PEDAGOGICAL EVALUATION OF PROTOTYPE 3 OF THE AR LEARNING PLATFORM BASED ON THE RESULTS ACHIEVED DURING THE THIRD ARISE SUMMER SCHOOL [1]

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Abstract

Augmented Reality teaching /learning platform is an innovative technology aimed at implementing links between the real and virtual world. The technology developed by the ARiSE project focuses on offering conditions for customers not only to observe a combined view (real and virtual) but also to directly interact with the real world (real objects). It is likely that the approach learning by doing is more effectively realized in the educational process.

Creating teaching/learning modules and constructing didactical scenarios of practicing the modules is one of the main conditions to use the above mentioned innovative technology in the educational practice. The primary purpose of the international research project ARiSE (Augmented Reality in School Environments) was to test pedagogical effectiveness of introducing augmented reality (AR) into the comprehensive school and creating remote collaboration between classes around the AR display systems.

In the given article the results of the pedagogical evaluation of the prototype 3 of the AR learning platform are presented. The students agree that Prototype 3 of the AR platform is a new and useful tool that could be successfully applied for learning purposes in the educational process.

Key words: *augmented reality, pedagogical evaluation, educational process, comprehensive school.*

Introduction

Four years ago, when starting scheduling the international project *ARiSE* (the team of the project has been chaired by Judith Muehl), we did not get across the idea that Augmented Reality Technology could serve as an effective instrument for teaching/learning. It was an objective evaluation of teachers. However, within the period of three years, the team working on the project has accomplished a number of different fundamental tasks. The partners from Germany, Romania, the Czech Republic, Lithuania and Great Britain have implemented innovative and strong ideas. J.Muehl (2006) remarks that new methods in teaching demand new technological solutions and new possibilities in user interfaces. One of the main objectives of the project was to use Augmented Reality Technology to create a new teaching/learning platform for comprehensive school providing possibilities of organizing and implementing the educational process locally and remotely in a qualitatively new environment the

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evaluation of pedagogical effectiveness and suitability of which had to be carried on.

In the run of the last three years, a group of scientists from Siauliai University Natural Science Education Research Centre have conducted a number of in-depth research that one or way another helped with successful implementation of the project (Lamanauskas, Pribeanu, Vilkonis, Balog, Iordache, Klangauskas, 2007; Lamanauskas, Vilkonis, 2007 etc.). A qualitatively new, innovative teaching/learning platform of augmented reality is an apparent product of the team. Original technical decisions have been realized, for example, two original instruments - Filipek and Myselbek have been created for Prototype 3. The programs have been created by the scientific team of technical university from the Czech Republic. The software can run on MS Windows and Linux. Filipek is a tool for a '3D photo-box' construction. Filipek allows making a 3D box covered by four photos from four sides (left, right, front, and back). Bottom and top sides are left empty. Filipek is a simple-to-use tool for pre-processing photos in terms of perspective distortion removal, background removal and object size specification (Zara, 2008). Myselbek is original software for creating 3D objects and making different activities with them in augmented reality environments. For example, you can select a colour and shape of the created object, load and save 3D object etc. It seems to be clear that educational didactical approaches assisted in making efficient technical decisions as a newly created technology first of all has been designed for teaching/learning purposes. In 2006, an assessment of using information communication technologies in science education in comprehensive school was carried out and research methodology and instruments were prepared (Lamanauskas, Vilkonis, Klangauskas, 2006). The first scenario using Augmented Reality Technology has been constructed and is still being improved and augmented. Prototype 1 of the AR teaching/learning platform was tested during the first summer school in Malta in 2006. In collaboration with colleagues from Romania research on educational efficiency and usefulness (suitability) of the above introduced platform was carried out (Lamanauskas, Pribeanu, Vilkonis, Balog, Iordache, Klangauskas, 2007). The second scenario was created during the next year of work on the project and chemistry was chosen as a subject of discussions. An international expert survey of chemistry teachers was conducted in order to specify a few topics on the course in chemistry a better acquisition of which should be a basis for a better understanding of the whole course on chemistry in comprehensive school (Lamanauskas, Vilkonis, 2007). Simultaneously, a pedagogical evaluation of Prototype 1 of the AR teaching/learning platform was conducted (experts – highly qualified teachers of sciences working in comprehensive schools). The most important findings of activities undertaken during the second year of work on the project present Prototype 2 of the AR teaching/learning platform created and tested during the second summer school in Bucharest, Romania (Lamanauskas, Vilkonis, Bilbokaitė, 2008). In addition, conceptual and didactical reasoning of using augmented reality for teaching/learning purposes in comprehensive school was employed. In 2008, the third scenario was created using the Internet and Augmented Reality Technology. The main idea of Prototype 3 is to prepare a scenario implementing possibilities of integrated teaching/learning (combines a few taught subjects and other cognitive fields) and remote collaboration the principle opportunities of which were successfully demonstrated during the third summer school in Germany and Lithuania on 22-26 October, 2008. The learning module for the 3rd prototype of ARTP is intended for international communication and remote collaboration using ARTP in the comprehensive school. Prototype 3 of the AR learning platform was tested and evaluated during the third ARiSE summer school.

