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Real and ideal perception of the intelligent classroom environment of future teachers

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Abstract: The proliferation of information and communication technology tools in the last years has led many teachers to review the way they teach and structure their learning environments. The growth of technological applications in teaching and the training of future teachers is not only gaining momentum; it is also becoming an important part of the current educational scene. The objectives of this study were to adapt and validate the Real and Ideal Intelligent Classroom Questionnaires (REQSC) and (IEQSC), and to determine if there were significant differences in the perception that future teachers had of the real and ideal environment of intelligent classrooms. A quantitative methodology was used, applying the statistical software SPSS 23 for the factor analysis. The results indicated that both questionnaires showed a valid and reliable internal consistency. The real and ideal perceptions of the use of technology as a learning tool and access to information make it clear that it is currently being used correctly. It is important that future teachers acquire adequate skills for their use and research in different topics.

Keywords: *Classroom Environment; Information and Communication Technology; Technological Education; Technological Innovations; Higher Education.*

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Introduction

"Intelligent" is a new concept that was created to describe the technological, economic and social developments caused by those technologies that are based on sensors, new ways of connecting and exchange of information. In most cases, it is not so much the individual technological developments, but rather the interconnection, synchronization and arranged use of different technologies what constitutes an intelligent behavior (Giannakos, Sampson & Kidziński, 2016).

According to Bhagat, Wu & Chang (2016), with the recent advances in information and communication technology (ICT), in the twenty-first century, the Internet is very important for

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accessing training from anywhere. The use of the Internet in higher education has grown at an exponential rate. There is a high level of Internet use, particularly in university education. The Internet not only provides access to the major learning contents; it also offers the chance to interact with other people, as it allows to share one´s own ideas and participate in discussion forums all around the world. The integration of the Internet in a face-to-face learning environment has shown to have a positive effect on academic performance (Kemp & Grieve, 2014). Thereby, the development of Information and Communication Technology (ICT) is influencing all the aspects of our society. The field of Education is not an exception (Lee, Lee & Park, 2013), and the most important change is the emergence and development of e-learning. In this regard, Lee, Zo & Lee (2014) state that e-learning, as it overcomes the limitations of time and space, provides a learning environment that allows to learn at any time and place (Sykes, 2014). According to Oliver, Herrington & Mcloughlin (2014), the use of technology in teaching and learning has already been shown to provide many opportunities to teachers and learners. These opportunities include, among other things, increased access to learning, increased flexibility for learners and enhanced learning outcomes in domain-specific knowledge outcomes. With the advancement of ubiquitous technologies and learning practices, e-learning is becoming the intelligent learning (Noh, Ju & Jung, 2011).

Other authors claim that the rapid progress of wireless communication, sensors and mobile technologies have allowed students to learn in an environment that combines the resources of learning, from both the real world and the digital world, considering it as a new learning style known as "context-sensitive ubiquitous learning" (Hwang, Chu, Chen & Cheng, 2014).

However, as stated by Li, Kong & Chen (2015), despite the dramatic growth and evolution of e-learning, ICT has not brought significant changes in the real-current context of educational centers. Although a variety of ICT tools have been incorporated into the classroom, their use has not stimulated novel changes in learning practices; the use of these tools is still rather discrete and limited to enhance learning methods. Nowadays, intelligent design is considered a new paradigm that arises from the combination of advanced teachings with information and communication technology. Within ICT, there are basically three concepts of intelligent learning: e-learning, m-learning, and u-learning. Therefore, we are facing a new classroom environment that emerges from the convergence and combination of advanced teachings with intelligent ICT. In this regard, according to Hedberg (2014), any mobility teaching must accept the idea of the reflexive teaching practice that involves the students in significant learning in environments that are not limited to the classroom.

The research problem was to assess the practical classroom environment with the use of existing technologies in the university context.

Literature review

According to Aldridge, Dorman & Fraser (2004), the study of classroom environments has received increased attention from researchers, teachers, school administrators and administrators of school systems. The concept of environment, as applied to educational settings, refers to the atmosphere, ambience, tone, or climate that pervades the particular setting.

Lizzio, Wilson & Simons (2002) state that a good perception of the environment influences the students in their motivation to study, and that the perceptions of learning environments influence the learning results.

In the current society of information, the low levels of literacy, such as reading, writing and calculus, would be replaced by high levels literacy, such as critical thinking, communication, exchange and complex problem solving. These new learning skills are not achieved only with the support of innovation in content learning and learning approaches, but also with the support of learning environments. In this line, Hall, Ramsay & Raven (2004) analyzed the changes in the learning approach through specific changes in the learning environment. Therefore, it is necessary to investigate the classroom environment in the society of information in which we are immersed, i.e. the environment of the intelligent classroom.

In its inception, the expression “intelligent classroom” was used to differentiate it from the computer classroom. It is frequently used to refer to classrooms equipped with interactive whiteboards to facilitate real-time interaction between teachers and students, and the realization of teaching-learning activities (Zhao, 2006).

