Experiences with Remote Laboratories

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***Abstract*—The paper reports on experiences of academics and students involved in using remote engineering laboratories both when students work individually or collaboratively with others on the experiments. Positives and negatives are highlighted and are contrasted with expectations of what the remote laboratories can bring into pedagogical environments. Recommendations and conclusions follow on how to better use the remote laboratories in teaching.**

***Index Terms*—e-learning, engineering education, remote laboratories, student collaboration.**

I. Introduction

The laboratory paradigm in engineering, technology and science education is increasingly moving toward incorporating to larger or lesser extent e-learning methods. Real laboratories with hands-on experiments on physical equipment are still an important part of the curricula but increasingly, virtual laboratories – web-based simulations, both locally and remotely, and remote laboratories, where experiments are conducted remotely on real equipment, are becoming to be a routine part of the laboratory programs.

The reason for the growth of remote laboratories in engineering and science is succinctly summarised in [1]:

"

- the growing complexity of engineering tasks,
- the increasingly specialized and expensive equipment, software tools, and simulators required,
- the necessary use of expensive equipment and software tools/simulators in projects with short time frames (such as presented in [2]),
- the application of high tech equipment required in small and medium enterprises,
- the need of highly qualified staff to control new equipment, and
- the demands of globalization and division of labour."

The scale of developments in the area of remote laboratories worldwide is massive. Search for "Remote Laboratories" in the search engine of the digital library IEEEXplore in March 2010 delivered nearly 3,600 IEEE journal and conference publications, some going back to 1999, with the majority published early in the 21st century. Keeping in mind that many publications appear in non-IEEE journals and conference proceedings, the number of publications on remote laboratories to-date may have already exceeded 8,000. Remote laboratories are no longer objects of utopia. They are here, as real as they can be!

Whether we speak of real, virtual or remote laboratories, usually the purity requirement is not met as most of the current ones are hybrid. In real laboratories, students compare measured results with those predicted, either using manual calculations or computer algorithms. In the case of remote laboratories this is still the case. Virtual laboratories often have more than one software system to offer reflective comparison between different models used.

The physical remoteness and simulated (or tele-present) attendance of students in a remote laboratory causes some confusion and disbelief. "Our laboratory classes are not on the booking system but we are supposed to submit laboratory reports for the first experiment in week four of the semester. Which room do we go to? Where do we have the laboratory classes?" Such was the question by several students in the course "Electrical Circuit Theory" taught by us in Semester 1, 2010. "No physical presence of students in the laboratory is needed; the only requirement is to access the laboratory through the Internet from anywhere in the world!" was our answer.

In this paper we review student and staff experiences in both single-user and collaborative settings in remote laboratories.

In settings which comprise international student teams, in addition to local and national collaborative opportunities, there is also an opportunity to learn from students of differing locations, cultures, languages and work practices. These generic skills are becoming increasingly important for professional engineers globally.

II. Overview of Experiences

The majority of learned publications on remote laboratories focus on the technical side of the remote access to the real equipment, hardware, software, interfaces, servers, protocols, measurement equipment and components, the experiment design, the guidelines for conducting experiments and producing reports. Undoubtedly, these are very useful aspects for further development and refinement of new and existing remote laboratories.

A salient observation coinciding with the advent of remote laboratories is that the associated e-learning environment has been progressively shifting the responsibility for learning from teachers to students. The students are increasingly expected to maximise their learning outcomes using electronically accessible instructional materials, laboratory access via the Internet, the relevant media, human resources and their own competencies. This is "student-centred learning" in its truest sense, where the student assumes responsibility for own learning. Evidently, the experiences of both the learners and their teachers are important in gauging the success in any endeavour to enhance the learning outcomes.

Yet, few papers report on experiences of students and staff with remote laboratories. This will be the focus of the paper.

A. VISIR Project

Virtual Instrument Systems in Reality (VISIR) project was started at the Blekinge Institute of Technology, Sweden in 2006, with the support of the National Instruments, USA, and Axiom EduTech, Sweden, to disseminate the open source and open access remote systems in engineering laboratories. A special interest group for VISIR was established in the International Association of Online Engineering (IAOE) to facilitate 24/7 access to remote university and industrial laboratories [3].

After initial trials, the Faculty of Engineering at the University of Deusto, Spain has adopted the VISIR platform for core laboratory teaching in Electronics and Control Engineering and Informatics Engineering courses.

