**Research Article**

# Examining the pre-service science teachers views on intelligence games used in science teaching[1]

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| Article Info | Abstract |
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| | In this study, the relationship between classroom teachers' professional commitment and This study aims to examine pre-service science teachers' views on the use of different intelligence games in science teaching. The research was designed in a case study pattern. The research study group consists of 19 second-year pre-service teachers studying in the science teaching undergraduate program at a state university in the fall semester of the 2020-2021 academic year. Intelligence games were introduced to the participants in the online seminars given for 6 weeks. They were asked to plan a science teaching related to the intelligence game of the week and to fill out a form to express their opinions every week, and at the end of the seminars a focus group interview was conducted. Data collected through weekly opinion forms was analyzed through content analysis and the data gathered from focus group interviews were analyzed through descriptive analysis. At the end, it has been understood that pre-service science teachers generally think that intelligence games are useful for science teaching and believe that they make learning permanent and fun in science education. The opinions of pre-service science vary depending on the game. While preservice teachers evaluated Magic Pyramid and Missing Words as the most useful intelligence games for science teaching, they found the Kendoku game less suitable for science teaching. |
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## Introduction

Play is a natural and fun way of learning from childhood onwards. Play triggers our brain's dopamine-reward system, keeping us motivated. The playing process of a well-designed game leads to focused engagement in the learning processes (Myers & Reigeluth, 2017). Educational games are games that aim to teach a specific concept or target behavior to an individual or individuals (Aksoy, 2014). Educational games support and develop students' skills such as using imagination, evaluating information, competing, and making decisions (Prensky, 2008; Yazıcıoğlu & Çavuş Güngören, 2019).

Educational games are divided into digital games and non-digital games (Li & Tsai, 2013). Digital games are games for entertainment purposes played with tools such as computers, tablets and phones. Non-digital games, on the other hand, are games that can be played with traditional methods such as paper, pencil, or any game object, as well as games

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that use physical limbs such as hand-foot coordination (Uzun et al., 2013). Intelligence games are counted among the educational games in the non-digital games group.

Intelligence games involve cognitive strategies in which an individual filters his/her solutions through a specific thought filter in order to reach a solution (Alessi & Trollip, 2001). These games are also accepted as brain-building or brain-training games because they provide brain gymnastics (Ott & Pozzi, 2012). Students should find the most accurate way to reach the result in the shortest time possible, which contributes to the development of skills such as decision-making, trial and error, using prior knowledge, and developing alternative ways to solve problems (Arslan & Dilci, 2018).

Intelligence games include reasoning and processing games, verbal games, memory games, strategy games, geometric-mechanical games and intelligence questions (Ministry of National Education [MoNE], 2013; MoNE, 2016). Examples of reasoning and operation games are Sudoku, Alphabet Linking, Admiral Sunk, Magic Pyramid, Kakuro, Kendoku, Operation Square, Futoshiki (MoNE, 2013). Anagrams, Missing Words and Word Hunt are verbal games, while Picture Recall and Picture Matching are memory games; games such as Chess, Checkers, Mangala, Tik-Tak-Toe are strategy games, while Jenga, Tangram and Mikado are geometric-mechanical games (MoNE, 2013). Examples of intelligence questions are Wolf-Lamb-Ot, Three Light Bulbs, 12 Balls, Liar-Corrector (MoNE, 2013).

Intelligence games are thought to be an educational tool that brings together the similarities and close relationships between different disciplines and develops students′ ability to think at a higher level and use the knowledge they learn in daily life (Ebner & Holzinger, 2007). However, in Turkey, intelligence games are mostly associated with mathematics courses. Çağan and Usta (2023) found that intelligence games increased the mathematics achievement of middle school students, while Yöndemli and Taş (2018) found that they had a positive effect on mathematical reasoning ability. It has been revealed that teachers are also of the opinion that intelligence games will positively affect mathematical skills (Alkaş Ulusoy et al., 2017; Kel & Kul, 2021). Consistent with these studies, Erdoğan, Eryılmaz et al. (2017) concluded that intelligence games have potential for teaching mathematical concepts.

However, science teaching and intelligence games are compatible with each other in terms of curiosity, generating various solutions to problems and looking at things from different perspectives. Numerical and verbal materials used with intelligence games especially enable students to explore, generate solutions to a problem and try different ways (Bottino et al., 2007). Moreover, in line with these features, the middle school science curriculum (MoNE, 2018) has specific objectives such as finding solutions to the problems encountered in the relationship between humans and the environment, developing reasoning ability, scientific thinking habits and decision-making skills by using socio-scientific issues.

Despite these close relationships, it is seen that the number of studies on the application of intelligence games in science courses is limited. Kurupınar et al. (2022) took the opinions of science, pre-school and primary school teachers about the use of intelligence games in science teaching and found that teachers saw intelligence games as an educational tool in science teaching; however, most of them did not receive any training on intelligence games. In their study, Çetin and Özbuğtu (2020) questioned the opinions of pre-service science teachers about the use of intelligence games in science teaching after the studies in which intelligence games were introduced practically, and it was revealed that they expressed positive opinions in a positive direction. Yükseltürk et al. (2022) questioned the opinions of a group of pre-service teachers about the educational applications of intelligence games in their study focusing on the digital play of intelligence games. There were no pre-service science teachers in the study group. However, the pre-service classroom teachers in the study group revealed that they had the view that intelligence games were more compatible with mathematics lessons.

The positive views of pre-service teachers regarding the educational use of intelligence games are important for them to develop positive attitudes. However, it may be more appropriate to focus on the opinions of pre-service teachers in situations where they focus on the instructional applications of intelligence games, rather than examining the impact of beliefs and attitudes towards educational use based on practices based on learning and experiencing intelligence games. Can (2020) examined the inhibiting and supporting factors that may form the basis of pre-service teachers′ attitudes towards the instructional use of intelligence games. In this study, which was conducted on classroom teachers, pre-

service teachers were trained on how to integrate intelligence games and teaching, and they were asked to associate an intelligence game of their own choice with a course, learning domain and outcome of their choice and to associate it with the learning and teaching process of a primary school level course.

