



Citation: Kurt, F. & Batdi, V. (2022). Analyzing the effect of coding-based applications on retention scores through the mixed-meta method. *International Journal of Scholars in Education*, 5(2), 90-100. <http://dx.doi.org/10.52134/ueader.1164479>

Analyzing the Effect of Coding-Based Applications on Retention Scores through the Mixed-Meta Method

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Abstract: In this study, it is aimed to examine the studies on coding-based applications through the mixed-meta analysis method. The effect of coding-based practices on retention scores was examined using the meta-analysis method at first step. Following the first step, a meta-thematic analyzes of the qualitative studies were carried out on behalf of the effectiveness of coding-based applications and results regarding the relationship and effectiveness of coding-based practices with retention were reached. 10 studies on the effectiveness and retention of coding-based practices were attained through the scanning databases regarding document review. According to the results from meta-analysis, effect size ($g=1.48$ – huge) of coding-based applications had a significant difference in favor related practices. In addition, it has been determined that coding-based applications are effective teaching methods when studies based on participants' opinions in line with the themes and codes were examined within the framework of meta-thematic analysis. The results of the research revealed that meta-analysis and meta-thematic analysis findings are compatible with each other and that coding-based practices contribute to easy, effective and enjoyable learning, positively influence students' cognitive development processes, improve their skills, and affect them to come up with new products. Additionally, it has been concluded that the proper usage of the related applications can increase retention. It has been observed that coding-based applications contribute to analytical and multi-dimensional thinking, possess problem-solving property, are easy to reinforce, and provide retention.

Keywords: Coding-based applications, meta-analysis, meta-thematic analysis, retention

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Introduction

For centuries, human beings have been in search of both to meet their needs and to make new discoveries. The industrial revolution has an important place in the process that started with the hunting period and continued until the technological developments that we cannot keep up with today. Industry 4.0, which draws attention as the last stage of the industrial revolution, is a revolution that started under the leadership of Germany and started to take place all over the world in the following process. The main working areas of Industry 4.0 are artificial intelligence, robotic activities, 3D printers, coding, biotechnological activities, nanotechnology and space technology. Industry 4.0 can be defined as an intelligent production period in which all objects, whether living or non-living, can interact with other objects using an internet connection (Aksoy, 2017). With the development of Industry 4.0, computer science has taken its place among the indispensables of human life. For this reason, the use and integration of computer science in educational environments attracts more and more attention every day. The fact that computers and education are so intertwined is undoubtedly that computer skills, which are likely to be one of the features to be sought in the workforce need in the coming years, will contribute greatly to the economic and technological progress of all countries.

Teaching with Computer and Coding

Computer instructional technology includes all kinds of materials and objects in the learning and teaching processes. Among the learning processes, computer science can take place in different ways. When it comes to teaching with computer sciences, various applications draw attention. These applications can be grouped under two different headings as computer-based teaching and computer-assisted teaching (Göksoy & Yılmaz, 2018). In the process of teaching knowledge, the computer is considered a functional tool for the repetition of the subject, as well as supporting the given information and providing a better understanding. Computer-based teaching is used to design, manage and implement teaching activities, to monitor and evaluate students, and to collect and store data about students. Computer-assisted education, on the other hand, helps education and training processes to be used efficiently and effectively due to the advantages it brings. Thanks to computer-assisted teaching, students can carry out learning activities regardless of time and place, without the need to contact a teacher or an instructor. For this reason, computers should be seen as tools that facilitate and support learning in educational processes (Göksoy & Yılmaz, 2018). In teaching processes in which computer science is used, one of the important factors that enables learning to take place is software. The quality of the software and its contribution to learning are possible with a properly planned ideal coding. The ability to code, or in other words to program, draws attention as a very important skill in computer science. According to Askar and Davenport (2009), students who receive coding education in pre-school periods may have difficulties in their educational activities when they start school. In addition, some of the concepts and processes they encounter while learning coding seem abstract due to their presence in the pre-operational period, and therefore they may encounter problems in applying what they have learned. In order to eliminate this problem and to ensure the permanence of coding teaching, different media tools are blended together and visual coding tools are created. However, “programming languages with a predominance of visual tools are becoming increasingly common for students who are just getting acquainted with coding (Çakır, 2020). In addition, when the coding platforms developed for children are examined, it is striking that they are easier to understand and use fun platforms instead of a complex structure as in traditional programming languages. Therewithal, the basic philosophy of coding at an early age will contribute to success in other fields. If we were to make a simple definition about coding, we can use the phrase that ‘coding is the work of programming the computers to perform the desired tasks’. From this point of view, we can conclude that computer systems will not have an effect where coding is not used correctly.