A survey of students using the remote VISIR laboratory concentrated on the usefulness, immersion, sense of reality, usability and the quality of service. The results [3] indicate a general acceptance of VISIR by the students, advice of its further integration into other courses and involving more students, good selection of different devices and extension of the laboratory scope. Student think that VISIR is more useful than usable that suggests the improvement of the user manuals and the user interface.

B. PEMCWebLab

Power Electronics and Electrical Dives and Motion remote laboratory network PEMCWebLab has been created with partners in the Netherlands, Czech Republic, Germany, Austria, Poland, Hungary, Bulgaria, Romania and Greece [4].

The implementation has proved to be useful for self-study by students, when adequate materials were provided, experimenting with different circuit parameters and developing overall measurement proficiency. The results of the students utilising the remote platform were better than those without but as the authors state “the transfer of this knowledge and skills in new life application is still doubtful” [4]. Students report difficulties in bridging individual concept to the whole.

C. Micro-web Server Remote Test Controller

A remote workbench dealing with IEEE 1149.1 standard test access port was created with remote experiments integrated into Moodle at the University of Porto, Portugal that facilitates the student collaborative activities between partner universities (Nota Bene: Moodle has been adopted by the University of South Australia as the leading platform for on-line activities from 2010 onwards) [5].

The Moodle module called *Meeting Room Booking System* (MRBS) has been adopted, which, being an open source software, eliminates upgrading problems. MRBS facilitates the integration of remote experiments scheduled as core student activities. This model resembles remote experiments closely to real laboratory sessions, both in essence and in terms of scheduling.

The model creates excellent opportunities for students from Portugal and Australia to collaborate on the same software/hardware projects using the client application and the DSTNIm410 remote micro-server Java code.

D. NetLab

NetLab [6] is a remote laboratory system developed at the University of South Australia (UniSA) and used since 2002 for teaching in several main-stream courses; several hundreds of students have been using it annually. NetLab from the onset was designed as a collaborative environment [7], [8]. [9], allowing students to work in teams consisting of either UniSA domestic students (using shared or individual computers, locally and remotely) or international students in Singapore and Sri Lanka.

NetLab is a mature remote laboratory, with open access to anyone (http://netlab.unisa.edu.au), developed by generations of final year students, Master’s and PhD students, overseas exchange students and supervising academics. It was selected as one of the leading remote laboratories in the AUD3.4million Australian project LabShare [10] with the target of national remote laboratory sharing.

Student responses on the NetLab environment and its use [11] indicated general satisfaction with the system. Responses of students of the same course in two consecutive years 2003 and 2004 are shown in Figure 1.

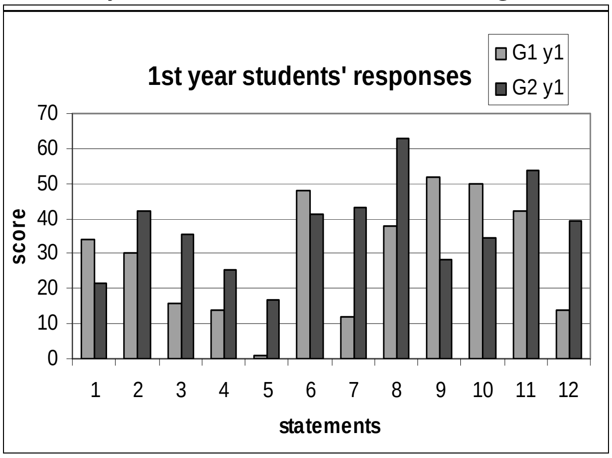

Figure 1 Student responses for two generations (G1 – 2003 and G2-2004) of the same course

The questionnaire sought responses to the following:

1. It was easy to book a session
2. It was easy to learn how to use NetLab
3. It was easy to control equipment
4. It was easy to access the NetLab
5. I had a feeling as if I was working in the real laboratory
6. I liked moving the camera around to see what was in the lab
7. The collaboration with other students was useful
8. I liked the option of being able to repeat the experiment on my own
9. I prefer working in the real laboratory
10. I would like to be able to do wiring of the circuit myself

11. I would like the option to be able to talk to other students during the experiment
12. Using NetLab was fun

In general, G2 scores were higher than G1 as result of improvements in NetLab after G1 feedback. These included a booking system with restricted number of hours per week per student (currently 3 times one hour per week per student). Unlimited number of access hours encouraged abusing the system, for instance booking out big chunks of laboratory time without using it. The other important improvement was the introduction of a remote wiring system - the Circuit Builder allowing students to have an experience similar to the real laboratory. Improved manuals and control mechanisms of equipment contributed to better scores in Q.3 and Q.4.