Methodology of Research

General research background

Methods include observation and a verbal questionnaire (sectional interview). The data was analysed using content analysis method of students` answers.

The Procedures of Evaluation

- The evaluation interview of Prototype 3 included 14 questions:

- Is a remote collaborative lesson with the students from Germany has stimulated your interest in the cultures of other European countries?
- Has the use of *the AR learning platform* strongly stimulated your interest in the peculiarities of your native culture while preparing for a remote lesson?
- Has the use of *the AR learning platform* helped you with broadening your knowledge? What new subjects have you learned?
- Has the use of *the AR learning platform* helped you with understanding new information? What new things have you learned?
- How has the process of creating new 3D objects been useful for learning?
- Have the recent forms of collaboration with contemporaries been different from the previously used ways of communication? Why?
- Do you think you have received benefit from preparation for a remote collaborative lesson with the students from Germany?
- Do you think you have received benefit from a remote collaborative lesson with the students from Germany?
- Has individual learning been more active while preparing for a remote collaborative lesson with the students from Germany? Why?
- Identify the merits of *the AR learning platform* comparing them with an ordinary computer used for learning purposes.
- Would you like to regularly use *the AR learning platform* in the classroom? Why?
- What feelings did you experience during a remote lesson with the students from Germany (or Lithuania)?
- Imagine that your school has an *AR learning platform*. How do you think it could change the process of learning?
- What requests could be submitted considering experience gained using *the AR learning platform*?

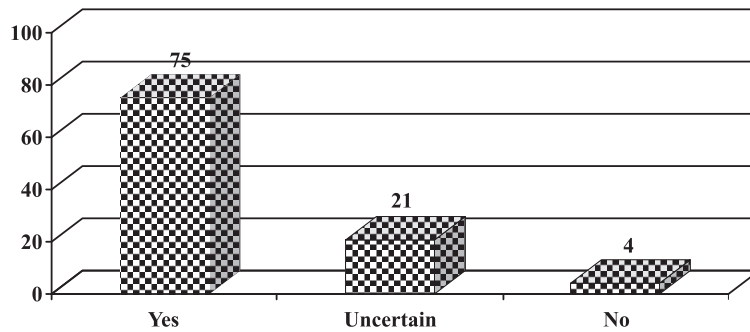*Place and time of evaluation*

Research was conducted simultaneously at Siauliai University (Lithuania) and Fraunhofer IAIS (Germany) on 21 – 24 October 2008. The remote collaboration using ARTP was used during third summer school (via internet). Learning process during the remote lesson was divided in three parts: introduction, basic part and final part. The remote students communicated in pairs – one to one. They had the same learning environment.

Participants

Two teams from two countries (Germany and Lithuania) with a total number of 24 students including 10 boys and 10 girls participated in the third summer school. Due to the specificities of the comprehensive school curriculum in different countries, the age of students varied. None of them was familiar with the AR learning platform. All respondents had covered the topic 'The Culture of Europe–Differences and Similarities of the Old and New Members of the EU'.

Results of Research

The data summarized applying the method of descriptive statistics shows (Figure 1) that 75% of the surveyed participants were engaged in the culture of other country.

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Figure 1.   Students' interest in the culture of other country following the remote lesson.

The situation indicates that a method of learning based on collaboration with students from other country stimulated learners' interest in the culture of other country. It is likely that engagement should be more serious if the students were offered the possibility of acknowledging the traditions and history of other country in a more detailed way. Some students did not express their interest in the culture of other country as they were more involved in the process rather than in the content of communication as within adolescence, the most important concerns are developing the ability to communicate and efforts to obtain as much information on contemporaries as possible. It is clear that the use of AR technology has played an important role. The factors of age can be crucial and determine uncertainties about interest in rather serious aspects having a strong spiritual basis such as culture and history. The position of the majority of respondents conditions a general positive evaluation in terms of the students interested in the culture of other country.

Table 1.   Students' interest in the culture of other country following the remote lesson.

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Motivation	20	*Involvement in the process*	14	Very interesting; very engaging; engaging; I wanted to know more; I'd like to find more information; really interesting; I am interested; quite interesting; I'd like to see it real.
		Interest in objects	6	Interest objects; interesting stories; many interesting holidays; interested in culture
Methods of transferring information	14	*Verbal information*	6	Accurately described;
		Oral information	4	To listen; to hear; to talk with a partner.
		Visual information	2	I saw many interesting things.
		News	2	I found out interesting things
Cross-cultural aspects	12	*Information on the other country*	7	About Germany, one of the biggest countries in the European Union; about Lithuania, its culture
		Information on real phenomena	5	Holidays and national events; about printing; different traditions; holidays and architectural monuments.

