Teachers' Views on Effective Use of 5E Model in Primary School Mathematics Education

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Abstract

This study was carried out to investigate the classroom teachers' constructivist approach models, their use of the 5E Model in mathematics lessons, their opinions about the positive and negative aspects of the model, and their suggestions on what kind of applications can be used to enrich the model. The working group consisted of a classroom teacher (n = 9) with a service period of 9-33 years. The study is a descriptive study and purposeful sampling was used. The data were obtained by semi-structured interview technique and content analysis was performed. As a result of the study, it was stated that the teachers are not alien to the steps in this model, they generally use but do not know that they are called as "5E Model", although they have hesitations about using the model in the current classroom conditions, the majority of them find the 5E Model useful and it will be more suitable above the 3rd grade level.

Key words: Primary school, mathematics education, 5E Model.

INTRODUCTION

Societies can realize their experiences and knowledge they have gained into the future by providing education to each generation. The sophistication and dignity of a country is proportional to its education and knowledge (Aydın, 2003). In this sense, education has always been valued in the past and present and even has been specialized and comprehensive in various fields. Mathematics education is one of these areas. Mathematics is the simplest form of life, abstracted form of life (Altun, 2006). Mathematics is needed to reveal the miracles of modern technology. Today's society will be dysfunctional without mathematics. Television, mobile phone, gigantic jet

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passenger aircraft, satellite navigation systems in vehicles, medical scanners and everything that seems natural to us are actually based on mathematical ideas and methods (Stewart, 2019, p.7-8). Societies have to keep themselves up to date in order to meet the changing and developing technology and the changing needs.

In today's conditions, societies are expected to be developed in many skills. 21st century skills that we can say as versatile; It is expected to be individuals who are not consumers but producers, think critically, have problem solving skills, and have high social communication (Partnership for 21th century skills, 2008). Communities can renew themselves only through education and follow developments. In this context, scientists are constantly in search of education. This quest is made in order to develop students in many ways, and at the same time, it is to have individuals who have the ability to learn permanently by having fun, be productive, integrate knowledge into daily life and solve problems in the problems that they will encounter. Mathematics allows students to think, criticize, solve problems and therefore has the versatility mentioned. Mathematics positively affects not only the daily life of students but also their success in education. In mathematics, the student learns to organize information systematically, to enter data correctly, to research, and to think related and provides success through these skills. It was found that students who were successful in mathematics course showed positive results regarding success in other courses (Göğüş, 2008).

Mathematics is a difficult lesson to learn at almost all levels. The success of our country in mathematics is assessed by both national and international evaluation programs. PISA (Program for International Student Assessment), known as the International Student Assessment Program, and TIMSS (Trends in International Mathematics and Science Study), which are known as the International Mathematics and Science Trends Research, and how they rank with other countries. Since 2003, with intermediate points average of all countries as 459, Turkey with 454 average takes place in 42 out of 79 countries shows that it is below average in mathematics literacy field (MEB, 2019). TIMSS in line with the actual figures for the actual research in 2015, the average

international level, designated for 4th class as 500, and Turkey received 483 points which was below average. At this level, it ranked 36th out of 49 countries. In the 8th grade, Turkey was again below average by 458 points. Turkey took 24th place out of 39 countries in the last level (MEB, 2016). Along with the problems, student's failure in mathematics negatively affects attitude towards this course (Tabuk, 2019). In this case, it can be said that the student continues his life by memorizing enough to get a valid grade, not learning mathematics. In this case, it would not be wrong to say that generations that cannot fully understand the information, criticize, interpret it, love mathematics, but instead turn it into fear.

If mathematics is considered as a lesson consisting of abstract concepts and difficult to understand, it is important to make use of methods and approaches in which students can participate, have fun and learning is permanent at the same time. After 2005, the constructivist approach, in which the student was taken to the center and the teacher assumed the guidance role, was preferred. In the this approach, the student draws an active role in the lesson, and the teacher does not transmit the information to the students. They get their own information under the guidance of a teacher. In this process, the student is encouraged to make connections between the old and new information he has acquired (Hagerman, 2012).

