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Original scientific paper

AN EXAMPLE OF A WEB-BASED LEARNING SYSTEM SUPPORTED BY INNOVATIVE MOBILE APPLICATIONS TO INCREASE THE INTERACTION BETWEEN STUDENTS AND LEARNING CONTENT: ARGEBILIM

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Abstract

One of the potential ways of making students active and increasing their motivation to learn in web-based learning systems is to present the content to the students in interactive ways. However, student and content interactions in today's web-based learning environments are still limited to traditional interaction methods presented in the web interface. Research indicates effective student-content interactions in a web-based learning system strongly enhance meaningful learning. Especially during the pandemic period, it has been observed that online learning content is insufficient for reasons such as supporting self-learning and not allowing experimental applications. Many studies during this period reveal that poor student interaction with learning content negatively affects student participation and learning.

In light of advances in technology, it is important to ensure that the learning content is delivered to the student in more effective ways and that the student interacts with this content in the context of self-controlled learning. In addition, there is a need for learning environments with new technologies that enable them to do the practical activities that need to be done in the classroom in their working environment. In this context, a new web-based learning approach was presented by using the web and innovative mobile applications together, increasing the interaction between the student and the learning content, improving the self-controlled learning skills of the students, and making the applied learning content in their working environment. In this study, a web-based learning system (ARGEBILIM) supported by Augmented Reality and simulation-based mobile applications was introduced.

In the study, information about the features of ARGEBILIM was presented and discussed in the context of pedagogical approaches that shed light on its development. The teaching potential of the system was evaluated, and the elements related to the interaction of students, teachers, and learning content were defined. In addition, the factors affecting students' use of this system and the improvements that should be made in these matters are presented and the potential benefits of the system are discussed.

***Keywords**:* Web-based learning system, interactive learning, mobile learning, augmented reality.

1. Introduction

One of the potential ways of making students active and increasing their learning motivation in web-based learning systems is to present content to them in interactive ways. Research indicates effective student-content interactions in a web-based learning system strongly enhance meaningful learning. However, in today's web-based learning environments, student content interaction is limited to web-based interfaces. Especially during the pandemic period, web-based learning systems didn't support students' self-learning experiences. In addition, the students couldn't perform the experimental applications at home, which they should have done in the laboratories of their schools. Many studies during this period reveal that poor student interaction with learning content negatively affects student participation and learning. In light of advances in technology, it is important to deliver the learning content to the student in more effective ways and to enable the student to interact with this content in the context of self-directed learning (Brookfield, 2009). In addition, there is a need for new learning environments that allow students to do the practical activities that need to be done in the classroom in their work environment. In this study, a new web-based learning approach supported by innovative mobile applications is presented. In this context, a web-based learning system supported by

Augmented Reality and simulation-based mobile applications and the development stages of this system were introduced. The objectives of this learning approach are to increase the interaction between the student and the learning content, develop students' self-directed learning skills, enable students to make applied learning content in their study environment, and record and evaluate learning data in both theoretical and applied learning processes.

2. Pedagogical Approach Used in ARGEBILIM

In the developed web-based learning system (ARGEBILIM), the 5E Instructional Model (Figure 1) was used to support the self-directed and active learning processes of the students. This model consists of cognitive stages of learning that comprise engaging, exploring, explaining, elaborating, and evaluating (Duran & Duran 2004). In the Engagement phase of the cycle, the teacher aims to assess students' prior knowledge and/or identify possible misconceptions. In the Exploration phase, students are encouraged to apply process skills, such as observing, questioning, investigating, testing predictions, hypothesizing, and communicating, with other peers. The Explanation phase enables students to describe their understanding and pose questions about the concepts they have been exploring (Duran & Duran 2004). In the Elaboration phase, students are encouraged to design new experiments or models based on the new skills or concepts they have acquired. Evaluation is the stage in which both formal and informal evaluation approaches are presented.

Figure 1. 5E Instructional Model.

3. Augmented Reality and its Educational Benefits

Recent developments in communication and mobile platforms have greatly increased the demands for human-digital interactions that take place more deeply than traditional desktop computers (Xiong et al., 2021). The demands for this interaction are also largely reflected in educational environments. Today, innovative technologies such as Augmented and Virtual Reality (AR) have unique features that allow interaction in educational environments. AR is a technology that allows simultaneous placement of virtual objects on real-world images (Azuma et al., 2001). AR supports immersive environments, video, animation, and audio (Demirer & Erbaş, 2015). It offers students the opportunity to simulate real-life learning scenarios. For example, medical students can examine virtual patients using AR instead of real ones. This increases students' real-world experience and allows them to practice in stressful situations. In addition, AR provides the following contributions to the learning process:

- With innovative, engaging, and exciting features, AR increases the willingness to learn and supports student participation and continuity in the learning process (Ibanez et al., 2014; Masmuzidin & Aziz, 2018; Martin-Gutierrez et al., 2012; Wu et al., 2013),
- AR gives virtual objects a sense of touch, creating a sense of presence during the learning experience (Özdemir, 2017),
- Highly skilled at concretizing abstract concepts (Huang et al., 2016; Sommerauer & Müller, 2014),
- Interactive AR makes learning active (Wojciechowski & Cellary, 2013; Gavish et al., 2015),
- AR has the potential to increase academic achievement (Akçayır & Akçayır, 2016; Fonseca et al., 2014; Hwang et al., 2016; Safar et al., 2017),
- AR is motivating in the learning process (Chen & Liao, 2015; Gopalan et al., 2017; Pribeanu & Iordache, 2008),
- AR can contribute to the development of students' scientific process skills (Chiang, et al., 2014),
- AR helps students improve their problem-solving skills (Cheng et al., 2017),
- AR contributes to students' critical thinking skills (Syawaludin et al., 2019),
- AR develops students' spatial/spatial thinking skills (Contero et al., 2012),
- AR does not require computer skills. Easily usable by students of all levels (Lu & Liu, 2015).
- AR supports collaborative learning environments (Kaufmann & Schmalstieg, 2002; Lin et al., 2013),
- Information presented with AR can appeal to audio and visual channels (Leslie et al., 2012). Thus, AR helps students develop their visual and auditory learning abilities.

4. H5P and its Educational Benefits

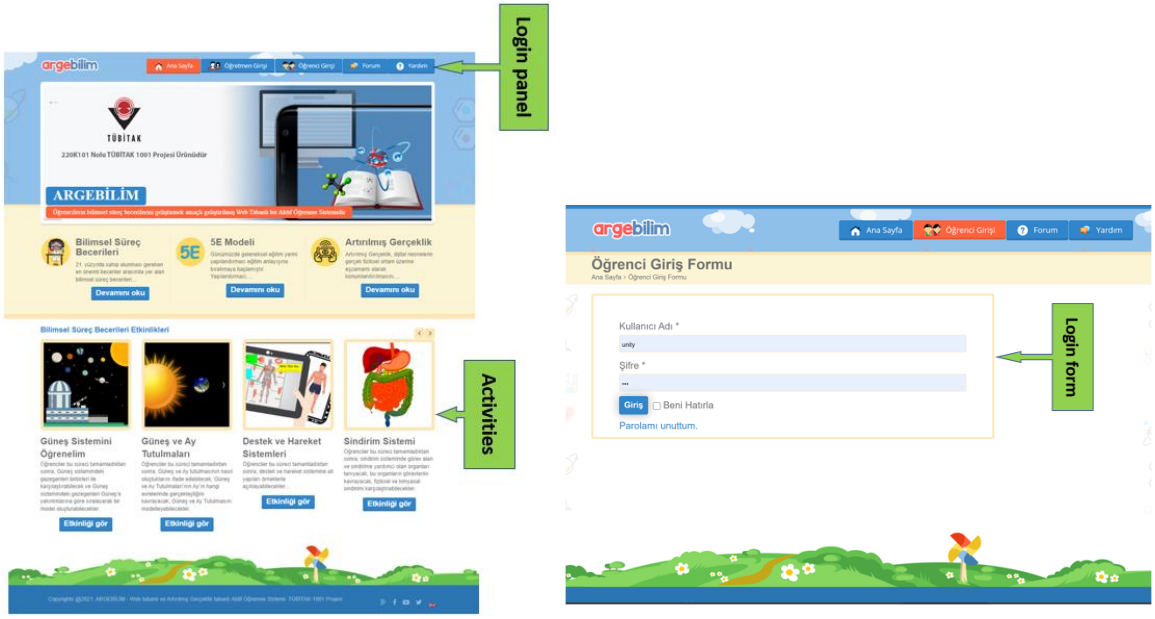
Pedagogically effective instructional designs can be very effective in increasing student participation and success in online learning environments (Jacob & Centofanti 2023). H5P is software that allows the development of pedagogically effective interactive learning tools. H5P is software that allows the development of pedagogically effective interactive learning tools. Interactive learning tools developed with H5P can serve as a tool to support students' self-study and active learning (Sinnayah et al., 2021). Based on the HTML5 language, H5P is an effective, free-to-use solution for teachers to create interactive materials (Homanová & Havlásková 2019). Creating an interactive learning material with the H5P is quite easy. This is because H5P offers an online, inexpensive, and user-friendly material development environment for teachers. Using the H5P, teachers and instructors can create interactive videos, simulations, quizzes, and other interactive materials for students. Thus, thanks to its variety of content, H5P offers many benefits to enable students to learn interactively. H5P contents can be customized according to students' needs. Background, colors, and other visual elements of educational materials can be changed. In addition, the learning content can be tailored to suit students' needs. H5P allows teachers to easily create interactive learning materials without requiring coding skills. Allows ways to create, edit, and distribute interactive didactic tools in Education Management Systems (LMS) (Homanová & Havlásková 2019).