Coding is just as important as math, science and reading skills. Being able to develop coding skills also means developing skills such as analyzing information and technological systems, producing solutions for existing problems and working collaboratively with the team while solving the problem (Kaya & Alpan, 2020). The features of the coding contribute to the originality and permanence of the works that emerge as a result of coding. In this context, coding education has taken its place in 21st century education practices as it encourages students to research and discover new things, to gain knowledge in terms of technological values and to contribute to their teamwork skills. Coding applications used in education activities not only make the learning situation more permanent and meaningful, but also provide creative solutions to existing problems (Altay, 2019).

Retention and Coding

The activities to be determined during the coding studies are of great importance for the results that will emerge as a result of the studies. In particular, robotic coding activities should be evaluated in a wide range in order to be inclusive and respond to the needs of students (Talan, 2020). The effectiveness and retention of the education will be incomplete since the applications that the teachers will make by using the coding tools, without considering the needs of the students in the coding lessons, will only be for the students who are related to science, mathematics and technology. Failure to take into account the needs will ensure more active participation of male students in coding practices and no application will be made in the learning environment for female students. In addition, the use of ready-made coding kits causes a narrowing of the group to be studied (Secer, 2020).

Among the variables that enable students to encode a new information in a more meaningful way, it is the persistence variable that draws the most attention. Facts play an important role in learning situations. Knowing the relationships between facts, concepts and principles is an important factor that supports the permanence and transfer of learning. The permanence of any learned information can be achieved by coding the information. Correct coding of information is one of the factors that make it easier to remember when needed (Telli, 2016).

Purpose and Significance of the Research

The main purpose of this research is to examine the effects of coding-based applications on retention scores and the related studies on the effectiveness of coding-based applications in detail. When the literature is examined, it is seen that there are studies on coding and coding-based applications (Büyükkarci, 2019; Çakır, 2020; Karalar & Özdemir, 2013; Sayın, 2020; Talan & Batdı, 2022; Yüksel & Gündoğdu, 2018). In this study, it was aimed to find different and common features related to the core subject of the research by comparing the meta-analysis and meta-thematic analysis findings as a result of the mixed-meta method. In addition, by using different analysis methods together, it was desired to obtain a holistic result on the related research subject. This study, which we have been conducted on the effect of coding applications on retention scores and the effectiveness of coding applications, is important in terms of getting more detailed results, unlike the previous studies. This study, thus, can fill the gap in the literature on the subject and can be a guide for future studies that are suitable for similar content. In line with the purpose of the research, the following sub-purposes were determined:

- Determining the effect size of coding applications on retention scores,
- Identifying the effectiveness of coding applications by examining the studies based on the opinions of the participants in line with the themes and codes determined in the meta-thematic analysis based on the document analysis.

Method

In the study, the mixed-meta method consisting of two stages was used in order to determine the effect of the coding applications on the retention scores. In this context, the determination of the effect of coding applications on the retention scores was carried out within the scope of the mixed-meta method by making meta-analysis with the quantitative method and meta-thematic analysis with the qualitative method. Herein, we can define the mixed-meta method as a method based on document analysis, which includes the analysis of the data obtained by quantitative and qualitative methods with a holistic perspective. If we are to make a more comprehensive explanation of mixed-meta method, we can say that CMA/MetaWin etc. programs are made use of while analyzing the quantitative data, on the other hand, Nvivo/Maxqda etc. programs are used while analyzing the qualitative data. The fact that the products offered by these programs we mentioned allow us to combine and examine a new study shows that the mixed-meta method is a comprehensive and content-rich method. In short, we can define the mixed-meta method as a combination of meta-analysis and meta-thematic analysis based on document analysis. While conducting a mixed-meta study, it should be noted that the studies to be used in the analysis include quantitative (meta-analysis) and qualitative (meta-thematic analysis) data published by having scientific qualifications (Batdı, 2020). Since both meta-analysis and meta-thematic analysis were carried out in the analysis process of this study, the method will be conveyed with the processes carried out under two main headings.