All students' answers to the first question were divided into three categories that were subdivided into eight sub-categories. The first subcategory 'Involvement in the process' indicates that students

were interested in native culture due to the learning process which appeared to be unusual, new and almost having no analogues to traditional classes at school. To prepare for activities in the classroom, the learners were searching for information engaging their partners living abroad. The second sub-category 'Interest in objects' shows that remote communication encouraged the learners to take an interest in the culture of foreign countries due to exiting objects and stories heard from their partners. The first category 'Motivation' discloses that the majority of students point to internal motivation as a reason for involvement that stimulates interest in the culture of foreign cultures. Unusual learning environment and technology used determined students' involvement in culture.

The second factor that made students involved in overseas culture is *different methods of transferring information*. They indicate that different ways of representing information stimulate an interest in educational content. The use of AR teaching/learning platforms and Skype program helped with creating an unusual learning environment and methods transferring information visually, verbally and aurally. More ways of collecting data help with a better understanding of information as in this case, knowledge is longer remembered and used when required. All ways of imparting information made a harmonious complex of transferring knowledge that had impact on students' motivation expressed as an identified need for showing interest in the culture of other countries.

The category 'Cross-cultural aspects' indicates that the majority of respondents became engaged in the culture of other countries due to differences in their national culture. The students were involved in stories about the culture and traditions of other country. The exceptional elements of the culture of other country attract, thrill and stimulate the learners to know more new information on stimulating subjects in order to be more prominent than their contemporaries. It can be accepted that students' interest in the culture of other country is stimulated by motivation and uncommon ways of imparting information used in the classroom as well as by the other intriguing aspects of the culture of other country.
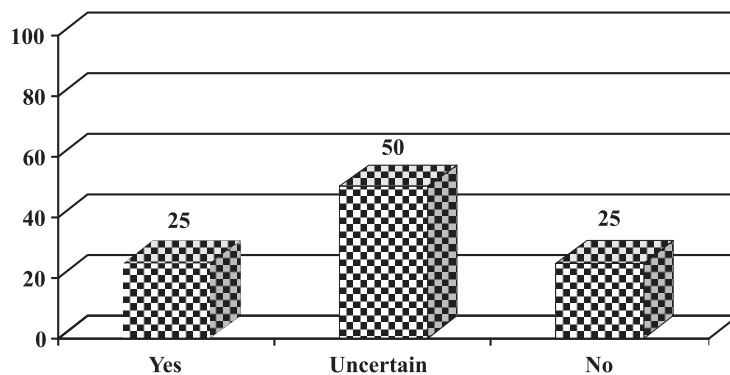
Figure 2.   Students' interest in native culture following the remote lesson.

Research data indicates that a half of the surveyed participants became more actively involved in native culture following a remote lesson with a foreign partner. The results demonstrate that further research could be useful for offering remote lessons as a means of increasing students' motivation for stimulating interest in the cultures of both foreign and native country. Prior to the survey, every learner was provided an opportunity to think of what cultural and historical aspects of the native country should involve a foreign partner. The respondents collected material, were fond of native culture and remembered of a large amount of information. Some of those have become really engaged in the content of information, and thus felt more touched by native culture after research.

The students the motivation of which did not increase following the survey were absolutely sure they only were collecting material to participate in research on project and the remote lesson. Having collected the required material, a focus was directed to other subjects rather than to national culture which appears as a motivating factor.
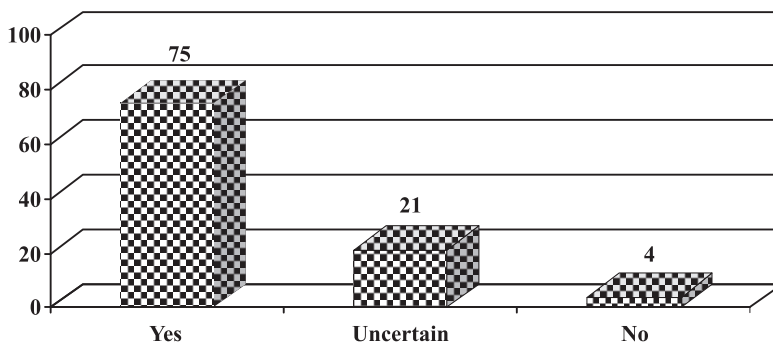
Figure 3. **Assistance in using the AR teaching/learning platform for understanding purposes.**

Research data indicates that the majority of students obtained new information. The fact discloses the function of cognitive dissemination that manifests itself in working at the AR platform. This is one of the most significant indicators of the teaching/learning platform certifying that AR platforms can be applied for learning purposes. A few students have some doubts whether they really accepted information. It seems such phenomenon was determined by the encountered problems of knowledge of a foreign language. Besides, to get things clear, some learners felt worried and the German team was troubled by insufficient skills at working at the AR platform (students from Germany had no previous experience of mastering technologies more thoroughly).