5. A Web-Based Learning System (ARGEBILIM) Supported by Innovative Mobile Applications (AR and H5P-based)

One of the ways to activate students in online learning environments and increase their motivation in the learning process is to present learning content interactively. However, today's online learning environments do not have effective learning content. In addition, these online learning environments cannot contribute to the development of students' self-directed learning skills. In particular, there is a need for innovative technologies that enable students to do the hands-on activities they need to do in their classrooms or laboratories, also in

online environments. In this context, a web-based online learning system (ARGEBILIM) supported by innovative mobile applications (e.g., Augmented Reality, H5P interactive training tools, etc.) is presented below. This active learning system facilitates the increase of interaction between the student and the learning content, contributes to the development of students' self-directed learning skills, and allows students to do in-class practical training at home.

ARGEBILIM can be accessed at http://argebilim.com/webportal. Students who reach ARGEBILIM from this address are greeted with a login screen. On the welcome screen (Figure 2-a) of the system, there are web elements required for students and teachers to log in. Students are required to log in (Figure 2-b) to the system with their usernames and passwords.



(a) (b)

Figure 2. (a) Welcome and (b) Login screen of ARGEBILIM.

Students who log into the system are directed to the activity room. In this room, there are activities assigned to students by their teachers which they must do. In the activity window (Figure 3); there are earning outcomes related to the topics to be explained, buttons leading to the tasks in the activity, and the percentage of completion of the activity. In addition, students can see other activities on this page and can choose the activity they want.

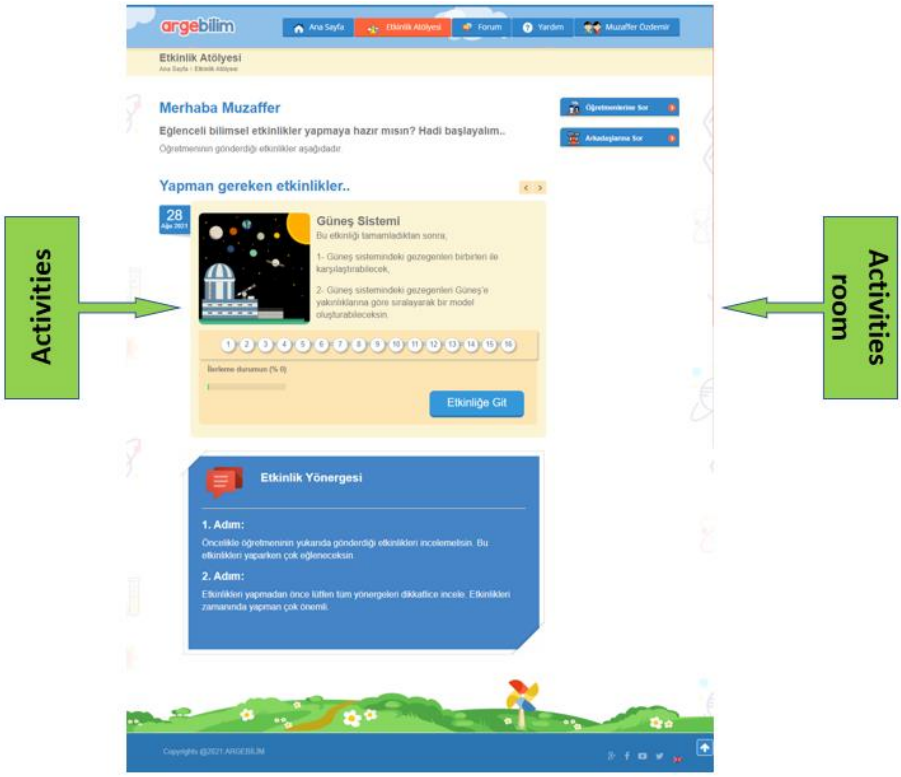


Figure 3. Learning outcomes related to the topics to be explained on the welcome screen of ARGEBILIM, buttons leading to the tasks in the activity, and the percentage of completion of the activity.

The student who chooses one of the activities is ready to do the first tasks of that activity. The tasks on this page are related to the "Interaction" phase, which is the first phase of the 5E Teaching Model. Tasks seem to be closed to the students at first. Students cannot see the next task until they complete a task. After the first mission is completed, the second mission is unlocked.

