The 16th International Scientific Conference
eLearning and Software for Education
Bucharest, April 23-24, 2020
10.12753/2066-026X-20-080

# STUDENT ACTIVE LEARNING IN A TWO CAMPUS ORGANISATION

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***Abstract**: Higher education is facing disruptive changes in many fields. Students wants to have the option of learning anywhere, anytime and in any format. Universities need to develop and deliver to future students a complete learning ecosystem. At the same time universities are facing challenges such as growing costs and the pressure to give the students the knowledge, competence, skills and ability to continuously adapt to future job environments. As a consequence, many universities are investigating new ways of collaboration and sharing resources to cater to the demands of students, industry and society. An example of this collaboration is a new joint master between the two largest Universities in Norway: University of Oslo (UiO) and Norwegian University of Science and Technology (NTNU). In this paper, we present the lessons learned from almost two years of teaching and learning in the new joint master's programme, "Music, Communication and Technology" (MCT), between NTNU and UiO. This programme is a run in a two-campus learning space built as a two-way, audio-visual, high-quality, low-latency communication channel between the two campuses, called "The Portal". Moreover, MCT is the subject of research for the SALTO (Student Active Learning in a Two campus Organisation) project, where novel techniques in teaching and learning are explored, such as team-based learning (TBL), flipped classroom, and other forms of student active learning. Educational elements in this master, provides the student with 21st century skills and deliver knowledge within humanities, entrepreneurship and technology. We elaborate on the technical, pedagogical and learning space-related challenges toward delivering teaching and learning in these cross-university settings. The paper concludes with a set of strategies that can be used to improve student active learning in different scenarios*

***Keywords:** Two-campus learning environment; pedagogy; flipped learning; 21 century skills*

## I. INTRODUCTION

The first joint international master`s programme “Music, Communication and Technology” (MCT) between University of Oslo (UiO) and the Norwegian University of Science and Technology (NTNU) has now been running for almost two years. It is Norway’s first joint master’s programme, run by the two largest national universities, NTNU and UiO. The programme is hosted by the Department of Musicology at UiO, and at the Department of Music at NTNU.

One of the novel elements of the MCT programme is the wide adoption of cross-campus online synchronous teaching and learning activities. These are enabled and supported by the “Portal”, a physical-virtual space that serves as the main communication channel between the cities of Oslo and Trondheim, which are 500 km apart. The Portal can be described as a high quality, low latency, permanently connected, audio-visual link between the two cities. MCT facilities also include other dedicated rooms, equipment and infrastructure at each location and the networked infrastructure

between the locations. The networked connection between the locations is delivered by Uninett (the ICT infrastructure company for Norwegian research and education).

The Portal is the shared physical-virtual workplace in which students and teachers work together every day. All communication, collaboration, sharing of resources, development, research, testing and social interaction happens here. Since the Portal is the main classroom for the MCT programme, it is important to develop pedagogical strategies and evaluate the technologies from an educational perspective.

In this paper we first present the basic structure and elements of the MCT programme. Then follows a short presentation of the pedagogical strategies that are under development through the SALTO (Student Active Learning in a Two campus Organisation) educational research project. Finally, we elaborate on the technical, pedagogical and learning space-related challenges toward delivering teaching and learning in such a cross-university setting. The paper concludes with a set of strategies that can be used to improve student active learning in different scenarios.

## II. THE MCT MASTER'S PROGRAMME

The intention of the MCT programme is to give students the personal skills and technical tools required to work out solutions to contemporary societal challenges in international and interdisciplinary teams. In the programme, music is at the core, but the scope is larger. The programme strives at educating what we like to think of as "technological humanists", with technical, reflective and aesthetic skills. We believe that the solutions to tomorrow's societal challenges need to be based on intimate links between technological competence, musical sensibility, humanistic reflection, and a creative sense.

