



## European Acoustics Association Schools

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### ABSTRACT

European Acoustics Association Schools are an integral part of the Young Acousticians Program of EAA. Meanwhile they consist a) of various "Hot Topic" courses for graduate level and b) of an introductory course "Approaching Acoustics" for undergraduate students. All parts are taught by internationally recognized and distinguished experts in acoustics. The first EAA (Summer) School was held in Ljubljana, Slovenia, in 2010 with short courses on "Soundscapes", "Voice and Musical Acoustics", "Building Acoustics", "Hydroacoustics", "Numerical Methods", "Psychoacoustics" and "Ultrasound". The second EAA (Winter) School was held in Merano, Italy, in 2013 with advanced courses on "Cutting Edge in Spatial Audio", "FEM and BEM", "Synergies between Environmental Noise Control and Soundscape Approach", "Understanding Musical Instruments in Practice", and "Introduction to Aeroacoustics". Furthermore, an undergraduate course "Approaching Acoustics" was attended by 100 students from 18 countries. In the paper, the background and the motivation of this initiative is illustrated. Content, organization and future plans of integration in the European higher education in acoustics are discussed.

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### 1. INTRODUCTION

The Young Acousticians Network, YAN, of the European acoustics Association, EAA, includes various activities for networking of the members. A networking platform in the website of the EAA, FENESTRA ([www.euracoustics.org](http://www.euracoustics.org)), but also using various social networks such as LinkedIn, Facebook and Twitter, is actively used by more than 900 young colleagues such as students on Master and PhD levels. They communicate on various topics related to their higher education, research projects, acoustic technology and internships and jobs.

In 2010, summer and winter schools became a key component of EAA conferences in collaboration with YAN. The first EAA School was held in Ljubljana, Slovenia, in 2010 at the occasion of the 1<sup>st</sup> EUROREGIO conference, and it was organized as a summer school. As presented by Maffei et al. (1), "the structure was conceptualized as an event, where Master and PhD students of acoustics, as well as other young acousticians, can learn about a variety of new accomplishments in the field of acoustics in half day courses (3-4 lectures) or full day courses (5-6 lectures)."

The courses of the 2010 summer school mainly consisted of classical lectures on 7 topics, however, including elements of round tables and workshops as well. The lecturers were internationally recognized and distinguished professors and experts in acoustics. They were invited by the EAA board and technical committees.

In this paper the feedback and evaluation from the participants in the 1<sup>st</sup> EAA school (2010) is discussed and it is described how the 2<sup>nd</sup> EAA school (2013) was prepared and adapted to the needs, expertise and expectations of the participants. The school programme, and the results of the most recent evaluation are presented.

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## 2. Structure of EAA SCHOOLS

The 1<sup>st</sup> EAA Summer School for young researchers was a special feature of EAA EUROREGIO in Ljubljana, Slovenia, held from 13 to 15 September 2010. The programme of the 2010 summer school included seven courses with different topics, namely “Soundscape” (full day course), “Voice/Musical Acoustics” (full day course), “Building Acoustics” (full day course), “Hydroacoustics” (half day course), “Numerical Methods” (half day course), “Psychoacoustics” (half day course), “Ultrasound” (half day course). The first three courses were co-sponsored by COST projects (European Cooperation in Science and Technology). The other courses were sponsored by the EAA itself. Sponsoring included grants for free participation.

Young researchers registered for the summer school on the congress website indicating which courses they plan to attend (at least two courses of their choice). Further on, students enrolled in the summer school also attended the structured sessions related to the topics of the summer school during the next two conference days in order to deepen their understanding of the specific field of acoustics. The last day of the event was scheduled for written exams for the participants of all summer school courses. Eventually the participants received a certificate equivalent to 2 ECTS credit points including the experience gained in 2 courses plus the connected structured sessions.