Although the constructivist approach is based on 3E Model for use in the classroom environment, it has been diversified as 4E, 5E and 7E Model with certain additions over time and is widely included in the literature (Bayram, 2015). 5E Model is the most preferred of these models. This model was developed and used by Rodger Bybee, one of the leading names in Biological Science Curriculum Study (BSCS) (MMS, 2002). The reason why the model consists of five digits and the English equivalent of each digit is taken into consideration is named as "5E". While these steps are in Turkish as “Introduction, Discovering, Explanation, Deepening and Evaluation”; “Enter, Exploration, Explanation, Elaboration and Evaluation” is available in English (Ezberci Çevik & Öner Armağan, 2018; Turgut, Baker, Cunningham and Piburn, 1997). Said steps can be briefly explained as follows.

It is important to draw the attention of students to the subject in the entry step. No information and recognition about the subject are included. The information that the students have is determined, and the student is motivated about the new concepts to be learned. The teacher can use various activities at this stage. A remarkable story, poetry, play, puzzles, materials can be used. It is important for the student to form question marks in this step. The aim is not to find the right answer but to ask questions (Dodge, 2017).

In the discovery step, the students question, try to explore and research the situation. At the same time, the student can think freely and make predictions. At this stage, the teacher can guide, show certain ways for students to discover, and enable them to work collaboratively. He observes students throughout the process (Güneş Koç, 2013).

In the explanation step, students are expected to explain the situation and concept in their own words. The form of expression can be verbal as well as provided by the use of writing, demonstration, and material. In the process of students' expressing themselves, the teacher can provide some guidance, make corrections, complete the deficiencies or make some additions. At this stage, the student can make changes and adapt to the information he / she has acquired (Dağ, 2015).

In the deepening step, the student develops and deepens the acquired knowledge. They are provided similar situations, and reinforcement is expected on the acquired information. New information can be associated with the use of situations in daily life. Thus, it can be ensured that solutions for many situations can be produced. At this stage, different techniques such as group discussions can be used (Bybee, 2019).

The evaluation step is a step where the peer evaluation will take place as well as the students can evaluate their own development in line with the information they have obtained. Besides the teacher observing the whole process gains many ideas about the development of the student. In this step, open-ended questions, multiple choice questions, and worksheets can be used to reveal more clear results regarding the student's development (Taşlıdere, 2015). Thus, the 5E Model enables the student to take

an active role in the lesson at every stage and allows them to reach their own concepts (Ergin, 2006). Researches on the 5E Model revealed that the model positively influences students' achievements and attitudes towards the lesson (Hagerman, 2012; Hiçcan, 2008; Kara, 2018; Öner, 2015; Yılmaz, 2018). It can be deduced that the attitudes of students at primary school level towards the lesson will also affect the success of the lesson.

METHOD

Research Design

This study is a descriptive study since it aims to determine the opinions of teachers about the use of 5E Model in mathematics education.

Participants

Nine classroom teachers in Isparta with 9-33 years of experience took part in the study. The number of people to be included in such studies should generally not exceed 10. It is natural that the number of people is limited since there will be long interviews and interviews requiring more than one session (Yıldırım & Şimşek, 2013). Teachers' professional age, gender, code and length of service are given in the Table 1 below.

Table 1.
Age, gender, code and service period of teachers

Gender	Age	Experience	Code
Female	42	21 years	T1
Female	49	28 years	T2
Female	46	25 years	T3
Male	32	9 years	T4
Male	55	33 years	T5
Male	41	18 years	T6

Male	48	29 years	T7
Female	35	12 years	T8
Female	46	27 years	T9

Data Collection Tools

In this study, semi-structured interview technique was applied to collect data. In addition to the questions asked in the interview form, additional questions such as why, how, exactly what did you mean, explain were asked in order to clarify the issues. The teachers in the study were coded as T1, T2,… T9. Teachers asked to answer;

1. Whether they use the 5E model in mathematics teaching,
2. How the 5E model affects or affects the mathematics teaching process in terms of academic and attitude,
3. What are the positive and negative aspects of the 5E model,
4. At what grade level the 5E model can yield a more effective result,
5. Answers to the questions of which methods and techniques can be used in the implementation of 5E model stages (Introduction, Exploration, Explanation, Deepening Information, and Evaluation).