## Aim of Study

In this regard, it was thought that there was a need to determine the content of the science education curriculum integrated with intelligence games to be developed for teachers and teacher candidates, by focusing on the hindering and supportive factors of integrating different intelligence games into science teaching. In this study, it was aimed to determine the views of pre-service science teachers on the use of different intelligence games in science teaching. In addition, the general views of pre-service teachers on the integration of intelligence games with science teaching were also examined.
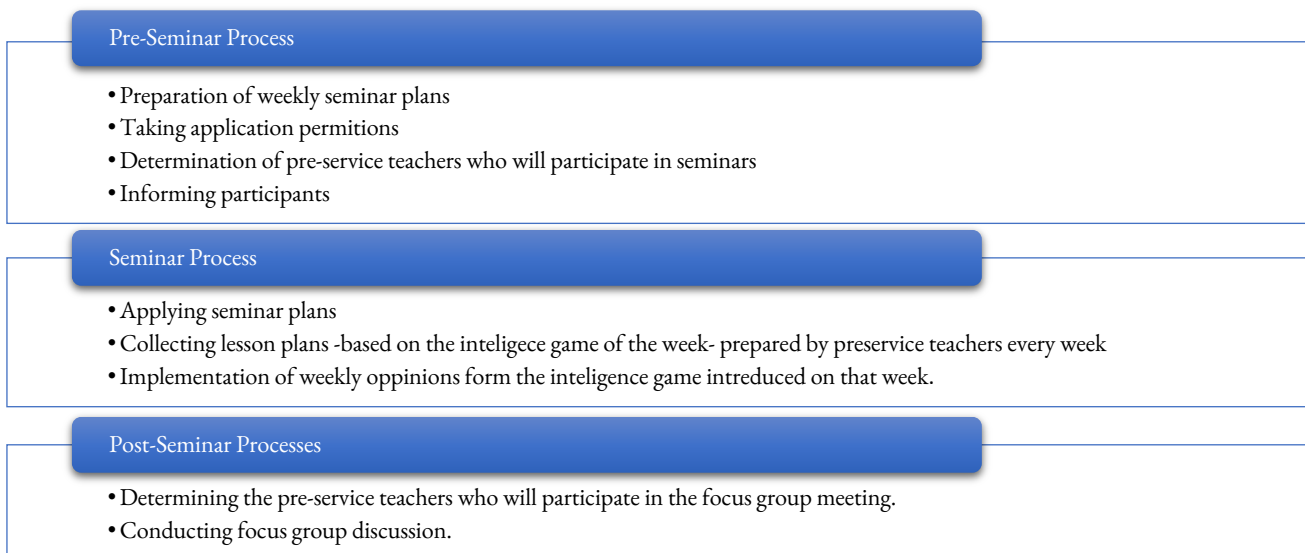
## Method

### Research Design

This research is a qualitative study designed with a case study design. Case study is one of the studies which intertwined with life and in which the researcher has the least influence from the outside in a way, and also it enables to investigate the research subject in depth by applying to many data sources (Gürbüz & Şahin, 2017). In case studies, it is generally aimed to reveal and interpret perceptions about a situation (Yıldırım & Şimşek, 2016:289- 291).

### Study Group

The study group of the research consists of 19, second-year science teaching undergraduate program students who are studying at the faculty of education of a university in the Marmara region in the fall semester of the 2020-2021 academic year and who voluntarily agreed to participate in the study. The study group was determined by criterion sampling, one of the purposeful sampling methods. The reason for the second-grade science teacher candidates in the study group was that they did not take courses that could cause them to develop resistance due to classroom management variables or pedagogical content knowledge, and  that they were taking the field Teaching Principles, Methods and Techniques course, which was thought to support the plans they were expected to develop within the scope of the study.

### Process

In the case study process, a 6-week seminar was planned by the researchers based on the Ministry of National Education's Mind and Intelligence Games Curriculum for Secondary Schools (MoNE, 2013) and implemented to the pre-service teachers by the researcher who  had previously received a Mind and Intelligence Games Trainer Training certificate. The procedures before, during and after this seminar process are schematized in Figure 1.

**Pre-Seminar Process**
- Preparation of weekly seminar plans
- Taking application permitions
- Determination of pre-service teachers who will participate in seminars
- Informing participants

**Seminar Process**
- Applying seminar plans
- Collecting lesson plans -based on the inteligece game of the week- prepared by preservice teachers every week
- Implementation of weekly oppinions form the inteligence game intreduced on that week.

**Post-Seminar Processes**
- Determining the pre-service teachers who will participate in the focus group meeting.
- Conducting focus group discussion.

**Figure 1.** Case study process diagram

As shown in Figure 1, weekly seminars were first planned. First, the intelligence games to be introduced in the seminar were determined. In determining the intelligence games, the criteria of being applicable in the classroom environment with few materials and being easy to adapt to the science course were used. From the category of reasoning and processing games, four games were determined as 'Alphabet Linking' (Week 1), 'Magic Pyramid' (Week 2), 'Futoshiki' (Week 3) and 'Kendoku' (Week 5), while two games were determined as 'Anagrams' (Week 4) and 'Missing Words' (Week 6) from verbal games, making a total of six intelligence games. Seminar plans consisting of four parts were prepared for teaching the games to pre-service teachers. The seminars prepared with the direct teaching approach consisted of a) introduction of the game including the purpose and rules b) playing under the guidance of the teacher c) playing an example of the game adapted to science subjects independently d) training on game development as an integrated subject area. A sample seminer plan was given in Appendix 1.

After the preparation of the seminar plans, the process of obtaining ethical approval and application permissions from the ethics committee of the graduate education institute of the university where the application will be carried out was started. Ethical approval and application permission were obtained with the decision of the board dated 04/12/2020 and numbered 06/02. The seminar was announced to the target participant group and volunteer participants were informed in detail about the research process.