The lowest score, although dramatically improved in G2 (due to the improved GUI) was attracted by Q.5. – “I had a feeling as if I was working in the real laboratory”. After initial uneasiness with the answer, we think that this should be treated as a genuine reflection of the fact that working from a computer pool or from home does not resemble a laboratory room full of people, possibly smelly and noisy, with live voltages. Perhaps we should not simulate these features in remote laboratories!

The highest scores were received for an opportunity to repeat experiments in the remote laboratory (Q.8), rarely available in real laboratories, and the ability to talk to other students during the experiment (Q.11).

The competitive research grant of $220,000, 2009-2010 won by us from Australian Learning and Teaching Council on ”Enriching Student Learning Experience through International Collaboration in Remote Laboratories” has allowed us to investigate the international dimension of collaborative experiments. A pilot project in 2009 [7] involved 4 international teams (members from Adelaide and Singapore) working on the same experiment. The majority of students were very satisfied or satisfied with the all aspects of the remote laboratory international collaboration. It was very encouraging that the students appreciated the collaboration aspect of the experiment, its close resemblance to the proximal laboratory and the possibility of repeating the experiment as often as required. The critical role of a team leader in the experiments was emphasised.

E. Virtual Robot Laboratory at NTUA

A pilot study comparing the effectiveness of teaching in a real laboratory with that of either a web-based virtual laboratory or a remotely accessed real laboratory was conducted at the National Technical University of Athens, Greece [12]. The focus of the study was on the educational impact of such studies, with major emphasis on the didactical perspective of the learning process. Evaluation of the study outcomes was conducted by means of test scores of three sample groups, undertaking laboratory work in (a) proximal laboratory, (b) remote laboratory, and (c) virtual laboratory. Their results are replicated in Fig. 2. The authors conclude that ‘…benefits from providing the means to obtain remote access to experimental infrastructure existing in various dispersed laboratory scenarios. The benefits from providing the means to obtain remote access to experimental infrastructure existing in various dispersed laboratory facilities can become significant *both from a socioeconomic point of view, as well as from an educational perspective*.” (*italics* ours for emphasis) [10].

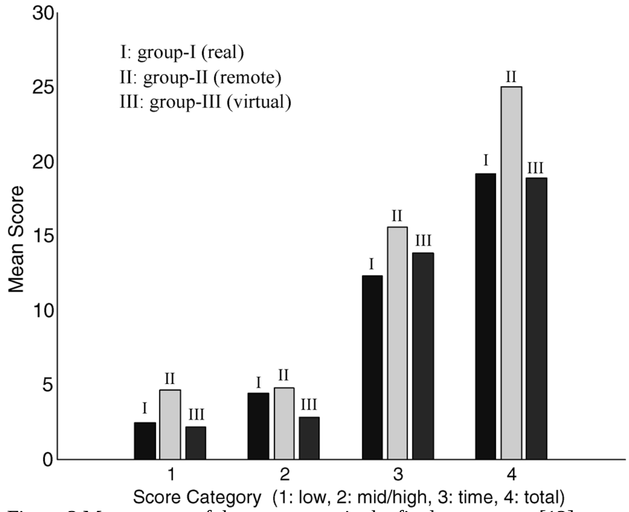

Figure 2 Mean scores of the test groups in the final assessment [12]

It would seem that the test group assigned to remote laboratory experiments surpassed the other two test groups in terms of performance both in low and medium-to-high level technical skills, time taken to perform the set tasks and the overall score. Interestingly, the authors observe that the “…group II (remote) students had to rely, for their training, on the visual and ‘functional’ quality of the pendant (emulation) panel, which apparently influenced, to some extent, the skill acquisition process.”

This observation is largely supported by a subsequent study investigating the impact of audiovisual aspects of remote and virtual laboratories [13]. The focus in this case was on the difference that a rich audiovisual feedback can make as contrasted with *non-feedback*. Students responses to the question “If given a free choice, which access mode would you have chosen and why?” are tabulated in Table 1 [13]. The responses seem to indicate a preference for hands-on exposure in the case of proximal laboratory option and requirement for rich AV feedback in the case of remote laboratory alternative.