Data Collection

In this study, semi-structured interview technique was applied to collect data. The interviews were held at the appropriate time of the teachers. In order to ensure that the sound recordings to be clear, these interviews were held in the school manager's room and in the teachers' room. In order not to disturb teachers, questions were asked in the style of chat. The transcripts of the interviews were made and analyzed.

Data Analysis

Content analysis approach, one of the qualitative data analysis techniques, was used in the analysis of teachers' views on the use of the 5E model in mathematics teaching in primary school. In the content analysis method, data similar to each other are brought together within the framework of certain concepts and themes, and interpreted in a way that the reader can understand (Yıldırım & Şimşek, 2013).

In order to apply the analysis, sound recording was performed first and then coding was performed. The data written in the transcripts by the researcher were made with descriptive analysis and thematic codes were created. In addition to the main theme determined from the data, sub-themes were created by making content analysis. As a feature of the study, “direct quotations” are frequently included. The realized theme and sub-theme model are given in the Figure 1.

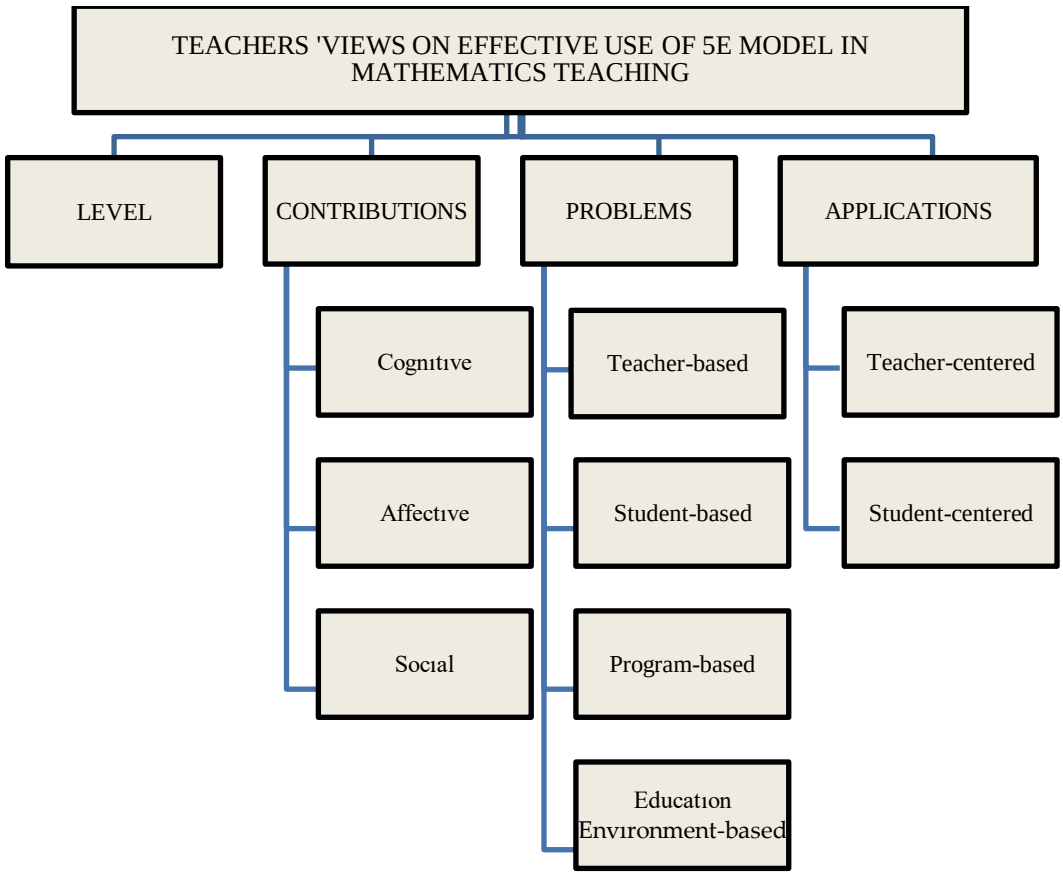

Figure 1. Theme and sub-theme model realized in content analysis approach

FINDINGS

With the 2005 primary education program, the adoption of a constructivist approach brought with it a number of teaching models. One of these models is the 5E Model, and our teachers were asked about what they know about this model and how they can make this model more effective. First of all, teachers were asked whether they use this model or not. In line with the answers, it was among the results that the name of the model is unknown. "*Can you explain*? (T2) "," *5E Model is foreign to us* (T7) "," *I heard it partially* (T8) *", " If you open the 5E Model a little* (T4) "," *Can you explain*? (T3) "," *I have no idea about 5E, but… the basis of the issue is the same, even if there have been minor changes for years* .. (T5) "

After the Turkish equivalents and definitions of the letters " E "in the 5E Model were explained to the teachers, it was revealed that the teachers used this model but remained very foreign by name. However, the use of the 5E Model was grouped as those who used it with the 2005 program and those who used it before. Results regarding the usage status of teachers are presented in Table 2.