Meta-Analysis Process

In the quantitative dimension of the research, meta-analysis was used to determine the effectiveness of coding applications on retention. Meta-analysis, also called the synthesis of quantitative research, creates a visual summary evaluation by making inferences from the data values of previous studies related to the research subject to be examined (Cooper et al., 2009). As one of the positive aspects of meta-analysis, it can be said that the results of different studies are richer, have wider content than a single study and can be generalized compared to the results of a single one (Borenstein, et al., 2007). Meta-analysis can be described as a re-synthesis of previous quantitative research. It can be defined as a statistical technique used to bring together the results of different studies on a particular subject and add a new interpretation (Crombie & Davies, 2009).

The databases of the Council of Higher Education, Google Scholar, Taylor & Francis Online, Web of Science, ScienceDirect and ProQuest Dissertations & Theses were searched in order to reach the studies on the effect of coding-based applications on retention scores. In the scanning, “The effect of coding-based applications on retention scores”, “The effect of robotic Educational”, “The effects of robotic coding”, “The impact of robotic”, “The effectiveness of robotic” were the key words/expressions used. Studies including the effects of coding-based applications on retention scores, covering the data necessary for analysis, applying the pretest and posttest experimental design were included in the analytical process. While determining the studies included in the analysis process, articles published in peer-reviewed scientific journals, master’s and doctoral theses published in Turkish and English were included. 11 data out of 6 studies were determined within the framework of the relevant inclusion criteria from 740 studies reached as a result of the search.

Meta-Thematic Analysis Process

A meta-thematic analysis, which has a qualitative dimension as a complement to the quantitative dimension, has been added in order to be able to examine the research subject in more detail and to expand the scope of the study. While applying the meta-thematic analysis process, it is aimed to re-evaluate the results obtained from the qualitative studies determined according

to certain criteria regarding the subject content of the relevant research and to gather the themes and codes revealed as a result of the evaluation activities. In other words, meta-thematic analysis is the examination of documents and studies with a qualitative dimension based on document analysis, the analysis of verbal and textual findings, and the bringing together of all these qualitative findings with themes and codes (Batdı, 2019). In this research, the study of determining the effectiveness of coding applications was carried out by making meta-thematic analysis. The data obtained to determine the effectiveness of the use of coding applications were examined by document analysis. Document analysis can be defined as a systematic and planned process, which is carried out to examine existing documents in detail by working with written or digital materials, allowing to accumulate knowledge from these documents and to make sense of existing documents (Corbin & Strauss, 2008). In this context, qualitative studies, which included participant views, were examined in order to determine the effectiveness of coding applications. The obtained data were collected for the purpose of the research. While examining the qualitative dimension of the research, 4 studies in which the themes and codes were taken and related quotations were included were considered. Codes and themes have an important place in the meta-thematic analysis process. In this respect, 5 themes such as “permanence”, “mental effect”, “skill”, “learning” and “application” were created, and the themes and codes were grouped and modeled.

Results

In this section of the study, the results obtained from meta-analysis and meta-thematic analysis processes were explained under two titles. At first, the meta-analysis findings of the studies regarding the effectiveness of coding-based applications were presented and interpreted. The next stage includes the findings and comments obtained as a result of the meta-thematic analysis of the studies related to coding-based applications.

Meta-Analytical Results

In the first part of the study conducted through a mixed-meta analysis, the findings obtained as a result of the meta-analysis are presented in Table 1. When the relevant findings are evaluated in the light of the data, the effect size the coding-based applications on retention is found to be 1.48 [1.14; 1.82]. This effect size value regarded as a large level according to the Thalheimer and Cook's (2002) classification. According to this result, it can be stated that the effect of coding-based applications on retention has a positive effect. In addition, when the test type scores were examined, a significant difference was found ($p < .05$).

Table 1
Meta-Analysis Results

Test Type	Models	n	g	95% Confidence interval		Heterogeneity		
				Lower	Upper	Q	p	I ²
Retention	FEM	11	1.39	1.20	1.59	31.00	.001	67.74
	REM	11	1.48	1.14	1.82			

When the data in Table 1 are examined according to the random effects model, with an average effect size of 1.48, it can be said that the effect of coding-based applications on retention is more effective than traditional teaching methods. Moreover, the result is seen to be in favor of coding-based applications. When the heterogeneity test type value is examined, it is recorded that the effect sizes of retention ($Q=31.00$; $p < .05$) are heterogeneously distributed. On the other hand

the I^2 value (67.74%) indicates that the observed 68% variance is due to the true variance among the available studies (Cooper et al., 2009).

