

TechPaper - An Interactive Learning Information System Game

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Keywords: BYOD, TechPaper, Peddy-paper, Scavenger Hunt, Deep-learning, Pervasive, Mobile, QR-Codes, Gamification.

Abstract: Nowadays, the presence of technologies in people's daily life is constantly increasing and, consequently, accessing information is easier. Keeping this in mind and allying it to the need to captivate students attention to take advantage of activities and events, TechPaper game was created. The goal of this game is to stimulate the interest of the participants by being captivating, disruptive, innovative, and because it consisted of a set of fun challenges, very enriching (soft and hard skills) and practiced outdoors. The TechPaper was created entirely from scratch by students in articulation with a professor of the information systems department, with the purpose of including the game in the event (TSI.2.MARKET) and integrate all the participants of the event assigning them a role. This game consists of several challenges designed to test the knowledge of participants and compel them to work in teams with people of different ages, genres and profiles. A proof of concept of this game was deployed, and the results are motivating. Considering all the opinions, we can conclude that the implementation of this game was a success at all levels and that it has the capability to be implemented and played in other realities, events, scenarios or institutions.

1 INTRODUCTION

Nowadays new technologies are emerging as a disruptive way of learning. Smartphones are now part of the learning environment. Students are using their mobiles to consult information, analyze data and other tasks. Having this in mind, we can conclude that mobile devices have the potential to become a powerful tool in learning. In this sense, TechPaper arose.

TechPaper represents a new way to test the Information System and Technologies bits of knowledge. A new intuitive, interactive and fun way of learning. The students face challenges associated with topics addressed in classrooms. The first edition of TechPaper was played in TSI.2.MARKET, an event hosted by Information System students at University of Minho. TSI.2.MARKET was used as proof of concept (UMINHO, 2018b).

It uses a person-centered approach, promotes interaction between individuals and groups of individuals and incentive the sports practices and continuous learning.

This paper is structured in seven sections. The first section introduces the idea. The second section

presents the related concepts. In the third section the game concept, architecture and requirements are presented. Section four presents the case study with particular focus to the game in action. Then a brief discussion about the results and a presentation of opinions are present in section five. The last two sections (six and seven) present some conclusions about the game and future work.

2 BACKGROUND

2.1 Bring Your Own Device

BYOD and their features can be considered as a way of applying the Human-Computer Interaction (HCI) concept (Ballagas et al., 2004). The human can bring their computer to an environment and use it to perform activity tasks. BYOD can run in a pervasive environment where everything is available on the internet (Najar et al., 2014). The user can use their mobile device to access to any data and perform several tasks using the environment and application capabilities to interact with the human. BYOD addresses

several concepts as HCI, ubiquity, security, pervasiveness, real-time processing, mobile, situated devices, networks and many others topics in this area. The use of BYOD in education is increasing (Raths, 2012) however the security is a big issue (Miller et al., 2012; Nwebonyi and Ani, 2015).

2.2 Scavenger Hunt based Game - Peddy-paper

Peddy-paper¹ is a variant of the traditional Scavenger Hunts, that got introduced to the Portuguese language from French, adapted from the term “rally paper”, a competition made for motor vehicles (Spikol and Milrad, 2008; Sprogis, 2005). Peddy-paper was created for the pedestrian variant, and can be described as a playful competition based on orientation, designed for teams to follow certain paths which have associated questions or tasks, located in intermediate points in the route. For teams to complete the journey, or the peddy-paper, they must complete tasks to proceed to the next “checkpoint”, and so on (dos Santos Pereira et al., 2011).

The questions, or tasks, are typically connected to knowledge acquisition, about a certain subject determined by the creators of the event. The typical way to prepare the questions/tasks is making a road book that teams must follow and read together to decode the puzzles. There is, usually, an activities program with the schedule previously available, and the rules of the event.

In Portugal, events like this are prepared in a lot of schools, so the majority of students have already participated in at least one. Thus, we felt the need to take this activity and innovate it with some technology, trying to optimize it for both ends - hosts and participants.