In their study, Li & Kong (2014) indicated that the most attractive characteristic of the intelligent classroom is the integration of all kinds of interactive technologies, context-sensitive technologies and intelligent digital devices into the teaching-learning activities. Ramamuruthy & Rao (2015) consider that the rapid development of technology has boosted the creation of new devices for all of life´s sectors, regardless of age. In this fast-advancing era of technology, many individuals have high-tech devices, such as laptops, tablets, iPads and smart phones. University students are especially enthusiastic about using smart phones. Thus, they are becoming increasingly passive in the classroom, as they are attached to their smart phones. This situation raises the question of whether learning is really taking place while the students are too busy with their smart phones in the classroom.

With the advances in person-computer interaction, it is possible nowadays for the users to employ their body movements, such as sliding, pushing and moving, to interact with the content of the computer or smart phone without the traditional input devices (e.g. mouse and keyboard). Thus, according to Kumara, Wattanachote, Battulga, Shih, & Hwang (2015), the integration of applications based on body movements into the classroom makes the learning experience of students very active and entertaining.

In the last years, studies about augmented reality began to be published. Specht, Ternier & Greller (2011) indicate that, until very recently, most augmented reality applications were only available for large computers. The introduction of augmented reality applications for smart phones has enabled new experiences for daily users. Due to the increase in smart phone generalization, augmented reality is becoming a ubiquitous product for mobile leisure and learning. With this omnipresent availability, mobile augmented reality makes it possible to define and design innovative learning settings in real environments. Thus, Wojciechowski & Cellary (2013) assessed the attitude of students towards learning in environments of augmented reality. They adapted the TAM questionnaire to explain the determining factors that foster the use of the ARIES system; this system is used to build learning environments of augmented reality based on 3D images.

These studies about the intelligent classroom show that intelligent technology is enhancing the emergence of inquiry-based learning, collaborative learning, group learning, mobile learning and ubiquitous learning (Lin, Huang & Cheng, 2010).

Li, Kong & Chen (2015) summarize the characteristics of the intelligent classroom into the following points:

- The intelligent classroom is a learning environment rich in technology that combines the physical and virtual worlds, has the capacity to know the context and can automatically adjust the parameters of the environment, such as light and temperature.
- The intelligent classroom could provide the learning contents, the interaction of support and the tools of constructive learning for all kinds of teaching and learning activities, including personalized learning, group learning, inquiry learning, collaborative learning, mobile learning and virtual learning. The intelligent classroom suitable for learning is focused on the students, providing them with the support of adaptive learning for an active learning, and the activities of constructive learning.
- The intelligent classroom has the capacity to store, compile, calculate and analyze the large amounts of data from the students to optimize the pedagogical decisions.

- The intelligent classroom is an open learning environment that brings the students to a genuine learning context. It can stimulate the motivation of students to learn, involve them and give them effective, practical learning experiences.

Methodology

Research Goal

The goals proposed in this study were:

- To adapt and validate the instrument created by Li, Kong & Chen (2015), in order to demonstrate that the Real Environment Questionnaire for Intelligent Classrooms (REQSC) and the Ideal Environment Questionnaire for Intelligent Classrooms (IEQSC) are valid and reliable instruments for the evaluation of the environment in practical technological classrooms in the university context.
- To describe and compare the real and ideal classroom environments perceived by university students from the Degree of Elementary Education in the digital practical lectures of the subject Information and Communication Technology, with the aim of establishing similarity versus difference in the perceptions that the three student groups have about real and ideal environments.

Participants

The first group of participants was used to translate into Spanish and adapt the questionnaire to the university educational context. The questionnaires were piloted with 80 teachers in initial formation of the last year (fourth year).

A second group of teachers in initial training was used to collect the information using the two final questionnaires. The sample consisted of all the students registered in the fourth year of the Degree in Elementary Education at the University of Seville (Spain) in the academic year 2016/2017, all of whom studied the core subject Information and Communication Technology, whose practical lectures are taught in the computer classrooms of the Faculty of Education. There were three class-groups, which made up a total of 125 students, of whom 49 were from group 1, 43 from group 2 and 33 from group 3. The sample was almost entirely constituted by one gender, with 122 females (97.6%) and 3 males (2.4%).

The total sample of students was used, first of all, to validate the questionnaire about the real and ideal environment perceived by the students in the computer classrooms. Then, the sample was used to gather information about the perceptions that the students from the Degree in Elementary Education at the University of Seville had about the real and ideal environment in the practical lectures of the subject Information and Communication Technology.

Instruments

For the collection of data, the Real Environment Questionnaire of Smart Classrooms (REQSC) and Ideal Environment Questionnaire of Smart Classrooms (IEQSC) were used. Both of these questionnaires were produced from the translation and validation of the instrument created by Baoping, Siu Cheung & Guang (2015) after its translation into Spanish and adaptation to the Spanish educational context in teachers in initial formation, taking into account the three environment dimensions proposed by Moos (1974), which have been valued the most in the different questionnaires and scales created to measure classroom environment. The questionnaires used in this study are two Likert-type scales of 35 items each, grouped into 10 factors integrated by intelligent classrooms (see Table 1); each of these scales gathers the information that the students show about their real perception of the classroom environment and the characteristics that the ideal classroom should have. The questionnaires also include a brief explanation of the goal of the instrument and how it must be completed, in two sections: basic information of the participants, questions about the real perception of the classroom environment and questions about the ideal perception of the classroom environment. All the items have a positive connotation and use a measuring scale that ranges from 1 to 5, where 1 is “never”, 2 is "seldom", 3 is "sometimes", 4 is "often" and 5 is “always”.