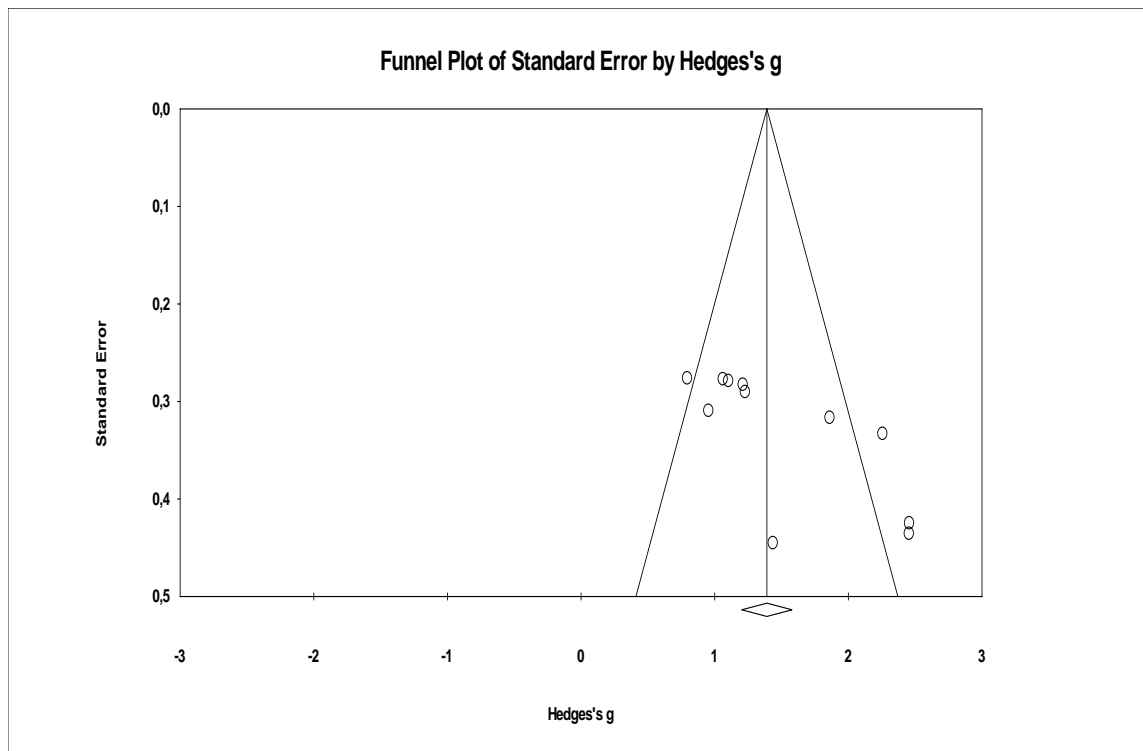


Figure 1. Funnel plot

As shown in Figure 1, it was determined that the majority of the 11 data included in the analysis process indicated a distribution towards the middle part of the graph. In order to avoid publication bias, it is expected that related studies will spread symmetrically on both sides of the vertical line indicating the combined effect size (Borenstein et al., 2009). The same case is seen above which means a reliable analysis has been carried out. In addition, Orwin's Fail-Safe N calculation was made to test the publication bias. The Fail-Safe N calculation reveals the number of studies that may be missing in a meta-analysis (Borenstein et al., 2009). In the related study, this value was calculated as 630. So, it can be stated that the values revealed are a high figure within the framework of the research. Based on the high values specified, it can be concluded that the analysis transactions performed are reliable.

Meta-Thematic Findings

In the second stage of the research, a meta-thematic analysis was carried out by conducting document analysis. The obtained data were presented as a model and interpreted. The themes and codes obtained as a result of the analyzes are specified in the model. As seen in the model, the codes created regarding the effectiveness of the coding-based applications were presented under the sub-themes of the main theme in Figure 2.

