the classroom.**

***Keywords – teacher, teaching programming, motivation, MEMA method, young children, innovation acceptance models***

## I. INTRODUCTION

Programming is a very useful activity. With programming, a man becomes a computer master. Without the ability to program, a man becomes only a user, using the machine's capabilities, which he knows how to use, and is often frustrated when the computer gives him wrong answers. So why can not we all program, just like we can all read and write?

If in a classroom of any school the question is asked, "Is programming easy?", almost all respondents will answer that programming is difficult. You will get a similar answer if you ask students, adults or retired people. It is amazing that even people who are assumed to have no problems with programming, such as students of computer science and engineering, think similarly. But no, even among these students, many have problems precisely with programming. Therefore, it is logical that we try to answer the question, "Why is programming difficult for most people?"

To write a program, i.e., a set of instructions in a computer language, it is necessary to think like a machine, i.e., to apply computational thinking. Only some find it easy to get into this role, so there are few in the class who have no problems with programming. From teachers' experience, we know that these students often do not need to be good at other subjects. These students find programming so easy that teachers sometimes fear that the students will outperform the teacher. But how can programming be taught to all, not just the talented?

One can try to find the answer in the analogy to reading and writing. Everyone learns to read and write, not only those who are gifted. But it was not always so. A hundred years ago, there were many people who could neither read nor write. How is it that today the situation is quite different and illiteracy has been almost completely eliminated, except in some parts of the world [1].

Illiteracy is eliminated thanks to education. Good education begins in early childhood. What is normal for learning to read is normal for all other skills. Good athletes train in childhood, children learn foreign languages, play instruments, operate various devices - all without problems. Therefore, an early start to programming seems like a good idea.

If we analyze the letters of the Latin alphabet, there are about thirty characters, which in some languages receive some hooks, two dots above the letters or umlauts, tildes, tails below the letters and more. Also, in some languages there are rules on how to read when two or more letters are written together. In each language, the letters of the alphabet are learned very early (usually from the age of six or even earlier) and very gradually (in one year, the letters are learned and over four primary grades, reading and writing are repeated and completed in the mother tongue).

No one expects children in Croatian schools to learn to read in English or in any language other than Croatian, and this is true for other languages as well, so that little Frenchmen learn to read in French, Englishmen in English, and Italians in Italian. They learn to read and write not only in their mother tongue classes, but also in history, nature, geography and mathematics classes, because everywhere something was read and written. Everything is taught to them by their teacher, who knows exactly what the children can do and how much they know.

If children would learn programming step by step in their native language, as one learns letters and reading, without extra lessons, and if their teacher knew how to explain everything necessary, programming could become easy for all, not only for some.

## II. MEMA Method As A Proposal For Programming Learning For Young Children

There are many approaches and numerous computer programs designed specifically for students' first encounter with the world of programming. When one of the existing programming languages is used for the child's first encounter with programming, a new set of problems emerge waiting to be solved. Unfortunately, the solutions are neither easy nor cheap. Schools must be equipped with hardware and software to work with these programs, teachers must be trained to use this software on this hardware, and students must learn the new material in addition to other material. Classroom teachers are not capable of teaching such programming, and there is a shortage of computer science teachers because they would rather become programmers, at least those who can program well.

For this reason, the MEMA method (without the use of an electronic computer) is recognized by some as a method for the first steps in programming that certainly alleviates and perhaps even avoids all these problems. The MEMA method uses the MEMA toy - a didactic toy that simulates the operation of a computer's main memory [2]. For the first grade of elementary school (Fig. 1), the MEMA toy consists of 9 drawers of different colors, while in the higher grades it uses the names on labels (Fig. 2) that address the variables. Neither hardware nor software is needed.

Figure 1. Toy MEMA (According to the original author of the Mema method, Ph.D. Marina Čičin-Šain)

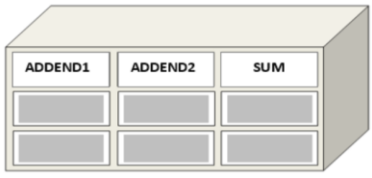


Figure 2. Names of variables on MEMA drawers (According to the original author of the MEMA method, Ph.D. Marina Čičin-Šain; Use the MEMA toy from the first grade, just turn it around - the idea of teacher Divna Bjelanović)

With this method, children in the lower grades of elementary school are taught programming by their teachers, who also teach them other subjects, regardless of whether or not they can program in any of the existing programming languages, which is best for children because they know how young children should be treated.

