Use of Augmented Reality Mobile Devices to Support Farming Teaching and Learning

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1 Introduction

Computing has become part of the daily lives of people and organizations from different sectors, including the educational environments. According to Menezes, Nunes, and Livi (2018), knowledge in this area is very important for life in contemporary society. With this, new ways of learning and teaching concepts emerge at every moment to understand society in constant evolution. Thus, it is essential that all individuals have basic knowledge and can learn about and with computing.

Mobile computing technologies are currently undergoing rapid evolution and appear destined to become the new dominant computing paradigm (Myers & Beigl, 2003). The use of mobile devices in education has created a concept, called Mobile Learning or m-Learning. Its great potential lies in the use of mobile technology as part of an integrated learning model, characterized by the use of wireless communication devices, transparently and with a high degree of mobility (Ahonen, Joyce, Leino, & Turunen, 2003; Syvänen, Ahonen, Jäppinen, Pehkonen, & Vainio, 2003).

The provision of telecommunications services and mobile devices capable of providing mobility to different participants in educational projects presents several opportunities for the development of research in the field of mobile computing applied to education (Meirelles, Tarouco, & Alves, 2004). In support of learning, three-dimensional virtual environments, where the individual can move, listen,

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see, and manipulate objects, as in the real world and learn, represent interesting opportunities available to educators. The introduction of the so-called augmented reality systems (ARS) in education can significantly modify the role of these educators (Meirelles et al., 2004).

In this study, we propose to analyze the potential of the ILPF—livestock and forest integration system in mobile devices as a teaching and learning tool for agriculture, starting from the idea that continuous and open activities in education are necessary in educational, productive, and social organizations and that new technologies can contribute to student learning.

2 Methodologies

The methodological procedure that guided the research was divided into different stages, detailed below.

2.1 Methodological Approach

The research had a quanti-qualitative approach due to the nature of the collected data, which allowed to make quantitative and qualitative analyses. For Vieira (1996), qualitative research can be defined as that which is mainly based on qualitative analysis, characterized, in principle, by the non-use of statistical instruments in data analysis. On the other hand, according to Vieira (1996), quantitative research is characterized by the use of statistical instruments, both in the collection and treatment of data, and whose purpose is to measure relationships between variables. The research was also exploratory-descriptive.

2.2 Data Collection Procedures

Data collection during the research was carried out using two instruments, a questionnaire and an interview.

The questionnaires and interviews were directed to students and teachers of the third year of the Agricultural course at Licungo University, Extension of Beira, in the academic year of 2019.

We opted for the combination of a mixed research methodology, using several methods of data collection and analysis since it is "often useful, if not necessary, to use different techniques in the same research" (Lessard-Hébert, Goyette, & Boutin, 1990).

Sampling was done for convenience, using informal contacts, and asking students and course Teachers to participate. It was possible to work with a sample of 40 respondents among teachers and students, mostly students. The questionnaires were distributed and answered on paper.

Lists of validated indicators were used as a starting point for data collection. The questionnaire started with the search for requirements related to the course, from the classroom to the campus, after which the students were submitted to a pre-test. Then an explanatory text related to the contents (ILPF Networks) of the pre-test questionnaire was generated, which was provided to the same group of respondents to be aware of what was going to be addressed. Following the explanatory text, the participants had the possibility to install the application and interact with the ILPF cube in augmented reality.

After the students interacted with the application and cube ILPF about the programmed contents, they were submitted to a post-test. Following the post-test, students and teachers were invited to answer a satisfaction questionnaire about the functionalities of the ILPF cube application.

The interviews were conducted with teachers and students. They allowed to extract information related to the research objective, the level of satisfaction after the experiment with the ILPF cube application. The interviews enabled the enrichment of numerical data throughout the work.

2.3 The Experiment

This session presents the ILPF system and its augmented reality markers (AR-markers), the operation and visualization of objects (Fig. 1).

The virtual model is made up of different AR-markers, each of which is available for viewing different phenomena related to farming, livestock, forest and their integration. For visualization there is a need to install the ILPF cube application on a mobile device.