Table 1
Factors of the Real and Ideal Environment Questionnaires of Intelligent Classrooms (REQSC and IEQSC).

Factors	Description	Moos´s Scheme (1974)
Physical design	The characteristics of an intelligent classroom with respect to the classroom space, furniture and technological infrastructure.	Maintenance and Change System
Flexibility	The extent of the comfortable support for users of the classroom environment.	Maintenance and Change System
Technology usage	The extent to which students use information technology as a tool to learn and to access information.	Maintenance and Change System
Learning data	The extent to which the information technology was used to acquire and compute the learning data of the users.	Personal development
Differentiation	The extent to which teachers cater for students differently on the basis of ability, rates of learning and interests.	Personal development
Research	The extent to which skills and processes of inquiry and their use in problem solving and research are emphasized.	Personal development
Cooperation	The extent to which students cooperate with one another on learning tasks.	Personal development
Students cohesiveness	The extent to which students know, help and are supportive of one another.	Relationship
Equity	The extent to which students are treated equally by the teacher.	Relationship
Learning experience	The extent of students' satisfaction and some special learning experience in the intelligent classroom.	Maintenance and Change System

Data analysis

All the data obtained from the classroom environment questionnaires were processed and analyzed using the statistical software SPSS v.23. The validity and reliability of REQSC and IEQSC were analyzed and then a descriptive and comparative analysis of the perceptions that the students had of the real and ideal environments of the computer rooms was carried out.

Findings

Reliability and validity of the questionnaires

The results of Cronbach´s alpha for each factor and the exploratory factor analysis of the real and ideal environments of both questionnaires are shown in Table 2. As can be seen, the values obtained for the total score of REQSC and IEQSC were 0.877 and 0.886, respectively, which indicated that both questionnaires showed a quite acceptable internal consistency, suggesting that both of them were reliable instruments for measuring the real and ideal environments perceived by students who used the computer classrooms. As shown in Table 2, the internal consistency of each dimension (factor) and items of REQSC are extremely high (α > 0.70); the values for each of the factors ranged between 0.759 and 0.806. Likewise, the values of Cronbach´s alpha for each of the factors and items of IEQSC ranged between 0.792 and 0.823. The items of the factors were higher than 0,7, which reflected that the structure of the factors has not changed.

Table 2
Cronbach's α coefficient for the factors and items of the questionnaires of the Real and Ideal Environment of Smart Classrooms (REQSC) and (IEQSC).

Factors and items	Real	Ideal
Factor 1: Physical design, Real α = 0.784, Ideal α = 0.799		
The classroom is adapted for the use of Tablet, PC and other resources, and it is comfortable.	0.872	0.881
The lighting is suitable for reading material on screen or paper.	0.872	0.879
From anywhere in the class and without obstacles I can see at the same time the teacher and the projection of the subject.	0.873	0.880
The class is quiet: I can hear what teachers and classmates say clearly.	0.874	0.884
Factor 2: Flexibility, Real α = 0.806, Ideal α = 0.813		
The classroom climate is controlled with temperature and humidity sensors.	0.877	0.878
The classroom can become a theater, a group work space or any other educational setting.	0.878	0.879
I can only access the platform and the virtual secretary using my UVUS user.	0.880	0.896
Factor 3: Technology usage, Real α = 0.775 , Ideal α = 0.820		
I enjoy studying or doing work using computers or technological devices.	0.876	0.883
I send my work to teachers using computers or digital resources.		
I get information related to the studies through the computer or other	0.875	0.886
resources.	0.872	0.881
I use the computer to read the documents and materials of the subjects.	0.875	0.891
Factor 4: Learning data, Real α = 0.782 , Ideal α = 0.823		
I can find my background, my activities (practices that I must do) and discussion forums on various digital platforms (e.g. virtual teaching).	0.872	0.885
I have my own digital folder for the different subjects (drive, Dropbox ...)	0.873	0.880
Factor 5: Differentiation, Real α = 0.769 , Ideal α = 0.813		
I can learn at my own pace in the classroom.	0.870	0.884
I can choose what tasks to do in the classroom.	0.867	0.881
I can choose the different subjects to study in the course.	0.874	0.883