Table 2.

Frequency distributions of the time when teachers started using the 5E model.

Using Primary Educatıon Program	Related participants
Beginning with 2005 Primary Education Program	1 (T1)
Those who used before the 2005 Primary Education Program	8 (T2,T3,T4,T5,T6,T7,T8)

Level

Opinions differed on which grade level the 5E Model would be suitable for. While some teachers thought that it would be right to apply the students before they learned the subjects from the 1st grade, some teachers found it more appropriate at the 3rd grade levels. Findings are grouped in the Table 3 below.

Table 3.

5E Model's suitability and frequencies at class levels.

Class levels	Related participants
From 1st grade	3 (T3,T5,T9)
Above Grade 3	5 (T7,T8,T1,T2,T6)
Secondary and high school	1 (T4)

The teachers expressed their views as follows:

We can see more clearly in 4th grade (T1).

4th grade (T2).

We also use it in 1,2.3 more intensely… .4. We use it in all classes (T3).

As a result of the interviews, it is revealed that the teachers find this model appropriate at the grade levels above the 3rd grade.

Contributions

The contributions of the 5E Model were examined under three headings: cognitive, affective and social, and the frequency distribution in the sub-titles is given in the Table 4 below.

Table 4.

Frequency distribution under the cognitive, affective and social subtitles of the 5E Model

Subtitles	Related participants
Cognitive	8 (T1,T2,T3,T4,T5,T6,T7,T8,T9)
Affective	3 (T2,T3,T5,T9)
Social	4 (T2,T3,T5,T8,T9)

Cognitive

The teacher views showed that students benefited in terms of achievements with the 5E Model, and the model provided ease in solving math problems, and they explained their opinions on this subject as follows:

I think it has a positive effect on achieving the gains (T1).
It gradually increases children's success to a high level (T3).
When we apply all the aims and steps of this (5E Model), learning is realized (T6).
A view was expressed that it would allow the student to think creatively:
Based on his creative thinking, he finds himself dominating the subject by finding himself with the method of invention.

Affective

Four of the teachers reported that the 5E Model supported the students in an affective dimension and stated as follows:

It increases self-confidence; Since she has the right to speak and can express her own ideas, she increases her self-confidence… I believe and observe that children are happy… we have an enjoyable lesson with the children (T3).
... I am sure that math will not be a nightmare for students in Turkey (T5).

Social

Five teachers stated that the 5E Model supports the social development of the students. A few of these views are as follows:

It minimizes problems in the classroom and increases children's respect and cooperation (T3).
It is mentioned that students are associated with life and benefit students in this sense as follows:
It is the most important for me to get the child into the event for your life… (T9).
… Can practice it, put it into daily life… good experiences have been experienced (T8).

Problems

In the use of the 5E Model, some teachers expressed various opinions about the negative sides they experienced or could experience. However, some teachers stated that they did not encounter any negativity related to the model in every sense.

I see it as positive (T1)", "I did not see its negativity, there are no negative aspects to me (T2).

The negative sides, according to the teachers, may result from: *teacher*, *student*, *program* and *educational environment*. The distribution of the possible problems are given in the Table 5.

Table 5.

Frequency distribution of the possible problems with the 5E Model.

Possible problems	**Related participants**
Teacher-related	3 (T4,T6,T7)
Student-related	2 (T5,T8)
Program-related	4 (T8,T9,T4,T5)
Education environment-related	4 (T3,T4,T5,T6)

Teacher-related

Teacher-borne problems in the implementation of the 5E Model may be "not practicing enough, and not being creative enough". Teacher views are as follows.

…. *Implementation* is *left to the creativity of teachers* (T4).