In order to motivate young acousticians to participate in the summer school, EAA decided not to ask for any additional summer school fee, i.e. the registration fee for the congress includes also the participation in the summer school. Moreover, the EAA supported with grants the participation of a limited number of European young researchers and students in the EAA Summer School, as part of the First Forum of Young Researchers’ Network, YAN. The grant included free registration for the summer school and the congress.

### 2.1 Feedback from the evaluation in 2010

During the last day of the summer school the participants received a questionnaire for giving feedback to the EAA. 86 participants replied and gave very useful information for further establishing a sustainable process for improving the summer school content and structure. Among them were 3 undergraduate (Bachelor) students, 21 graduate (Master) students, 45 PhD students, 13 Postdoctoral researchers and 4 docents in acoustics. The median age was 28 ranging 23 to 39. The male to female ratio was 70% to 30%. The participation was distributed to different courses as follows

“Soundscape”	21%
“Voice/Musical Acoustics”	9%
“Building Acoustics”	30%
“Hydroacoustics”	4%
“Numerical Methods”	11%
“Psychoacoustics”	21%
“Ultrasound”	4%

The specific choice was explained in two ways. Some of the participants wanted to gain knowledge and experience in a new field, others preferred to go into deep details of their own field of work. 56% participants in the course in building acoustics did not find what they expected – fundamentals in buildings acoustics and corresponding standards and regulations. They commented that the content was too special, possibly too advanced and aiming too much towards future questions of psychoacoustics and noise effects in buildings. In contrast to that, in the course on numerical methods, the main comments was that the content was mathematically too advanced, while the participants expected more an introduction into the field.

It was stated that other topics would have been interesting as well, such as structure-borne sound, room acoustics, and audio signal processing.

The final grade the participants gave for the content was between “good” and “okay”, while they think that the course content was useful and the lecturers made a good to a very good job. The exam was considered as adequate. The participants were still unsure, however, how they could use the new knowledge in their daily work and studies.

### 2.2 Lessons learned for the organizers

In summary, the EAA summer school in 2010 was well accepted by the participants. They particularly liked the programme as a whole including all opportunities to meet fellow students,

colleagues and teachers from all Europe and aboard. They used the travel grant system very well and submitted good papers for the competition for EAA best paper awards. But there is also space for improvements. The main lesson learned for the EAA School organizers, however, is that for the diversity of participants a more specific programme must be designed. Students requesting fundamental courses must get a different course setting than experienced PhD students or Post Docs who like to get a demanding workshop-like offer focusing on their field of expertise.

### 3. Refinement of the structure - EAA Winter School 2013

Along the preparation of the 2<sup>nd</sup> EUROREGIO conference (Merano, Italy 2013) the second school was initiated in early 2012 and finally held in March 2013. A new structure of the school content was designed to take into account the large diversity of the audience. The coordinators were the three authors of this paper.

The Winter School for young acousticians was, again, organized and sponsored by EAA during the days before the EUROREGIO AIA-DAGA 2013 Conference on Acoustics. The Winter School was held at the Kurhaus (venue of the Conference). Included was also a sponsored social program with get-togethers, evening events and a lot of opportunities of “student meets expert”.

The main change compared with the previous EAA school was the separation into two kinds of audience: a) “Approaching Acoustics” for undergraduate students in the third year or for students in a Master program, and b) “Hot topics” for PhD students and young researchers that are already involved in acoustics studies.

#### 3.1 Approaching Acoustics

This was intended for undergraduate students in the third year or for students in a Master program. The idea was to teach young students the fundamentals of acoustics and to make them aware of the opportunities for a professional career in acoustics. Teachers are experts in the field, not only academic teachers but also professionals in acoustics with background in industry or consulting. The offer was open for max 100 participants. They registered at no registration fee and they had a free accommodation for 3 nights.

In 90 min each, acoustic fundamentals were briefly illustrated, and various fields of applications related to job profiles were introduced (Hearing, Measurements, Acoustic materials, Noise control, Room acoustics, Sound Design, Underwater Sound, Ultrasound, Musical Acoustics).

