INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
10-11 SEPTEMBER 2020, VIA DESIGN, VIA UNIVERSITY COLLEGE, HERNING, DENMARK

Developing an Online Course in Computer-Supported Collaborative Design (CSCD)

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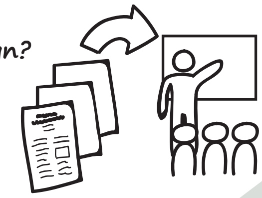
Developing an Online Course in Computer-Supported Collaborative Design (CSCD)

In this visual paper, the process of developing an online short course in CSCD is described. The requirements of successful CSCD in education were found in the literature and were used to create an offline workshop to prepare students for Global Design Projects. Gaps in students knowledge on CSCD were identified and addressed through iterations of the workshops. After five iterations the class was transformed to an online course to allow more students to engage.

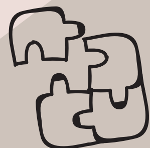
Why do we need an Online Course in Computer-Supported Collaborative Design?



Knowledge shared in the literature often does not make its way back into the classroom

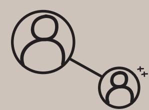
Students benefit from the latest technologies which they are familiar with in there personal lives

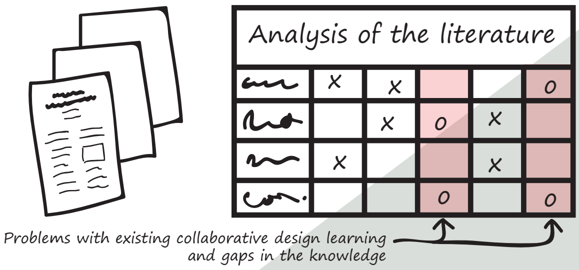
Students can best understand there digital literacy requirements and build on them in a safe environment

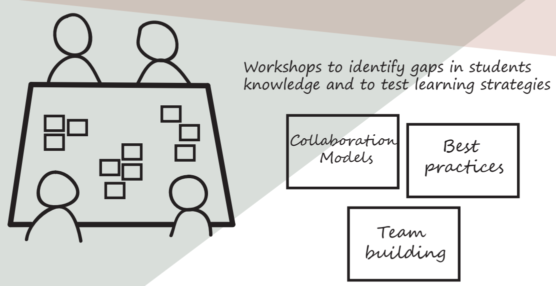


In addition to participation, students can meaningfully reflect on there interactions with other team members

Support educational theories such as Active Learning considering skills building as well as subject knowledge building and sharing the responsibility for learning







An Introduction to CSCD
In the first class students are encouraged to discover different technologies which may support there classes and engage in global communication

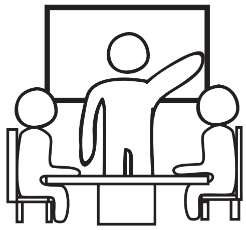
Collaboration Models
In the second class students are introduced to models of collaboration and are asked to reflect on successful collaboration endeavours

The CSCD Matrix
In the final class students are introduced to a matrix which supports technology selection for global collaboration projects.

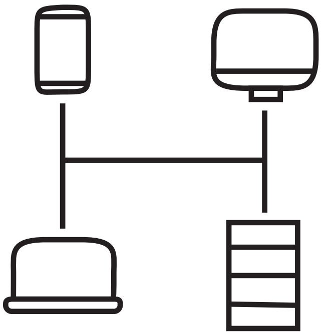
What is CSCD?

The research area of CSCD is concerned with supporting a teams design process. "Computer-supported" refers to the application of computer technologies, hardware and software, between several parties and usually but not always in distributed locations (Brisco et al. 2019a). CSCD enables concurrent design to support multidisciplinary teams who are responsible for the entire product life-cycle (Shen et al. 2015). CSCD can be conducted across boundaries such as companies, geographies and time zones (Borsato et al. 2015).

The CSCD architecture uses multi agent nodes which can be modelled and simulated based on existing design process knowledge. This work has implied product design quality and market competitiveness (Dong et al. 2010).



