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Pregledni članak

STUDENTS' AND THEIR TEACHERS' VIEWS OF COMPUTER-ASSISTED INSTRUCTION: THE CASE OF THE PROBABILITY SUBJECT

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Abstract *– Traditional instructional methods fail to overcome difficulties when teaching the subject of probability. Hence, the use of information and communication technology may be a useful approach to overcome these obstacles. This paper aims to find out the elementary school students' and their teachers' views about computer-assisted instruction in the school subject of probability. To achieve this end, computer-assisted instructional materials consisting of animations and simulations with 30 interfaces were developed by means of Dreamweaver MX 2004 and Flash MX 2004, and then they were transferred to an HTML medium. Instruction based on the materials developed in the study was conducted with 8th grade students in two different elementary schools. The study sample consisted of two mathematics teachers and their own classes of a total of 46 students. To collect data, semi-structured interviews were conducted with both the teachers and 6 students from each school. In the light of the results, it can be deduced that both the teachers and the students have positive opinions of and a tendency towards computer-assisted instruction. It made the subject more concrete and associated it with real life. At the end of the study, some suggestions regarding both the material and the effectiveness of CAI are also provided.*

Key words: *Computer-Assisted Instruction, mathematics education, material development, teachers' and students' views, probability*

1. Introduction

Teaching technology can be defined as the use of all kinds of necessary technologies in designing, implementing and evaluating the teaching process so as to conduct more effective teaching to attain the desired goals. In line with advances in teaching technology, computers began to be used in learning environments in order to develop audio-visual materials such as animations and simulations, and thus the term Computer-Assisted Instruction (CAI) has emerged. In CAI, "students learn by interacting with the computer and the appropriate feedback is provided" (Ash, 2005, 12). Rapid advances in technology and new educational paradigms have brought about interactive alternative educational environments in which animations and simulations are used instead of traditional mathematics learning environments (Gürbüz, 2007). It is known that the quality of developed material in CAI is one of the most significant factors that have a direct influence on students' success. In a meta-analytic review, according to the results of 41 studies, Chadwick (1997) stated that using CAI elevated the scores by a mean of 0.51 standard deviations, and for studies with a minimum of 100 participants, CAI also raised the scores with a moderate effect size of 0.33. Similarly, in a recent meta-analysis study conducted by Liao (2007), the findings suggest that CAI is more effective than traditional instruction.

CAI is a teaching method that helps the teacher in a computer-assisted learning environment, increases student motivation and strengthens the teaching process, enables students to learn at their own pace, and combines computer technology with interactive learning principles (Şahin and Yıldırım, 1999). On the other hand, it is also known that teachers' attitudes and experiences play an important role in using computers in teaching and learning mathematics (Birgin, Çatlıoğlu, Coştu and Aydın, 2009). A CAI environment with well-designed animations and simulations enables learners to choose from the computer screen, to concretise abstract maths concepts, and to create cognitive representations. In teaching mathematics concepts, it is known that CAI materials that stimulate the students' visual and cognitive features in the teaching process have a positive effect on students' success (Chritmann, Badget and Kucking, 1997; Pijls, Dekker and Van Hout-Wolters, 2003, 2007; Gürbüz, 2007; Birgin, Kutluca and Gürbüz, 2008).

Although the probability subject is a very important tool to improve creativity and thinking skills which are some of the most important goals not only of mathematics but also of other domains, it previously appeared in the curriculum only of the 8th grade in Turkey. Now, however, with the new education programme, it is in the spiral maths curriculum of the 4th, 5th, 7th and 8th grades (Republic of Turkey Ministry of National Education [MEB], 2005). Similar to many other countries, concepts related to this subject cannot be taught properly in Turkey for several reasons, among which are the facts that

subjects are generally taught in teacher-centred class environments, there is a lack of proper teaching materials or the developed materials are too abstract (Aksu, 1990; Gürbüz, 2006; Pijls, Dekker and Van Hout-Wolters, 2007), most maths teachers are not well equipped with the necessary tools for the effective teaching of the probability subject (Bulut, 2001), and students have misconceptions about probability (Fischbein and Schnarch, 1997). These deficiencies make studies related to the development, implementation and evaluation of computer-assisted materials in learning environments necessary. In fact, Hsiao (2001) argues that "advancements of technology have removed some of the constraints to studying probability" (23). To achieve this end, in addition to material with 30 interfaces transferred to an HTML medium by using Dreamweaver MX 2004 and Flash MX together, a concept map was developed through Flash MX 2004 software. Lessons were then implemented based on these materials.