There are several advantages in providing a challenge like this to people, which are:

- Promote collaborative learning, team spirit and teamwork among colleagues or even total strangers (Moura and Carvalho, 2009);
- Outdoor activity, ideally in a forest or mountain area, due to the appealing environment for teams to hike and find the hidden puzzles;
- Playful way to acquire knowledge, that may be used in educative environments, but having fun is the central goal (dos Santos Pereira et al., 2011);
- Relatively easy to prepare activity, which only demands a few collaborators

¹Linguistic Note: Peddy-paper is a word created using elements of the english language, although it's only understandable in Portugal.

- The duration usually varies between 4 or 6 hours, which can be adapted based on the creator's intention

2.3 QR-Codes

During the design, the TechPaper developing team was aware of the concern to innovate, in a way that would let the students interested in participating in this game and encouraging their colleagues to participate. However, at the same time the game would have to be intuitive and easy to perceive and play.

That said, instead of using the road book that we find in traditional peddy-papers, we use the QR-Codes (Ashford, 2010). We decided to use them because, in addition to giving a more technological, innovative and attractive vibe to the game, they are easy to implement. QR-Codes have some advantages that we consider important, such as (Walsh, 2010):

- Easy to generate the QR-Code (generated in a matter of seconds)
- Small dimensions, ideal to place them hidden in one “checkpoint”
- Easy to access website pages using a smartphone

Thus, teams only need a smartphone, capable of reading QR-Code natively, or installing an application that allows it, to access the game questionnaires. In addition, they integrate perfectly into a challenge like this, since the traditional elements of a Peddy-Paper, such as interaction with the environment and teams walking together, were not lost. Figure 1 shows one of the QR-Codes used in TechPaper.



Figure 1: Example of QR-Code.

2.4 Related Work

There are a lot of literature debating about all the applications that emergent technologies can bring. For Connolly and Stansfield (2007), interactive technologies can play a relevant role, engaging the learner and providing a different and rich learning experience. Some authors believe interactive technologies, such as visualizations and simulation games have the potential to increase the development of information systems knowledge and skills. Gomes et al. (2014) agree with this perspective and refers that game based educational activities supported by mobile computing

devices can act as a trigger to added success and effective learning outcomes.

Gomes et al. (2014) merged mobile computing devices and augmented reality to develop a Musical Peddy-paper, which had the goal of engage students in collaborative learning towards the Aesthetical Periods of Music History. In their work, the authors propose students to use their own smartphone/tablet, and their skills to find the correct answers, through a collaborative work to find the stations and the answers to the clues. The Musical Peddy-paper was developed mixing Geo-location, QR-codes and Augmented Reality concepts. This work had interesting results, revealing high levels of enthusiasm in the students to do all the activities, achieving good time results and accurate answers.

Holzinger et al. (2011) report on the design and development of a mobile application to support archaeological education and to raise awareness for cultural heritage by making use of the powerful notion of play - archaeological scavenger hunt. This application reads information from QR-Codes, which are placed at points of interest. The players start at one point of interest and get hints on how to find the others.

Internet Scavenger Hunt, from Monahan (2002), is another example of application. This is an educational game for children that teaches about animals and how exactly computers and internet work, through an investigative virtual scavenger hunt. In this game, the users can comment about facts they've discovered and share their knowledge with teammates, promoting information exchange.

Finally, Gunn (2008), talks about the common practice of doing Scavenger Hunts across the University, with freshmen students. This game promote a connection between freshmen students and the University. Students can see the University with different eyes, learning about their culture and all the new things in a fun way. At the end, they feel that they are truly part of the University.

Were presented various examples from different areas, which proves that interactive technologies can be a powerful tool to achieve great learning outcomes in different areas or scenarios. However, Connolly and Stansfield (2007) alert that game based e-learning will not be for all learners, and that there may be issues surrounding development costs. Nevertheless, same authors refer that there are successful case studies in the field and they believe that further work should be done on various aspects of games-based e-learning to understand their potential and limitations.

3 TECHPAPER - A GAME IN MOVEMENT

In this section the TechPaper concept is presented.

3.1 How Did it Born?

Although this work has practical results, all the work followed a research methodology and was developed by the students in articulation with a professor of Information System Department. This work followed the Design Science Research Methodology (DSR). DSR is composed of six tasks where the primary goal is developing an artifact able to answer a problem. Applying DSR to this work, a problem was identified in the first instance. The students are consuming more time than the expected using the smartphones. Block and prohibiting the use of a smartphone, in a technological era, is not the solution.

In this sense, a question emerged: How to use the mobile phones to motivate Information System students?