Figure 4. Tasks related to the first stage (Participation) of the 5E Instructional Model in ARGEBILIM.

When a task is completed, that task is marked as done (Figure 5). The "done mark" does not appear on uncompleted tasks. Thus, students can easily see which of the tasks included in the activities in ARGEBILIM have been completed or not. It is not possible to switch to other steps before completing each step in the 5E Instructional Model.

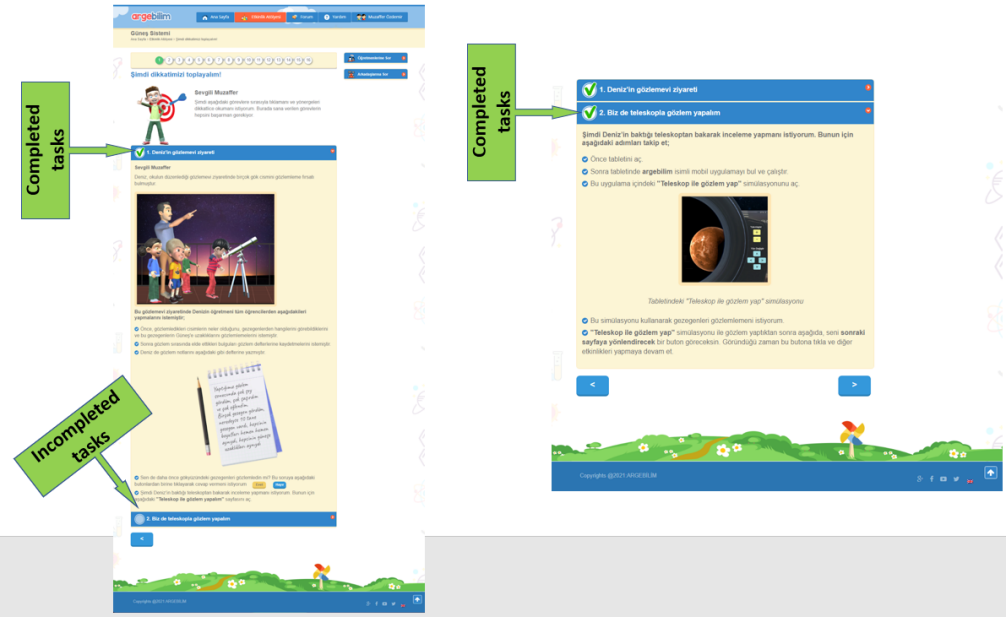


Figure 5. Screenshots showing the completion status of event tasks in ARGEBILIM.

The student who completes the tasks given in one of the 5E stages is directed to the page of the other stage (Figure 6). At the bottom right of the screen, the button that directs the student to the other step of the 5E Instructional Model becomes visible. Since the steps of the 5E Instructional Model are in a sequential structure, there is no transition to the next step until the previous step is completed.

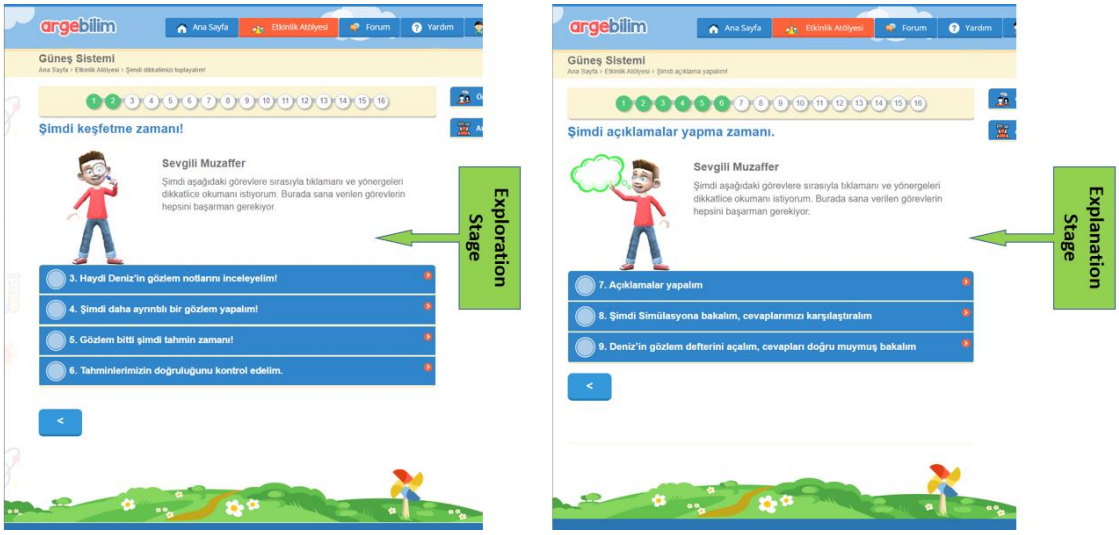


Figure 6. Activity stages (exploration and explanation) designed according to the 5E Instructional Model at ARGEBİLİM.