The application was carried out online through the application used by the relevant faculty of education in the distance education process in the Fall semester of the 2020-2021 academic year (which fell into Covid-19 pandemic duration). All seminars were recorded with the permission of the preservice teachers. The seminars lasted 20-30 minutes as planned. The Figure 2 and Figure 3 contain the a few screen shots from the online seminars.
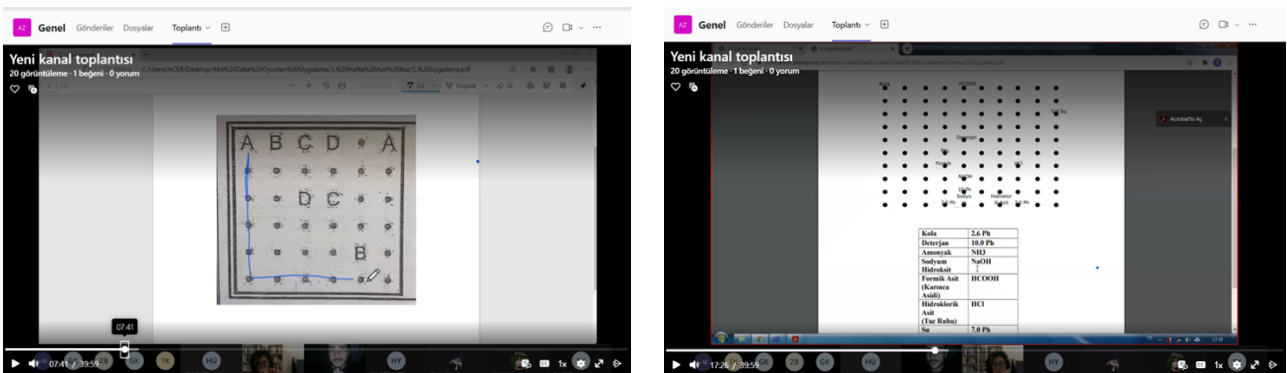


**Figure 2**. Screen shots from the seminar in which alphabet linking was introduced
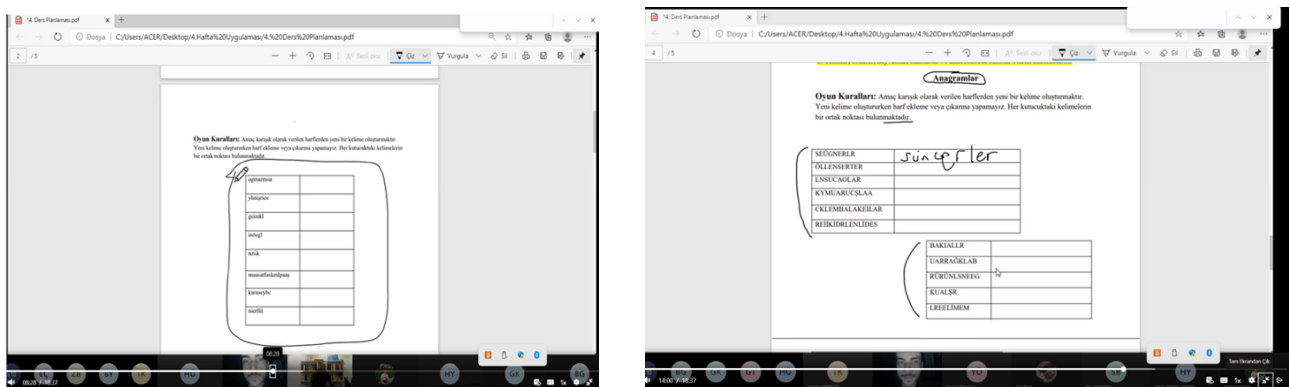


**Figure 3.** Screen shots from the seminar in which anagrams was introduced

At the end of the seminar, each week, the pre-service teachers were asked to choose a learning outcome suitable for the science course, make a lesson plan accordingly and use the intelligence game they had learned in the seminar in these lesson plans. In this way, it was ensured that the pre-service teachers had an experience on the use of intelligence games in science teaching. The pre-service teachers filled out an opinion form about the plan they developed until the next seminar and the weekly intelligence game application and submitted it to the researchers via the online application platform.

After the seminars were completed, the lesson plans prepared by the teachers were examined and the participants of the focus group interview were determined from the pre- service teachers who prepared lesson plans with different qualities and eight pre-service teachers were invited for the focus group interview on a voluntary basis. All the invited pre-service teachers volunteered to participate in the interview. With the participation of both pre-service teachers and the researchers, the focus group interview was conducted through the online application. During the focus group interview, pre-service teachers' opinions were obtained through a semi-structured interview form. The interview lasted 1 hour, 15 minutes and 53 seconds and was recorded.

**Data Collection Tools**

Opinion forms about the weekly intelligence games application and focus group interview form were used as data collection tools in this research. Opinions about the weekly intelligence games application form consists of three open-ended questions (Appendix 2) aiming to reveal the opinions of pre-service teachers about the application in science teaching of the intelligence games they have learned in that week's seminar and its possible effects on students and science teachers. The draft form was shared with an academician who is an expert in the field in terms of language and expression. Corrections were made in the statements by considering the opinions of the expert. And also, a semi-structured interview form was prepared for the focus group interview (Appendix 3). In this form, it was tried to determine the supportive and obstructive views of pre-service teachers regarding the use of intelligence games in science teaching. Expert opinion was also taken for this form.

**Data Analysis**

The data obtained from the opinion forms about the weekly intelligence game application were subjected to content analysis and the data obtained from the focus group interviews were subjected to descriptive analysis. Content analysis is an approach that investigates the truth by classifying expressions according to their meanings and making inferences (Tavşancıl & Aslan, 2001). Opinion forms about the weekly intelligence game application were analyzed one by one and codes were created. The coding process was done manually by the researcher. In addition, common categories were determined from these codes. The number of pre-service teachers who preferred the codes (frequency) was analyzed and tabulated. The focus group interview was first transcribed and then analyzed by descriptive analysis. Descriptive analysis is the method of first determining the themes while presenting the data and then presenting them by establishing relationships between these themes (Yıldırım & Şimşek, 2016:239-241). The data obtained from the focus group interview were presented in relation to the categories that emerged in the content analysis of the data obtained from the opinions about the weekly intelligence game application forms.

**Validity and Reliability**

In qualitative research, validity is defined as the attempt to assess the accuracy of the findings made by the researchers and it is recommended that researchers engage with at least two of the existing 'validity strategies' for this assessment (Creswell, 2013). In this study, rich description and external moderation were utilized as validity strategies. While presenting the findings, it was tried to be exemplified with as many quotations as possible.

For reliability, inter-coder consistency was checked. Reliability generally refers to the stability in the responses of more than one coder (Creswell, 2014). In this study, codes and categories were first extracted by one researcher. The other researcher analyzed some of the data on her own. It was seen that the codes obtained by the researchers were common. Subsequently, the researchers categorized and presented all codes with common decisions.