Table 2. **The impact of the AR teaching/learning platform on understanding certain factors**

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Advantages of dual code representation mode	10	*Clear information*	6	Very clear demonstration; 3D space; It was good to see an object; I could see what I learnt and could imagine it better; I could imagine how objects looked in reality.
		Visual assistance to verbal information	4	You can see and observe an object all round; it's better to understand the discussed matters; words and pictures together are better than only words; explaining words through painting was better.
Technological evolution	4	*New technologies*	3	Helped with understanding that the number of professional technologies is increasing; introducing new technologies; there are plenty of interesting subjects and innovations
		New possibilities of creation	1	Received knowledge of creating objects applying original software
Communication problems	3	*Lack of foreign language skills*	3	My knowledge of English is poor enough; not good enough at knowing English; it was in English

The students' answers disclosed the subjects that were understood by employing the AR teaching/learning platform. The largest category is 'Advantages of dual code representation mode'. The first subcategory 'Clear information' shows that after applying the AR platform, learners understood information, found it clear and uncommon, emphasized clear pictures and 3D environment. The re-

mote lesson helped with concentrating students' attention towards the way of imparting information showing such qualities as 3D, virtual environment and clear and uncommon pictures. The situation that encouraged students in remembering experienced impressions and aided at recording imparted information shows that information picturesqueness was really uncommon and intriguing.

The second subcategory 'Visual assistance to verbal information' reveals that the students consciously identify the importance of visual information in perceiving complex verbal concepts, and therefore this phenomenon is one of the main aspects refreshing memory. Apart from remote learning, the way of imparting information rather than the content of information is the most understandable subject. It can be concluded that the use of new resources for learning transfers the basic field of understanding to the principles of tool operation rather than to the content of the information presented. This precondition could bear witness that a deep understanding of information can only be expected if the tool was not the main focus of attention.

The second category 'Technological evolution' shows that remote learning helped in understanding that training aid is advanced technological innovation. It can be related to the content of the first category as both reflect the same situation – the students grasped the importance, peculiarities and new ideas of the tool for learning, and therefore when describing the accepted facts, they enumerate the data on a technological advantage of the AR platform. Technological innovation obviously made the strongest impression. Finally, selecting an optional topic on the elements of culture resulted in a situation of more voluntary learning that did not impose any restrictions on the learners, and thus they became more concentrated on the most important issues – communication and learning applying modern technologies.

The last category 'Communication problems' also points to students' need for noting and evaluating the advantages of technological innovations. Remote learning caused difficulties to the respondents encountering problems with the use of a foreign language – they felt lack of necessary wording required for expressing ideas and some wording that had been used by a partner was difficult to be properly understood.

Thus, within the process of learning, remote learning based on the use of AR teaching/learning platforms helped students with understanding the most important, interesting and disturbing points
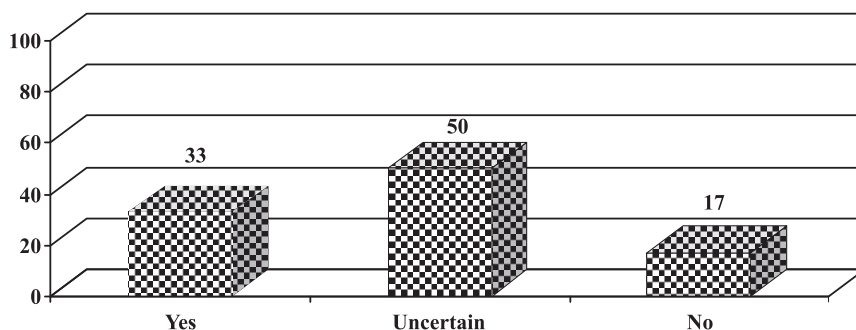
**Figure 4.   The evaluation of the usefulness of creating 3D objects (%).**

The data presented in Picture 4 shows that only 33% of students find creating 3D objects useful. A half of the surveyed participants have no clear position on the question discussed. Such data can be interpreted as a precondition that learning a chosen topic partly discourage the learners from concentration to perceive and process information so that every action taken using the AR platform should be based on broadening knowledge at appropriate level. It is supposed that the students were not focused enough on the information in order to understand that creating 3D objects had a major impact on broadening knowledge. If the only AR platform had been helpful in mastering complex information in the classroom during the remote lesson, the process of creating 3D objects would have had a greater positive impact on learning.

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Table 3. Factors having impact on the usefulness of creating 3D objects.

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Experience	12	*Skills*	4	Such tools are only available here; experience; I learned to develop new skills (using a modelling tool); skills
		Involvement	3	It was interesting experience; very interesting; really exciting
		Positive emotions	3	It's fun; I'm so happy; it was fun to create the objects
		Clear information	2	Easier to understand explanations;
Negative aspects of the process of learning	4	*Drawing*	3	Drawing was only drawing; it was only drawing
		Difficulties in using technology	1	Complicated and time consuming

The data presented in Table 3 complements information available in Picture 3. The first category 'Experience' shows it being the main factor explaining the usefulness of creating 3D objects. The first category 'Skills' discloses that some students agree that creating 3D objects helped them with obtaining certain skills, for example, mastering a similar tool. Such positive evaluation is based on the fact useful for learning and is consciously identified by the learners i.e. they understand and positively evaluate the results of the taken remote lesson. The second category 'Involvement' indicates that some students did not distinguish any basic differences except from individual motivation for creating 3D objects. The third category 'Positive emotions' reveals that involvement and positive emotions are partly related, and thus it is supposed that creating 3DF objects had impact on good learners' mood and increased motivation. A precondition that 3D space creates effects uncommon for human understanding and attracting students can be made. The fourth category 'Clear information' points out that creating 3D objects helped with understanding information and served in clarifying information. In conclusion, the process of creating 3D objects largely worked for broadening respondents' experience including more positive emotions, a clearer understanding of information, skills at applying technology etc.