Then an idea occurred: develop a game where the students can use the smartphone capabilities to test their knowledge in this area. Then the idea won a shape. The artifact should explore the BYOD concept, involve the use of mobile technologies (smartphones) and combine it with the practice of physical exercise in beautiful places. In addition, each space should have a challenge by using QR-Code technology. TechPaper arose after allying these ideas.

3.2 Architecture

The architecture developed to make the TechPaper work as efficiently and effectively as possible, without any kinds of problems, by minimizing risks and preventing potential problems, is very simple to explain and implement, but it must be planned in detail.

It was possible to develop an idea capable of supporting any fault that could lead to its failure, such as attempts to falsify the results (solving the challenge on behalf of other teams, trying to do more than one submission, and many others), infrastructure failures, early access to the forms, and more.

The architecture's diagram in Figure 2 allows to demonstrate how the TechPaper works. Firstly, it's necessary to have participants who are willing to challenge their knowledge, then they are assigned a map and a set of clues from the places where the various challenges are located. From this moment forth, the participants have the necessary material in their hands, including a mobile device, to start searching for the QR-Codes which will allow them to uncover

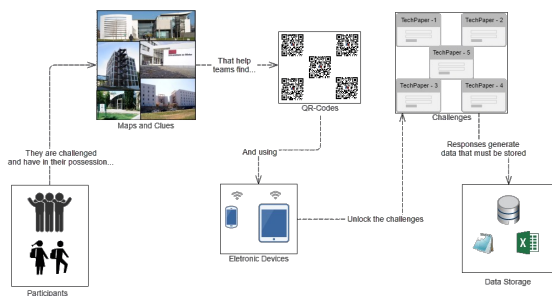


Figure 2: Architecture of TechPaper.

the existing challenges. When the participants enable the challenges and answer them, a set of data will be created and stored to be analyzed at a later date from the team responsible for the TechPaper.

In the case study, the participants were students who belonged to the Information Systems Master Degree, and the map contained various locations around the University of Minho Campus, where the QR-Codes were placed, and each QR-Code was relative to a particular school year of the masters degree. After the participants finished answering the forms, allocated in the platform JotForm², the data for each team was stored in that same platform to be analyzed.

3.2.1 Forms

For the development of the forms, which the teams must respond, it can be used any software that lets you create online forms, make them available and limit the execution time. In that software (the one used in the TSI.2.Market TechPaper was the JotForm), for each challenge, two forms were developed. The first form consists in the identification of the team that wants to access the challenge (it must match with the name that the organization assigned to the team) and the second form, a set of multiple choice questions, two of them with an equivalent score and the question theoretically more demanding / difficult with a higher score.

The questions should address specific topics which are or should be known by participants to assess their skills, experiences and knowledge on these subjects, in a more interactive and appealing way, with a time limit depending on the complexity of the questions. As for the TechPaper released at the TSI.2.Market, each challenge corresponded to a different year of the MiEGSI³ course, with three questions related to different courses of that year, with a limit of 1 minute per challenge.

²<https://eu.jotform.com>

³<http://miegsi.dsi.uminho.pt/>

3.2.2 Places

Regarding the places where the QR-Codes should be placed for each challenge, these can be distributed according to three options:

- **Clues** - The QR-Codes are placed at strategic points, and the participants are given a set of clues which should help them find the QR-Code.

Here we can see an example of the clues used in the game (the answer is trees near the library of campus):

"We grow up big, we grow up tall

We usually lose our clothes in the fall

Books seem to know a thing or two about our kind,

If you go near their home, information you will find";

- **Map and / or Logical Route** - A small map is handed to each team, with the indications of the places where the challenges. These places are not ordered correctly, but follow a logical sequence when given some thought;
- **Hybrid** - Delivery of a small map with indications of possible places where the QR-Codes may be hidden and more specific clues that may help in this process. In the case of TechPaper within the TSI. 2.Market, we used the third strategy, by giving to the participants a small map with several locations in University of Minho - Campus of Azurém. In addition, the QR-Codes were distributed according to the students' daily route (as we can see in Figure 3), i.e.:
 - **First** - Entrance of the University of Minho;
 - **Second** - School of Engineering;
 - **Third** - Canteen;
 - **Fourth** - Library;
 - **Fifth** - University Residences.