- What is acoustics? (Michael Vorländer, RWTH Aachen University, Germany): Fundamentals of vibrations and waves, plane and spherical waves, sources - directivity and power, reflections, diffraction and scattering, sound descriptors - the decibel and other quantities, ... and what to do with all that?
- Hearing (Steven van der Par, Oldenburg University, Germany): Human auditory system, physics and physiology of the peripheral auditory system, examples: use of masking models in low-bit rate audio coding and spatial audio reproduction over headphones using dummy-head recordings.
- Measurements (Peter Svensson, NTNU Trondheim, Norway): Transducers, calibration and frequency response, dynamic range, measurement uncertainty, measurement of transfer functions, or impulse responses
- Acoustic materials (Paolo Bonfiglio, University of Ferrara, Italy): Understanding and applications of elastic and porous material for noise and vibration control: Definition of acoustic quantities (sound absorption and transmission) and basics on wave propagation in elastic and porous materials.
- Noise control (Joachim Scheuren, Müller BBM and Chalmers University, Sweden): Noise limits, noise regulations and strategies towards noise mitigation in various examples.
- Room acoustics (Martijn Vercammen, Peutz Consultants, The Netherlands): Sound modes in rooms, wavefield models in room acoustics, sound absorption, geometrical room acoustics, statistical room acoustics, evaluation of room acoustics, areas of research, and example: design considerations for a lecture hall.
- Sound Design (Klaus Genuit, HEAD acoustics, Germany): Sound design is important for product sound design and soundscape. Practical applications of psychoacoustics and sound design can be found in the field of automotive industry.
- Underwater Sound (Michael Taroudakis, University of Crete, Greece): Historical facts on the use of sound in water, sound as an efficient carrier of information in water, applications of

Underwater Acoustics: commercial and non-commercial applications, environmental applications, marine bioacoustics, Forward and inverse propagation problems in the sea.

- Ultrasound (Juan Gallego Juarez, CISC Madrid, Spain): Ultrasound in numerous scientific, technological and medical areas. Application of low-intensity ultrasound (non-destructive testing, medical diagnosis, ...). Application of high-intensity ultrasound in material engineering and medicine.
- Musical Acoustics (Murray Campbell, Edinburgh University, United Kingdom): Fundamentals of sound generation and radiation, theoretical and experimental approaches.

The course ended with exams and final certificates.

### 3.2 Hot Topics

For PhD students and young researchers (under 40 years old) that are already involved in acoustics studies, five parallel courses on “Hot Topics in Acoustics” were planned for max 50 participants per course (the participants had also to register at the Conference, at reduced registration fees). Following is reported a description of the five courses in the same way it was announced in the website of the EAA Winter School.

#### **Course A.** *Cutting Edge in Spatial Audio* (didactic organizer: Franz Zotter)

Admitted: spatial audio is not an entirely new subject. Nevertheless research has been bringing forward big leaps and cutting-edge technology in spatial audio for the entire last decade, with many excellent experts contributing to research and development. We can bluntly say that today our understanding of spatial audio is unprecedented in many ways: we know much more about neural mechanisms of spatial hearing, experimental data are available that cover many relationships in great precision, and models of spatial hearing become more precise and applicable. On the other hand, we can demonstrate various high-quality sound reinforcement systems showing the power of binaural (headphone-based) or loudspeaker-based holophonic technologies, such as wave field synthesis and Ambisonics, or parametric audio coding methods exploiting psychoacoustic effects. Virtual acoustics rendering systems with room auralization are complemented by recording concepts such as spherical arrays with improved spatial resolution, distributed intelligent array technologies for audio scene transcription, and parametric audio coding for first order microphone arrays. The audible result is finally most relevant: profound evaluation of the various technical methods is currently being researched. It reveals where methods are most effective, and which combinations of technology could yield our research into an interesting future.