The carried out research made known a few negative aspects. Some of the students underline that creating 3D objects was only 'drawing' which in reality is not under obligation and is more related to staying relaxed rather than to the process of learning. The respondents did not notice the positive aspects of creating 3D objects. One of the students faced problems with using technology.
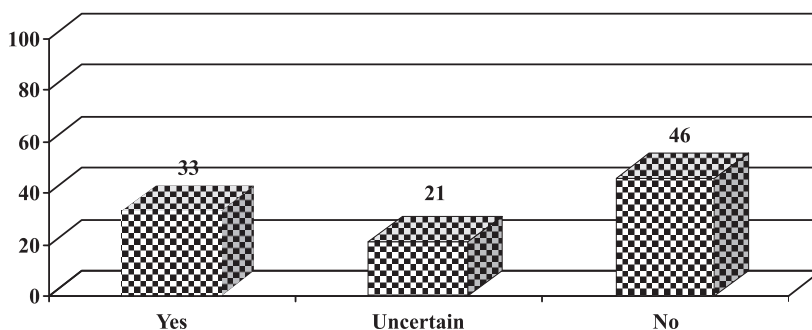
Figure 5. **The evaluation of contemporaries' collaboration peculiarities and use of technology (%).**

The data in Figure 5 shows that the majority of the surveyed participants disagree that remote collaboration during the lesson had a different format. Such answers could be affected by the fact that the students communicated with their colleagues for a short time and communication was based on partly targeted, thought over and learned information. However, the style of communication remained the same, and therefore larger differences cannot be identified by the respondents.

Table 4.   Factors indicating the peculiarities of communicating with contemporaries.

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Intercultural communication with a modern technological tool	10	*3D technology*	5	Easier to communicate when you can point to the objects and when you are shown?? , New technologies; different 3D objects; with 3D objects
		Communication in a foreign language	5	Working with Lithuanians was different due to the combination of computer and English, we already did a lot of group work in school – only speaking English was new to me, you can understand English, we used to communicate in English.

The data in Table 4 shows that only one category discloses 'intercultural communication with a modern technological tool' which means that creating 3D objects determined intercultural communication that was underlined due to communication with students living abroad and because of broadening knowledge of a foreign language. A part of students find 3D virtual environment an exceptional indicator suggesting uncommon communication environment to be in touch with partners, whereas the others preferred communicating in English as a significant feature on meeting contemporaries. In conclusion, it can be maintained that while communicating with partners, the remote lesson encouraged students in understanding the advantages of technology and use of English which is invaluable experience.

Table 5.   The evaluation of the remote lesson emotional environment .

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Positive emotions	26	*Joy*	17	Happiness; it was entertaining; fun to communicate; very funny; it's a fun to speak a foreign language; It was amazing; I'm happy; it was funny; fun; big fun
		Interest	7	It was really interesting to communicate; it was interesting to communicate in English; it was interesting; it was very interesting; it was quite interesting, interesting
		Thrill	4	very exciting, felt touched
Negative emotions	**7**	*Nervous*	4	At the beginning I was pretty nervous, I was nervous, a bit nervous
		Fair	3	A bit tricky, afraid of not knowing enough English words, a bit disappointment

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Research data discloses that the majority of respondents most frequently experience positive emotions during research. Contacting foreign students offered the possibility of understanding the benefit of communication and the need for exchanging information which is very important at this age stage. The previous data clearly shows that students particularly like the process and results of communication. Subcategory 'Joy' indicates that the larger part of students experienced positive emotions and dignity which are the states of mind encouraging feeling happiness and harmony. This is one of the best results successfully implemented within the test of the third scenario to generate motivation. Obviously, a greater number of respondents wanted to learn and share experience with friends in Lithuania and abroad, and thus the subcategory 'Interest' comes next and falls into the category of positive emotions. Interest can also be accepted as inquisitiveness expressed through the emotions of happiness. A few students were worrying which stimulated interest in learning and communication.

Two negative emotions were experienced by the learners during the process of studying. 'Worrying' and 'fear' emerged because of insufficient information on what partners every student would meet to communicate with and on the facts provided by a foreign respondent as well as due to lack of certainty over how the respondents will understand each other, whether knowledge of English is sufficient enough to communicate etc. It can be maintained that negative emotions were determined by the ambiguities of the learning process and foreign language barriers.