Collaboration in our global world must be sustainable. In order to reduce the environmental footprint of travel we must manage with fewer physical meetings, but without compromising the richness of communication between people. This is a fundamental motivation for the MCT programme.

Our students are as a rule collaborating in cross-campus teams, and often work on real-world problems in collaboration with organisations in the public or private sector. The aim is to use the knowledge and experience acquired to find solutions to the issue at hand, often in a totally different area than you would have imagined. It is our intention to let the students develop skills in interdisciplinary problem-solving and multicultural team-work, something that is in high demand amongst employers. The cross-campus setting also fosters students' skills to work in geographically distributed teams, with communication and management facilitated by Internet-based technologies. The students get hands-on experience with facilities including state-of-the-art audio-video communication platforms, motion capture systems, music production studios, physical computing toolkits, and loudspeaker arrays. The theoretical components include acoustics, music cognition, machine learning, human-computer interaction, high-level programming, audio digital signal processing, sound design and more. In order to solve real world complex problems it requires a team who possess different but complementary expertise and have the ability to work together on different levels to find a collective solution [1].

This unique high-tech learning environment and the focus on team-work and collaboration in a cross-campus setting, will on one hand develop so-called 21$^{st}$ century skills [2], [3]. On the other hand, it is an introduction to the 4$^{th}$ industrial revolution [4], which requires to prepare the students for the fusion between the physical, digital, and biological worlds: a transformative process which merges artificial intelligence (AI), robotics, the Internet of Things (IoT), ubiquitous computing, and other technologies. It represents a fundamental disruption to the way we live, work and relate to one another, and students need to gain the knowledge and obtain the abilities and competencies to change accordingly.

In order to fulfill our goals, the curriculum of the MCT master's programme has the following structure: 60 credits compulsory courses, 30 credits elective courses and 30 credits master's thesis.

### 2.1. Introduction course

The aim of the course is to provide a broad introduction to the core topics of the Music, Communication and Technology master's programme: acoustics, music cognition, audio digital signal processing, machine learning and human-computer interaction. To establish a baseline of common knowledge and practical skills to enable the student to perform collaborative work, ethical and aesthetic reflection and critical thinking.

### 2.2. Research ethods

Aims to develop the students' knowledge of and skills in various research methods, tools and issues in the field of music, communication and technology. These range from qualitative to quantitative methods, and from both artistic and scientific perspectives.

### 2.3. Entrepreneurship

Aims to develop theoretical and practical knowledge of the foundations of entrepreneurship and how they can be applied in practice. Through a combination of readings, exercises, and practical, action-based learning, students will practice identifying problems, developing solutions, and learn how to bring their ideas (both business and non-business) into life.

### 2.4. Portal

The students need to learn how to operate and maintain the Portal, the audio-visual communication platform connecting the two campuses in Trondheim and Oslo. The Portal constitutes a laboratory for network based collaboration, communication and experimentation. Here the students can develop, test and evaluate solutions, strategies and technologies, which can be used as a future feature of the Portal.

### 2.5. Applied projects

The aim of the course is to carry out a music technological project in a real-world setting with an external client. The problem at hand may be of a non-musical nature and will require the students to apply their music technological knowledge in new and creative ways. Furthermore, to work as a cross-campus team, with a complementary knowledge base toward a collective solution.

### 2.6. Elective courses

Contains small module courses within: Music-related Motion Tracking, Interactive Music Systems, Spatial Audio, Sonification and Sound Design, Music and Machine Learning and Audio Programming. These courses provide the students with many aspects towards the 4th industrial revolution, like development and experiments with interactive systems, IoT (Internet of Things), XR (extended reality), and the fusion between man and machine.

### 2.7. Master thesis

The Master's thesis is a research-based academic report based on individual research in the area of music, communication and technology. The topic of the thesis may be chosen by the student alone, in collaboration with the supervisor, or together with an industrial partner.