There are many Web 3.0 elements in the system (Figure 7) where students can answer the questions directed to them during the tasks. In some of the tasks, game elements have been added to the system to both make the students active and help them learn the subjects in a fun way. These game elements have been prepared with the help of software called H5P, which allows the development of interactive learning tools.

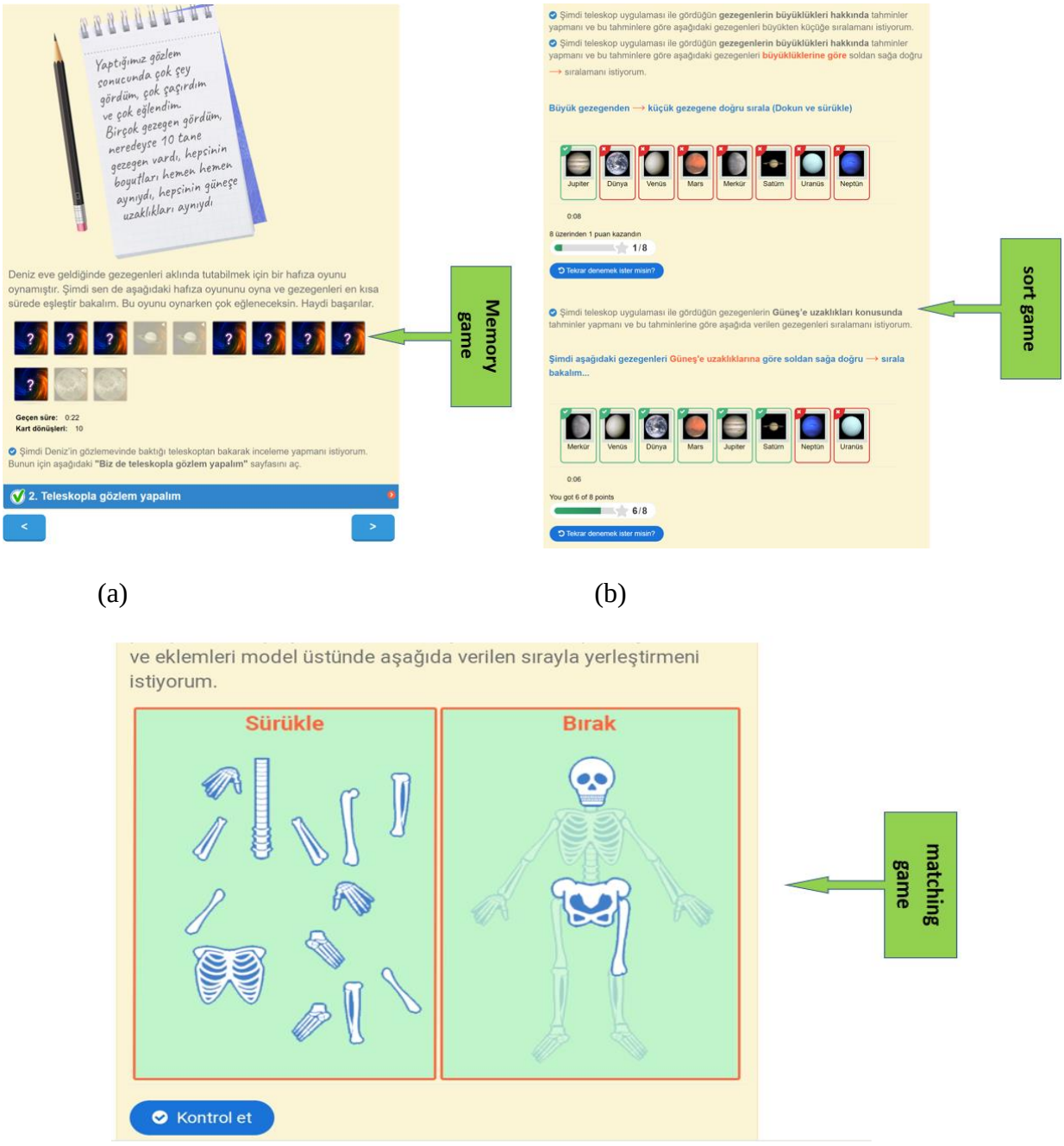
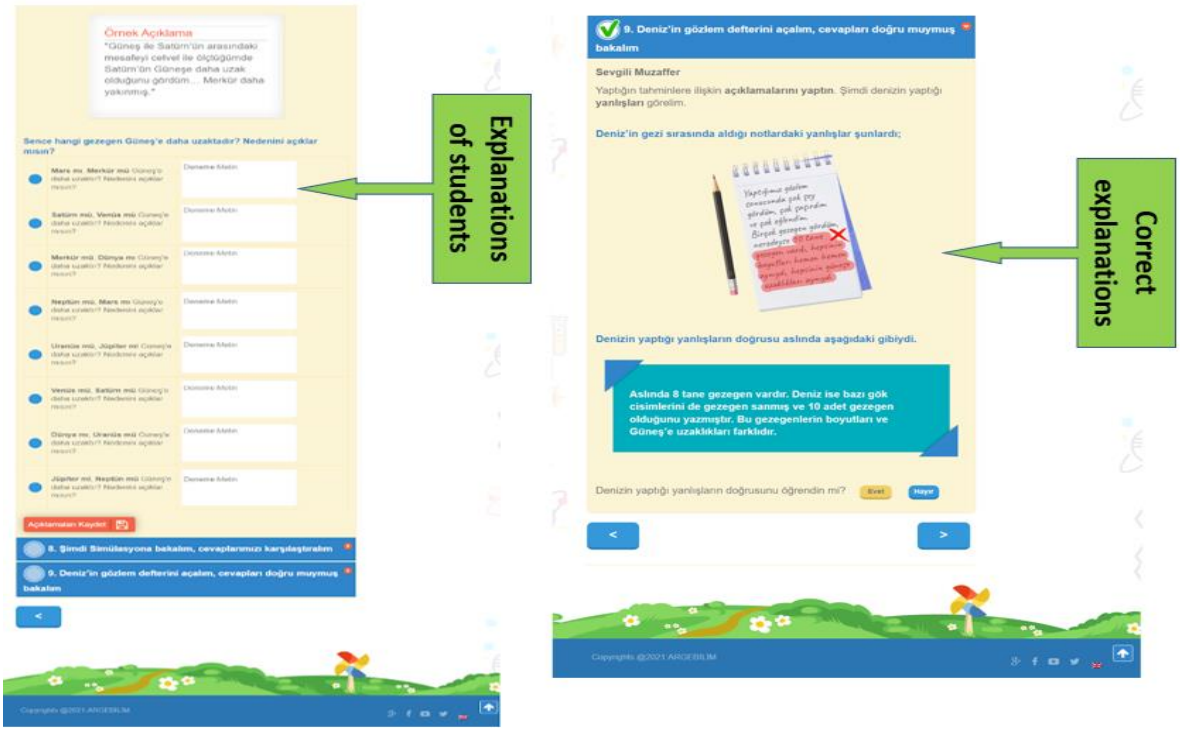