I can choose different types of evaluation to be marked.	0.874	0.887
Factor 6: Research, Real α =0.766, Ideal α = 0.792		
I investigate when I have concerns or I want to check ideas.	0.873	0.882
I research to do class work.	0.875	0.882
Teachers demand that I present evidence (theories, authors ...) that support my ideas or opinions.	0.873	0.883
I find answers (to my doubts) through the readings.	0.871	0.881
I can design my own research ways and instruments to tackle a topic.	0.871	0.87
Factor 7: Cooperation, Real α = 0.759, Ideal α = 0.804		
I cooperate with other students when we carry out class work.	0.873	0.879
I can work with someone who is not in the classroom through the Internet.	0.869	0.882
I can make videocalls in the classroom with colleagues to do work.	0.872	0.882
I can share my data and documents with other students during lectures.	0.870	0.885
Factor 8: Students cohesiveness, Real α = 0.802 , Ideal α = 0.796		
I make friends among classmates.	0.877	0.881
I am kind to the rest of the classmates.	0.876	0.879
I help other classmates to perform tasks, activities, etc.	0.876	0.878
Factor 9: Equity, Real α = 0.788, Ideal α = 0.823		
The teacher cares about me.	0.871	0.885
The teacher takes my feelings into consideration.	0.872	0.881
The faculty treats me the same as the rest of the students in the classroom.	0.874	0.890
Factor 10: Learning experience, Real α = 0.779, Ideal α = 0.814		
Multimedia resources are motivating for my learning.	0.873	0.881
The resources and programs are easy to use.	0.876	0.887
The resources and programs help me get experience with the learning objectives and situations.	0.872	0.884

The results obtained in the Kaiser-Meyer-Olkin (KMO) and Bartlett´s tests verified the realization of the factor analysis of both questionnaires. The KMO value obtained for REQSC was 0.700, which is considered an excellent value, and the Bartlett´s sphericity test showed an approximate Chi-square value of 2145.392 ($p<0.000$), which means that the correlation matrix of data for the factor analysis of REQSC was appropriate. The KMO value of IEQSC was 0.764, which turned out to be valid, and the Bartlett´s sphericity test showed an approximate Chi-square value of 3056.520 ($p<0.000$), which means that the correlation matrix of data for the factor analysis of IEQSC was also adequate (Table 3).

Table 3
Results of the KMO and Bartlett´s test of REQSC and IEQSC

KMO and Bartlett´s test		REQSC	IEQSC
KMO measure of sampling adequacy		0.700	0.764
Bartlett's sphericity test	Approx. Chi-square	2145.392	3056.520
	gl	595	595
	Sig.	.000	.000

Student´s perception of the real and ideal environments of the practical computer classrooms

The measurements of the perceptions of the real and ideal environments of intelligent classrooms based on the items and factors of REQSC and IEQSC are shown in Table 4. The results obtained indicate that there is a large difference between the students´ perceptions of the real and ideal environments in the digital classrooms, especially in the factors "physical design", "flexibility", "differentiation", "cooperation", "equity" and "learning experience" (see Figure 1); the average score was below 3 for the perception of the real environment in the factors "physical design", "flexibility" and "differentiation". The highest scores for the real environment were obtained in the perception of technology usage (X=3.73), research (X=3.82) and, with the highest score of all, students´ cohesiveness (X=4.29).

On a general level, there are large differences regarding how the students of the three class-groups perceived the real and ideal classroom environments. Figure 1 shows the need that students perceived for improving the real environment, as the results of the questionnaire of the ideal environment obtained higher levels in eight of the ten factors: physical design (X=4.75), flexibility (X=4.58), learning data (X=4.45), differentiation (X=4.57), research (X=4.60), cooperation (X=4.64), equity (X=4.80), and learning experience (X=4.72). Regarding the items of the factors of the perception of the students about the real environment, the results obtained for physical design are low (X=2.66). The highest perceptions of the items of the real physical design above 2.5 are: "the classroom is adapted for the use of Tablet, PC and other resources, and it is comfortable" (X=2.52), "the lighting is suitable for reading material on screen or paper” (X=2.59), and “from anywhere in the class and without obstacles I can see at the same time the teacher and the projection of the subject” (X=3.09).

Table 4
Results of the items and factors of REQSC and IEQSC of the three classrooms