## Findings

**Preservice teachers' views on the use of different intelligence games in science teaching**

In this study, the views of pre-service science teachers on the use of different intelligence games in science teaching were also examined. For this purpose, pre-service science teachers' opinions were analyzed for each intelligence game and positive and negative aspects codes were obtained. The frequency table of the obtained codes for all games is given in Table 1.

**Table 1.** Content analysis of preservice teachers' opinions about the educational aspects of different intelligence games used in science education

| | Codes | Alphabet Linking | Magic Pyramid | Futoshiki | Anagrams | Kendoku | Missing Words | Total |
|---|---|---|---|---|---|---|---|---|
| **PA** | Increases retention | 7 | 12 | 7 | 8 | 5 | 8 | 47 |
| | Convenient | 4 | 11 | 7 | 9 | 5 | 14 | 46 |
| | Reduces workload | 4 | 9 | 6 | 8 | 6 | 7 | 40 |
| | Enjoyable | 5 | 3 | 6 | 6 | - | 4 | 24 |
| | Student development | 4 | 2 | - | 4 | 6 | 3 | 19 |
| | Facilitates learning | - | - | 8 | 4 | - | - | 12 |
| | Draws attention | 4 | 7 | - | - | - | - | 11 |
| | Ease of evaluation | 2 | - | - | - | - | - | 2 |
| | Increase participation | - | - | - | - | - | 2 | 2 |
| **NA** | Increase workload | 4 | 1 | 3 | 1 | 8 | 5 | 22 |
| | Usage limited | 1 | 1 | 5 | 2 | 10 | 1 | 20 |
| | Difficult | - | - | - | - | 7 | - | 7 |

**PA**: Positive aspects **NA**: Negative aspects

As seen in Table 1, for each game introduced to them, pre-service teachers stated that intelligence games would increase retention in science teaching and that they could be used for science teaching. In addition, it was believed that for most of the pre-service teachers' other than Kendoku, the other games would make lessons enjoyable. They also stated that they would improve learning, facilitate learning, and attract attention. Although fewer than the positive opinions, it is seen that there are also negative opinions about intelligence games. It is seen that they stated that they would increase the workload, that the science subjects they can be applied to are limited and that they are difficult to use in science teaching. While the magic pyramid game received the most positive comments, Kendoku received the most negative comments.

When Table 1 is examined, it is understood that the majority of the pre-service teachers stated that intelligence games increase retention in the weekly interview form. As can be seen, pre-service teachers stated that all of the games introduced would increase retention:

> *"The student's enjoyment of intelligence games leaves a mark on the student in learning the concepts learned in the lesson more quickly and making them permanent." (Teacher10, opinion for Alphabet Linking)*

> *"I think that the intelligence game we learned this week can be used for more information (reminder) level questions in science teaching. It will be especially useful in reinforcing memorize topics. It can provide morepermanent and easily understandable learning."(Teacher3, opinion for Magic Pyramid)*

> *"Lettering the concepts will help them retain the concepts in their minds. They will be able to better comprehend the concepts that we separate as big and small."(Teacher16, opinion for Futoshiki)*

> *"There may be some conceptual words, I think it is a good way to keep these conceptual words in mind" (Teacher11, opinion for Anagrams )*

> *'When we apply the intelligence game called Kendoku to the acquisitions in science teaching, I think that if it is applied in subjects such as sorting subject-based acid base pH forces towards acidity, finding and sorting the densities of substances in density, etc., the students will keep the order in their minds in a schematized and correct way."(Teacher2).*

> *"It can be effective in teaching concepts in science education. This application facilitates the retention of Latin words with scientific content and gives the opportunity to practice." (Teacher4, opinion for Missing Words)*

Based on examination on opinions of pre-service teachers, it is understood that they generally think that it increases retention because it allows learning by doing and experiencing. Teacher6, Teacher2 and Teacher4 especially emphasize that it increases retention because students have the opportunity to practice the subject themselves. Teacher3 and Teacher11, on the other hand, mentioned that using it at the recall level, that is, in situations requiring memorization,

would increase retention. It is understood that Teacher 10 thinks that the intelligence games increases retention because it makes the lesson enjoyable for the students and allows them to enjoy it.

Another view that pre-service teachers expressed at a high rate about intelligence games is that intelligence games are useful for science teaching. Moreover, pre-service teachers expressed this view for all games. Some of the opinions of pre-service teachers in this direction are presented below as examples:

*"It can be used very well and comfortably during the lesson. Depending on the place, we can prepare very good games on science subjects and apply them in our teaching life." (Teacher8, opinion for Alphabet Linking),*

*"Since the activity is suitable for many subjects, it can be used in most lessons." (Teacher5, opinion for Magic Pyramid)*

*"I think it can be used easily in many subjects. When students make comparisons on any subject, they can both repeat the subject while sorting from big to small, and their thinking skills will be improved with this application." (Teacher3, opinion for Futoshiki)*

*"Even if it is not used in every subject, it can be preferred in some subjects (usually subjects that involve numbers or sequences). It does not necessarily have to be numbers, but I think it is more usable in those subjects." (Teacher9, opinion for Futoshiki)*

*"The use of the intelligence game I learned in science teaching provides many advantages. It is useful for handling difficult subjects in an easy way."(Teacher6, opinion for Anagrams)*

*" I think this intelligence game is an application that will be very useful in subjects that have a sequential relationship between them." (Teacher14, opinion for the Kendoku)*

*"Since there are a lot of concepts in science lesson, it is a game that can be used a lot in this lesson."(Teacher5, opinion for Missing Words)*

*"I think this intelligence game can be used in almost every subject of our lesson because it is very easy to apply. It can be used to teach concepts in every subject."(Teacher7, opinion for Missing Words)*

As can be understood from the quotations and Table 1, pre-service teachers think that all intelligence games can be easily used in science teaching. However, it is understood that they find Missing Words the most suitable for science teaching. Missing Words, which is a verbal game, is considered appropriate for teaching the concepts in the science course, and Teacher 5, Teacher 7 and Teacher 8 clearly stated this.

Pre-service teachers state that when the teacher uses intelligence games as activities or measurement tools in science teaching, this will make the teacher's job easier as it will lead to easier learning for students.

Pre-service teachers stated that all other games, except Kendoku, would make the lesson fun.