Figure 7. Interactive items in ARGEBILIM. Here, (a) the game of sorting the planets in the solar system according to their sizes, (b) the game of ordering the planets in the solar system according to their distance from the Sun, and (c) a matching game in an activity related to the support and movement system.



(a) (b)

Figure 8. In the tasks included in the "Explanation" stage of the activities in ARGEBİLİM, (a) the explanations requested from the students and (b) the accuracy of the answers given by the students.

In the web environment, the student acquires theoretical knowledge. The mobile environment is the student's experimental environment. In other words, the student's tablet can be thought of as an experiment tool or an experiment laboratory. While using ARGEBILIM, the student's tablet can sometimes be a telescope and sometimes a measuring instrument. In this case, students can do the experiments in the activities in their working environment (e.g., home, library, etc.) as in the laboratory at school. This allows them to make applications independent of time and space. These hands-on activities can be carried out with the help of interactive learning tools created with simulation, AR, or H5P on students' mobile devices (e.g., tablets). ARGEBILIM can record and report all the applied activities that students do on their mobile devices. Whether the applied activities are done or not can be followed by both students and teachers. In addition, for the student who does not perform a practical activity or experiment, that task is considered incomplete. Because the next tasks may depend on a hands-on experiment or activity that needs to be done beforehand. Figure 9 shows a simulation application that allows students to observe planets in the Solar System with a telescope.