To install the application, you must access the mobile application store, for Android or iOS, and download the ILPF RA cube application. The application can be installed on a cell phone or tablet. After installing the application, access the website https://www.embrapa.br/documents/, download, and print the images. Cut out and assemble the cube. After the assembly, open the application and point the camera of the cell phone or tablet to each of the faces (Fig. 2).

On each face of the cube there are markers that visualize certain phenomena of the integration of farming, livestock, forest and some buttons that allow interaction with the application for the user.

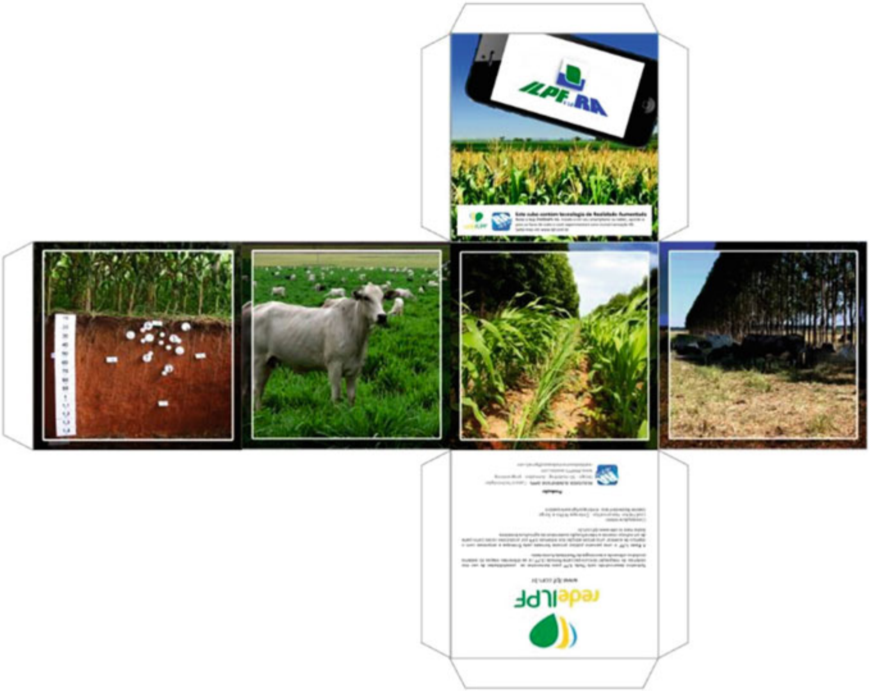


Fig. 1 Virtual model in augmented reality. Source: Embrapa (2019)

2.4 Visualization of Objects in Augmented Reality Available in Markers

One of the first activities was the demonstration of ILPF network as an aid to farmers and teaching and learning processes. Figure 3 show some activities offered by the ILPF network in augmented reality.

Figure 4 illustrates a system of soy and corn production planted in a straw in the same area where it can be seen that the growth of each crop does not disturb the growth of the other, thus verifying the beginning of integration.

Figures 5 and 6 illustrate the benefits of integrating cultures. In the figures it can be seen interaction buttons that allow to give the effect of whether or not there is straw. In Fig. 5, the cultivation of corn was done without straw, which does not benefit the soil, where it can be seen that the roots are unhealthy than in Fig. 6, where the cultivation was done with straw and it is noted that the roots have more nutrients.