	Real Environment Mean				Ideal Environment Mean			
	G.1	G.2	G.3	Factor	G.1	G.2	G.3	Factor
Item 1	2.26	2.41	3.03	Physical design Mean = 2.66	4.75	4.74	4.75	Physical design Mean = 4.75
Item 2	2.40	2.55	2.90		4.75	4.72	4.72	
Item 3	2.89	3.14	3.33		4.69	4.67	4.84	
Item 4	2.22	2.32	2.63		4.79	4.76	4.75	
Item 5	1.95	2.04	2.33	Flexibility Mean = 2.91	4.77	4.74	4.75	Flexibility Mean = 4.58
Item 6	1.95	1.93	1.84		4.79	4.72	4.72	
Item 7	4.71	4.69	4.72		4.26	4.20	4.12	
Item 8	3.08	3.20	3.51	Technology usage Mean = 3.73	4.04	4.00	4.36	Technology usage Mean = 4.15
Item 9	3.81	3.88	4.06		4.04	4.07	4.42	
Item 10	3.98	4.16	4.27		4.42	4.41	4.63	
Item 11	3.53	3.44	3.87		3.55	3.53	4.06	
Item 12	3.83	3.90	4.03	Learning data Mean = 3.61	4.59	4.60	4.75	Learning data Mean = 4.45
Item 13	3.16	3.41	3.54		4.06	4.32	4.54	
Item 14	2.34	2.60	3.27	Differentiation Mean = 2.54	4.81	4.81	4.81	Differentiation Mean = 4.57
Item 15	1.87	2.34	3.00		4.16	4.16	4.57	
Item 16	3.02	3.41	3.45		4.59	4.48	4.72	
Item 17	1.69	1.97	2.30		4.42	4.51	4.57	
Item 18	4.00	4.07	4.06	Research Mean = 3.82	4.81	4.76	4.81	Research Mean = 4.60
Item 19	4.57	4.53	4.42		4.87	4.81	4.81	
Item 20	3.59	3.67	4.03		4.06	4.18	4.36	
Item 21	3.51	3.76	3.93		4.67	4.67	4.54	
Item 22	2.98	3.14	3.33		4.55	4.58	4.60	
Item 23	4.16	4.20	4.51	Cooperation Mean = 3.37	4.79	4.67	4.72	Cooperation Mean = 4.64
Item 24	3.65	3.72	3.84		4.79	4.69	4.75	
Item 25	1.65	1.88	2.42		4.26	4.25	4.42	
Item 26	3.34	3.44	3.72		4.71	4.67	4.69	
Item 27	3.81	3.81	3.81	Students cohesiveness Mean = 4.29	4.57	4.48	4.63	Students cohesiveness Mean = 4.73
Item 28	4.65	4.67	4.75		4.77	4.81	4.87	
Item 29	4.38	4.20	4.33		4.77	4.69	4.78	
Item 30	2.73	3.14	3.75	Equity Mean = 3.33	4.91	4.88	4.81	Equity Mean = 4.80
Item 31	2.75	3.04	3.48		4.83	4.76	4.78	
Item 32	3.57	3.74	4.15		4.73	4.74	4.72	
Item 33	3.63	3.81	4.15	Learning experience Mean = 3.44	4.67	4.65	4.66	Learning experience Mean = 4.72
Item 34	2.73	2.95	3.21		4.77	4.69	4.54	
Item 35	3.53	3.67	3.84		4.87	4.79	4.75	

The factor “flexibility” of the real environment perception obtained low levels (X=2.91). The students did not perceive the real classroom environment as comfortable, since very low mean values were obtained in the items of this factor, especially for “the classroom climate is controlled with temperature and humidity sensors” (X=2.08), and “the classroom can become a theater, a group work space or any other educational setting” (X=1.92), although a high value was obtained for the item “I can only access the platform and the virtual secretary using my UVUS user”, with an average score of 4.71.

With respect to “differentiation”, this is the factor that obtained the lowest levels (X=2.54) in the perception of the real environment in the three class-groups. The items with the lowest scores were: “I can choose what tasks to do in the classroom” (X=2.33) and “I can choose different types of evaluation to be marked” (X=1.92). Group 1 obtained the lowest perceptions in these items, with a mean score of 1.87 and 1.69, respectively. And the students in group 3 obtained the highest perceptions of real environment in the four items of this factor.

With respect to “research”, this dimension was perceived in the real environment with values above 2.5, with the lowest item being “I can design my own research ways and instruments to tackle a topic” (X=3.12). Even so, there are differences between the perceptions of the groups, as group 1 obtained a mean score of 2.98 in this item.

The factor “cooperation” of the real environment was perceived with high values in the items “I cooperate with other students when we carry out class work” (X=4.27), “I can work with someone who is not in the classroom through the Internet” (X=3.732) and “I can share my data and documents with other students during lectures” (X=3.48). However, the students of the three groups perceived with a very low value the item “I can make videocalls in the classroom with colleagues to do work” (X=1.93).