All these emotions are not clearly defined as students' thinking is balanced at the stage of formal operations, and therefore they have not enough potential for identifying inner states. Next, the learners feel lack of appropriate psychological knowledge to properly distinguish the occurring states. The authors of the article interpreted the acquired data on the basis of general psychological background that helped with understanding respondents' states of mind within the research.
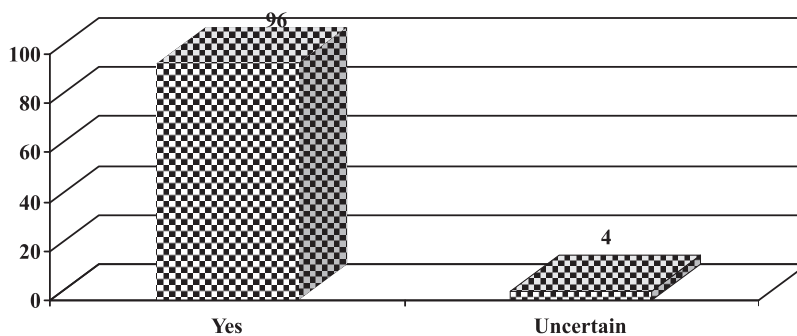
Figure 6.   The usefulness of preparation for the remote lesson (%).

The data in Figure 6 shows that almost all students are convinced that preparation for the remote lesson was useful which indicates that they learnt something new, acquired new skills and understood the importance and usefulness of preparation.
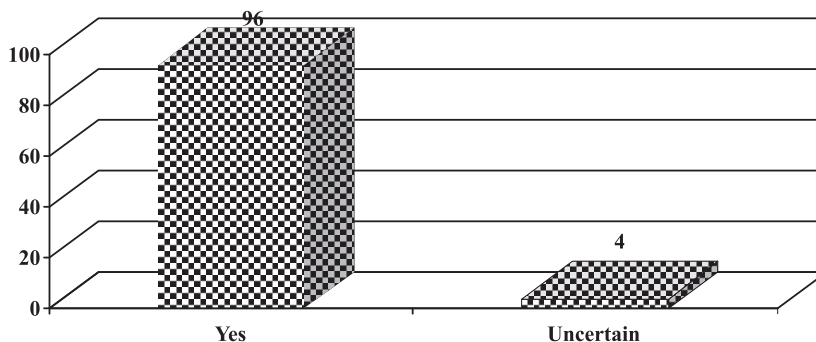
Table 6. **Factors showing the usefulness of preparation for the remote lesson.**

Category	Number of quota- tions	Subcategory	Number of quota- tions	Quotations
Better communi- cation skills	21	*Specific knowl- edge*	9	Obtained more information about Easter, Pancake Day, German fortresses, chapels and decorated crosses; learned more about topics taught at school; research on my topic; I learned a lot of new things about prepared objects
		Language skills	7	I feel more fluent in communicating with foreign partners; helped with learning new English words; I improved my vocabulary; de- veloped knowledge of English; I had a chance to improve my knowledge of the English language; I had a good basis for vocabulary; I have learned English; trained my English skills
		Experience	5	I learned more about it, prepared for the remote session and self conscious, enabled me a better explanation, writing my text and learning in general; it was new experience of collaboration; it was interesting to introduce objects to German students.

The data in Table 6 indicates that all factors proving the usefulness of preparation for the re- mote lesson can be attributed to one category falling into three subcategories. The first subcategory 'Specific knowledge' reveals that usefulness is also described as the process of receiving the latest knowledge of the culture of other country, obtaining specific information and devoting more effort to prepare for the lesson comparing to preparation for common classes. The respondents admit knowledge gained on their own and give a positive evaluation as having usefulness. The acquired specific knowledge shows that students are aware of the fact that preparation for the lesson has had a positive impact on their knowledge.

The second subcategory 'Language skills' presents that a number of respondents perceive the usefulness of preparation for the lesson through the processes of language development that determines better skills at knowing a language. Skills at improving a foreign language are frequently mentioned when answering other questions which only underlines that the students highly evaluate experience of collaborating with foreign students as the possibility of broadening knowledge of a foreign language. In this case, preparation for the remote lesson obliged the students to learn the text of native culture in English and present it in an understandable way so that a foreign partner could understand it. The respondents also had to think of the questions addressed to the partners after the presentation had been over. All these aspects confirm that the students understand and properly evaluate efforts for preparing for a lesson as they helped with increasing knowledge of a foreign language.

The last category 'Experience' discloses that some of the students deeply appreciate gained ex- perience, feelings, emotions and a possibility of mastering technologies. Experience is distinguished as developing skills at collaboration with foreign students, language development, improving verbal abilities, increasing the level of concentration and a longer remembering of the acquired knowledge. In conclusion, preparation for the lesson helped the students with developing skills required for ef- fective communication.

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**Figure 7.   The usefulness of the remote lesson (%).**

The usefulness of the remote lesson is acknowledged almost by all students (Figure 7) which means that this method of teaching greatly assists in the process of learning and displaying positive emotions. Experience is also given a positive evaluation and it is likely that the respondents would like to proceed with using this method.

Table 7.   Factors showing the usefulness of the remote lesson.