This study aims to assess teachers' and students' views on the teaching implemented through the material developed for the probability subject for 8th graders.

2. Method

This study is a descriptive one and was carried out using the case study method. This method enables us to conduct deeper research and to maintain a more focused approach on the subject. Qualitative data collection tools were used in the study and data regarding the process during the study and how these events influenced the study group were recorded. With this approach, teachers' and students' views on the CAI of the probability subject were revealed.

2.1. Participants

This study was carried out with 46 eighth graders enrolled in two elementary schools located in a town centre in the north-eastern part of Turkey. 12 students with 6 students from each class and two maths teachers from each school participated in the data collection process. In the sampling process, students who could express their thoughts and feelings easily were chosen with the help of their teachers.

2.2. The structure of CAI materials

CAI materials consisting of animations and simulations with the use of Dreamweaver and Flash MX 2004 software that are Macromedia products were prepared in an HTML milieu. In addition, with the use of Flash MX 2004 software, a concept map of the subject was formed. Dekker (1994) formulated four criteria for learning materials at a mathematical level in collaborative

learning. Problems must be: *real or meaningful,* in order to motivate and stimulate the students; the problems must be *complex,* so that the students need to work together; the students must *construct something*, in order to reveal their thoughts and to promote discussion; and of course the problems must be aimed at *level raising*. Regarding this study, although all the criteria asserted by Dekker were mostly met, it is hard to claim that all the criteria worked thoroughly. Since it was observed that some groups could not establish effective communication in the process due to their individual working habits, they could not benefit from this process properly. Moreover, in traditional learning environments, students do not have the chance to make predictions, argue, think intuitively, become motivated, do an experiment and see the direct findings gathered from the experiment, deduce formulae, relate real experiences with scientific information, use their creativity, work in groups and achieve one-to-one communication with the teacher. However, the computer-assisted learning environment is designed to mostly provide all these opportunities. The pilot study of these materials was carried out with a group of 8th graders and necessary arrangements were duly made.

2.3. Procedure

The study was implemented with the cooperation of two volunteer teachers from two elementary schools. Students were not given any pre-information regarding the process so as to capture their natural perceptions towards the maths class and teacher. It was implemented in each school's computer lab with students working in groups of two. The students' study arrangements changed from time to time. Students took an active part in the class by interacting with the material. As concepts regarding probability are presented with their real-life reflections and in such a way that students can use their previous experiences in the CAI process, the knowledge gained was thought to be at a conceptual level. In addition, since students working in pairs question each other's work by saying, "why are you doing that", "how did you get that", "oh no, it isn't right, because…" it is believed that they can construct information more meaningfully and can cognitively develop better. During the implementation, when individuals or groups needed help, they were guided in the form of clues rather than by answers being given directly. In brief, traditional teacher and student roles changed during this process. In this way, the researcher who undertook the role of teacher left the old role of "lecturer", "demonstrator", "test giver", and "grade giver", and adopted the new role of "designer", "assistant", "facilitator of understanding", "consultant", "provider of cooperation", "planner", "supervisor", and "evaluator". As for the students, they left the old roles of "passive listeners", "rote learners", and adopted the desired roles of "active participators", "ones who can access knowledge", "ones who construct knowledge", "ones who question knowledge", and "ones who can

communicate about knowledge". In short, the students' role changed from one of gaining knowledge belonging to someone else to one of acquiring their own knowledge that they can use in the new situations they will confront. However, although students embraced their new roles and found the classes taught in this process enjoyable, colourful, lively and exciting, they continued their habit of confirming what was learnt with their teacher on account of their fixed teacher perceptions, and sought to hear absolute and precise knowledge from the teacher to ensure their success. Furthermore, as it was not known whether or not what the pairs of students were talking about was strictly related to the topic, it could not be fully known if this process always affected learning positively. The teaching material developed in this process was implemented by researchers in the 2006-2007 school year at the time specified in the curriculum for 6 hours in each class. During the implementation, the maths teacher of each class participated in the implementation as an observer.