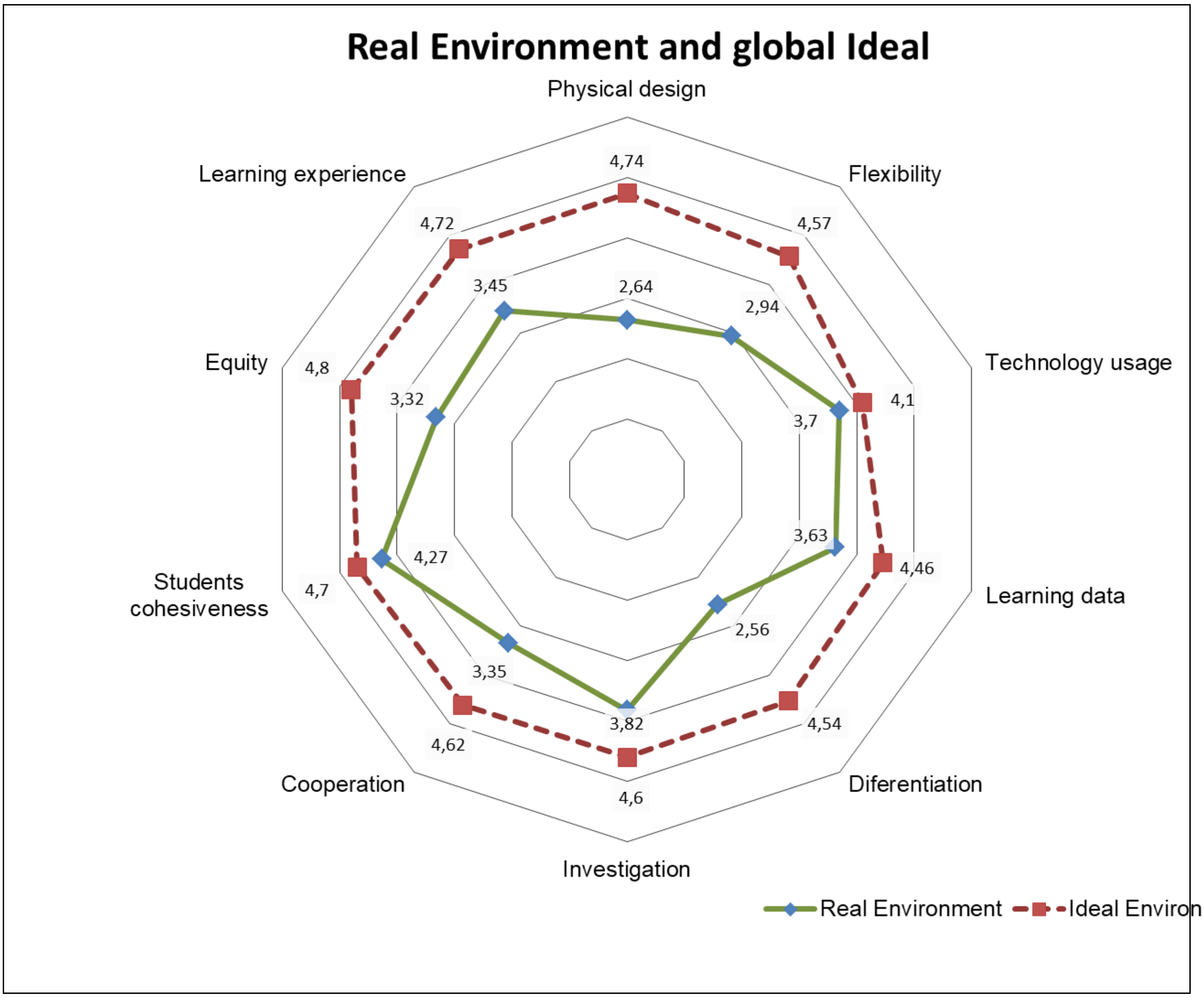

Figure 1. Perception of the real and ideal environment of the students

The dimension "learning experience" was perceived in the real classroom environment with levels above 2.5. The students perceived the need for a change in the real environment in the item "The resources and programs are easy to use" (X=2.93).

The differences in the perception of the real and ideal intelligent classroom environment among the students of the three university groups are clearly shown in Figure 2. As can be seen, there are no large differences in the scores obtained for the three groups, as they all perceived the same level of changes needed. The three groups show the highest scores of the real environment in the factors "students cohesiveness" (XG1=4.28, XG2=4.23 and XG3=4.30), "research" (XG1=3.70, XG2=3.83 and XG3=3.95) and "technology usage" (XG1=3.73, XG2=3.83 and XG3=3.95), suggesting that the real environment needs to be improved, which is why such high values were obtained in the perception of the ideal environment. The values obtained on a global level for the ideal environment in the different factors are very high, as can be seen in Table 4 and Figure 3, which means that important changes must be done in the real classroom environment: physical design (X=4.75), flexibility (X=4.58), technology usage (X=4.15), learning data (X=4.45), differentiation (X=4.57), research (X=4.60), cooperation (X=4.64), students cohesiveness (X=4.73), equity (X=4.80), and learning experience (X=4.72).