Category	Number of quota-tions	Subcategory	Number of quota-tions	Quotations
Better cross cultural communi-cation skills	22	*Skills at learn-ing a foreign language*	11	It was useful for improving knowledge of the Eng-lish language; it is useful to talk to foreign students; I liked speaking English, thinking in English and using English;
		Foreign culture	11	I had a chance to present interesting information to German students and extend my knowledge of German culture and places to remember. It was a fun to find a new friend from Germany, to know more about new cultures and to hear a legend about early printing in Germany; etc.
Deep knowledge	10	*Learned*	6	I think I learned, I learned something, I know I spoke, I could learn
		Understood	4	I found out something new

The factors proving the usefulness of the remote lesson can be subdivided into four subcategories and two categories. The first subcategory 'Skills at learning a foreign language' shows that similarly to the previous answers, the students put emphasis on the development of skills at learning a foreign language. Improving skills at learning a foreign language during the lesson is one of the main aspects that attracts students and increases motivation for communicating with foreign partners. The second subcategory 'Foreign culture' discloses that the majority of students point to the positive aspects of acquiring knowledge of a foreign culture which means that a didactical purpose is accomplished and have positive outcomes. In conclusion, it can be stated that the remote lesson helped the respondents with developing skills at cross-cultural communication.

The second category 'Deep knowledge' indicates that the learners see much usefulness in terms of psycho-pedagogical aspects. The remote lesson supported some students in a better understanding and faster learning of the chosen topic as it was better analyzed. Thus, such lesson only reinforced the process of learning.
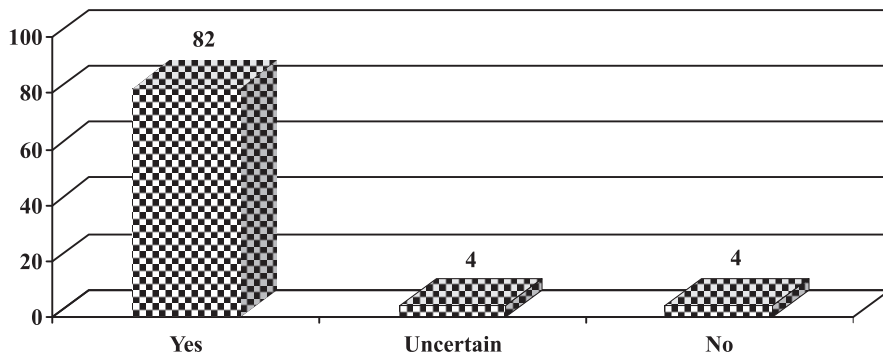
Figure 8.   **The qualities of the AR platform.**

The data presented in Figure 8 reveals that a greater number of students agree that the AR platform helped with learning issues which means that the remote lesson is positively evaluated. Therefore, in the future, in order to offer students the possibility of studying different aspects, the lesson scenario could be improved and applied for other subjects taught.

Table 8.   **Factors showing the qualities of the remote lesson.**

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Virtual objects	12	*3D visualization*	8	3D picture is a clearer picture as this is virtual space; the AR platform is based on 3D view; 3D space is of extremely high quality; objects are three-dimensional; 3D is more interesting than a common PC.
		Clear visual perception	4	See an object from all sides; to draw and see objects virtually; object form and size
Easier to learn	7	*Easier under-standable*	5	Easier to get the discussed objects; easier to acquire information; easier to display things, etc.
		Clearer	2	It s more clear

Two categories disclosing factors showing the qualities of the AR teaching/learning platform can be distinguished. The first category 'Virtual objects' indicates that students see the qualities of visualization. 3D visualization is frequently emphasized as a clear and interesting format to introduce pictures. 3D visualization is rare in the classroom and some learners find it as a really new way of reflecting data in the learning process. The introduced method of displaying facts and figures stimulates to positively accept and evaluate information. Three-dimensional objects and virtual/augmented reality are the most intriguing phenomena as technological progress is a part of the culture of those, and therefore interest in the above mentioned phenomena is a natural reaction to cultural challenges and purposes to feel a superior personality in a post-modern world.

Another important positive criterion of the AR teaching/learning platform is 'clear visual perception'. The students find the reflected data using 3D visualization very useful as it helps with a clearer understanding and remembering information as well as provides a possibility of

observing them from all sides that is impossible using common training aids. Virtual objects remind of computer games that are a part of daily life of a number of learners as such method of learning involves and awakes admiration. Therefore, the discussed method of learning is more like a game rather than a process of learning. In this case, the students feel personal responsibility because the teacher is not directly involved in the process of learning.

The second category 'Easier to learn' shows that the AR platform assists in understanding and processing information using it in the educational process. It is clear, that virtual objects and 3D visualization had the major impact, and thus the degree of perceiving objects increased. Moreover, students' motivation for learning and self-confidence as an organization of individual learning to obtain broader knowledge was partly strengthened. To sum up, the qualities of the AR platform are ***high quality visualization*** and have impact on understanding and remembering information.
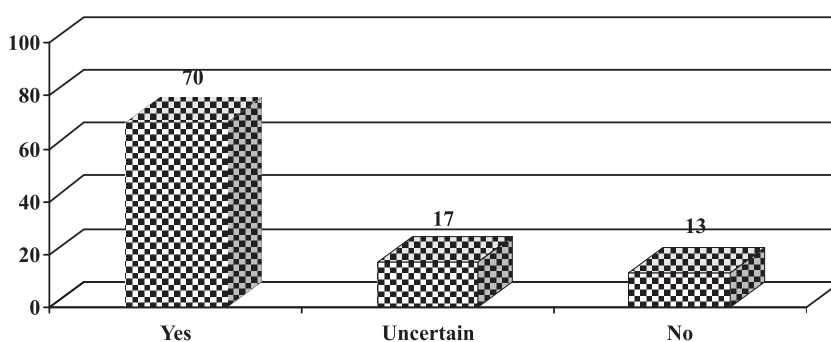
Figure 9.   Students' intention of having the AR teaching/learning platform in the classroom.