If the teacher does not master this, he cannot do this anyway ... If there is a lack of information or if he does not master the subject then there is of course a problem (T6).

One of our participant teachers saw teachers as practitioners; He stated that he will definitely have problems at the time of application, and he can solve this problem with his experience, or that he can share it with other teacher friends and school administration and find a solution to the problem.

Student-related

Teachers stated that during the implementation of the 5E Model, students may be bored with being constantly active and may be reluctant to participate in activities due to individual differences in student-borne problems. The views are given below.

Students may be tired of being active all the time… Always the same students can be active in the lesson (T5).

The child must have a high level of interest (T8).

Programme-related

In the interviews, the issues such as *"the lack of time during the application, the inability to apply to every subject, the training of the curriculum of the teachers, the duration of the lesson and the inclusion of more applications in the course"* rose out. Teachers expressed these situations as follows:

The applications should be given more space, rather than filling our heads with theoretical information (T4).

Lesson times are not enough. Time is not enough. We teach 5 hours of mathematics lessons per week. How do you activate the student in 5 hours of mathematics lessons? How will you train the subject? Then is it not necessary to adapt the curriculum to the 5E Model? (T5).

The curriculum has to catch up. We give our exam dates accordingly. I place a student-centered place, but I have to master it later. I take the rush to take a moment and finish a subject (T8).

In addition to these views, one of the teachers stated that it would not be possible to apply the 5E Model in every subject.

Education Environment-related

In the use of the 5E Model, teachers talked about a number of problems that may arise from the educational environment. These problems have come to the fore as "*the*

schools are not in the city center, the preparation or acquisition of materials, the crowd of the class sizes and the noise". Teachers' opinions are given below.

I*t is negative to have some more fusion and noise while helping each other* (T3).
We often have material problems. In some cases, we try to do something with our own efforts…. Schools can be supported in this regard (T4).
This may not be applicable in a restricted, very scarce village school (T6).

Applications

In order to make the use of the 5E Model more effective, our participating teachers reported some practices as advisory opinions. These are the practices that teachers use in mathematics lessons or believe that their use will have an effect. Teachers did not study these practices under any method and technique name, but shared their ideas as the applications they obtained only with their own experience. In the study, the expressions of the participant teachers are given exactly as they do not include the application that teachers say under any method and technique name.

Since the applications are diverse, they are gathered under two groups as teacher-centered and student-centered. It was found that all teachers benefited from student-centered applications and that both participants included both applications in their four teacher teachers.

Teacher-Centered

Four of the participating teachers included teacher-centered practices in their views and mentioned five different practices. Applications and frequencies are given in the Table 6 below.

Table 6.

Teacher-centered practices recommended for effective use of the 5E Model

Teacher-centered practices recommended	Related participants
Covering the topic	1(T3)
Exampling	1(T6)
Feedback	1(T6)
Question-answer	1(T7)
Storytelling	1(T8)

The opinions of teachers about teacher-centered applications are given below.

The question-answer method is better applied (T7).

In the stories, the method of sensing is used first for that child. Is it rectangular without its name? Is it trapezoid? ……. That shape is formed in his head. The scheme is being formed. "Yes, children, such things happened at the end of this story, draw it." When we say, they can draw that shape .. Then it is called "trapezoid", this name is "rectangular" ... .. it is very nice to walk that way by storytelling (T8).

Student-Centered

In line with the interviews, it was revealed that there was a consensus that all of the participant teachers included student-centered practices and there could be applications to make use of the 5E Model effective. The teachers also shed light on that student-centered understanding can be applied before, during and after the lesson. The Table 7 below lists the student-centered practices that teachers advise to make the 5E Model effective.

Table 7.

Student-centered applications proposed for effective use of the 5E Model

Student-centered applications proposed	Related participants
Drama	2 (T1,T8)
School-trip-observation	1(T2)
Game	2(T1,T7)
Material Use	1(T1,T4)
Material preparation	3(T3,T4,T8)
Preliminary	2(T4,T5)
Project	2(T5,T8)
Group work	1(T5)
Homework	1(T6)
Drawing	1(T6)
Identification with his life	1(T9)

For example, we will shop… We can use something like a small market in the classroom. I think it is effective in drama studies. It becomes effective when you gamify (T1).

They like it more when they do it with the materials they prepare (T3).