Lectures and fascinating audio demonstrations given by Piotr Majdak, Ville Pulkki, Craig Jin, Maurizio Omologo, Sascha Spors, Hagen Wierstorf, Florian Völk, and Matthias Frank.

#### **Course B.** *FEM and BEM : Computational Acoustics* (didactic organizers: Andrew Peplow, Martin Ochmann)

Many physicists and engineers are interested in the reliable simulation of processes using computational methods in which acoustic waves are scattered by obstacles with applications arising from many diverse subjects. Topics which are “live” in computational acoustics research today span a broad, subject and application, base which cannot be covered by these lectures. However we shall present a useful perspective of various modern methods that have undergone specific research previously and are now widely available to the researcher today. We shall also present new techniques in finite elements including methods which exploit the underlying physics to reveal a powerful scientific method for the study of noise and vibration transmission in waveguides. But for more general domains flexible discretization techniques for the solution of coupled wave propagation problems will be discussed. Here we have to deal with the tricky situation of non-conforming grids appearing at the common interface of two subdomains. We demonstrate the applicability of the discussed method for two practical examples in mechanical-acoustic coupling arising in vibro-acoustics and computational aeroacoustics. Boundary element methods have undergone significant growth in availability and use for researchers and engineers recently. Here we shall show how to extend the applicability of BEM as an integral equation formulation by using special Green’s functions and as a tool with applications in flow noise not normally associated to this method.

Lectures given by Andrew Peplow, Elisabetta Manconi, Manfred Kaltenbacher, Martin Ochmann, and Rafael Piscoya

**Course C.** *Synergies between Environmental Noise Control and Soundscape Approach* (didactic organizers: Jian Kang, Brigitte Schulte-Fortkamp. Co-sponsored by COST TD-0804 “Soundscape of European Cities and Landscapes)

This course will explore the development from conventional environmental noise control to soundscape approaches. Based on the EU COST Action on ‘Soundscapes of European Cities and Landscapes’, the course will cover basic concepts and understanding of Noise Control and Soundscapes, and health impacts through acoustic environments but also standards and guidelines, and practical examples concerning soundscapes.

The multidimensional Soundscape approach is emphasizing on the way the acoustic environment is perceived, experienced and understood by the individual and by society (ISO/TC 43/SC 1/WG 54). Moreover, it accounts for people’s concerns and integrates the exposed people as experts. The process of tuning of noise pollution or sound design with respect to the expertise of people’s mind is related to the strategy of triangulation of interdisciplinary data. Moreover, the Soundscape approach provides the frame work to integrate contextual and subjective variables to improve the respective Soundscape with regard to quality of life.

Lectures and practical examples presented by Brigitte Schulte-Fortkamp, Jian Kang, Dick Botteldooren, Peter Lercher, Luigi Maffei, Luis Bento Coelho, Truls Gjestland, Lisa Lavia, and Max Dixon.

**Course D.** *Understanding Musical Instruments in Theory and Praxis* (didactic organizer: Malte Kob)

This course will cover the generation, propagation and perception of sounds created by musical instruments. Lectures layout the basic principles of sound generation in wind instruments, string instruments and the human voice. For each instrument group appropriate methods for assessing different quality aspects relevant to players and listeners are presented and their principles and limitations are discussed. In the workshops participants will have the opportunity to apply their knowledge and to gather hands-on experience by measuring acoustic characteristics of musical instruments and the human voice. For air driven instruments acoustic impedance, pulse response and radiated sound are measured and it will be demonstrated how these results can be interpreted in a musical context to derive practically relevant characteristics like intonation, responsiveness and sound quality. For string instruments the bridge mobility will be measured and deflection shapes of the instrument’s body which correspond to prominent structural resonances will be identified. It will be shown how the modal structure is associated with the sound quality of the instrument. For the singing and speaking voice it will be demonstrated how usually invisible physiological characteristics of the Larynx can be measured or estimated and how typical voice disorders can be studied by computer simulation.

Lectures and fascinating audio demonstrations given by Malte Kob, Wilfried Kausel, and Lamberto Tronchin.