Table 1 Students’ Preferred Mode Distributions (%) [13]

	Non-feedback Trial			Feedback Trial		
Preferred Mode	Proximal	Remote	Simulation	Proximal	Remote	Simulation
Proximal	89.8	81.1	95.2	86.7	66.3	59.1
Remote	4.1	10.8	0.0	8.9	27.9	10.2
Simulation	6.1	8.1	4.8	4.4	5.8	30.7

F. Remote Networking Laboratory at UC

The Interdisciplinary Telecommunications Program (ITP) at the University of Colorado developed a remote laboratory infrastructure (ReLI) for use in master’s level post-graduate studies [14]. Their goal was “…to create an environment that reproduces (not just emulates) the lab experience.” The team seems to have considered the experiences both in terms of successes and failures of others treading a similar path, eventually coming up with a remote laboratory learning environment comprising (a) a setting for computer assisted laboratory experiences, and

(b) an administrative system which includes authorisation and booking procedures among other functions.

The authors observe and report that despite some "glitches", the users greatly appreciate the ability to repeat the laboratory experiments" [14]. This aspect is seen as one of the strongest features in favour of the remote laboratory paradigm, expressed as a notion in the words: "We see that the consistent reuse of the remote environment as a means of reviewing or reinforcing the material for both remote and in-lab students as being a strong motivator to continue to improve this environment." [14].

III. Remotely Shared Resources and Student Collaborative Skills as Seen by Staff

During the WIETE 1st Annual Conference on Engineering and Technology Education, 22-25 February 2010 in Pattaya, Thailand, the authors conducted a *participants'* survey on student teamwork and collaborative skills in the context of using remote laboratories (The questionnaire is appended as Attachment 1). Responses to the questionnaire are summarised below in six categories.

A. Good Technical Solutions

The survey participants emphasised that remote laboratories offer optimal utilisation and sharing of unique resources, where distance barriers are overcome. Good technical solutions facilitate the development of competence in carrying out certain technical proceedings and mastering the modern technology on a contemporary basis. They also allow students to work at their own pace, increase self-motivation, bring people together and the provision of repeatability of the experiment for consolidation.

B. New Resources

New remote resources usually involve modern equipment, good design and use of sophisticated user interface. Students get familiar with new technologies, perhaps not available in their location, and have access to better quality laboratory equipment. In some cases industry makes their resources available to the students, thus increasing industry relevance of engineering education.

C. Collaborative Learning

Remote laboratories create new ways of collaborative learning, either working on the same computer with partners or working with partners using individual computers, nationally or internationally.

Collaborative experiments increase teams'capabilities, identifying the strengths of individual team members as well as developing collaborative and leadership skills. Partnerships and friendships may be established as a result of collaborative work.

Collaborative learning is about sharing new and different practices and knowledge, and to use them to enhance learning outcomes. 'The world is one big classroom.' It may develop friendships and be good fun.

Collaborative learning brings people together and overcomes technology being distractive, interfering with the work.

D. New Approaches

Remote laboratories give the opportunity to create a new framework for designing and sharing a joint curriculum, or at least sharing remote laboratories between universities (e.g. LabShare – the national Australian project for laboratory sharing [10], VISIR – Virtual Instrument Systems in Reality [3), borderless technology transfer, using on-line instruments, developing new skills, like creating collaborative online documents, using communication tools such as Voice Over Internet Protocol (VOIP). Student learn to use new tools and how to select them, both hardware and software-based, not normally available in the curriculum. Occasionally challenges include organising online meetings at odd times to overcome widely different time zones of collaborators.

E. Team Development

The major question is how a group transforms into a team. One aspect is to build the attitude of sharing skills and information with others and to get familiar with other work cultures and approaches. Students learn about preferences of individual team members and learn to work in a team. They are able to identify individual learning styles of team members allowing for teaming up. They can develop creativity in a group setting, share the knowledge, motivate others and have an opportunity to reflect on mutual ideas and convey their innovative ideas on others. What bonds them most is when the job is well done.

A good team leader must be a good listener, be compassionate, able to work under pressure and value contributions of fellow team members. The leader must also have organisational skills and passion to lead the team by example.

F. Communication

In remote laboratories, students can practice their communication skills required for a successful career. They have a chance to work with people from multicultural backgrounds. They can have access to modern communication tools such as Centra® Saba software, with audio and/or video facilities, including recording of the laboratory sessions [7].