*"I think it would be nice to make the lesson fun with games by using the Alphabet linking game in science lessons." (Teacher15, 'Opinion for Alphabet Linking intelligence game)' '...the teacher will analyze how well the concepts are learned, go back to the places where they are not learned and have a fun and productive time with her students at the same time.' (Teacher17, opinion for the Magic Pyramid)*

*"The lesson becomes more enjoyable for the student. When the game is mentioned, the student looks forward to the game and listens to the subject with his/her ears, which is a very good situation for both the student and the teacher." (Teacher8, opinion for Futoshiki)*

*"Students understand the subjects with more concepts more fun, better and permanently. Students can be less bored in the lesson with this application."(Teacher9, opinion for Anagrams)*

*"Although the students have a little difficulty in the first words of the game, they will solve it quickly afterwards. This game will be both enjoyable and instructive for them."(Teacher7, Opinion for Missing Words)*

As can be seen in the quotations, it was mentioned that it would provide pre-service teachers with the opportunity to develop different skills such as reasoning and self-evaluation apart from learning the subject. As shown in Table 1, Kendoku is the intelligence game that pre- service teachers most frequently stated that it develops students. In addition, some pre-service teachers also stated that the Intelligence games they knew would facilitate learning and attract students' attention:

*"The mind and intelligence game that I learned in this course is a successful method to learn easily about the subjects that have a relationship of magnitude and minuteness between them." (Teacher 1, opinion for Futoshiki)*

*"The intelligence game that I have learned in this course includes reason and logic in science teaching. It makes it easier for them to learn the subject by grasping their logic."(Teacher6, opinion for Kendoku)*

*"Inconnections with the subject, if we use intelligence games in our lessons we can attract students' attention and interest to the lesson." (Teacher18, opinion for Alphabet Linking)*

*Kids' interest in the lesson will increase, they will make an effort to understand the lesson in order to be successful in the given games and they will make an effort to listen to the lessons. (Teacher10, opinion for the Magic Pyramid)*

While T1 and T6 mentioned that the games would facilitate learning, T18, T10 and T13 stated that the games would attract students' attention. In addition, as shown in Table 1, several teachers also mentioned that they facilitate assessment and increase participation in the lesson as positive features of intelligence games. Although not as many as these positive views, pre-service teachers also expressed negative views about intelligence games. It is understood that some pre-service teachers think that Intelligence games will increase the workload of the teacher:

*"The teacher and the student will have a mutual workload because the teacher will prepare the questions and the student will benefit the teacher with the knowledge of the subject in the following subjects." (Teacher11, opinion for Alphabet Linking )*

*"I think that the games we prepare now will increase the teacher's workload because preparing the games requires a lot of effort and a significant preparation is needed beforehand. The advantage can be during the lesson and on the students."(Teacher8, Futoshiki)*

*"It is difficult for teachers to prepare. When it is given to a student as an assessment, it can be evaluated in a difficult way."(Teacher12, opinion for Futoshiki)*

*"It is a type of game that will increase the workload. It is really difficult to prepare the game and adapt it to the subjects."(Teacher8, opinion for Kendoku)*

*"..... applying it to every subject requires thinking, I think that it will take students a long time and take time from the lesson in terms of the application in the lesson."(Teacher 1, opinion for Kendoku)*

The preservice teachers stated that all the intelligence games introduced to them would reduce the teacher's workload. However, there is no consistency among these opinions. Magic pyramid, Anagrams and Missing Words were the three games that were positively consistent in terms of reducing workload.

*'Since the activity is fun, it will have a great effect on the functioning of the lesson. Since it is an activity that will increase the participation and attention of the students in the lesson, the teacher's job will be easier."(Teacher5, opinion for Magic Pyramid)*

*"Intelligence games play an important role in the development of students such as thinking skills and logical reasoning. In addition, these games will increase the motivation and concentration of the students to the lesson, which provides convenience for the teacher in the teaching of the lesson." (Teacher3, opinion for Anagrams)'*

*"The application of the intelligence game I learned in science teaching makes it easier for teachers to explain the lesson. They can apply it when they want to do an activity. It can reveal more permanent solid learning and teaching. It will lighten their workload more."(Teacher6, opinion for Missing Words)*

For the Alphabet Linking Game, there is no consistency among the opinions. As seen in Table 1, the pre-service teachers were not in agreement about the effect of the Alphabet Linking Game on the teacher's workload; some stated that it would decrease, some stated that it would increase and some stated that it would have no effect on the teacher's workload. However, for the Kendoku game, the majority of the pre-service teachers stated that it would increase the teacher's workload. It is understood that other negative opinions are also directed towards the Kendoku game. Some pre-service teachers criticized the Kendoku game on the grounds that the subjects they can use in science teaching are limited and that it is difficult to apply in science teaching:

*"It is a game with a very limited area of use." (Teacher8, opinion for Kendoku)*

*"I think it can be used for very few things. It's a complicated game. It can be used in 1-2 subjects at most. It was difficult to adapt the subject to the game."(Teacher9, opinion  for Kendoku)*

*"I think it is a difficult game to use because I think it will be difficult to find a topic that can be used with this game." (Teacher11, opinion for Kendoku)*

Kendoku is the only game that pre-service teachers found difficult to use in science teaching. After the Kendoku game, Futoshiki is the other game that teachers expressed negative opinions by stating that the science subject that can be applied is limited:

*"I think it is a more restricted game in terms of subject compared to the other games we have done." (Teacher12, opinion for Futoshiki)*

*"I think it is not a very useful application, the number of subjects to be adapted is limited" (Lecturer13, opinion for Futoshiki)*

In line with these opinions, the pre-service teachers emphasized the supportive factors of the Magic Pyramid, Anagram and Missing Words games more, while the Kendoku game was the game that the pre-service teachers emphasized the most on the hindering factors due to its difficulty, lack of fun and negative effects on workload.  Futoshiki game, on the other hand, was found to be inappropriate in terms of content with science lessons.