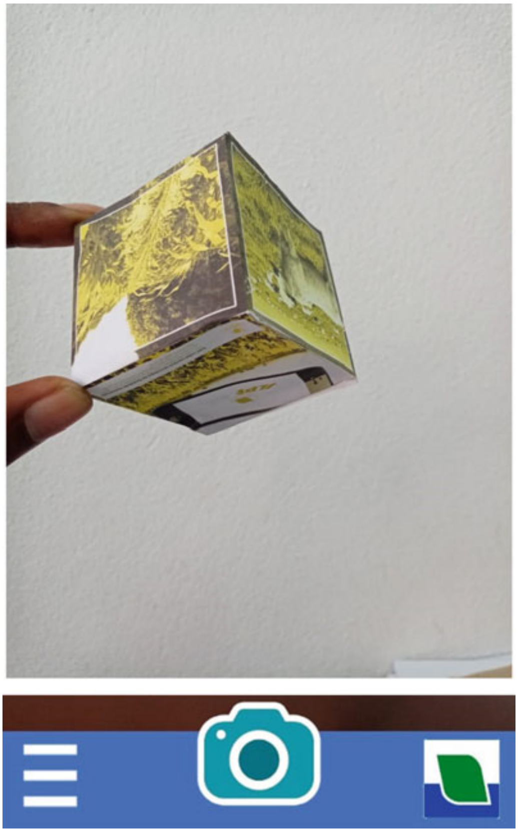


Fig. 2 Assembled cube viewed from a mobile device

The interaction with the application allows to verify the effects that water causes in the cultivation areas such as soil degradation, erosion, and even the details of the culture (Figs. 7 and 8). It is also possible to see the profile of the soil, what is happening to the roots and nutrients. In Fig. 7, it can be seen that in rainy season there may be cases of erosion due to the lack of straw in the plantation, a different situation in Fig. 8 where the planting was done with straw.

Figure 9 illustrates the integration of livestock and forest where it is possible to see the benefits of one activity for the other and also the dynamics of carbon dioxide between the two activities.