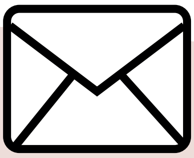
HSU (2013) deduces that CSCD can be analysed in two categories from two perspectives: usage and cost. Within an educational environment students tend to opt for free options, and so the greatest hurdle seems to be educating students on the importance of the technologies they choose to use and the factors which influence usage. This visual paper documents the development of a online class which aims to fill this gap.



The factors which influence the success of CSCD projects are closely linked with a design activity related to Human and technological factors and wither they positively or negatively impact the available knowledge and resources available to the activity (Brisco et al. 2018). CSCD development has mostly been in a design context such as industrial design, engineering design or product design, however lots of work and cross over potential has been observed in computer science journals exploring CAED and CIM systems with additional and advanced functionalities (Li et al. 2011, Ane et al. 2011).

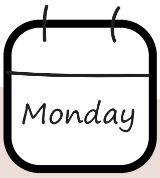
Where Product Life-cycle Systems (PLM) have found popularity as rigid packages usually sold with Computer Aided Engineering Design (CAED) and Computer-integrated manufacturing (CIM) systems, CSCD systems have remained modular (Xu et al. 2010). CSCD systems can be well defined within specific companies but they tend to be tool-kits where newer technologies can be swapped out for newer ones. The system itself offers capabilities beyond the scope of any individual software system which it contains (Shen et al. 2015).

How do we typically facilitate CSCD?



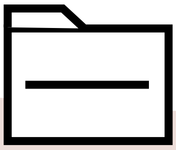
Email

Email is the most common tool used in industry to communicate digitally, however, students do not tend to use Email within an academic setting. Email has developed from a basic text sending and receiving service to include dynamic multimedia packages using HTML and attachment protocols. Email programs have developed to include functionality to display enhanced multimedia directly on them including images, videos, Gif's, 3D CAD, audio, calendar invites, contact information and others.



Shared Calendar

Using a shared calendar can assist in informing a team on the members schedule and indicate times when they may be busy, or finding common times where team members can meet. Calendar systems are usually integrated into Email platforms which enables ease of management. Stand alone platforms can be used to share information on availability when the team member perhaps doesn't want to share there entire availability.

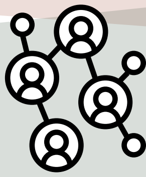


Shared Storage

Teams need to be able to share documents with each other. In a distributed environment a shared storage space offers immediate access to knowledge when required. Systems can be privately hosted by a company for security and speed, or on a cloud service for flexibility and easy access from anywhere. Shared storage can include functionality to save different versions of a documents history.
Advanced shared storage spaces enable live document working by multiple team

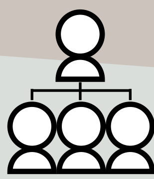
Video/Audio Conferencing

Video and Audio conferencing can enhance conversations where text based methods end. These methods offer the ability to convey language nuances, body language, but are not as complete as in situ face to face meetings. Audio conferencing typically uses phone lines to connect, but not always, and Video conferencing uses the Internet to communicate but can use other means. Advanced conferencing software can use shared screens or whiteboards, Polling and non verbal communication methods.



Social Network Sites

In an education environment, Social network sites and messengers which are linked with them tend to be the most popular communication methods for students. In addition to private team communication they offer the ability to send and store multimedia, notify of the latest information, tag team members for input and polling of opinions. Social Network sites integrate with a students personal and social communication for greater awareness in personal time and more opportunities for opinion sharing.

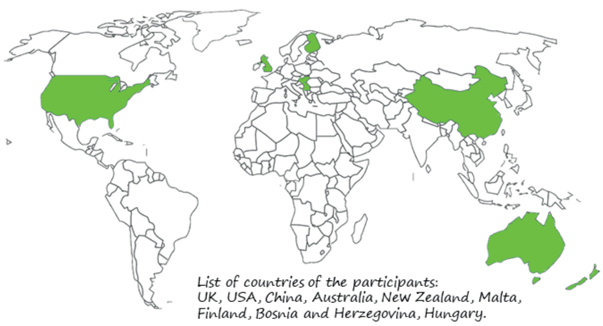


Group Management Tools

Many group management tools have emerged in recent years to merge social network site functionality (web 2.0) with professional team tools. Similar to Social Network Sites, team members have greater awareness of others work through regular sharing, tagging and notifications of completed work.
Advanced Group management tools may also include integrated storage solutions, conferencing, calendar scheduling and messaging for an all in one platform.