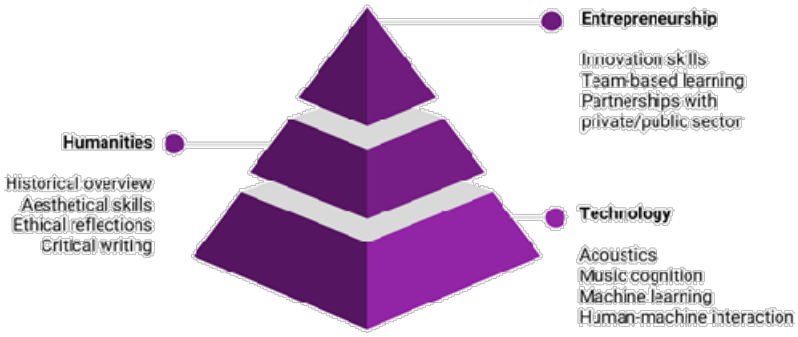


Figure 1

The MCT programme teach students to use and develop music technological methods/tools and reflect on how technology shapes human communication. Furthermore, to provide the student with a platform of interdisciplinary knowledge, literacy, skills and competences in order to take on complex societal challenges in multidisciplinary teams. (Figure 1)

## III. STUDENT ACTIVE LEARNING IN A TWO CAMPUS ORGANISATION

SALTO (Student Active Learning in a Two campus Organization) started in 2018 and is a 3 years project within the Norwegian University of Science and Technology's (NTNU) Teaching Excellence scheme. The initiative consists of a portfolio of development measures, with the purpose of developing innovative approaches to learning, teaching and assessment.

The SALTO project was set up in parallel to the MCT programme, as a resource to develop pedagogical tools and methods for MCT [5], but also to explore the possibilities of scaling and adapting the developed results to the future campus of NTNU. Furthermore, to use SALTO as an instrument to do surveys and data collections for research on cross-campus learning scenarios and finally to reflect on how these tools and methods work in a real-life cross-campus university teaching and learning (https://ntnu.edu/salto). In this paper we focus on two goals in the SALTO project:

1. extensive cross-campus collaboration and communication.
2. active student participation.

### 3.1. Extensive cross-campus collaboration and communication

The technology in and between the endpoints of the portal facilitates many layers of collaboration modes and ways of communication. It ranges from a low-latency, high-bandwidth and high-quality point-to-point audio-visual communication channel, to a mesh of IoT devices and sensors communicating with low speed and bandwidth.

For standard cross-campus teamwork students and teachers use Zoom as their main platform. Zoom is a flexible platform with many features for video conference, webinars, common work surface, and screen sharing. In addition to a basic set of communication tools available in the Portal, it is up to the students to bring their own devices. They should practice on existing technology in the Portal and evaluate new solutions, experiment with combinations of technologies to find the right tool for the specific job. Most of today's audiovisual communication solutions focus on simplicity and flexibility. This is necessary in a mass market in which the most important goal is to connect people with a large number of different devices (mobile phones, tablets, laptops, etc.). Such solutions may work well for basic speech communication and teamwork in a huddle space but does not provide the type of nuances experienced in communication between people being close together in the same space. They are also far from satisfactory for music performance and perception.

From our experience, the quality of the connection in a cross-campus learning scenario should be prioritized, when students work together in the Portal for a full day. A "low quality"connection reduces engagement and interaction. Students and teachers get tired from trying to grasp the details in an image, hearing what is being said. The technology creates a filter that degrades communication and hinder collaboration; hence the students turn passive.

### 3.2. Active student participation

The SALTO project is continuously developing strategies for cross-campus collaboration learning in the MCT programme [6]. The groups have members from both locations and they need to work together in the Portal to solve the tasks. The main focus is on three different forms of collaborative learning:

1. Shorter group projects with a duration of one week, aimed as a specialization in subject-specific topics. [7]
2. Problem-based learning [8] in the form of semester-long projects with external clients.