2.4. Data collection

Two distinctly formed questionnaires were prepared for the teachers and students under the guidance of field teaching experts in order to gather the views of the teachers and students regarding the implementation process. Informal observation was also made of the teachers and researchers as participating observers in the implementation process.

2.5. Data analysis

After previously informing the teachers and students that interviews would be videotaped, they were assured that the recordings would only be used for research purposes. While transcribing the sound recordings, the students' views on the same questions were grouped in accordance with the similarities and differences and they were analysed in distinct tables. By analysing the teachers' views through similar phases, they were reflected as the teacher's views. Informal observations were also used from time to time.

3. Findings

In the CAI process, among factors influencing teachers' and students' views are teacher-student and student-student interactions, the computer, the teacher's role, the student's role and CAI materials.

3.1. Findings gathered from interviews with students

In this section, interview questions to students regarding CAI, and the answers to these questions are analysed in tables.

Question 1: "*Can you compare CAI with previous instruction*?"

Table 1. The answers given by students to question 1 and frequencies (*f*)

Students' Answers	*f*
In the past, our teacher used to lecture and we used to listen, but now we are running the classes together. We learn the subjects on the computer mostly by ourselves. The teacher assists us in the sections only when we need it.	3
The fact that classes are given through computer-assisted material has made the boring maths classes "fun", "lively", and absorbing like a "puzzle".	3
The fact that classes are taught through developed materials has facilitated association of the classes with real life and has made us aware that we already knew a lot about the subject when we started the subject.	3
While in previous classes we received the written formulae directly, through material-based teaching we found the formulae on probability on our own.	2
Computer-assisted teaching allowed the board to be used less frequently.	1

As illustrated in Table 1, three students expressed the view that teachers, as a source of knowledge, used to lecture and that the students would hear the lectures as passive listeners. However, they maintained that in the process of CAI, teachers led them like guides, and that they participated in the process as givers and receivers, thus being involved in the process together. Three students asserted that when maths classes were given through CAI, it made the previously boring maths lessons "fun", "lively", and absorbing like a "puzzle". Three students said that as teaching maths through developed computer-assisted material facilitated the association of the classes with real life, they became more interested in the classes and they realised they knew a lot when starting the subject. Two students said that in previous classes they received written formulae directly, but through CAI they found formulae on probability on their own. One student noted that while the teachers used the board more frequently in the past, in these classes they used the board less frequently.

Question 2: "*Can you explain the effect of CAI on your understanding of the subject*?"

Table 2. The answers given by the students to question 2 and frequencies (*f*)

Students' Answers	*f*
In computer-assisted teaching we see and learn the subjects on the screen, so we learn better and do not forget, as we are sure that the knowledge we learn is correct.	4
In the past when we faced a question in maths, we started to solve it, trying to remember the formulae; but now while solving probability questions, we solve them by trying to visualise the material brought to class.	3

As we are trying to find things with our friends, we do not get bored and we learn a lot from each other.	3
For the first time, concepts on one subject of maths were touched upon frequently and compared to other subjects in maths; we learnt probability concepts better, as well as the relationships among concepts.	2

As illustrated in Table 2, four students expressed the view that since in CAI they could see everything on the screen, and did everything on the screen themselves, they learnt the subjects better and in a more lasting way. Three students explained that while solving the probability questions for the entrance test to high school, they solved them by visualising the material brought to class. They also added that if they had learnt with the traditional approach, they would have tried to remember the formulae related to the subject. Three students maintained that they were pleased to work with their friends and that they learnt a lot from each other in this process. They added that since they had exchanged each other's ideas before carrying out the tasks on the screen, they learnt a lot from one another. Two students noted that concepts in one subject of maths were touched upon so frequently and compared to other subjects in maths that they learnt probability concepts and relationships among the concepts very well.