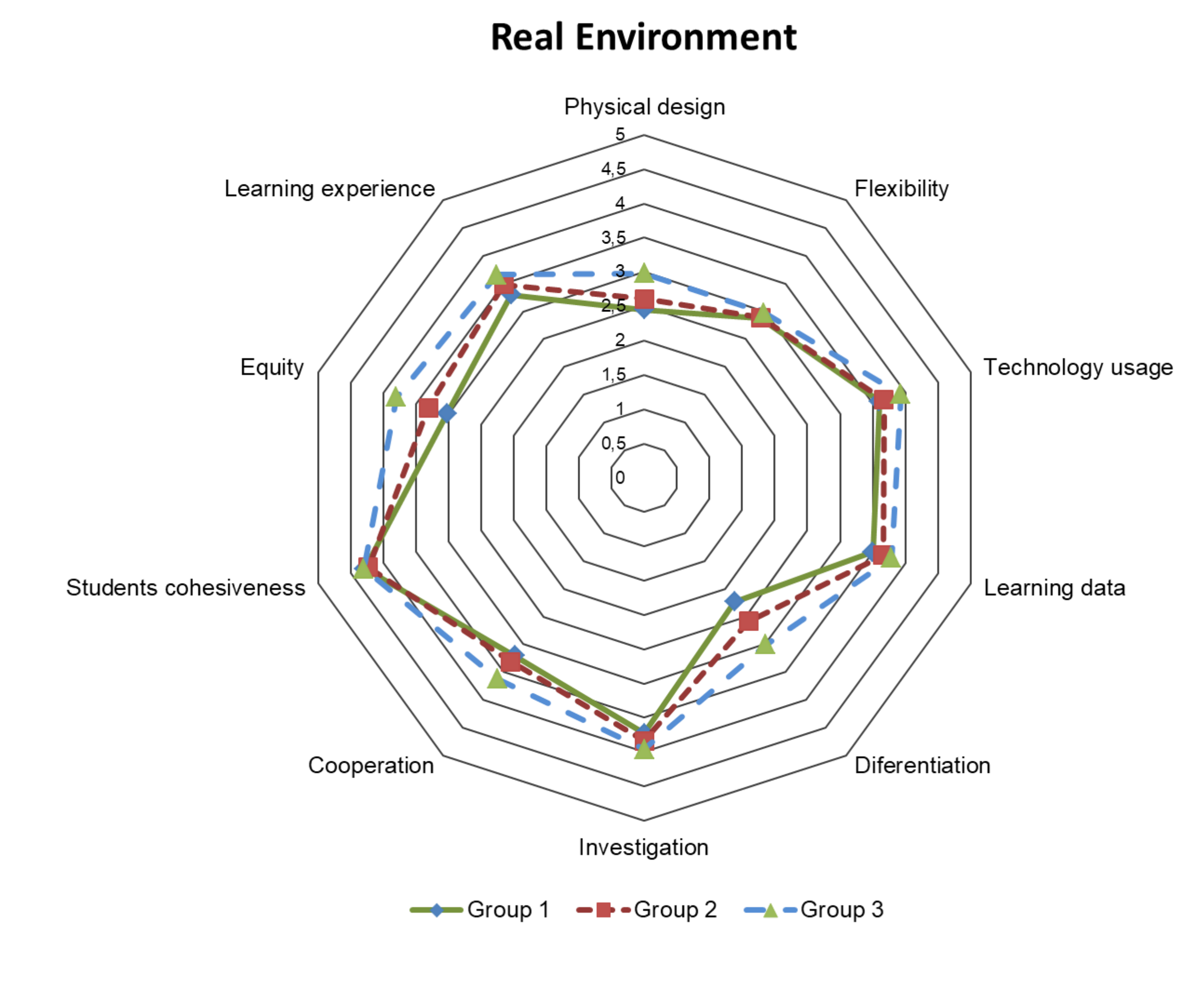

Figure 2. Perception of the Real Environment of the three class groups

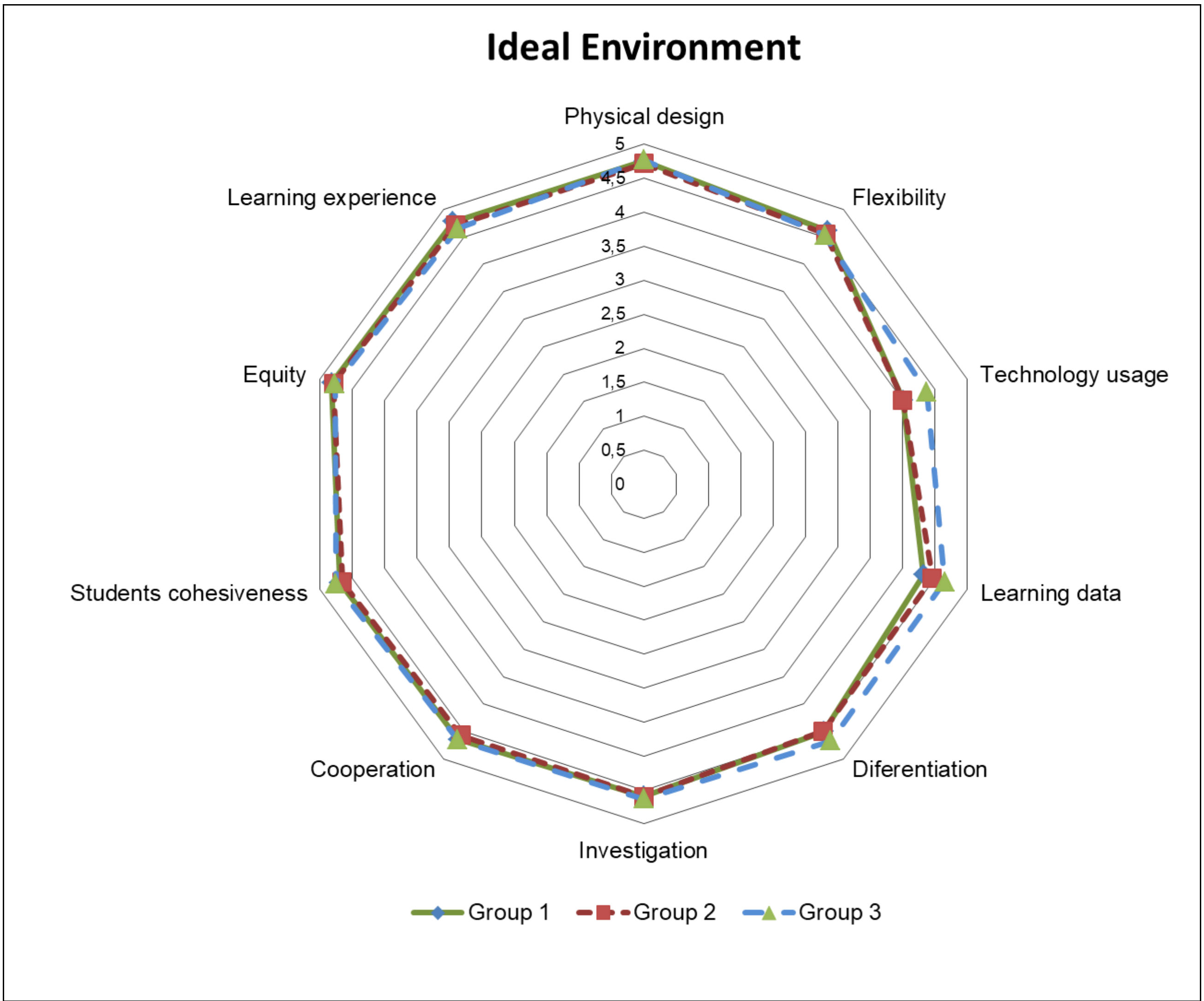

Figure 3. Perception of the Ideal Environment of the three class groups

Discussion

Considering the perceptions of the students, and meeting the objectives proposed in the presented study, it can be concluded that there is a large difference between the students´ perceptions of the real and ideal environments in the digital classrooms, especially in the factors "physical design", "flexibility", "differentiation", "cooperation", "equity" and "learning experience"; the average score was below 3 for the perception of the real environment in the factors "physical design", "flexibility" and "differentiation". The highest scores for the real environment were obtained in the perception of technology usage, research and, with the highest score of all, students´ cohesiveness.

On a general level, there are large differences regarding how the students of the three class-groups perceived the real and ideal classroom environments. Students perceive the need to improve the real environment, since the results of the ideal environment questionnaire put high levels in eight of the ten dimensions. Students do not perceive comfortable the real classroom environment.

With respect to “differentiation”, this is the factor that obtained the lowest levels in the perception of the real environment in the three class-groups. The factor “cooperation” of the real environment was perceived with high values. The dimension “learning experience” was perceived in the real classroom environment with levels above 2.5. The students perceived the need for a change in the real environment in the item “The resources and programs are easy to use”

The differences in the perception of the real and ideal intelligent classroom environment among the students of the three university groups are clearly seen. There are no large differences in the scores obtained for the three groups, as they all perceived the same level of changes needed.

The three groups show the highest scores of the real environment in the factors “students cohesiveness”, “research” and “technology usage”, suggesting that the real environment needs to be improved, which is why such high values were obtained in the perception of the ideal environment.

The values obtained on a global level for the ideal environment in the different factors are very high, which means that important changes must be done in the real classroom environment.

Conclusion

The main conclusion is that the questionnaires REQSC and IEQSC are valid and reliable for assessing the perceptions of students about the real and ideal environments of ICT classrooms.