3. Operational groups with long-term responsibility for documentation, evaluation and development of the physical, methodological and pedagogical framework conditions for learning, communication and interaction in the Portal.

The latter function is particularly important for the operational capacity of the Portal, but also as a strategy for sharper reflection on the learning processes. This is, in fact a student-driven educational development project in itself, including hands-on-exercises [9] and a considerable element of technological innovation with the aim of optimizing the environment of the Portal into the optimal learning scenario. This is where "finding the right tool for the job" mentality is crucial.

Knowledge transfer in the MCT programme primarily takes place in the form of Flipped Learning [10]. This means that development, storage, and distribution of digital learning materials in various forms, will play an important role in the project, especially initially. Individual learning obtained by working with the digital learning material, must be followed up with joint student activities that stimulate engagement and reflection, in the form of discussions, group work and smaller projects. This section requires testing and concretization over time and will vary from subject to topic. Flipped Learning is in any case the preferred model in all theory subjects.

## IV. CHALLENGES

### 4.1. Student active learning

The Pedagogy-Space-Technology framework (PST) [5], [11], [12] is used throughout the whole lifecycle of the MCT programme, Portal and SALTO. In addition, we would like to refer to the extended version developed by TU Delft, which adds people and governance to the PST-framework.

In the design [13] and use of a cross-campus learning space to support student active-learning, we will encounter challenges on all the elements in (Figure 2), the TU Delft Governance PST model.

If we look at the student active learning per se, a reanalyzed summary [14] of two systematic reviews [15], [16] funded by the Norwegian Ministry of Education and Research, reveals that the most important barriers which prevents student active learning in HE, can be grouped in the three categories:

- Institutional inertia
- The quality of courses for teachers
- Academic leadership

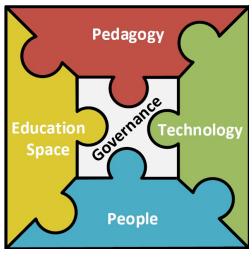

Figure 2

The easiest group to relate to is the quality of courses for the teachers. This is just the tip of the iceberg and beneath we discover that the teacher needs more help to overcome the barrier. The teacher needs time to prepare, knowledge of pedagogical principles, training in a broad range of technologies, and supporting resources to be able to adapt his course to be a successful cross-campus interactive session. In class, there is no technical support or backup solution for the teacher. If the technology fails during his session, it is too late to call support and send someone to fix the problem. Hence, the use of technology to mediate a cross-campus simple lecture or a more advanced student active session, can lead to cognitive overload for the teacher. The layers of technology need to be operated and interpreted. Images, sound, cameras, presentations, screens, chats and results coming in from response systems needs to be processed and integrated into the ongoing learning activity. A technical failure during the session, will often result in that the teacher feels that he failed to deliver and will rather go back to the old familiar way of teaching in a normal classroom, where he is the sage on the stage.

We will not elaborate more on these facts, but pinpoint that the transition to more student active-learning scenarios presupposes that teaching, development of curriculum and pedagogical methods, is perceived as teamwork with allocated resources. Types of resources can be exemplified by support with technical and pedagogical issues, scheduling and room reservation, training, production

and distribution of learning materials, related physical and technical infrastructure. In sum, a collaborative effort on many levels, anchored within the institutional leadership.

Indeed, these issues will appear in cross-campus and cross-university settings. Due to the fact that we get a new and often extended variety of organizational structures, cultures and institutional leadership, there will be a need to obtain synchronization and alignment of learning management systems, IT/AV/network management and security, routines and activities regarding equipment acquirement and financing, allocation of sufficient teacher and learning assistants with relevant training and not to forget student training, support and administration.

### 4.2. Technical challenges

The MCT Portal is a living lab, where technology testing, adaption, development and maintenance is a part of the daily activities. With an open mentality toward technology, no one is baffled or frozen, when the technology doesn't work as expected. The day to day challenges are solved within the Portal course or by the responsible group and teacher for each learning scenario. The main challenge is the technology and solutions depending on "external/out of the Portal" deliverances and remote assistance.