**General opinions of preservice teachers on the use of intelligence games in science teaching**

The general opinions of pre-service teachers about the use of intelligence games in science teaching were obtained by analyzing the data obtained from the focus group interview conducted after the training seminars. It was seen that these opinions were consistent with the opinions stated for different intelligence games and the positive effect on retention was emphasized first. Regarding this situation, pre-service teachers expressed the following opinions in the focus group interview:

*"... when students do intelligence game activities, they learn without getting bored and the retention of the subjects is longer. You know, they do not forget quickly. In addition, in some of our games, we did schematization and grouping activities. If we apply them in these acquisitions, students can learn grouping more easily. I think this way in such acquisitions such as the classification of living things."(Teacher2)*

*" For example, there, since the student will try more than one way, he will use the words continuously until he finds the right way and I thought it would be more memorable and I think it is useful in providing attention*

*and visual intelligence."(Teacher14)*

*"First of all, because there are so many concepts in science education, I think these games are much better. Because we always use words in these games. Because they always focus on the words, you know, we always associated something with that word in their minds, you know, for example, we said a word, for example, 'a', for example, in the game, he tried to find that a, for example, so in my mind, involuntarily, that is, even if they did not want to, those words and concepts could always stay in the minds of the students. That's why I think it can be used. That's how it is."(Teacher16)*

In the general opinions of pre-service teachers on the use of Intelligence games in science teaching, fun and increasing interest were another supportive factors emphasized.

*"...I generally used it in systems or sequential subjects, mostly for them to understand the location of concepts. I mean, I used it mostly for them not to confuse, to memorize correctly."(Teacher7)*

Most pre-service teachers mentioned that regardless of the intelligence game used, intelligence games would increase students' interest in the lesson and make the lesson more fun and contribute to both having fun and learning. Student 7 mentioned this issue in the focus group interview as follows:

*"Teacher, actually, the student looks at it like a game, that is, he looks at it like a game. I mean, he has fun, but at the same time I think he learns without realizing it."(Teacher7)*

Finally, the pre-service teachers mentioned that the subject area in which some intelligence games can be used in science teaching is limited and therefore their usefulness decreases. When Table 1 is examined in relation to this issue, it is seen that the game that the pre-service teachers stated quite a lot of opinions on this issue is the 'Kendoku' intelligence game. The pre-service teachers also mentioned the limitation of the science subjects that can be applied in the adaptation of intelligence games in the focus group interview in Kendoku as follows:

*"... I can't remember the name of it, but we made a table and there were different sections in the shape of a square. It was indicated with lines. I had a little difficulty in this game, there was a game that was something like one plus two. I had a hard time preparing that game. I mean, I couldn't find a topic. Even though I found a topic, I got a little confused about how to do it. That's what happened."(Teacher7)*

*-"How should I say it, I mean, it was quite complicated for the student to be able to do the operations there, or to distinguish the pH of the substances, or to understand the implementation of that activity. For example, I would not make them apply it, teacher."(Teacher10)*

The general opinions of preservice teachers regarding the use of intelligence games in science teaching are consistent with the views stated for different intelligence games and the positive effect on performance

## Discussion and Conclusion

In this study, pre-service science teachers' views on the application of different intelligence games in science teaching were examined. During the research, six games were introduced to pre-service science teachers for six weeks, one game per week. Each week, pre-service science teachers were asked to prepare a lesson plan in which they used the intelligence game introduced that week in science teaching, thus providing them with a design experience. Data were collected through opinion forms filled out for each game. At the end of the study, a focus group interview was conducted and the opinions of pre-service science teachers about the application of intelligence games in science teaching in general were examined.

As a result of the research, it was observed that pre-service teachers' views on different intelligence games differed and the emphasis on supportive and obstacles factors varied from game to game. Preservice teachers' views on the supportive factors of the use of Intelligence games in science teaching are largely in agreement on learning and their effects on

students. The pre- service teachers emphasized the positive effects of intelligence games such as learning concepts, increasing retention, and supporting student development both on the basis of games and in general.

When the literature is examined, it is seen that there are studies that have reached the results that intelligence games increase success (Bottino & Ott, 2006; Demirel, 2015; Orak et al., 2016) and increase creativity (Ott & Pozzi, 2012). In this study, it was determined that pre-service teachers believed the use of intelligence games in science teaching would increase the retention of what was learned. In addition, pre-service teachers stated that Intelligence games would develop students and facilitate their learning. In line with this finding, there are studies that found that pre-service science teachers stated that intelligence games will improve students (Çetin & Özbuğtu, 2020; Savaş 2019). Kurupınar et al. (2022) reported that teachers believed intelligence games would increase the retention of what was learned in science lessons.

However, there are different game-based opinions about the effect of intelligence games on learning and learning-teaching process. Pre-service science teachers reported that the use of Alphabet Linking and Magic Pyramid games in science teaching would increase students' attention to the lesson. In addition, the pre-service science teachers of the games other than Kendoku also stated that intelligence games would make the lessons fun.

The opinions of pre-service teachers differ from game to game in terms of teacher workload and use in science lessons. While most of the pre-service teachers emphasized that the Magic Pyramid, Anagram and Missing Words games would reduce the teacher's workload by focusing on facilitating learning, they could not reach a consensus on this inhibiting factor in the Alphabet Linking game. Kendoku came to the forefront with inhibiting factors in terms of both increasing the teacher's workload and adaptation difficulty to science content. Futoshiki game was also evaluated as incompatible with science content. Kurupınar et al (2022) also stated that teachers had difficulties in associating science subjects with intelligence games in their research in which they examined teachers' views on intelligence games in general. The views of pre-service science teachers in this study on the application of intelligence games in science teaching in general also support the findings of Kurupınar et al (2022).

The results of this study reveal that the perception of supportive and inhibitory factors related to the use of intelligence games in science teaching changes depending on the selected intelligence game. Teachers' and pre-service teachers' perceptions of inhibiting and supporting factors should be considered as the source of their attitudes towards the use of Intelligence games in science teaching. In this direction, it reveals that teacher educators who aim to train teachers and pre-service teachers on the use of intelligence games in teaching should be careful in game selection. Otherwise, teachers may avoid using intelligence games in science teaching due to their negative attitudes.

## Recommendations

In this direction, it can be suggested that the Magic Pyramid and Missing Words games should be included in the education to be given to pre-service science teachers and teachers on the use of intelligence games in science teaching, and Kendoku game should not be included. However, this study is limited to six intelligence games. Determining appropriate games with similar studies and creating a game content pool will be contributory for science teacher educators. Similar studies can be conducted on the use of Intelligence games in different teaching subjects.