The majority of students would like to have a similar platform at school as they suppose it should help with starting learning complex subjects if other didactical scenarios were applied.

Table 9.   Factors stimulating students' interest in having the AR teaching/learning platform in the classroom.

Category	Number of quotations	Subcategory	Number of quotations	Quotations
Motivation for learning	18	*Interesting lessons*	12	The process of learning is more interesting; classes are more interesting; the method of learning is more attractive; comprehensive learning; more stimulating than during ordinary classes; valuable experience; different from school; very interesting
		Comprehensible material	6	Information is better acknowledged; the platform should be useful for figuring out and understanding different points; helps with a better understanding of the topic learnt; visual information is clearer in 3D space and this facilitates the process of learning.
Negative aspects	3	*Inappropriate from the point of view of ergonomics and time*	3	Though it's an interesting idea, plenty of platforms would be required; complicated and time-consuming; seems to be too complicated.

The factors determining whether the students would like to have an AR platform in the classroom can be divided into two categories. The first category 'Motivation for learning' shows that the students most frequently would like to use the AR platform to make lessons interesting and different from those taken at school. They find the content, form and method of learning attractive and unusual, and therefore are engaged in everything new. Comprehensive material greatly helped with learning and understanding information due to clear visualization and accurate information given from the partners. The process of learning was intriguing.

A few negative aspects can be noticed. First, students think there no similar platforms and schools are not able to purchase them soon. Second, the platforms are too cumbersome, and therefore hardly can be placed in the classroom. In conclusion, the respondents really would like use the AR in the classroom.

Conclusions

1. The students agree that Prototype 3 of the AR platform is a new and useful tool that could be successfully applied for learning purposes in the educational process.
2. Prototype 3 has created the possibilities of communication and collaboration within the process of learning. Besides, the opportunity to develop both local and remote collaboration has been provided. In both cases, similar AR learning environment stimulating students' inquisitiveness and creativity has been used.
3. The following factors demonstrate the educational value of the AR learning platform created working on the project ARiSE:
   a. has increased students' interest in an object(s) and subject(s) of learning in the educational process (preparation for a remote lesson at international level, participation in a remote lesson and aspirations to keep communicating after the lesson is over);
   b. teachers has enjoyed positive emotional environment created during the educational process, whereas students have appreciated the process of learning and achieved results;
   c. a favourable attitude towards using the AR teaching/learning platform in the future has been adopted.

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Pedagogical Evaluation

Prototype 3: The Culture of European countries – old and new members of EU:
differences and similarities

Dear students,
You have been provided a possibility of testing a recently created tool for learning. Please, respond
and make comments on the below presented questions. The comments are of vital importance to the
producers of the tool.
Read the questions first to provide precise answers.

1. Is a remote collaborative lesson with the students from Germany has stimulated your interest in the cultures of other European countries?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

2. Has the use of *the AR learning platform* strongly stimulated your interest in the peculiarities of your native culture while preparing for a remote lesson?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

3. Has the use of *the AR learning platform* helped you with broadening your knowledge? What new subjects have you learned? Point out the ways of obtaining new information.

☐ Yes ☐ Uncertain ☐ No	*Comments:*

4. Has the use of *the AR learning platform* helped you with understanding new information? What new things have you learned? Point out the ways of obtaining new information.

☐ Yes ☐ Uncertain ☐ No	*Comments:*

5. How has the process of creating new 3D objects been useful for learning?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

6. Have the recent forms of collaboration with contemporaries been different from the previously used ways of communication? Why?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

7. Do you think you have received benefit from preparation for a remote collaborative lesson with the students from Germany? Identify the main points.

☐ Yes ☐ Uncertain ☐ No	*Comments:*

8. Do you think you have received benefit from a remote collaborative lesson with the students from Germany? Identify the main points.

☐ Yes ☐ Uncertain ☐ No	*Comments:*

9. Has individual learning been more active while preparing for a remote collaborative lesson with the students from Germany? Why?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

10. Identify the merits of *the AR learning platform* comparing them with an ordinary computer used for learning purposes.

☐ Yes ☐ Uncertain ☐ No	*Comments:*

11. Would you like to regularly use *the AR learning platform* in the classroom? Why?

☐ Yes ☐ Uncertain ☐ No	*Comments:*

12. What feelings did you experience during a remote lesson with the students from Germany?

13. Imagine that your school has an *AR learning platform*. How do you think it could change the process of learning?

14. What requests could be submitted considering experience gained using *the AR learning platform*?

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