**Course E.** *Introduction to Aeroacoustics* (didactic organizer: Yves Auregan. Co-sponsored by the ITN Marie Curie “Silent Air Flows in transport, buildings and power generation- FlowAirS”)

Air flows are used to transfer heat and mechanical work in a large number of technical processes and systems distributed including ventilation systems in vehicles and buildings, cooling systems in laptops and engines, IC-engine, power plants, gas transportation, gas turbine intake/exhaust systems, etc. Frequently there is an associated generation of unsteady flow and pressure, which inevitably leads to sound generation. Sound produced by various airflow systems is responsible for an important part of community noise problems.

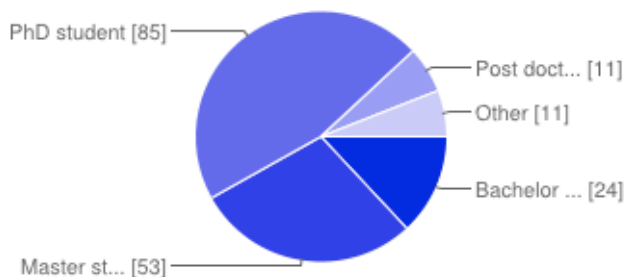
The aim of this course is to give an introduction to aero-acoustics from the basic concepts to some concrete applications. The course begins with an introduction to the fundamental equations and principles of aero-acoustics, including the concept of acoustic analogy. This is followed by a lecture on the propagation in flow ducts including the effect of silencers in presence of flow. A sequence will be devoted to the measurements technique. The second part will be dedicated to the acoustical sources induced by airflow. The first source will be the noise induced by vortices i.e. the whistling. The second source studied will be the noise induced by turbulence i.e. the jet noise. The last source will be the noise induced by the rotating machines.

Lectures given by Christophe Schram, Yves Auregan, Hans Bodén, and Mats Åbom.

### 4. Results and discussion

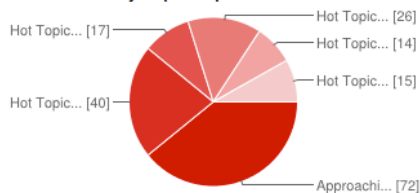
249 young acousticians participated in the EAA Winter School Merano 2013. This is a very big success, and it can be explained, at least partly, with the good information and registration provided through EUROREGIO, EAA and its member societies. The participation was distributed as shown in fig. 1. The age distribution is shown in fig. 2. It should be noted that these figures show only the distribution of the students that filled in a survey after the EAA Winter School was finished.

#### My level of education is...



Bachelor student	24	13%
Master student	53	29%
PhD student	85	46%
Post doctoral researcher	11	6%
Other	11	6%

#### What course did you participate in?



Approaching Acoustics	72
Hot Topic A - Cutting Edge in Spatial Audio	40
Hot Topic B - Computational Acoustics	17
Hot Topic C - Synergies between Environmental Noise Control and Soundscape Approach	26
Hot Topic D - Understanding Musical Instruments in Theory and Praxis	14
Hot Topic E - Introduction to Aeroacoustics	15