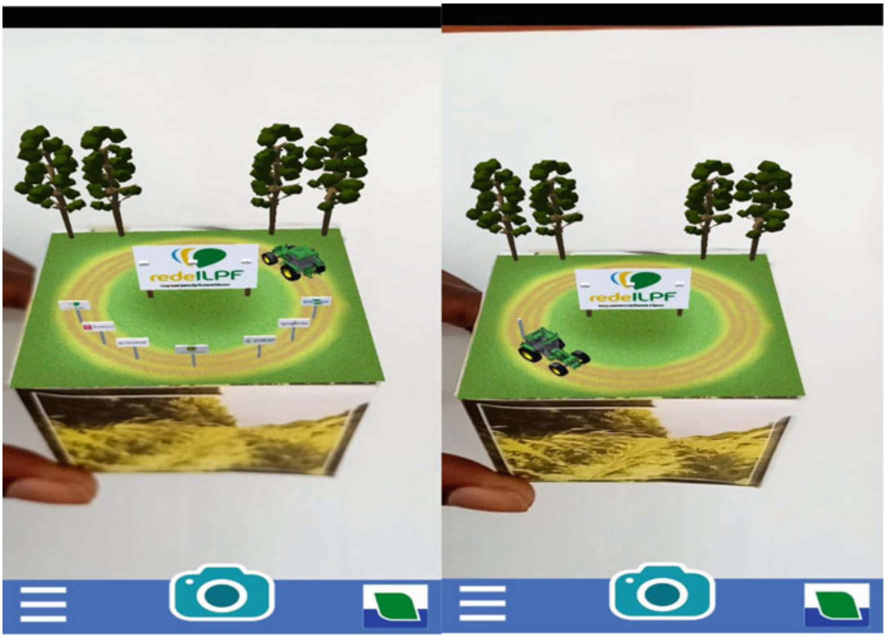


Fig. 3 Activities offered by the ILPF network in augmented reality

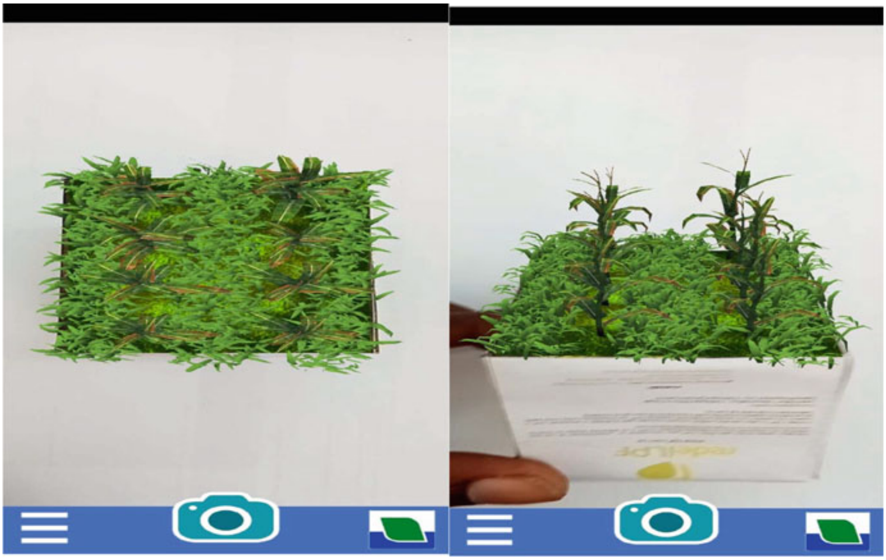


Fig. 4 Integration of soy and corn plantations in the same area

Fig. 5 Profile of the soil without straw

Fig. 6 Profile of the soil with straw

Fig. 7 Soil profile without straw and rain effect

Fig. 8 Soil profile with straw and rain effect

Fig. 9 Livestock and forest integration in augmented reality

3 Results

This section presents, in a clear and detailed way, the results achieved by the experiment performed, which in the previous section was made the description.

The data was collected from the 40 participants (including teachers and students of the third year agricultural course, from Licungo University—Extension of Beira) that will be analyzed, who were given the opportunity to test and use the ILPF Cube application in Augmented Reality. The collection and analysis of data was divided into four phases, shown below.

3.1 Requirements Survey Questionnaire

The first questionnaire applied aimed at evaluating the students' perception about the farming course, mobile devices for interacting with farming, livestock and forest environments, and augmented reality.

In the first question, the students were asked whether the farming course is more practical or theoretical. The answers are shown in Fig. 10.

More than half of the respondents (62%) said that the course has two aspects of teaching, being theoretical and practical. Twenty-five percent answered that the course is theoretical and thirteen percent that the course is practical. By the distribution of the students' answers, it can be concluded that the course has a theoretical and practical character witch is the genesis of a farming course.

In the following question, we tried to find out if there has been consolidation of theoretical and practical classes. The answers are shown in Fig. 11.

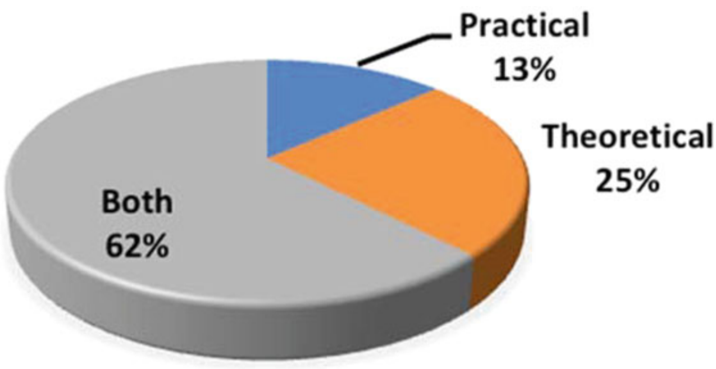


Fig. 10 Model of the farming course. Fonte: Autor

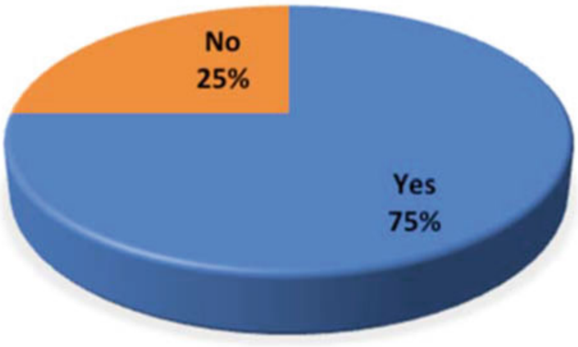


Fig. 11 Consolidation of theoretical and practical classes

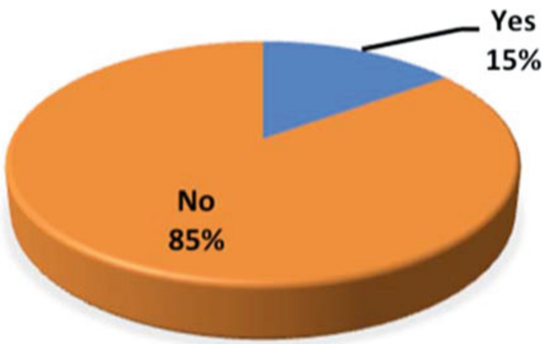


Fig. 12 Existence of spaces prepared for practical classes in the course

It was observed that the consolidation of theories and practices classes has taken place as shown in Fig. 11. However, due to the observations made, there are contents that are taught theoretically and that are not possible to be observed in practice due to the lack of adequate or appropriate equipment and fields of experimentation. It is for this reason that some of the respondents (25%) do not confirm the consolidation of practical and theoretical classes. This information is reinforced by the answers to the following question presented in Fig. 12.