Children learn programming with minimal extra effort because they repeat along the way what they learn in school anyway, e.g., in first grade they repeat adding and subtracting natural numbers up to 20 [3], in second grade they repeat multiplication tables [4], and in third and fourth grade they practice reading with comprehension and more mathematically complex tasks [5]. Practice has shown that children who have worked with the MEMA method in the lower grades of elementary school master programming in the real programming language more easily [6]. The research was conducted only in a school where only one class worked according to the MEMA method. It was these students who showed statistically significantly better success in programming.

From 2022, the project ERASMUS + will be carried out with the aim of applying the MEMA method and it is expected that the same hypothesis will be confirmed on a much larger sample.

## III. Teachers' Motivation

Many years of experience have shown that the greatest problem in introducing a new thing into schools is the lack of motivation on the part of most teachers. As Crosby quotes Tolstoy in his work [7], the teacher's inertia can be described as follows:

- "The teacher always has a tendency to select that method of teaching which is easiest for him;
- that the easier it is for him, the less satisfactory it is for his pupils; and
- that method only is good which gives satisfaction to the pupils. And to give satisfaction to the pupils it is necessary to take account of the differences between them and of their natural aptitudes."

In order to apply the MEMA method in their teaching process, teachers need certain knowledge, skills and attitudes. However, so far, the results of the practice show that the application of the MEMA method in the classroom is problematic, although teachers expressed positive attitudes towards this method during the trainings conducted in the past period.

Therefore, further research needs to be conducted to identify the motivational factors that could encourage teachers to apply the MEMA method in different educational settings.

### *A. Motivating Current and Future Teachers to use the MEMA Method for Early Learning of Programming*

Prof. dr. sc. Marina Čičin-Šain developed the MEMA method for learning programming at an early age more than 40 years ago and has since held numerous lectures and workshops with current and future teachers to this day.

The lectures and workshops have been delivered in various ways: live and online, in small and large groups with current and future teachers in Croatia, Slovenia and

Poland. This can be seen on the Rijeka Cybernetics Society website [8]. However, only a small number of them have used this method in their teaching. As mentioned above, during the training on the MEMA method, teachers regularly have a positive attitude towards this method, and yet most of them do not end up using it.

To date, several studies have been conducted with the goal of obtaining feedback on the usefulness of MEMA in the classroom and the desire of teachers to continue using this method. After lectures about the MEMA method for experienced teachers and prospective teachers, some questionnaires were distributed and some researches were conducted by the authors of this paper.

After a live lecture on MEMA in 2017, a survey was conducted with students – future teachers (N=30) who attended the second year of Teacher Education [9]. The results of this research [9] showed that student-future teachers find programming difficult, and that Mema is useful as an aid for acquiring knowledge about algorithms in mastering numbers, motor skills developing, and learning colors. Interestingly, 58.6% of them think that the MEMA toy is easy to use, 70% think that the MEMA method is interesting, and 68.6% of them would like to learn more about its use in teaching. Also, a large number of future teachers (70%) considered MEMA to be suitable for children aged 7 and 8 years. It should be pointed out that the participants-future teachers pointed out their insufficient IT education in programming before enrolling in college.

At the end of the workshop "Really first steps in learning programming for teachers" on the application of the MEMA method in teaching, which was held within the "All Digital Week 2018" activity, a survey was conducted with teachers (N = 11) who were between 25 and 60 years of age [10]. The results of the research [10] showed that teachers were hesitant in answering the question of whether programming was difficult. Almost all teachers found the MEMA method useful as an aid in mastering numbers, colors, motor skills and learning algorithms. 90.9% of them expressed the opinion that the MEMA method is interesting and that it is easy to use and that they would like to apply the method in their classes. Since only the MEMA method for the first grade was presented at this workshop, the results of the research [10] confirmed that the MEMA method is suitable for children aged 7 and 8 years. It is important to mention that 63.6% of the participants in this study have never learned programming in any of the programming languages (Logo, Qbasic, C++, Python, ...).

From the previously mentioned results, it is evident that current and future teachers believe that the MEMA method enables the development of IT and general content, especially for the development of logical thinking that every child needs regardless of whether or not they will become a programmer or computer scientist.

### *B. Potential Factors of Teachers' Motivation for Application of MEMA Method*

In the literature it is possible to find a large number of models that have in many ways sought to detect the factors, starting from different aspects, which affect the use of innovations by users.