Figure 1 – Distribution of participants and in the EAA Winter School Merano 2013

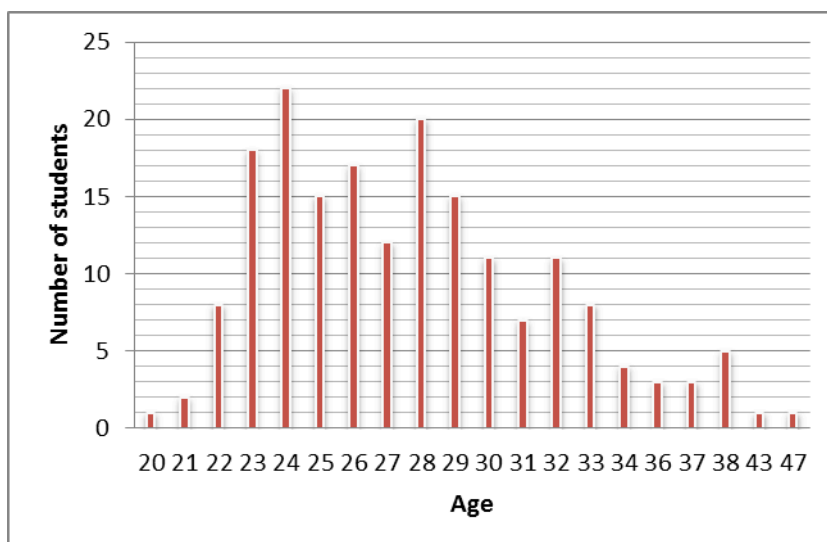


Figure 2 – Distribution of the age of the participants in the EAA Winter School Merano 2013

#### 4.1 Evaluation

A total of 184 participants filled the survey over 249 students attending the school. Generally

speaking, the participants were rather pleased with the whole organization of the school. Detailed answers can be seen in Fig. 3. A five point scale was used with 5 as “fully appreciated”. Best rated was the city of Merano chosen as venue for this event, and also the accommodation hotel offered without fees to the participants of the “Approaching acoustics” course. A very good average note was given also for the venue of the particular lectures. Less appreciated was the length of the school.

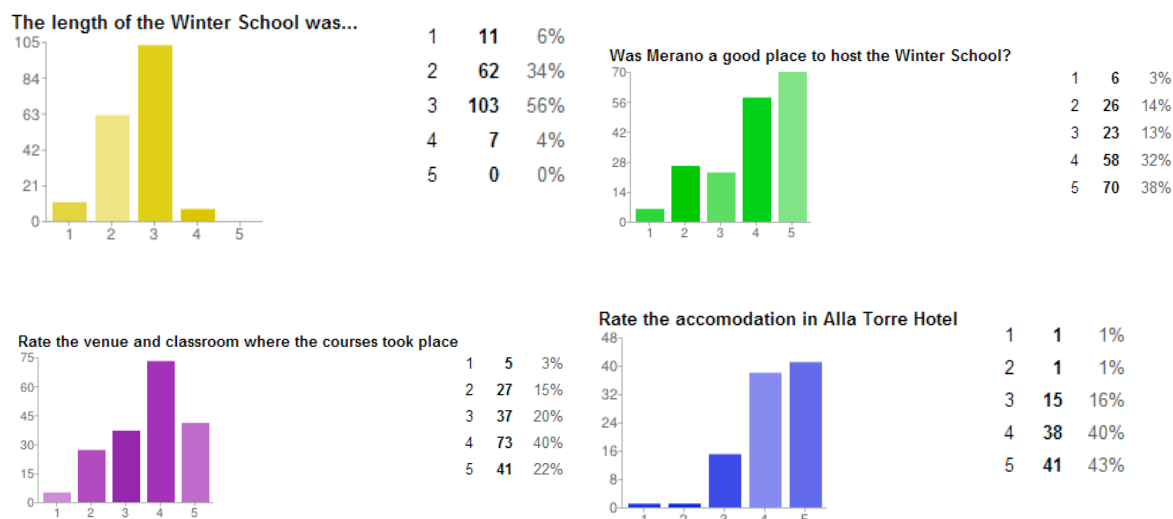


Figure 3 – Opinion about various organizational aspects of the Winter School.

All winter school courses were evaluated also in more detail regarding the following three statements: “The imparted knowledge applies to my actual studies”, “The course contents were useful for me” and “How challenging were the course contents?”. The participants had the possibility to give grades from 1 (bad) to 5 (excellent). It is interesting to note that almost all courses received an average grade of 4, thus still showing potential for improving. An example of evaluation results (relative to the “Approaching acoustics” course) is reported in fig. 4. Similarly, all courses were evaluated also against the following categories: clear contents, appropriate material provided, open to discussions, difficulty level, matching course contents. The evaluation notes ranged again on a 5-point scale from “not at all” to “very much”, and again the average result for almost all courses was 4, meaning “much”.