3.2.3 Prevent Fraud Attempts

To make sure the game wasn't rigged by any team member, it was necessary to formulate some steps to make sure the end results were reliable.

- Making sure only the team members have access to the questions: A name was assigned to each team which they needed to access to the questions relative to each challenge, ex: "TechPaper01". If the inserted name was not present on the event team names list, it would not be possible for them to visualize the questions.



Figure 3: Map used in TechPaper.

- Making sure each team answers the questions in the 60 seconds allowed: One problem identified was the possibility that team members could refresh the questions web page having another 60 seconds to finish the challenge. Since it was not possible to stop users from refreshing the web page, the solution we found to this problem was analyzing the answers, where we could compare the submission time from the team form and the challenge form. In an ideal scenario, the difference between submissions would be 60 seconds maximum, but there were some aspects that needed to be considered, like the connection speed, so we decided to give a tolerance of 5 seconds to be added to the 60 seconds, that is, if the time between form submissions was superior to 65 seconds, then the answer to that challenge would be dismissed, otherwise it would be accepted.
- Identifying multiple answers: Seeing that we could identify the IP (Internet Protocol) address from the devices that were submitting the forms, it was possible for us to check if the same team was answering multiple times to the same challenge. If this happened, the first answer submitted was accepted while the remaining others were ignored.

3.3 Requirements

To "install" the game a few requirements are needed:

- Web:
 - Web Server
 - Mobile App

- Smartphone with internet access
- External Environment with QR-Codes

A set of sensors can be considered to improve the game:

- Accelerometer
- Light
- Proximity
- Pressure (when available)
- Timer

These sensors can be used to determine positions and proximity in order to increase the game's intereaction.

3.4 The Game

The main goal in developing this game was to encourage the students' participation, in an environment where their Hard skills acquired over the MIEGSI degree and Soft skills could be tested. The game was divided in two parts: the first part was a set of forms, and the second part was the Challenge@TSI. Next, we are going to clarify each one of these phases.

3.4.1 Rules

A set of rules was required to guarantee the good functioning of the game in it's various phases. Next, are explained the implemented rules.

- Teams between 3 or 5 members, and two of them had to be from different school years;
- Exchanging ideas between different teams or people who didn't participate in the game was strictly forbidden;
- While participating in the challenges was not obligatory, the Challenge@TSI was;
- To enable the participation in the Challenge@TSI, each team needed to have 5 different cards, which they could request after interacting with the organizations participating in the event Networking;
- Each team only had 60 seconds to answer each form;
- Only the first answer from the team was accepted for each form;
- If a team was caught doing the form pretending to be another team, it would be immediately declassified;
- Each team had 7 minutes to present their solution to the jury in the Challenge@TSI.

3.4.2 Challenges

The challenges goals were to promote teamwork, challenge the knowledge students acquired over the years in MIEGSI, and to promote the interaction between students from different school years. About the challenge itself, five forms were spread around the Campus and could only be activated by QR-Code - Figure 4. Each form had three questions related to lectured courses in MIEGSI: one form was related to the first year, another to the second year and so on. Two of the questions were low/medium difficulty and one of them had a high difficulty cap. Each team had 60 seconds to answer the forms, and each one was worth 8 points.

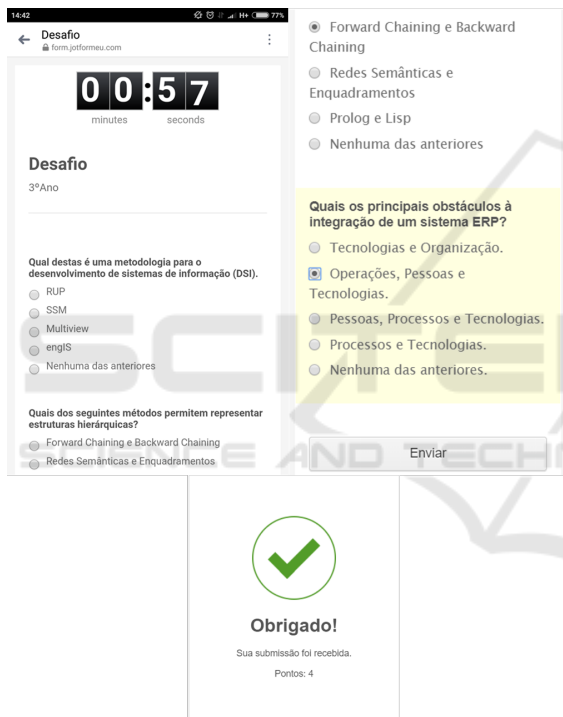


Figure 4: Forms example.