3.2. Findings gathered from the interviews with teachers

When asked*: "Do you suppose there are positive effects of CAI?"* both teachers explained that CAI kept the learning atmosphere lively, ensured the active participation of students, made teaching effective and fun, helped students associate the subject with real life, increased student interest in classes, made students question each other's tasks, kept students curious and alert, and helped them make the subject more concrete. Moreover, Teacher A reported that it facilitated understanding of the subject, helped students learn by questioning concepts in the subject, made students learn the concepts in the subject and the relationships between the concepts, helped them create relations among maths subjects, increased participation, and prevented students from losing interest in class. Teacher B stated that it helped students associate the subject with real life, increased students' commitment to the maths class, increased communication in the learning environment, thus helping teachers to get to know their students better and see individual differences, gave students the chance to construct knowledge on their own, thus improving their reasoning skills and self-confidence. Teacher B maintained that the concept map at the end of the implementation helped students to depict concepts and relations among concepts in the subject.

When asked: *"Do you think there are negative effects of CAI?"* both teachers replied "yes" and claimed that it was easy to use CAI but that some

students who were computer illiterate were negatively influenced by the implementation process. Furthermore, both teachers explained that it was hard to implement it in crowded classes and that some discipline problems could arise. In addition, Teacher A claimed that the operational skills of students who always went through this teaching process would weaken and so their achievement in key tests would decrease and that this process could remove the maths dignity of some students. Teacher A also stated that this process had a positive impact on all students, but that students lacking the prerequisites could not benefit enough from this process. Teacher B indicated that some students became detached from the class, perceiving the implementation process as a game and could not become motivated. Teacher B also noted that some students were inclined to trial and error without carrying out any operations, which could weaken their operational skills. However, this teacher also added that this could strengthen mental operations to some extent.

4. Discussion

Several studies (Bulut, 2001; Gürbüz, 2006) have shown that teachers have had problems in teaching, and students have had difficulties in learning, probability concepts. Both teachers and students who took part in the process implemented in the CAI environment stated that working in groups in this kind of learning environment not only encouraged students' participation and improved their reasoning skills but also made learning more meaningful and more lasting. This positive effect is influenced both by the material used and by students working in groups. But assessing the effectiveness of these factors is another matter for discussion. Going back to the CAI material used in this study, it can be clearly seen from the views of the two teachers and the students who took part in the process that using the material was easy and understandable; it increased learning enthusiasm; it provided an environment of learning through practice and experience; it made the subject more concrete and associated the subjects with real life; it increased students' interest in classes; it depicted the concepts and the relations among the concepts of the subject and it kept students curious and alert.

Moreover, it was reported by teachers and students that CAI helped students question their existing knowledge and to develop more scientific meanings, it exploited the potentials of individuals with different skills, developed problem-solving skills in groups, and made them enjoy the maths classes by providing opportunities for reading, writing and speaking about maths. It can be inferred from this that the developed material which is audio-visually attractive has instructive features and that the use of this material in the maths class has positive influences on students' success and attitudes. From studies done by Gürbüz, (2007), Pijls, Dekker and Van Hout-Wolters, (2003,

2007) and Birgin, Kutluca and Gürbüz, (2008), it is possible to conclude that CAI was effective in creating understanding of the probability subject and in increasing the students' success. It can also be said that the findings of this study are in line with the findings of studies carried out on CAI by Baki and Öztekin (2003). In addition, the views of some students and Teacher B related to the concept map which formed part of the developed materials are correlated to the findings of studies by Chang, Sung and Chen (2001) and Kaşlı, Aytaç and Erdur (2001).

Maths is not a mass of rules and formulas isolated from real life. These rules and formulas come from real life. The greatest problems faced by individuals raised in a traditional teaching environment are that they cannot use what they learn in their real life and that they cannot transfer their existing knowledge to different situations. This case leaves unanswered the questions about why and where individuals can use maths. In fact, Noss and Baki (1996) noted that knowledge transferred through rules and symbols produced people who cannot achieve high-level thinking, and cannot make assumptions and generalisations in their real life. Such problems may be overcome by associating the material used in teaching with real life. Teachers and students participating in the study explained that CAI facilitated the association of maths subjects and concepts with real life. Furthermore, it was observed that the fact that students had opportunities to relate what they learned with real life made them more willing and motivated towards the subject. At the same time, some students participating in the interview process emphasised that maths had to be related to real life so they could be sure that the knowledge they learned was real and could thus be made more enduring.