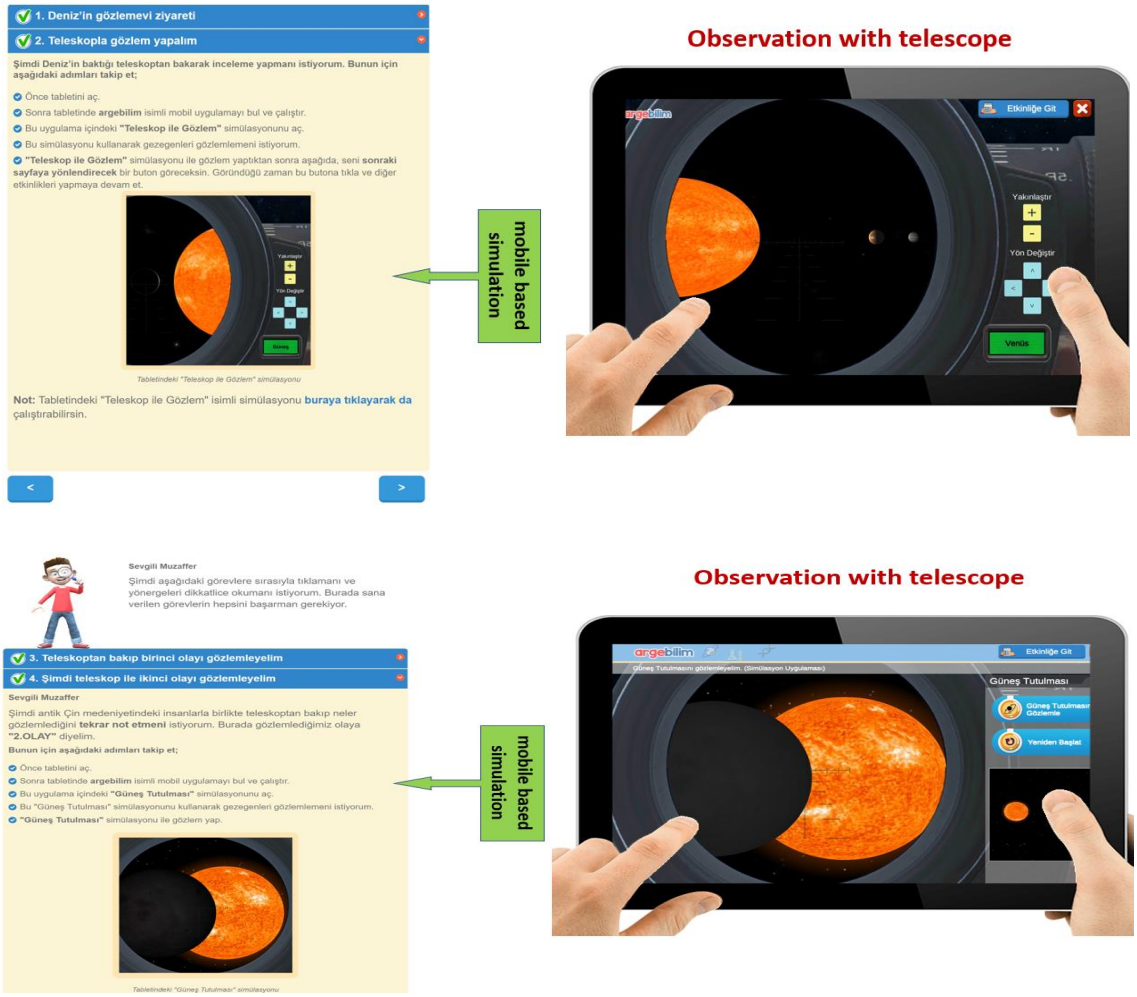


Figure 9. A simulation application in ARGEBILIM that allows observing planets in the Solar System with a telescope.

There are also augmented reality applications in the mobile environment that work integrated with ARGEBILIM (Figure 10). Augmented reality is a technology that allows us to show virtual objects in a real environment. In the AR app shown in Figure 10, the student watches the meteorites hitting the earth's surface with sound and animation. Students can take photos while doing AG or simulation activities on their mobile devices and their teachers can evaluate their activities. For example, here, students modeled a solar eclipse observed in Çanakkale on their mobile devices took their photos, and uploaded them to the system. They also wrote down how these events happened in the text boxes next to them. Then their teachers evaluated them.

Figure 10. A simulation in ARGEBILIM that allows observing planets in the Solar System with AR. On the screen on the left, the photographs that the students took with their tablets while observing and the necessary text boxes to make explanations about these photographs can be seen.

The ARGEBILIM also includes gamification elements (Figure 11). Students who complete the tasks earn one star for each task. Students who complete each 5E stage are given a badge. Motivating feedback is given to the student after all tasks and 5E stages are completed. After completing all the tasks, students can see the points and badges they have earned on the right side of the screen.