It was observed that this question helps to answer the research question, where mobile devices and virtual models can help in consolidating or supporting the consolidation of theory in practice, since 85% of respondents say that there are no prepared spaces to consolidate those classes. With this data, it can be assumed that mobile devices with the appropriate applications can help students to suppress this non-existence of these spaces.

The students were asked if they knew any way of interaction with the farming, livestock, and forest environments through the computer or mobile devices. The answers are shown in Fig. 13.

Fig. 13 Interaction with farming, livestock, and forest environments through computer or mobile devices

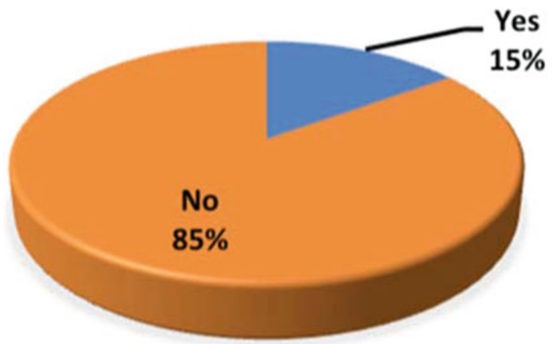
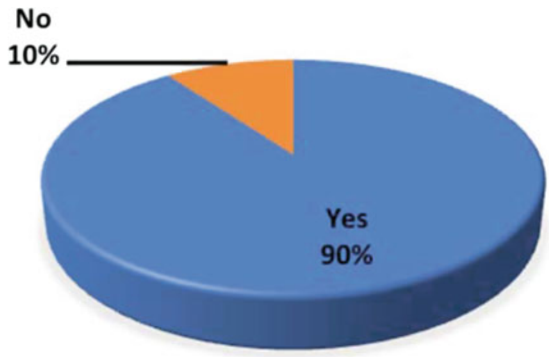


Fig. 14 Acceptance of 3D farming, livestock and forest integration model



It can be seen from the data in Fig. 14 that only 15% of respondents knew an environment of integration farming, livestock, and forest to support teaching and learning. For the vast majority, the Augmented Reality ILPF Cube was the first.

To view content in Augmented Reality, a virtual model is needed where it contains the contents in addition to a mobile device or computer. That is why students were asked if they would like to have a 3D model that makes it possible to check the content learned in the classroom, where they could have a greater sense of farming, livestock, and forest. The answers are presented below.

We can see that most of the respondents would like or want to have a 3D virtual model that will make it possible to observe the contents learned in the classroom in practice to consolidate the theoretical knowledge on the subject. The remaining 10% are not interested in having a model of this nature stating that the most important thing is to be aware of the integration.

We sought to know from the students about their interest in using technology through computers or mobile devices as a tool to support teaching and learning inside and outside the classroom.

In the question, respondents were given the possibility of choosing between several alternatives, it was a question with five alternatives, where by the nature of the question and the answers it shows that the technological tool proposed in the research and tested in it aroused interest in the use of technology by the respondents.

According to Fig. 15, it can be highlighted that 78% are very interested in using technology and this has made the research gain more impact on the course.

Finally, we tried to find out from the students if they had ever used an application in augmented reality. The answers are shown in the following Fig. 16.

Although the results show that 78% of students answered that they had never used applications in augmented reality, it was observed that there has been learning through mobile devices or computers, since some of the students participating in the experiment have mobile applications on their devices intended for learning.

This thinking is supported by the answer to the following question, where students were asked if they had ever used mobile devices for learning (Fig. 17).