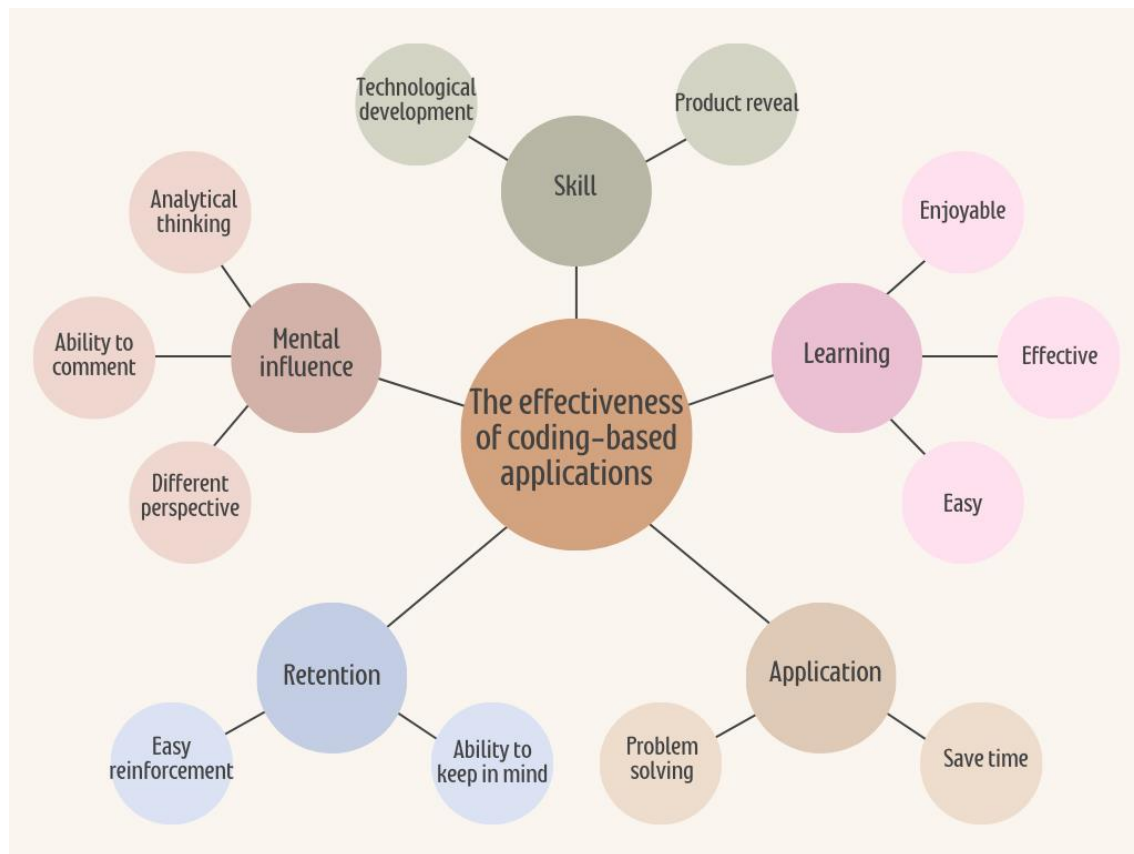


Figure 2. Effectiveness of coding-based applications

In Figure 2, some of the codes related to the effectiveness of coding-based applications can be expressed as “analytical thinking, mental influence, problem-solving orientation, product design”. In the context of the related theme, the following expressions can be presented that were quoted from the study encoded as M1-p. 371: “*I didn't forget what I did in the previous work.*”, as M2-p. 548: “*...plugging and running things, then coding them parts gives us something more visual. A product emerges. I like it.*”; and as M3-p. 789 “*...helps me find a solution, and I can establish different perspectives.*” These expressions are taken as a reference and the codes were created around these sentences. Moreover, in the M4-p.728 coded study the expressions like “*Absolutely usable. It can be taught by making the child love the lessons. The combination of the two courses makes the teaching permanent.*” and in the 10272872-p. 50 coded study, the statements like “*I believe that it will have a great impact, especially in areas that require thinking skills. I think children will have simpler and more practical thinking skills.*” can be presented as referenced phrases while determining the codes. With these relevant quotations, it can be said that coding-based applications contribute to analytical and multi-dimensional thinking, are problem-solving oriented, and are easy to reinforce, and provide retention.