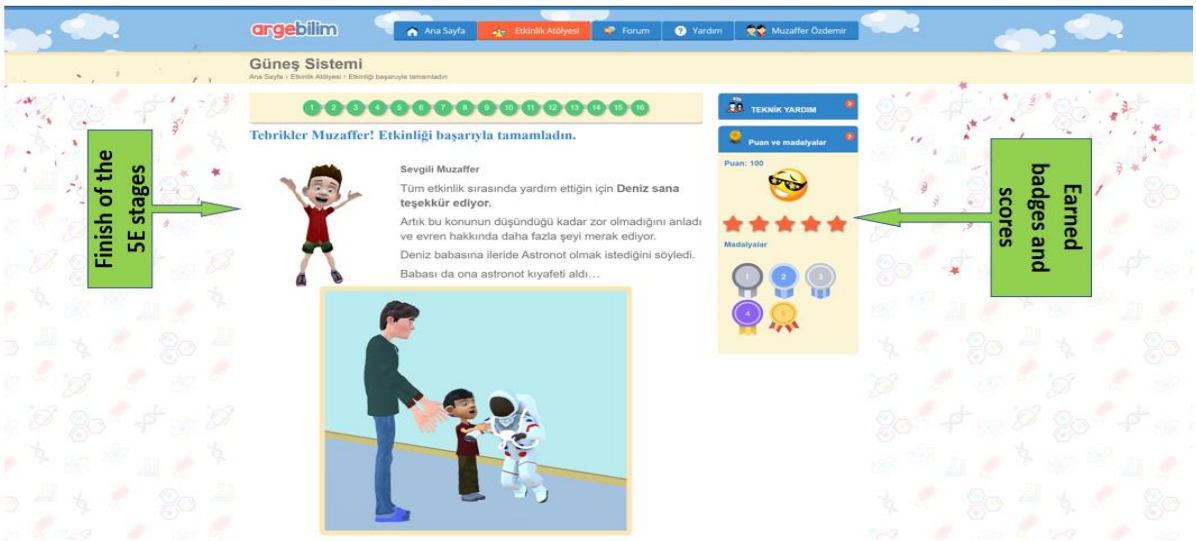


Figure 11. The scores and badges that the students see on the screen after completing all the tasks in ARGEBILIM.

6. Conclusion

In the study, the technical and pedagogical features of ARGEBILIM were discussed. The teaching potential of the system was evaluated, and elements related to student-teacher interaction and learning content were discussed. Today's online learning environments cannot offer effective learning content and cannot contribute to the development of students' self-directed learning skills. In online learning systems, it is very important to present learning content interactively to make students active and contribute to the development of self-controlled learning skills. ARGEBILIM offers a structure that supports active learning with its innovative learning tools. Augmented reality-supported simulations allow students to conduct science experiments independent of space and time. The ARGEBILIM learning system is also supported with gamification elements that ensure the continuity of the student's learning process. In this way, the student is motivated in the learning process and is willing to do the tasks. A lot of research has been done on the development of online learning environments to make students active in the learning process and to improve their self-controlled learning skills. In one of these studies, Huang et al. (2021), emphasize the importance of students' motivation and self-regulation skills for the development of students' self-controlled learning skills in online courses. Researchers state that students can have a more active learning process by developing their ability to set learning goals, monitor their learning progress, and make self-assessments. Xie & Ke (2020) examine how online learning environments can be used to improve students' self-directed learning skills and increase their academic success. The study emphasizes the importance of developing students' ability to set learning goals, use learning strategies, make self-assessments, and manage the learning process in online environments. Another study (Hsu et al., 2014) examines how online learning environments can be developed using a hybrid learning model to improve students' self-supervised learning skills. Researchers state that student-centered learning approaches should be used to improve students' self-regulation skills and opportunities should be provided for students to be actively involved in the learning process. These studies show that online learning environments can be an effective tool for improving students' self-directed learning skills. Online learning environments must use student-centered approaches and provide opportunities for students to make self-assessments for students to play an active role in the learning process, develop their self-controlled learning

skills, and achieve learning goals. Thus, online learning environments can enable students to be more effective and successful in the learning process. A few suggestions for the development of such active learning environments in the future may be as follows;

-Students' learning styles and pace are different. Future online learning environments may provide students with more flexibility to progress at their own pace and to process material following their learning style. This can help students have more control over the process of developing their self-supervised learning skills.

- Online learning environments that offer interactive learning tools that allow students to set their own learning goals, monitor their learning progress, and receive feedback can be developed.

-Future online learning environments can be designed to allow students to interact with course materials and take a more active role in their learning processes.

-More opportunities can be provided for students to interact with each other in these learning environments. This can help students develop self-directed learning skills by allowing them to help and learn from each other.

-Future online learning environments can provide teacher support to help students develop self-directed learning skills. This will allow students to set learning goals, track their learning progress, and seek support from their teachers when needed.

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