In addition, similar studies can be conducted with teachers and preservice teachers who are at the stage of completing their teacher education to examine the effect of pedagogical content knowledge on teachers' perceptions of inhibiting and supporting the use of intelligence games in science teaching. Thus, clues can be obtained about at which stage of teacher education these, and similar educational initiatives will be effective.

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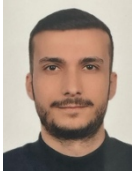
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## References

Aksoy, N. C. (2014). *Dijital oyun tabanlı matematik öğretiminin ortaokul 6. sınıf öğrencilerinin başarılarına, başarı güdüsü, öz-yeterlik ve tutum özelliklerine etkisi (Effects of digital game-based mathematics teaching on 6th grades students' achievement, motivation, attitude and self-efficacy)*. Doctoral Dissertation. Gazi University, Ankara.

Alkaş Ulusoy, Ç., Saygi, E.& Umay, A. (2017). İlköğretim matematik öğretmenlerinin zekâ oyunları dersi ile ilgili görüşleri (Views of elementary mathematics teachers about mental games course). *Hacettepe University Journal of Education, 32*(2), 280-294. https://doi.org/10.16986/HUJE.2016018494

Altun, M. (2017). *Fiziksel etkinlik kartları ile zeka oyunlarının ilkokul öğrencilerinin dikkat ve görsel algı düzeylerine etkisi (The effects of the physical activity cards and braïn teasers to the attention and visual perception levels of the primary school students)*. Doctoral Dissertation. Gazi University, Ankara.

Alessi, S. M. & Trollip, S. R. (2001). Multimedia For Learning (3rd ed.), Allynand Bacon.

Arslan, A., & Dilci, T. (2018). Çocuk oyunlarının çocukların gelişim alanlarına yönelik etkilerinin geçmiş ve günümüz bağlamında incelenmesi (Sivas ili örneklemi) [Games of children's in the context of a study of the effects of past and present for development areas of childrens (sivas province sampling)]. *The Journal of Fırat University International Social Sciences, 28*(1), 47-59. https://doi.org/10.18069/firatsbed.388064

Bottino, R. M., Ferlino, L., Ott, M. & Tavella, M. (2007). Developing strategic and reasoning abilities with computer games at primary school level. *Computers and Education, 49*(4), 1272-1286.

Bottino, R. M., & Ott, M. (2006). Mindgames, reasoningskills, and the primary school curriculum. *Learning Media And Technology, 31*(4), 359-375.

Can, D. (2020). Sınıf öğretmeni adaylarının zekâ oyunlarını öğretim süreciyle bütünleştirmeye yönelik görüşleri (Views of Pre-Service Primary School Teachers' About Integration of Mind Games with Teaching Process). *The Journal of Buca Faculty of Education, 50,* 172-190.

Çağan, B. & Usta, N. (2023). Akıl ve zekâ oyunlarının ortaokul öğrencilerinin matematik başarısına etkisinin incelenmesi (Investigation of the effect of mind and intelligence games on the mathematics achievement of middle school students.) *International Academic Social Resources Journal,* 8(52), 3331-3341. http://Dx.Doi.Org/10.29228/Asrjou Rnal.71353

Creswell, J. W. (2013). *Nitel araştırma yöntemleri: Beş yaklaşıma göre nitel araştırma ve araştırma deseni* (Translation of 3rd Edition). (Bütün, M. ve Demir, S. B., Trans. Ed). Siyasal.

Creswell, J. W. (2014). *Research design: qualitative, quantitative and mixed methods approaches* (4th Edition). Sage.

Çetin, A., & Özbuğutu, E. (2020). Fen bilgisi öğretmen adaylarının akıl-zeka oyunları ile ilgili görüşleri (the opinions of pre-service science teachers about mental-intelligence games ). *Dicle University The Journal of Ziya Gökalp Education Faculty, 1*(37), 93-99. http://dx.doi.org/10.14582/DUZGEF.2020.144

Demirel, T. (2015). *Zekâ oyunlarının Türkçe ve matematik derslerinde kullanılmasının ortaokul öğrencileri üzerindeki bilişsel ve duyuşsal etkisinin değerlendirilmesi* (Evaluating cognitive and affective effects of using mind games in Turkish and Mathematics courses on secondary school students) Doctoral Dissertation. Atatürk University, Erzurum.

Devecioğlu, Y. & Karadağ, Z. (2014). Amaç, beklenti ve öneriler bağlamında zekâ oyunları dersinin değerlendirilmesi (Evaluation of mind puzzle course at the context of goals, expectations and recommendations). *Journal of Bayburt University Faculty of Education,9*(1), 41-61.

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers and Education, 49*(3), 873-890.

Erdoğan, A., Eryılmaz Çevirgen, A. & Atasay, M. (2017). Oyunlar ve matematik öğretimi: stratejik zekâ oyunlarının sınıflandırılması (Games and Mathematics Teaching: A Classification of Strategic Brain Games). *Uşak University Journal of Social Sciences*, 10(Erte Special Issue), 287-311. https://Doi.Org/10.12780/Usaksosbil.373867

Genç, M. (2012). Öğretmenlerin çoklu zekâ alanları ile problem çözme becerileri arasındaki ilişkinin incelenmesi (Investigating of the relation between theteachers' multiple intelligences and problem solving skills). Bartın University Journal of Faculty of Education, 1(1), 77-88.

Gürbüz, S., & Şahin, F. (2017). Sosyal bilimlerde araştırma yöntemleri (Research in Social Sciences) (4th Edition). Seçkin..

Kel, S., & Kul, B. (2021). Akıl ve zekâ oyunlarının öğrencilere katkıları: eğitmenlerin görüşleri (The Contribution of Mind and Intelligence Games to Students: Views of Instructors) International Journal of Science and Education, 4(3), 207-225. https://Doi.Org/10.47477/Ubed.840868

Kurupınar, A., Yüksel, İ., & Kurt, H. (2022). Views of secondary school science, pre-school and primary school teachers on science education with intelligence games. *International Journal Of Education And Literacy Studies*, 10(1), 48-57.

Li, M. C., & Tsai, C. C. (2013). Game-based learning in science education: Areview of relevant research. *Journal of Science Education and Technology*, 22, 877–898.

Ministry of National Education of Türkiye (MoNET) (2016). Ortaokul ve imam hatip ortaokulu zekâ oyunları 5, 6, 7 v e 8. Sınıflar: Öğretmenler İçin Öğretim Materyali. (2. baskı). Devlet Kitapları.