The result showed a balance, where 53% of respondents did not use mobile devices to view educational content and the remaining 47% said they used it. It should be noted that 90% of those involved in the experiment have mobile devices.

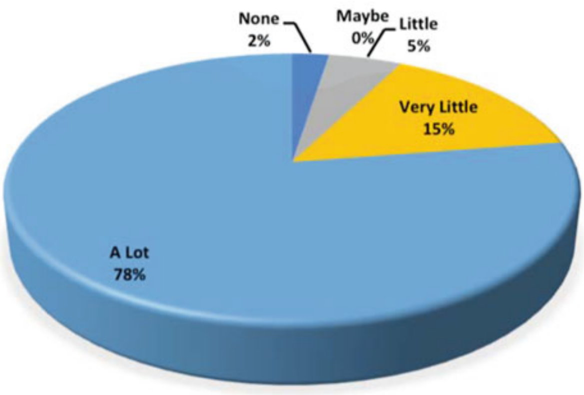


Fig. 15 Interest in the use of technology through the computer or mobile devices as a tool to support teaching and learning inside and outside the classroom

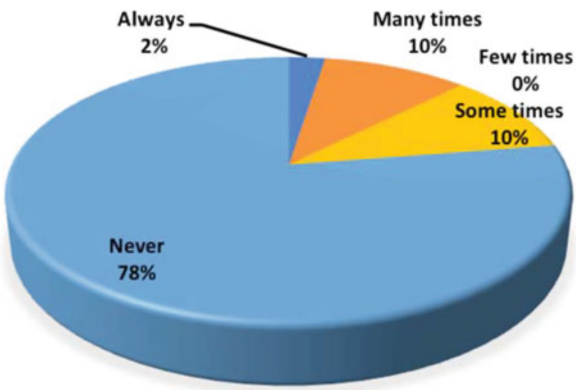


Fig. 16 Use of augmented reality applications

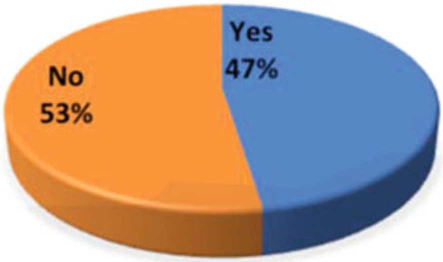


Fig. 17 Use mobile devices for learning

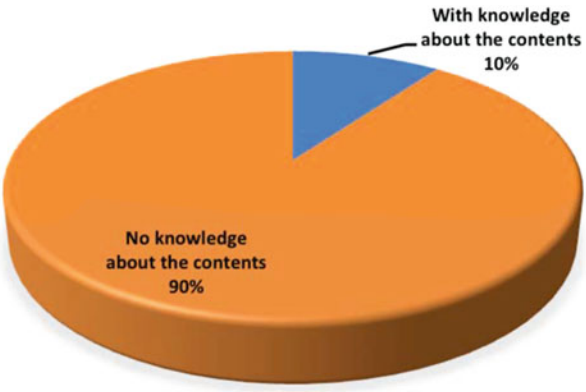


Fig. 18 Level of knowledge of students regarding the content covered in the research (pre-test)

Also, it should be noted that among the respondents, those who already had an understanding of augmented reality or had heard about augmented reality had this knowledge on television or in conversations with friends or colleagues.

3.2 Pre-test Questionnaire

Before carrying out the experiment, students were submitted to a questionnaire that aimed to assess the level of knowledge on the subject to be addressed in the research. The result of this questionnaire is shown in Fig. 18.

The results obtained from this questionnaire, which are shown in Fig. 18, showed that about 90% of the respondents did not know about the topic to be addressed in the research. Still, students were unaware of the usability of virtual models and mobile devices in supporting the teaching and learning processes for visualizing phenomena addressed in the classroom.