According to Rogers' model the theory of diffusion of innovations [11] the unplugged method MEMA can be seen as an innovation in the teaching process. Acceptance of this innovation by teachers can be associated with the speed of dissemination of MEMA information over some time through a specific communication channel. In doing so, the essential characteristics of MEMA (e.g. price, availability, usability, ease of use, ..) and the education system (e.g. compatibility with curricula of various subjects). It is important to stress that innovation users can make the decision to accept or reject innovation by personal free choice, collectively or commandingly, followed by a phase of using innovation in an environment [11]. The last stage in the process of accepting innovations according to this model [11] is a confirmation in which the user, under the influence of different factors, can even at the final stage make a decision not to accept or accept the innovation. Where the decision to embrace innovation is the result of a command form, the adoption of innovation can still be at different levels. In this case, it is also necessary to motivate users to apply innovation at higher levels. Embracing innovation, according to Rogers' definition of the process of adopting innovation [11] is "an individual's decision to make full use of the innovation available."

From the above, we can assume that the level of adoption of the MEMA method in educational settings will largely depend on teachers as a key stakeholder of the education system and their motivation for the above.

It is known, according to Deci and Ryan [12] and Vallerand [13], that individuals change their behavior under the influence of various factors extrinsic motivation and intrinsic motivation, and amotivation. Extrinsic motivation includes, for example, getting rewards for effort, monetary gain, praise, the possibility of promotion or, in a negative context, avoiding warning and the like. Intrinsic motivation refers to a set of motives that support the self-motivation of an individual to perform an action such as, for example, desire, self-interest, inner satisfaction and the like, while amotivation denotes a type of motivation when individuals depict a lack of motivation. As an example, it is possible that under this model [13] unmotivated classroom teachers do not see some advantage in using the method.

Furthermore, according to the Technology Acceptance Model – TAM [14], one of the most widely used models for technology acceptance, it starts from the claim that the use of technology can be explained by the motivation of the user in the environment in which they are exposed to the actual use of technology. According to this model, two key factors perceived usefulness and expected ease of use affect the user's attitude towards the use of technology, which has a direct impact on its use measure, which directly affects the actual use of technology.

One example of linking the model of acceptance of innovation and technology with the models of competence in the educational environment to understand the factors that influence the motivation of teachers to use technology in teaching is the conceptual model developed by Babić

[15]. According to this model, there are the following significant categories of factors that motivate teachers to apply innovations in teaching: knowledge, skills, and abilities of teachers, attitudes and values, situational factors, institutional factors, and personal factors.

According to the above conceptual model [15] potential factors that can influence the application of completely free *of charge unplugged* MEMA methods in teaching by teachers anywhere in the world are:

- Knowledge of the MEMA method, the skills of its application in teaching, and the ability of teachers to transfer them to the teaching process;
- Positive teaching attitudes about the application of MEMA in teaching with an understanding of the values of the same in teaching;
- Situational factors: characteristics of students and the subject within which the MEMA method is applied (computer science, mathematics, Croatian language, nature, ...)
- Personal factors of the teacher: personal characteristics, innovation, creativity, and self-efficacy.
- Institutional factors: the education system at all levels and possibilities of applying the MEMA method in teaching (time, incentives for effort, praise, the possibility of advancement, ...).

Within the category "situational factors", the role of student characteristics that can influence the use of innovation in the teaching process is emphasized. The practice has shown that the way students accept the MEMA method motivates teachers to design creative tasks using the MEMA method [3].

## IV. Conclusion

Although the MEMA method for early programming learning for young children has been proven as useful, free of charge and easy to use, practice shows that it has not been used in teaching on a larger scale so far.

Therefore, this paper discussed the motivation of teachers to accept this method, which is considered a complex process that requires additional research on a larger sample of respondents. On the basis of the existing models of acceptance of innovations in this paper, framework factors of motivation are given that can help in further research of teacher motivation for application of unplugged MEMA method for early programming learning for young children.

The ERASMUS+ project "CybeMEMA: Cybernetics in early childhood education – MEMA as a teaching method" (2022-1-PL01-KA220-SCH-000086129) is currently being implemented, involving partners from Croatia, Poland and Turkey. Within the project, the method will be available in four languages (Croatian, English, Polish, Turkish). In partner countries, the MEMA method will be applied and research will be conducted on its usefulness for learning and teaching programming for young children, involving a larger number of teachers and students.

## Acknowledgment

The paper was supported by the ERASMUS+ project "CybeMEMA: Cybernetics in early childhood education – MEMA as a teaching method" (2022-1-PL01-KA220-SCH-000086129).

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