Teaching Global Design?

The Global Design Project



Description of the class/projects:

The Global Design Project aims to introduce tools and practices necessary to complete the design of an artefact in a distributed and culturally diverse environment. The hands-on experience highlights the real issues of sharing and communicating design information with technological constraints. Students from across the participating institutions are mixed in teams of 6-8.

The project brief typically requires teams to undertake the development of a product of moderate complexity but with scope for innovation in configuration and interaction. Over the course of 8 weeks, teams are expected to move through the ideation, evaluation and prototyping phases to deliver a design solution. A series of lectures across the participating institutions provides background information on management, culture, information technology, and design methods.

Academics involved:

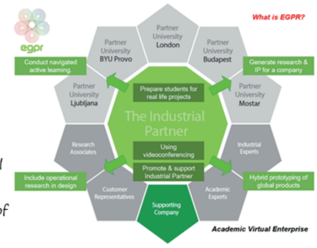
University of Strathclyde, City University of London, Stanford University; Olin College, Tongji University, Swinburne University of Technology, University of Canterbury, University of Malta, Turku University of Applied Sciences, University of Mostar, Budapest University of Technology

Number of students involved per year: 50 - 70
Years running: Since 2006

The European Global Product Realisation

Description of the class/projects:

Each year participating Universities and an Industrial partner form an Academic Virtual Enterprise of EGPR. Students are distributed in international teams of 8 formed by couples from participating partner Universities. The main communication comprising educational activities and project tasks is preformed through video-conferencing and other synchronous and asynchronous means of communication. The design process model applied in CODEVE originates from the model of Pahl and Beitz, but is extended and adapted to suit the fuzzy front end of design projects performed in academic virtual enterprises.



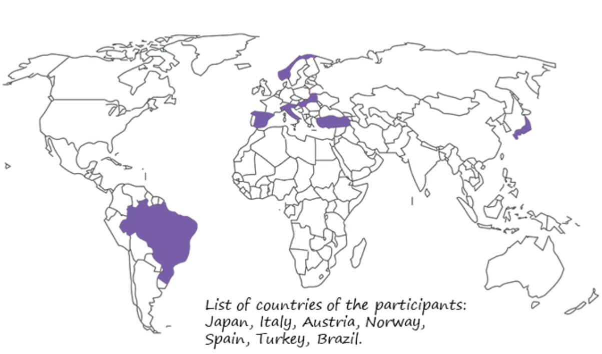
The extensions are related to creating a vision and implementing design research methodologies at the start of the project, blending phases of embodiment and detail design as well as bringing students for the first time in the final week long workshop at the end of 4 months process , which is aimed to culminate with the working prototype and public presentations of the products. The students are encouraged to perform conducted navigated active learning and include operational research in design process.

Academics involved:

Prof. Joze Duhovnik, Ljubljana Uni, Slovenia
Prof. Dorian Marjanovic, Uni. Zagreb, Croatia
Prof. Paul Xirouchakis, EPFL, Switzerland,
Prof Imre Horvath , TU Delft, The Netherlands
Prof. Peter Horak, BMU, Hungary
Prof Ahmed Kovacevic, City, London, UK
Prof Safet Isic, Uni Mostar, Bosnia and Herzeg.
Prof Bryan Howell, BYU, Provo, USA

Number of students involved per year: 28 - 48
Years running: Annually from 2002 - 2019

The Global Studio



Description of the class/projects:

The Global Studio projects themes (such as: re-imaging a folklore, gift giving and festivals) are selected to facilitate and provide the scope for the involved students to explore local believes and assumptions and to allow them to suggest 'playful' solutions. The projects will provide students with a number of learning experiences such as:

- Designing with others (cross-cultural communication)
- Designing for others (designing for other cultures)

During the collaborative international project the students undertake dual roles of: clients and designers. As the 'clients' they will commission 'designers' a design solution and vice versa they will be commissioned to design solutions by their counterparts.

The table below outlines the key 5 stages and associated outcomes and activities performed by students for each roles at each project stage.