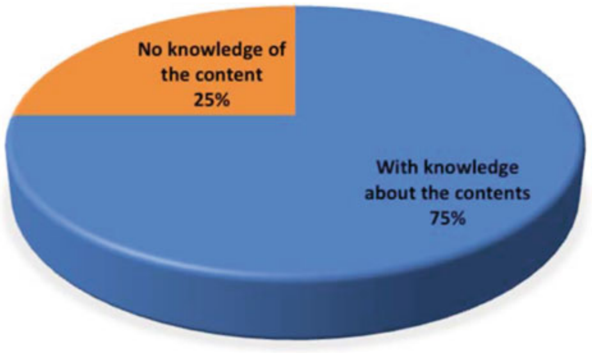


Fig. 19 Level of knowledge of respondents regarding the content covered in the research (post-test)

3.3 Post-test Questionnaire

The post-test was applied after the students had approached the programmed contents and used the ILPF application. The post-test questions addressed the same concepts as the pre-test (Fig. 19).

The results obtained from the post-test with the same questions as the pre-test showed an increase in the number of students who showed knowledge of the content.

3.4 Level of Satisfaction

After conducting the research, we sought to know from the participants (students and teachers) the level of satisfaction with the application, the usability and its integration in support of the teaching and learning process. For that, a questionnaire was applied to achieve the objective mentioned above. Figure 20 shows the results of the first three questions in the questionnaire.

The answers to the first three questions in the satisfaction questionnaire showed that approximately 100% of respondents rated the ILFP model positively. Qualitatively, responses ranged from 45% good to around 55% very good.

The next question sought to find out the opinion of the respondents regarding the usability of the ILPF system. Their responses are shown in Fig. 21.

It was observed that 70% of the respondents evaluated the ILPF model as being easy to very easy to use. The remaining 30% rated the model as having reasonable usability.

We also tried to find out from the respondents if, after carrying out the experiment, they would use the system to help the classes. The answers are shown in Fig. 22.