3.4.3 Challenge@TSI

The Challenge@TSI was the game’s last phase, having a bigger impact than the other challenges. The students were confronted with a real-world problem and they were asked to present a viable solution to the problem, using the acquired knowledge in MIEGSI. The real-world problem was the integration of the various public schools in one unique system, allowing to facilitate the information gathering and analysis for the Ministry of Education.

Each solution was presented to a jury, which consisted of teachers from the TSI Department, who

would give their opinion and ask questions to the teams after the end of the presentation. This last challenge encouraged the students to apply their knowledge in a real-world problem and a set of soft skills, like teamwork and the presentation of elaborated ideas, which allowed to enrich the students who participated in the Challenge@TSI.

3.4.4 Points

In order to make the game more interactive and competitive, the points must be set in a way that whoever gets all the points in the challenges does not win the game automatically, nor whoever wins only the challenge@TSI itself. To do this, the points were defined as shown in Table 1.

Table 1: Points distribution.

Name	Description	Points
Team*	One element of the first year of MIEGSI	5
	One element of the second year of MIEGSI	4
	One element of the third year of MIEGSI	3
	One element of the fourth year of MIEGSI	2
	One element of the fifth year of MIEGSI	1
Challenges	Two multiple choice questions. This questions are simple and they address to courses of the respective year which the challenge is inserted on.	2
	One multiple choice question. This question is very complex and addresses to a course of the respective year which the challenge is inserted on.	4
Challenge@TSI	Team classified on the first place	30
	Team classified on the second place	20
	Team classified on the third place	10

* Valid only for an element of X year, that is, if there is more than one element of X year, this rule only applies to one of these elements.

In short, the maximum points that a team could get was 85 points, and the team with the highest score wins the game.

4 A REAL CASE STUDY

This game was implemented and integrated in an event organized by AIS.SC UMINHO - Student Group of Information Systems (Association for Information Systems Student Chapter UMINHO), which was the first and currently the only Student Chapter of Association for Information Systems in Portugal, as they tell us in the history⁴ section of their website (UMINHO, 2018a).

4.1 Game Context

The event in which TechPaper was integrated is called TSI.2.MARKET. This is an annual event, that aims to bring students closer to the market, promoting workshops, challenges, thematic sessions and networking

⁴<https://aissc.dsi.uminho.pt/a-nossa-historia/>

with companies related to Information Systems and Technology (UMINHO, 2018a).

Since the creation of the event (about eight years ago), the goal was the same: give students the opportunity to create contact points with real world job market, understanding the needs, establishing contacts, understand their strengths and weaknesses and also be capable of leaving the comfort zone, to highlight themselves and face the challenges. This event allows students to understand the market's needs, the opportunities available to be taken, consequently realizing which opportunities would they like to embrace, and which hard skills and soft skills the companies are looking for, allowing them stand out (UMINHO, 2018a,b).

Based on this goal, since the day one, AIS.SC UMINHO try to innovate the event, in order to capture the attention of students, making them feel interested in the event and making them want to participate as much as they can. Thus, on the eighth edition of TSI.2.MARKET (2017), the team in charge in organizing the event created a plenty of challenges, surprises, exciting, challenges, and invited highly regarded speakers to present the sessions to the students. However, the core of the event remained the thematic sessions about Information Systems and Technologies (IST) and workshops aiming to increase the portfolio skills of the participants (UMINHO, 2018b).

The main target audience of the event are the students from all the years of the IST years (UMINHO, 2018b).

4.2 TechPaper in Action

Having innovation as focus, the TechPaper arose in this edition. A fully-thought-out game from scratch released on eighth edition of TSI.2.MARKET, with the main purpose of being extremely challenging and aggregator of all student profiles to invigorate the event.