Required are good language and communication skills, confidence in conversation and presentation, competence in validating results and writing joint reports. As a result, teams of collaborating students improve their technical language and vocabulary, accept opinions from other people with different cultural background, learn different ideas from people with different school of thought, listen to feedback and take corrective measures. They also get acquainted with the online collaborative working etiquette.

IV. Recommendations

As a result of shrinking technical support in engineering schools and increased academic workload in Australia and elsewhere, the remote experiments are conducted usually with little or no supervision; this is very different from real laboratories. This dictates the necessity of an adequate training of students in using a remote laboratory, through lectures, detailed didactically sound study guides/manuals and/or instructional videos.

The study guide (similar to a cookbook) should cover in-depth the working environment of the remote laboratory, the process of conducting the experiment and writing the report. There should be enough scope for creativity to motivate good students.

The technical robustness of a remote laboratory is essential. Time-down of a server, measuring instruments and components cause frustration to students, only comparable with faulty leads and instruments in the real laboratory. So, perhaps the frustration needs to be a small part of using remote laboratories to bring them on a par with real counterparts? The unavailability of a remote laboratory should be minimised by at least using a backup server to restore laboratory's functionality in the shortest possible time.

If remote experiments are conducted by a team, team members need to be trained in teamwork issues, including team dynamics and leadership aspects, as a team leader will play a critical role in the team's success.

V. Conclusions

Experiences with remote laboratories emphasise several aspects that are common to all of them. Availability of expensive or unique equipment on-line (such as in [2]) is a very attractive feature of remote laboratories. Savings on multiple repetitive sets of equipment required in real laboratories is the other. Sharing laboratory course components nationally and internationally is very much *signum temporis* and may enrich learning and teaching in many countries, including developing world that may miss the opportunity of a timely introduction to the exciting world of remote laboratories.

Collaborative learning with its multicultural dimension is much valued by students and is a very attractive option of remote laboratories that offer it. The skills acquired in the environment of a collaborative remote laboratory are invaluable, especially in the context of the era of globalisation

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References

[1] M.E. Auer and G. Gravier, „Guest Editorial: The Many Facets of Remote Laboratories in Online Engineering Education", *IEEE Transactions on Learning Technologies*, vol. 2 ,No. 4, ISSN 1939-1382 pp.260-262, 2009.

[2] Operated High Voltage Laboratory for Impulse Voltage Testing", *World Transactions on Engineering and Technology Education*, vol. 7, No.1, ISSN S. Karmakar, N. K. Roy, A. Nafalski and P. Kumbhakar, "A Remotely 1446-2257, pp.17-21, 2009.

[3] I. Gustavsson, K. Nilsson, J. Zackrisson, J. Garcia-Zubia, U. Hernandez-Jayo, A. Nafalski, Z. Nedic, Ö. Göl, J. Machotka, M. I. Pettersson, T. Lagö, L. Håkansson, "On Objectives of Instructional Laboratories, Individual Assessment, and use of Collaborative Remote Laboratories", *IEEE Transactions on Learning Technologies*, vol. 2 ,No. 4, ISSN 1939-1382 pp.263-274, 2009.

[4] P. Bauer, V. Fedak, O. Rompelman, "PEMCWebLab – Distance and Virtual Laboratories in Electrical Engineering: Developments and Trends", Transactions of 13th International Power Electronics and Motion Control Conference, IEE 987-14244-1742-1. pp.2334-2359. 2008.

[5] J. M. Ferreira, E. Sousa, A. Nafalski, J. Machotka and Z. Nedic, "Collaborative Learning Based on a Micro-webserver Remote Test Controller", *International Journal of Online Engineering*, vol. 5, Special Issue REV 2009, ISSN 1861-2121, pp. 18-24, 2009.

[6] Z. Nedic, J. Machotka, A. Nafalski and R. Haraszczuk, „Remote Experiments over the Internet – a Case Study of NetLab", book chapter *in Varia Informatica 2009*, eds. M. Milosz & P. Muryjas, Polish Information Processing Society, Lublin, Poland, ISBN 978-83-60810-21-7, pp. 37-46, 2009.

[7] A. Nafalski, J. Machotka, Z. Nedic, Ö. Göl, A. Scarino, J. Crichton, I. Gustavsson, J. M. Ferreira, D. Lowe, and S. Murray, "Collaborative Learning in Engineering Remote Laboratories", *Proceedings of the International Conference on Remote Engineering and Virtual Instrumentation REV* 2009, ISBN 978-3-89958-480-6, Bridgeport, USA, pp. 242-245, 22-24 June 2009.