It was informally observed that during CAI students mostly did what the teacher asked them to do, but from time to time some student groups made three or four incorrect guesses before finding the answer. The reason for this could be that these students did not like the writing activity or found the trial and error process easier. These students are believed to have been negatively influenced by the knowledge-construction process. Material developed for this purpose could be redesigned in such a way that students can do limited trials. Another point to make is that the teacher was occasionally too busy in this process, ran the class without knowing if the students were working or behaving well enough, and this particularly affected low-level students. This case might have resulted from the fact that students were not familiar with these types of learning environments, that some students had limited access to computers, and also that some were not even computer literate. It is clear that all students have to be computer literate and that from time to time these kinds of applications have to be provided so that the material can be more effective in the learning environment. It was observed in this process that students who were computer literate took an active part in the teaching process, questioned the process and discussed the tasks they had achieved with their friends and

teacher, showed greater improvement and enjoyed the process more than students with problems in computer literacy, who were passive in the process and who did not question the process. It was also observed that due to their individual working habits some groups could not maintain effective communication and could not benefit from the process properly. In parallel with this, Sfard and Kieran (2001) emphasised that students who had communication problems could not work effectively in groups and that for them group work was fruitless and ineffective.

Here, Teacher A's view that students' operational skills would weaken in this process, and that their success in key exams would consequently decline is correlated with the view expressed by Ayres, Sawyer and Dinham (2004) that exams had an effect on learning environments and that they prompted exam-oriented teaching. In this case, it could be claimed that there should be some changes in the exams and in students' and parents' expectations in order to more effectively transfer CAI into learning environments.

The findings of this study have revealed that though there are some negative influences of CAI, it is audio-visually attractive, makes students active and curious, enables them to make associations with real life and to participate in the process with interest, increases motivation, creates an environment in which students can construct knowledge by themselves, creates a social learning environment, and finally leads to more effective teaching. Moreover, it could be noted that CAI changes the role of student and teacher and alters students' maths perceptions. So, it can be inferred that CAI materials suit the philosophy of today's modern learning theories.

5. Results

It is possible to conclude from the findings of this study that both students and teachers are positively influenced by CAI. That students are positively influenced can be explained by the fact that they work in groups, that CAI enables them to write and discuss maths by providing rich learning experiences, that they gain experience from using the computer screen, that it facilitates their learning, that they learn the subject through questioning, that it ensures their participation and meaningful learning, that they see maths associated with real life, that they internalise concepts and relations among concepts by reasoning through the concept map, and that it increases their enthusiasm and responsibilities for learning. That teachers are positively influenced can be explained by the fact that CAI enables them to teach subjects more effectively, that it provides students with opportunities to learn through practising and through experience, that it makes subjects more concrete, that it keeps students active and curious, that it increases teacher-student communication, and that it better reveals students' individual differences.

The fact that students define CAI materials as original, lively and like puzzles, and the classes as absorbing and enjoyable shows that they are positively influenced by CAI. Similarly, although teachers note that there could be some negative influences of CAI, the fact that in general they believe it is effective in making the class enjoyable and fun, that it facilitates understanding and that it assures permanent learning shows that CAI has a positive effect on the learning environment.

It is therefore clear that CAI influences both students and teachers positively. The study shows that implementing CAI will increase educational quality and teachers' enthusiasm, prevent the loss of professional excitement, provide teachers with chances to improve themselves continuously and help them provide current content to their students. It will increase students' self-confidence, help them be aware of their potentials, and raise their commitment to the lessons and the school.

6. Suggestions

- The effectiveness of the material used in this study should be assessed by researchers through an experimental method.
- It is believed that from time to time these kinds of materials should be used in other classes as well, since it is an enjoyable and fun process and facilitates and motivates learning of the subjects.
- While preparing CAI material, it should be ensured that the material is easy to use, the content is current, the language used in teaching is easy to communicate and that it contains limited trials.
- While preparing CAI material, screen design, animations and simulations should be created in such a way as to appeal to students' interests and not divert their attention.
- Stimulating learning environments should be provided for teachers to use CAI in their classes.