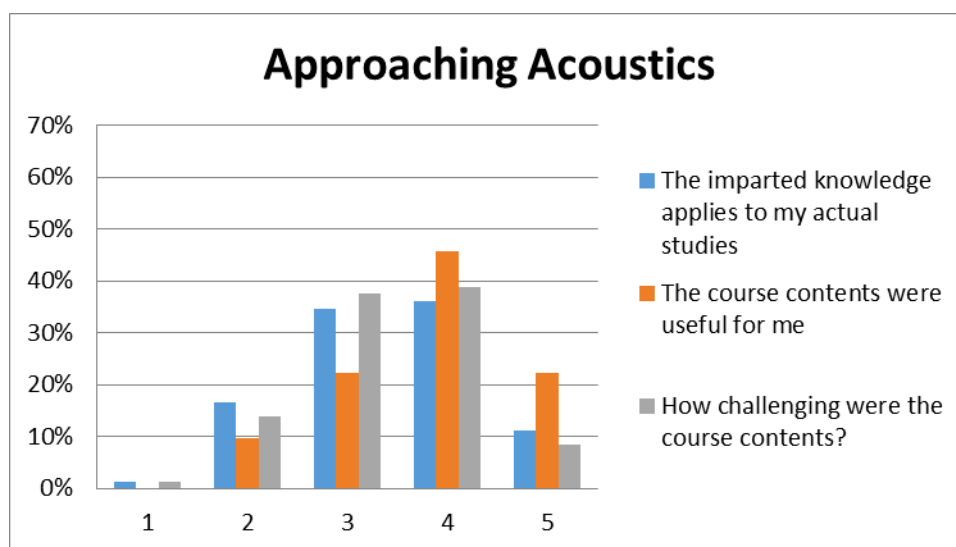


Figure 4 – Evaluation of results describing the contents of the “Approaching acoustics” course.

Particular suggestions received by the survey were mostly related to the form of lectures. Some participants asked for more practical examples and exercises to be included in the lectures, or that interactive workshops on some topics could be organized. Due to the tight schedule, the lectures were very concentrated and many participants would prefer an additional day for the school. Finally, suggestions were given about new topics in acoustics that could be the “hot topic” courses of the next EAA schools.

What is also very important for the YAN, that organized all social and professional events of this winter school, is that the YAN events were rated very high in terms of receiving interesting information, being useful for building relationships between participants, being amusing, but to a smaller extent also for being potentially useful for the professional career in acoustics. In the survey, many participants expressed their wish to receive all important information from YAN also via a Facebook page which was started just after the winter school and in the meantime became the most used networking platform of YAN.

## **5. CONCLUSIONS**

The European Acoustics Association Schools are only at the second edition. Nevertheless the number of participants coming from all European countries but also from America and Asia, the number of lecturers and the number of sponsors (mainly National Acoustical Societies and European projects managements) involved underline that this didactic initiative is already a success and the expectations for a third edition, planned in year 2016, are growing. This is also confirmed by the anonymous surveys organized among the participants after the schools.

It is opinion of the organizers that to keep and reinforce this success, the Schools should be organized on a regular time schedule (2-3 year time for example) and they should be strongly connected to an International Congress. In this case the merge between lectures and participants can be intensified and the didactic platform is much wider involving also research activities. Another key point of the success is the collaboration with the YAN and the evaluation and suggestions given by the young participants.

## **ACKNOWLEDGEMENTS**

The EAA Schools are a product of the European Acoustics Association that ideated the structure and sponsored the initiative but special acknowledgements go to the National Acoustical Societies of Slovenia (SDA), Italy (AIA) and Germany (DEGA) that supported the organization of the first two editions and to the Young Acousticians Network that contributed since the beginning with the enthusiasm of their members.

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