[8] J. Machotka, Z. Nedic, A. Nafalski and Ö. Göl, "A Remote Laboratory for Collaborative Experiments", *Proceedings of the 2009 ASEE 116th Annual Conference and Exposition*, ISBN 978-0-87823-202-4, Austin, TX, USA, 14 – 17 June 2009.

[9] A. Nafalski, Z. Nedić, J. Machotka, Ö. Göl, J.M.M. Ferreira and I. Gustavsson, "Student and staff experiences with international collaboration in the remote laboratory NetLab", *Proceedings of 1st World Institute for Engineering and Technology Education WIETE Annual Conference on Engineering and Technology Education*, Pattaya, Thailand, ISBN 978-0-9807664-0-0, pp.40-45, 22-25 February 2010.

[10] D. Lowe, A. Johnston, S. Murray, L. Weber, M. de la Villefromoy, E. Lindsay and A. Nafalski, "Towards a National Approach to Laboratory Sharing", *Proceedings of 20th Annual Conference for the Australasian Association for Engineering Education AAEE'09*, Adelaide, Australia, ISBN 1-876346-59-0, pp. 458-463, 6-9 December 2009.

[11] J. Machotka and Z. Nedic, „Students' Responses to Remote Laboratory Netlab", Proceedings of IASTED Conference on Web-based Education, CD ISBN: 0-88986-543-4 ; ISSN: 1482-7905 Puerto Vallarta, Mexico, 23-25 2006.

[12] C. S. Tzafestas, N. Palaiologou and M. Alifragis, "Virtual and Remote Robotic Laboratory: Comparative Experimental Evaluation", IEEE Transactions on Education, Vol. 49, No. 3, pp.360-369, August 2006.

[13] E. Lindsay and M. Good, "The Impact of Audiovisual Feedback on the Learning Outcomes of a Remote and Virtual Laboratory Class", IEEE Transactions on Education, Vol. 52, No. 4, pp.491-502, November 2009.

[14] D. C. Sicker, T. Lookabaugh, J. Santos and F. Barnes, "Assessing the Effectiveness of Remote Networking Laboratories", 35th ASEE/IEEE Frontiers in Education Conference, pp.S3F3-S3F12, Indianapolis, USA, October 2005.

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Attachment 1

Staff survey on students' team work and students' collaborative skills

With the following questions we seek your opinion as academic staff on what are the criteria that reflect a good team work and a good team member of an internationally distributed team of engineering students collaborating online on a project or an experiment.

For each question we listed a number of answers grouped under several categories. On the lines below, please add your own answers and categories and/or remove the answers and categories that you do not agree with.

Q1. What are the outcomes of a good collaborative team work in general?

1.1 Successful technical results, like

- € Successful completion of projects
- € Best technical solutions
- € Innovative solutions

1.2 Learning outcomes, like

- € Students learned new skills from each other
- € Students taught each other new knowledge
- € Students got inspired to think differently and to get new ideas

1.3 Social outcomes, like

- € Meeting new people
- € Making friends
- € Socialising

Q2. What are the additional outcomes of a good international online collaborative team work?

2.1 Multicultural experience, like

- € Learning about new cultures
- € Enriching your own culture
- € Learning new languages

2.2 Mastering new technology skills, like

- € Web authoring tools
- € Knowledge of YouTube uploading

Q3. What are the attributes of a good team member of a collaborating team?

3.1 Good technical knowledge, like

- € Good knowledge of course material
- € Competence in the use of simulation tools
- € Competence in writing report

3.2 Good communication skills, like

- € Shows interest in team members
- € Invites opinions of others
- € Rephrases statements to make sure everyone understands
- € Is a good friend
- € Is good fun

3.3 Good leadership skills, like

- € Makes effort to keep group working together
- € Makes effort to focus group work on the task
- € Makes effort to overcome team crisis
- € Shows initiative to allocate/split tasks
- € Helps others develop their potentials

Q4. What are additional attributes for an online international collaborative team member?

4.1 Competences in online tools, like

- € Knowledge and use of online chat/video communication tools
- € Web authoring tools
- € Knowledge of YouTube uploading
- € Knowledge of setting up a wiki

4.2 Understanding the impact of technology on communication and collaboration, like

- € New technology can be distractive – interfere with the work

4.3. Cultural attributes, like

- € Proficiency in a common (for the team) language