Ministry of National Education of Türkiye (MoNET) (2013). Ortaokul ve İmam Hatip Ortaokulu Zekâ Oyunları Dersi Öğretim Programı (5, 6, 7 ve 8. Sınıflar) [Elementary School Intelligence Game Teaching Program (5th, 6th, 7th and 8th Grades)]. Retrieved from https://mufredat.meb.gov.tr/Dosyalar/202152512057724-zeka_oyunlari.pdf.

Ministry of National Education of Türkiye (MoNET) (2018). Fen Bilimleri dersi öğretim programı (ilkokul ve ortaokul 3., 4., 5., 6., 7., ve 8. Sınıflar) [Science Teaching Program (Primary and Elementary 3rd, 4th, 5th, 6th , 7th and 8th Grades]. Retrieved from https://mufredat.meb.gov.tr/Dosyalar/201812312311937-FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf

Myers, R.D. & Reigeluth, C.M. (2017). Designing games for learning. C.M. Reigeluth, B.J. Beatty, R.D. Myers (Eds.), *Instructional-design Theories and Models. The Learner-Centered Paradigm of Education,* Routledge, New York, NY (2017), pp. 205-242.

Orak, S., Karademir, E. ve Artvinli, E. (2016). Orta Asya'daki zekâ ve strateji oyunları destekli öğretime dayalı uygulamaların akademik başarıya ve tutuma etkisi (The effects of intelligence and strategy games in central asia-supported mathematics learning achievement and attitude). *Eskişehir Osmangazi Üniversitesi Türk Dünyası Uygulama ve Araştırma Merkezi (ESTÜDAM) Eğitim Dergisi,* 1(1), 1-18.

Ott, M., & Pozzi, F. (2012). Digital games as creativity enablers for children. *Behaviour ve Information Technology, 31*(10), 1011-1019.

Prensky, M. (2008). Students as designers and creators of educational computer games: who else? *British Journal of EducationalTechnology,* 39(6), 1004-1019.

Savaş, M. A. (2019). *Zekâ Oyunları eğitiminin fen bilimleri öğretmen adaylarının eleştirel düşünme becerileri üzerine etkisi. (The effects of intelligence games education on prospective science teachers' critical thinking skills).* Master's Thesis, Bartın University, Bartın.

Tavşancıl, E. & Aslan, E. (2001). *Sözel, yazılı ve diğer materyaller için içerik analizi ve uygulama örnekleri (Content analysis and application examples for verbal, written and other materials).* Epsilon.

Uzun, L., Çetinavci, U. R., Korkmaz, S. & Salihoglu, U. M. (2013). Developing and applying a foreign language vocabulary learning and practicing game: the effect of vocaword. *Online Submission, 5*(1), 50-70.

Yazıcıoğlu, S., & Çavuş Güngören, S. (2021). Game-based activities related to light and sound unit and students views. *Journal of Inquiry Based Activities, 11*(1), 51–68.

Yazıcıoğlu, S., & Çavuş Güngören, S. (2019). Investigate the effect of game-based activities on middle school students' science learning according to achievement, motivation, attitude and gender variables.*Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education,13*(1), 389–413.

Yıldırım, A. & Şimşek, H. (2016). *Nitel Araştırma Yöntemleri (Qualitative Research Methods).* Seçkin..

Yöndemli, E. N. & Taş, İ. D., (2018). Zekâ oyunlarının ortaokul düzeyindeki öğrencilerde matematiksel muhakeme yeteneğine olan etkisi (The effect of intelligence games on secondary school students' mathematical reasoning skills). *Turkish Journal Of Primary Education, 3*(2), 46-62.

Yükseltürk, E., Ilhan, F., & Altiok, S. (2022). Preservice teachers' views about the use of mind and intelligence games in education. *Participatory Educational Research, 9*(6), 398-417.

**Appendix 1**. A Sample Seminar Plan

**1ˢᵗ Week**
**The Intelligence Game Introduced: Alphabet Linking**
**Time Duration:** 20-30 minutes
**Seminar Flow**
Enter the Microsoft Teams Application. After a brief acquaintance with the teacher candidates, they are asked, "Does anyone know what intelligence games are and what they involve?" If there are pre-service teachers who have experienced it before, their opinions are taken. For pre-service teachers who have not experienced it, intelligence games are briefly mentioned.

The game of the first week, Alphabet Linking, is briefly introduced to them by using the screen mirroring feature. After the rules of the game are explained, how to play the game and illegal moves are shown with the help of the pen used in screen projection. During the process, the game is completed by combining the clue questions directed to theparticipants by the researcher and their feedback; so that the answer key is created. This concludes the first stage of the seminar.

In the second stage, the Alphabet Linking game adapted to science is briefly explained and pre-service teachers are given 5-10 minutes to do this activity in Microsoft Teams. For students who cannot complete it after the deadline, the answer key is projected on the screen so that all of them can access the answer key.

As the last stage, teacher candidates are given information about how to design this game and how to adapt it to science. The opinions about the weekly intelligence games application for Alphabet Linking is sent to teacher candidates by e-mail. In addition, teacher candidates are asked to use the Alphabet Linking Intelligence game they learned this week in a science lesson plan prepared to reach an approprite outcome present in science curriculum.

**Appendix 2**. Opinions about the weekly intelligence games application form

## Semi-structured Interview Questions

**Q1**. What do you think about the usability in science teaching of the intelligence game that you have been learned in this course?

**Q2**. What effect do you think the application in science teaching of the intelligence game you have been learned in this course will have on the student?

**Q3**. How do you think the application in science teaching of the intelligence game that you have been learned in this course will affect the workload of teachers?

**Appendix 3**. Semi-structured Focus Group Interview Form

<div align="center">

**Focus Group Interview Form Questions**
</div>

**Q1**. What are your thoughts about the application of intelligence games in science teaching?

      a. What are their advantages?

      b. What are their disadvantages?

**Q2**. For what purposes should intelligence games be used in science classes, at which stages of the learning and teaching process? Why?

**Q3**. What suggestions would you give to teachers or pre-service teachers who will use intelligence games in science teaching?

      a. For what subjects should they use intelligence games?

      b. For what purposes should they use intelligence games?

      c. What should they pay attention to when preparing intelligence games for science teaching?