This game was designed and developed to fit perfectly in TSI.2.MARKET in a way that was capable of being a captivating, innovative, and aggregator challenge to different profiles of students, benefiting those who theoretically would have more difficulties because they still attend the first years of their courses. The architecture and implementation strategy (rules, points, challenges, ...) were planned in such a way that all participants of the event had a role in the game. The students that participated, were a part of multidisciplinary team composed by students with different profiles (both genders, different years and courses and with different soft and hard skills). This teams did

open-air challenges, talking to people until they guess the clues for the next challenge, responding to IST challenges, talking to various companies, and solving a real world problem (challenge@TSI) presenting and defending their solution to a jury. The companies that were present in the networking space of TSI.2.MARKET also had an important role, since the final challenge was only available if the teams manage to address at least five companies, so the organizations would give them a card recognizing their effort.

5 DISCUSSION

The feedback about this game was fantastic from all involved parties. The students loved the challenge and demonstrated their enthusiasm and excitement to solve the clues (thinking in team and talking to people about that), and finding QR-Codes (that allowed access to the next challenges). They were also very thankful, because the challenge, in a way, provided them with a goal and an extra motivation, to address the organization directly and get to know them better, their projects, main areas of activity, job opportunities/internship available, work environment, among other things. The teams that participated in the challenge also commented the challenge allowed them to improve their soft skills (talking to people, working as a team, not giving up, doing a presentation, being under pressure ...) and their hard skills (information obtained or remembered).

The game, in their opinions, made them feel encouraged to improve themselves. The feedback from the companies, was also very good, since they were able to talk to several interested students and they liked to felt well-received and included in the challenges and sessions being an integral part of them. Finally, the professors praised the fact that the AIS.SC UMINHO had the courage to innovate both the event and, in particular, this challenge, because in the organization of this kind of things, greater the complexity, greater the associated risks.

Summarizing, as this Case Study demonstrates, TechPaper has proven to be successful and can be applied in a wide variety of contexts and areas, presenting itself as an ideal way to integrate leisure, fun, curiosity, networking and resolution of various challenges that improve soft and hard skills.

6 CONCLUSIONS

Nowadays, people use their Smartphones very intensely, spending a big part of the day in front of

their phones. Even though there is a negative view around this phenomenon, truth is it will be around for a long time, so people should start thinking in ways to integrate it in their activities. This was one of the line of thoughts we made TechPaper come to life and allowed the event to be a success. Another strong point of the game is how easy it can be shifted to another environment, like another area of business. This makes TechPaper an interesting concept to whoever wants to create an interesting game, capable of integrating different people in a surrounding which will challenge and encourage them to reinforce the team spirit and promote a healthy environment, outdoors, and test their Hard and Soft skills.

The developed game was well-received between the students of the IST universe, it showed a motivating and interesting way of evaluating the students' knowledge and appealing to the team work, helping them reaching the objectives defined initially, that is, the game encourages aid, helps building links and sharing knowledge among people, teaching them to work together as a team to achieve a common goal, promotes the development of creative, innovative and collaborative skills through problem solving and, finally, it fosters a space for learning and developing professional skills by bringing together different people with different statuses. The feedback received by the participants was very positive making sense the development and distribution of the game.

About BYOD, it was a very present policy during the development of the idea, helping us in some decisions that led to the success of the project. In addition, it has been increasing its popularity in the academic context, being increasingly used in education, despite its security problems.

7 FUTURE WORK

As future work, it makes sense to develop our own application (both back-end and front-end), which includes all the parameters necessary for the organizers to develop the forms, define the timeouts (time that participants have to respond to the questions of each form), the quotations of each question and the automatically calculation of the total point for each questionnaire. In addition, it will be important that the application allows organizers to adequate forms to a wide variety of areas, perform effective security control, access control, monitor any type of fraud and allow sharing and storage of the results in real time so that participants can see their quotations and organizers can see whose playing, the points of each team, and more.

Lastly, it will also be relevant to make the game available on Google Play and to define a strategy for the dissemination of the game and the application to other institutions, courses, scenarios and areas. So, this game will be available in the next editions of TSI.2.Market and on the summer on Campus⁵.

ACKNOWLEDGEMENTS

This work has been supported by COMPETE: POCI-01-0145-FEDER-007043 and FCT Fundação para a Ciência e Tecnologia within the Project Scope: UID/CEC/00319/2013.

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⁵Summer on Campus is an event where High School students come to University of Minho to know the different degrees and areas of investigation of this institution. This is a good opportunity to let people know this game and have a feedback from younger ages.

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