Connecting the two-University learning spaces together through the Portal is a challenge under certain circumstances. The learning spaces are 500km apart and the network between the locations is delivered by Uninett. But the connection first goes through the local infrastructure of each university, presenting different settings regarding security, packet inspection, firewalls, Quality of Service (QoS).

Currently the Portal is evaluating a standard service with a guaranteed 1 Gbit/s . Under normal circumstances such capacity would be sufficient, but in our case, we are running several systems in parallel. One of our systems might need 10-20Gbit/s to transmit a 4K video with audio. We are also strongly dependent on a low-latency in the transmission, to be able to play music together in the Portal, with musicians placed in both locations.

First, this is a financial challenge. It is possible to reserve a fiber with fixed latency and enough bandwidth, load balancing and redundancy. However, in the development towards a full functional Portal for the future, we need to find a way to utilize "normal" public networks and not order a special solution or configuration each time we are testing out new equipment or collaboration methods. In this process, we are working together with Uninett on many fields, to find optimal solutions. One example is the web-music project. https://vimeo.com/256379278

Secondly, at each location, we depend on the local infrastructure and the way it is configured. We need help to reconfigure switches, ports, dedicated networks for new equipment and to test connections. This is usually done by the local IT/network department. So, in the connection from the Portal room in Trondheim (NTNU to the Portal room in Oslo (UiO), there are three separate institutions involved on many levels, ranging from network configuration and measurements, security policies, QoS, service and support.

Therefore, every operation regarding the networked connections in the cross-University Portal, requires that time and resources are allocated and synchronized between all three institutions on the appropriate level. Other technical issues are usually solved as a part of the Portal course or in conjunction with preparations of other activities like concert, presentations, workshops, with the students and teachers working together.

### 4.3. Pedagogical challenges

The design of the different courses of the MCT programme is based on a range of novel pedagogical methods, including: Team-Based Learning (TBL) [17] active-learning [18] and flipped learning [10] . One of the major challenges is lack of time and resources for the teachers to:

- produce/develop/collect the relevant resources to build the curriculum and adapt it to the chosen novel pedagogical approach;
- make interconnections between the different programme components to create a uniform master education;
- understand the key elements of successful flipping and the link between pre-sessions and the direct face to face session with local and remote students;

- understand the basics of TBL and how to apply a Portal test, discussion, group work and peer review;
- run courses in the Portal and at the same time control several layers of technology to obtain interaction and feedback, shared workspaces and discussions between locations;
- attend relevant courses for individual development and train in the Portal;
- develop a common feedback/evaluation system for all courses and activities.

In some elective courses, we need to have teachers present on both locations, during the dedicated workshop hours. This is the case for workshops that handle highly specialized equipment, such as electronics for interactive music systems, the motion capture system, or ambisonic systems running on speaker arrays in both Portal rooms. The teacher role is in this learning scenario divided between doing local support and being a moderator for cross-campus student-led activities. This is not sustainable from an economical viewpoint but is needed in the process to refine and finalize the cross-campus pedagogical methods. The pedagogy should promote active students and provide the same learning experience for all students independent of physical location and teacher location.

### 4.4. Space challenges

The cross-campus learning space is a mixture of physical rooms, extended/joined spaces and virtual spaces. It will change function and "layout" depending on the cross-campus activity (the choice of pedagogy and relevant applied technology).

Defining, applying and using a learning space scenario, is a complex task. Decisions regarding flexibility, usability, time to set up and stability, are just a few factors that must be considered in every course or activity. In addition, the transition between spaces and related activities must be seamless.

The physical spaces at the endpoints of the Portal, are the major nodes in MCT and the place where students and teachers spend most of their time. It can be considered as a living lab, where students and teachers work together to explore and develop pedagogical, methodological and technical solutions. It is a creative and ever-changing physical space, but at the same time it might be demanding and tiresome to work in a messy space, cluttered with wires, microphones, loudspeakers and screens for longer periods.