Discussion and Conclusion

In this study, the mixed-meta method, which consists of two stages, was used in order to determine the effect of the coding-based applications on retention scores. The mixed-meta method, which emerged with the analysis of documents, is a method that allows to reach results through enriched content by analyzing quantitative data (meta-analysis) via CMA/MetaWin programs and qualitative data (meta-thematic) via Nvivo/Maxqda programs (Batdı, et al., 2021).

In this context, a quantitative meta-analysis was conducted in order to determine the effect of coding-based applications on the retention scores. In addition, the mixed-meta method was carried out by performing meta-thematic analysis with qualitative method in order to determine the effectiveness of coding-based applications in terms of participants' views.

The results of the meta-analysis were discussed by comparing them with the results available in the literature. When the relevant findings are examined and evaluated, the effect size value of the coding-based applications on retention scores were calculated to be 1.48 [1.14; 1.82]. The effect size value attained a result of the analysis was found to be at a large level according to the Thalheimer and Cook's (2002) classification. According to this result, it can be stated that the effect of coding-based applications on retention has a positive effect. In addition, when the test type scores were examined, a significant difference was found ($p < .05$). As a result of the analysis regarding the random effects model; with the mean effect size of 1.48, it can be said that the coding-based applications is more effective than traditional teaching methods.

In line with the aims of the meta-thematic research, the analysis of 4 studies, which were achieved through document analysis, was made by content analysis. As a result of the meta-thematic analysis, a large number of codes related to the effectiveness of coding-based applications have been reached. As a result of the codes, it was concluded that coding-based applications have effects such as making learning more permanent and providing more effective learning, contributing to mental development and bringing advantages in terms of practice. When the literature is examined, it is seen that there are similar studies on coding applications (Büyükkarci, 2019; Çakır, 2020; Karalar & Özdemir, 2013; Sayın, 2020; Talan, 2020; Yüksel & Gündoğdu, 2018). For instance, Büyükkarci (2019) recorded in his study that coding-based applications improve students' problem solving and math skills. Moreover, in his research, Sayın (2020) stated that teachers' interest in coding-based practices is increasing day by day. The fact that the applications based on coding had a positive effect on the retention scores in the current study can be interpreted as the fact that the teachers' interest in coding may increase over time which were reached in the conclusion of Sayın's study and this result is also in parallel with the results obtained in the present study.

The current study, which we conducted on the effect of coding-based applications on retention scores, is important in terms of obtaining more detailed results, unlike previous studies. This study is expected to fill the gap in the literature on the related research subject and may be a guide for future studies that are suitable for similar content. As a result of the analyzes, it was concluded that coding-based applications contributed to easy, effective and enjoyable learning, had a positive effect on the mental development processes of the students, on their skill development, and increased the permanence with the right application methods. Ceylan (2020), in his study regarding the permanence of coding applications, evaluated the practices from the students' point of view, and as a result of this evaluation, the students stated that coding-based applications were instructive, suitable for their level, excited them, and positively affected their interest and attitudes towards the lessons. In addition, students stated that it would be beneficial to apply this method in all courses. In another research, Şahbaz (2021) examined the effect of the coding applications included in the scratch program. As a result of the applications carried out in this program, it was revealed that the applications had a positive effect on the students. In order to increase this effect, he suggested that the trainings given can be supported with robotic coding applications (Şahbaz, 2021).

The application-based approaches in today's technology world are thought to be an effective teaching approach in terms of facilitating learning and retention of knowledge. The inclusion of coding applications in the curriculum is not yet at a desired level. It is thought that the active use of new curriculum arrangements and coding practices, especially in primary school and even in pre-school period, will have positive effects on students in the following years. When

coding applications are mentioned, only applications related to informatics and technology courses come to mind. However, using coding applications in other branches such as science, mathematics, music, and visual arts is also important in terms of increasing the memorability of the activities. In addition, the use of coding practices in all courses will be beneficial in terms of an interdisciplinary approach. The active use of coding practices by teachers will contribute positively to educational processes. For these reasons, it is recommended to carry out activities to increase the proficiency levels of teachers about coding practices, to increase the interdisciplinary effectiveness of coding practices and to associate them with the cases in daily life. It is obvious that serious steps can be taken in order to raise solution-oriented, productive and interpretive generations thanks to the change of perspectives of individuals with coding practices.

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