I think this method is more suitable for group work; If it is installed, everyone takes responsibility (T5).

DISCUSSION, CONCLUSION AND IMPLICATIONS

In the study, the use of 5E Model, which is rarely used in the field in mathematics teaching, has been the focus of the current study, and the opinions of the teachers have been taken about this model. As a result of the study, it was found that the participant

teachers used the 5E Model in their classes before the 2005 primary education program, but did not know its definition, and the researcher had to explained that “E” sounds mentioned in the model were the initials of the English words. As a result of the explanation, it was revealed that the teachers are not far from these definitions and use them continuously. It is one of the results that the participant teachers who use the model do not use the on purpose, and that they have realized the ranking in the 5E Model by using their own experiences by chance.

Some of the participant teachers stated that this model can be applied in the 1^{st} , 2^{nd} and 3^{rd} grade because the curriculum allows to practice it in a longer period. But, the majority of teachers argued that it would be suitable to apply this model from 3rd grade for the students have not gained many of the necessary concepts. The teachers, who found the application appropriate in the upper classes, believed that the students would improve themselves at these grade levels. The study conducted by Kozcu and Çakır (2019), which supports the current study results, found that the lowest effect is realized at the primary school level, while the model has the highest effect at the secondary, high school and university levels.

All of the participant teachers think that 5E model will provide students with the opportunity to have creative thinking skills, and will contribute to positively cognitive skills of students in this context. In addition, some of the teachers stated that, with the application of the model, students can adapt what they have learned to their daily life, and will contribute positively in terms of social and emotional aspects.

During the implementation of the 5E Model, the creativity of teachers and their mastery of the subject were some of the possible problems that may originate from the teacher. Ayvacı and Bakırcı (2012), who worked with science and technology teachers, and Bozdoğan and Altunçekiç (2007), who gave their opinions about the model from science teacher candidates, emphasized that there were problems arising from the teachers' not knowing the model exactly. The participants of this study indicated that the students’ remaining active is a student-related problem In the process of activating the students. The inadequacy of the lesson times and the intensity of the curriculum for the

implementation of the 5E Model has led to a negative effect on the use of the model in the current program. In line with the opinions of the participant teachers, during the implementation of the model, the problems due to noise and classroom management, the number of students in the class, material deficiency and physical conditions have also emerged as problems arising from the educational environment (Bozdoğan & Altunçekiç, 2007).

During the lesson, teacher-centered and student-centered practices were mentioned to make the 5E Model effective by the teachers. While all teachers involved student-centered practices, four participants found it appropriate to include teacher-centered practices. Storytelling, getting feedback on the subject taught, question-answer and subject expression were included in these practices. While the material preparation frequency has the highest value in student-centered applications, it is recommended to use preliminary preparation, project, drama, game material use, trip-observation, group work, homework, drawing, identifying life. Participant teachers reported that the practices they proposed had more permanence and had a positive effect on attitude and success. The results of the studies carried out in various fields in Turkey support the opinions of the teachers. İlter and Ünal (2014), Pulat (2009) and Dağ (2015) found in their studies that students' attitudes towards the lesson were positively affected by the application after the application.

In this study, teachers stated that cooperative learning is an important teaching methods, and this finding is supported by other studies (Rodriguez, Allen, Harron and Qadri, 2019). While Erdoğdu (2011) worked on adapting the 5E Model to the teaching of electricity, he directed the students to cooperative work and got positive results in this regard. Also, our participants believed that this model will support the permanence of the information (Özsevgeç, Çepni & Bayri, 2007; Şahiner 2013). Bayram (2015) confirmed the grammar teaching with the 5E Model in the 6th grades by obtaining results in favor of the experimental group in the permanence test.

In line with the results of the current study, a guide book can be prepared about the new teaching methods added to the programs. Approach types and models can be included under the name of teaching methods and techniques in the guidebooks. Class sizes can be arranged on the basis of student-centered approach in all schools to make the implementation more efficient. Schools can be supported with teaching materials, or schools can be provided for practical materials. Classes may be designed for students to move easily, or math laboratories can be created for training. By conducting experimental studies, the 5E model can be run at the grade levels recommended by teachers. The development of students in terms of cognitive, affective and social aspects may be examined by using the 5E Model in various course topics.

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