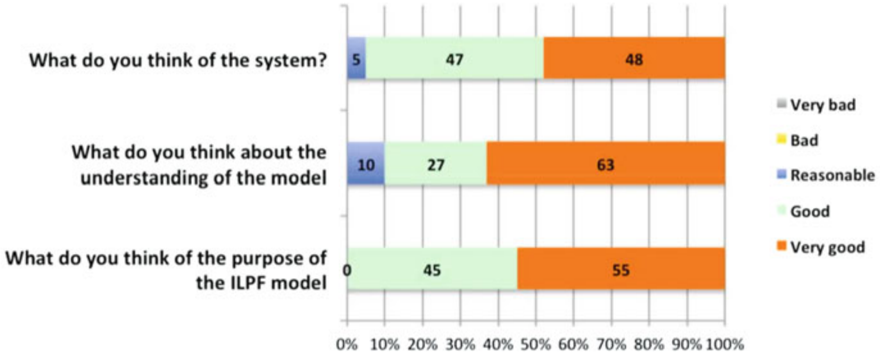


Fig. 20 Level of satisfaction with the application

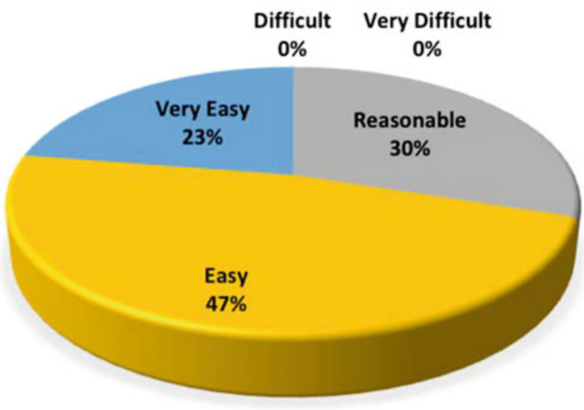


Fig. 21 Usability of the ILPF system

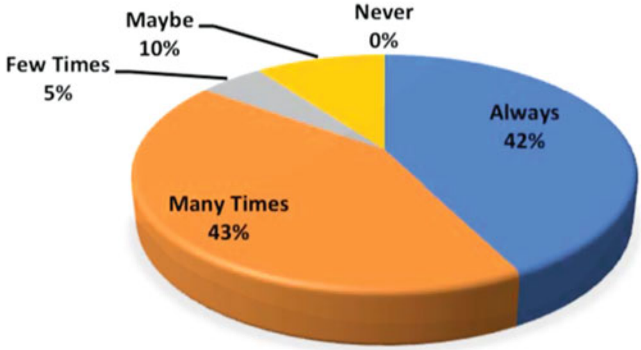


Fig. 22 Use of the system to help in class

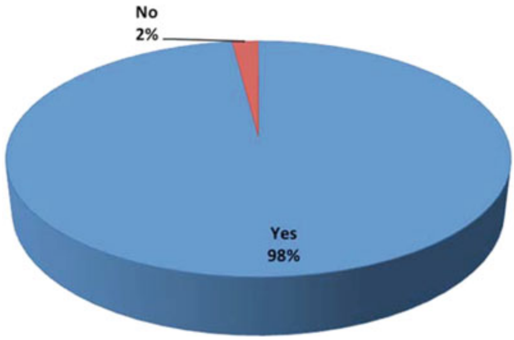


Fig. 23 Visualization of 3D objects

The question gave the respondents the choice between several alternatives. From the responses of the respondents, it can be concluded that the technological tool used in the survey aroused much interest on the side of the respondents.

As a last question about the usability of the ILPF model, we tried to find out from the respondents if they were able to visualize the 3D objects.

From the result shown in Fig. 23, it was possible to verify that from the mobile devices the respondents were able to observe the phenomena that occur in the farming activities proposed in the research.

This shows that the research has achieved the previously defined objectives and that the use of mobile devices with ILPF systems in aid to practical classes helps to consolidate theory in practice.

4 Conclusions

In this chapter, the conclusions arising from the present research are presented, where, according to the results obtained, we sought to achieve the previously defined objectives.

The work focused on making use of the ILPF system—Integration of Farming, Livestock, and Forestry in support of teaching and learning processes in agriculture in order to demonstrate the phenomena that occur covering the lack of integration between theory and practice and exploring the benefits that the system presents. This integration, in some way, improves the quality of teaching. Being a technical area, students have to graduate knowing how to consolidate theoretical classes to practices.

The research participants showed interest in using in a massive way the ILPF system—farming, livestock, and forest integration in augmented reality. This showed that the use of new technologies in teaching and learning is seen as an ally to traditional teaching and learning methods and that help in understanding certain thematic content.

Regarding the knowledge of the content covered in the research, it was possible to conclude from the results of the pre-test, that the respondents showed to have no knowledge of the research topic, about 90%.

After conducting the experiment with the ILPF system, the respondents were subjected to another test called post-test, with questions that addressed the same contents as the pre-test. The results of the post-test showed that 75% of the respondents had knowledge of the content in their responses.

After conducting the research, we sought to know from the participants (students and teachers) the level of satisfaction with the application, the usability and its integration in support of the teaching and learning process. The results showed that almost 100% of the participants were satisfied of using the system and were able to view the phenomena.

References

Ahonen, M., Joyce, B., Leino, M., & Turunen, H. (2003). Mobile learning – a different viewpoint. In H. Kynäslahti & P. Seppälä (Eds.), *Professional mobile learning*. Helsinki: IT Press.

Dias, C. (2000). Pesquisa qualitativa – características gerais e referências.

Lessard-Hébert, M., Goyette, G., & Boutin, G. (1990). Investigação qualitativa: Fundamentos e práticas. Instituto Piaget.

Meirelles, L., Tarouco, L., & Alves, C. (2004). *Telemática Aplicada à Aprendizagem com Mobilidade*. Porto Alegre: RENOTE - Revista Novas Tecnologias na Educação.

Menezes, C. S., Nunes, D., Livi, M. A. C. (2018). Pensamento Computacional: Revisão bibliográfica. Porto Alegre: UFRGS. Disponível em: https://lume.ufrgs.br/handle/10183/197566. Acesso em: 03 out. 2019.

Myers, B. A., & Beigl, M. (2003). Handheld computing. *IEEE Computer Magazine, 36*, 27–29.

Syvänen, A., Ahonen, M., Jäppinen, A., Pehkonen, M., Vainio, T. (2003). Accessibility and mobile learning. In: IFIP Etrain conference in Pori, Finland.

VIEIRA. (1996). Marcelo Milano Falcão Vieira. A comparative study on quality management in the Brazilian and the Scottish prison service.