The obtained results show that there are significant differences between the real and ideal environments perceived by the three groups of students from the Degree in Elementary Education of the University of Seville, who consider it necessary to improve the real environment of computer classrooms. With regard to the physical design of the classroom, it is necessary to improve the space, the furniture and the infrastructure, as they perceive that the ICT classrooms are not adapted to the use of technological resources such as Tablets, laptops and others; they also consider that these classrooms are not comfortable for working, that the lighting is not appropriate for reading the contents of the subject on the screen and even on paper, and that the lack of silence in these rooms does not allow them to hear what the teacher or their classmates say. The furniture, the devices and the software used in the classroom need to be well designed to facilitate the learning of students.

The flexibility of the classroom is not perceived by the students as comfortable for working with technology, especially regarding the climate of the classroom; they see that it is not controlled by temperature and humidity sensors, and that it is not a suitable space for group work or educational settings.

With respect to differentiation, all the students perceive that the teachers do not treat them differently based on their skills, academic results or interests.

The learning data indicate the use of technologies as learning and information access tools. As in the study by Dogan and Camurcu (2007), the students perceive that it is necessary to improve the educational platforms that they use for their training and that they should have the possibility to use digital folders for the different subjects. Regarding cooperation, the students consider it necessary to improve the use of videocalls to carry out group assignments. They also perceive that the teachers should treat them all differently in order to improve the relationship with them (Latham, Crockett, McLean & Edmonds, 2012).

As in the studies by Özyurt, Özyurt, Baki & Güven (2013) and Yang, Leung, Yue & Deng (2013), the students show a positive attitude about the learning experience in the ICT classroom; they perceive that, even though the multimedia resources used need to be improved, these motivate them to learn, the programs are easy to use and these help them improve their learning.

The real and ideal perceptions of the use of technologies as learning and information access tools demonstrate that, currently, the students are using them correctly, that they have the proper skills to conduct research of different topics and that they can work in groups and get mutual help. However, the introduction of novel technologies in the classrooms, such as augmented reality or flipped classroom, suggest that it is necessary to pay special attention to the importance that their use will have in educational centers, which affects the training of future teachers in their didactic use. Universities must pay attention to the satisfaction of the demands for teacher education, and provide the ICT classrooms with the most innovative and necessary technological resources to create didactic materials as teachers.

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