The extension of the Portal toward the extended/joined and virtual spaces, is an important feature and provides us with a variety of options for collaboration, communication and resource sharing/distribution. However, it requires a good overview, a cross-disciplinary knowledge and training, to exploit the full potential of these resources in a cross-campus learning space.

## V. DISCUSSION AND CONCLUSION

The critical success factor is that the organization of cross-campus and related student activities needs to be anchored within the cooperating institutions, on all levels (Fig 5). Preparing all stakeholders: administration, technical support from AV/IT department, teachers and students. It is vital to provide information to the students about principles and guidelines for flipped learning, TBL and what requirements this place on students, in order to obtain engagement [19] and enhance cross-campus social and emotional learning [20].

Delivering the same experience for all students in a cross-campus learning scenario is the major goal. The students are our customers and their given feedback is crucial in the whole process of the design, construction, use, evaluation and improvement of a cross-campus learning space, with regards to the dedicated technology as a tool for the applied pedagogy.

As mentioned earlier the two major barriers for student active learning lies within the inertia of the institution and at the academic leadership. The third barrier is the lack of support to teacher development. However, there might be a fourth barrier which relates directly to:

- the dialog between the learners and teachers;
- the structure of the instructional program;
- the autonomy or the nature and degree of self-directedness of the learner.

These three complex factors and their internal relationships defines the Transactional Distance Theory (TDT) by Moore [21]. According to Moore a good "distance" learning environment should provide the possibility for dialog/interaction and have a good, but not too rigid instructional design model. In this case, Transactional Distance is a function of dialogue and structure. With more dialog and less structure, the transactional distance is low. With less dialogue and more structure, the transactional distance is higher. This theory should be taken into consideration in how to plan and achieve student active/centered learning in a cross-campus learning scenario [22]–[24].

### 5.1. Transfer value and scaling

In the Portal environment, the student and the teacher work together on finding and using the best technology for the learning scenario. Hence, there is technical evaluation, support and help within the group. This continues refinement of "technology vs usefulness" is a scalable element that can be applied as a building block for larger cross-campus settings. In the Portal the students are active participants in their own learning by hands on experiences, trying out and building physical (room) setups, choosing technology and evaluating the related pedagogy by writing blogs, reflections, filling out questionnaires before and after courses. In many ways the elective courses are hybrid, where student-centered learning is achieved through a blended learning space (Portal) with online and experiential activities.

### 5.2. Conclusion

Cross-campus education is now a real possibility due to technology. The technology can connect students, teachers and resources over long geographic distances. The number and variety of courses can increase and provide the students with more options. Collaboration, communication and interaction between locations brings new possibilities and hopefully some synergy effects, but also new challenges.

The overall goal is from an economical and institutional viewpoint is to save resources by having one teacher running a course for a bigger number of students distributed across several campuses. In the transition from teaching one local class, to teaching in a "multi-class" with local and remote students in a cross-campus scenario, many considerations and measures must be considered. It is not just about the quantity of students and courses covered, but also about the quality of the deliverance. Many factors influence the process of creating a large scale functional cross-campus organization [25]–[27].

Not all learning scenarios from the Portal can be ported directly to a large-scale cross-campus setting and solve all challenges. In this process, the MCT-master and SALTO contribute with a focus on the small details and qualities that build a good cross-campus learning environment [5], with active students and teachers working together in a small controlled environment within a research-based learning space. Furthermore, we are in front of technological development and hence we are in the position to describe the future needs for an infrastructure regarding capacity, traffic patterns and services that are required. The scalable results from our research and gained experience, will be a valuable contribution in setting the standards for future cross-campus learning scenarios.


### Acknowledgements

This work was partially supported by the NTNU SALTO project (80340480)


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