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STAVOVI UČENIKA I NJIHOVIH NASTAVNIKA VEZANI UZ RAČUNALNO POTPOMOGNUTO UČENJE: PRIMJER POUČAVANJA TEORIJE VJEROJATNOSTI

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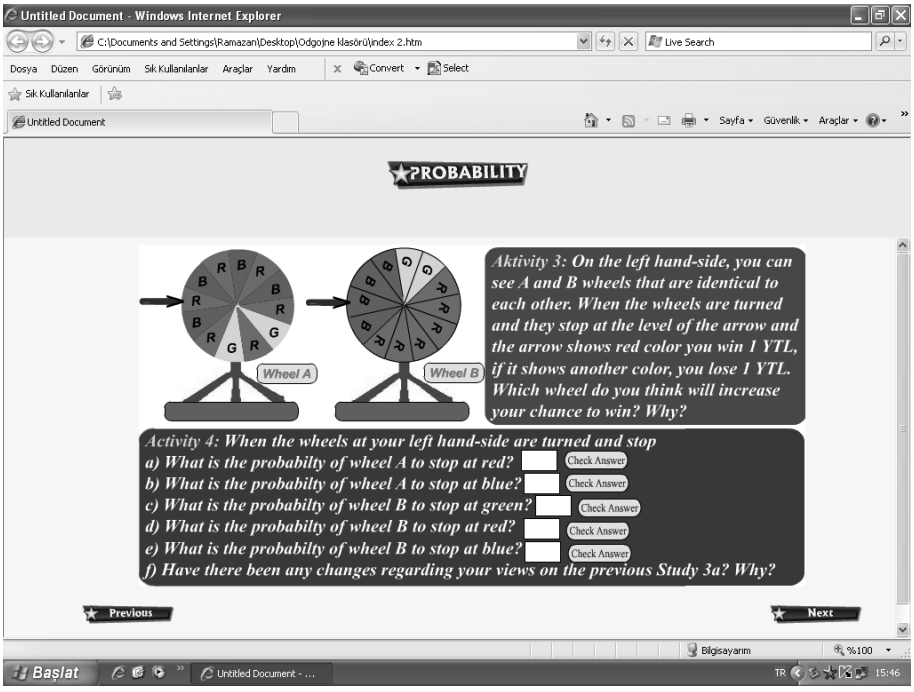
Sažetak *– Tradicionalne nastavne metode ne mogu prevladati poteškoće vezane za poučavanje računa vjerojatnosti. Zato bi korištenje informacijske i komunikacijske tehnologije moglo biti koristan pristup prevladavanju tih prepreka. Ovaj rad ima za cilj otkriti stavove učenika osnovnih škola i njihovih nastavnika o računalno potpomognutom učenju računa vjerojatnosti. Kako bi postigli taj cilj, izrađeni su računalni nastavni materijali koji su obuhvaćali animacije i simulacije s 30 sučelja pomoću programa Dreamweaver MX 2004 i Flash MX 2004, te su preneseni na HTML medij. Nastava pomoću materijala izrađenih u istraživanju provedena je s učenicima 8. razreda u dvije osnovne škole. Uzorak istraživanja sastojao se od dva nastavnika matematike i njihovih razreda uz obuhvat od ukupno 46 učenika. Za prikupljanje podataka, provedeni su polu-strukturirani intervjui kako s učiteljima tako i sa 6 učenika iz svake škole. Iz rezultata je moguće izvesti da i nastavnici i učenici imaju pozitivno mišljenje i pozitivne sklonosti u odnosu na računalo u nastavi. Računalo je nastavnu cjelinu učinilo konkretnijom i približilo je stvarnom životu. Na kraju istraživanja, dani su određeni prijedlozi vezani kako uz materijale tako i uz učinkovitost računala u nastavi.*

Ključne riječi: *računalno potpomognuto učenje, nastava matematike, izrada materijala, mišljenja nastavnika i učenika, račun vjerojatnosti*

Appendix

A SAMPLE INTERFACE FROM THE DEVELOPED COMPUTER-ASSISTED INSTRUCTION MATERIAL

Guideline for Using the Material: This is a sample from the material consisting of 30 interfaces presented to students in an HTML medium with Dreamweaer and Flash MX 2004 software used together in the implementation process. Students can carry out the tasks they are asked to do in each interface and can check their answers by pressing the "check" button. If a wrong answer is given, the answer check button signals: "wrong answer" and, if a correct answer is given, then students can confirm their answers and pass to the next interface by clicking on the "next" button. Students can return to the previous interface by clicking on the "previous" button when needed.



Note: On the wheels, **"R"** represents red; **"B"** represents blue and **"G"** represents green respectively.