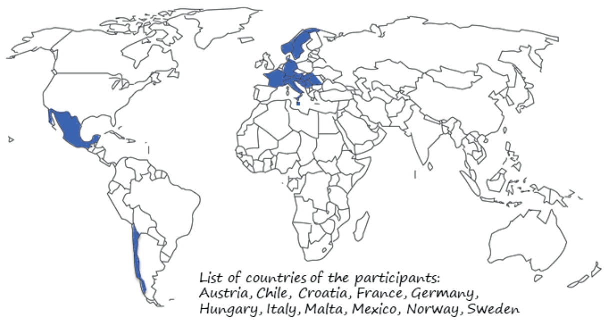
Stage	Outcomes	Designer	Client
1	Design Brief	Clarify	Research/Write
2	Design Concepts	Develop	Evaluate
3	Detail Design	Embodiment design	Evaluate/Clarify
4	Prototypes and Testing		Build and Test
5	Presentation		Feedback (Reflection)

Academics involved:

Yusuke Ashizawa, Shibaura Institute of Technology
Minami Tanaka, Shibaura Institute of Technology
Barbara Balbi, Università degli Studi Suor Orsola Benincasa
Francesca Nicolais, Università degli Studi Suor Orsola Benincasa
Ruth Mateus-Berr, University of Applied Arts Vienna
Erik Bohemia, Oslo Metropolitan University
Mabel Isabel Rodriguez, TECNUN-University of Navarra
İrem Dilek, Middle East Technical University
Harun Kaygan, Middle East Technical University
Pınar Kaygan, Middle East Technical University
Fernando Souza Ferreira, Federal University of Rio Grande do Sul,
Júlio van der Linden, Federal University of Rio Grande do Sul
Fabiane Wolff, Federal University of Rio Grande do Sul

Number of students involved per year: 60 - 250
Years running: Annually since 2006

Integrated Product Development International Summer School



Description of the class/projects:

The International Summer School on Integrated Product Development consists of the spring week in Malta, the autumn week in Germany or France, and the students project work between these two weeks.

Contents of the Spring Week

- Participants' scientific work presentation (with feedback from all).
- Lectures from science and practice on IPE, IDE, DfX, future technologies.
- Learning & discussions from different perspectives of the product life cycles.
- First personal coaching of each participant by all Summer School supervisors.
- Team building, tasks elaboration, projects initialization, start of the project works.

Project work between the two weeks:

- Participants work in mixed teams on the agreed projects.
- Preparation of a poster and a YouTube video for presenting the project results in the Autumn Week

Contents of the Autumn Week:

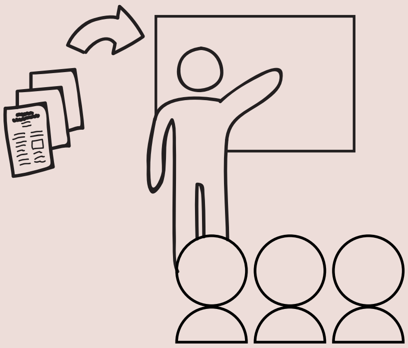
- Project results presentation and its preparation for presentation at a scientific congress.
- Lectures on business planning and entrepreneurship, performance recording, Int. Prop.
- Notes on how to preform scientific work (e.g. grant application, writing a thesis)
- Second personal coaching of each participant by all Summer School supervisors

Academics involved:

Prof. Dr. Julie Le Cardinal, CentraleSupélec Paris
Prof. Dr. Kristin Paetzold, Univ. der Bundeswehr Munich
Prof. Dr. Jonathan Borg, U Malta
Prof. Dr. Benoît Eynard, Univ. de Téchnologie Compiègne
Prof. em. Dr. Sandor Vajna, Univ. de Magdeburg

Number of students involved per year: 8 - 14
Years running: Annually since 2014

Why do we need an online course in Computer-Supported Collaborative Design?

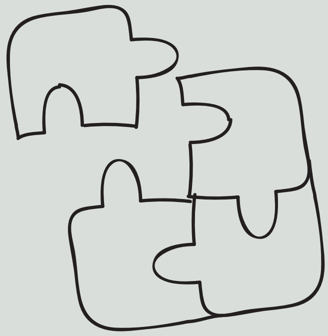


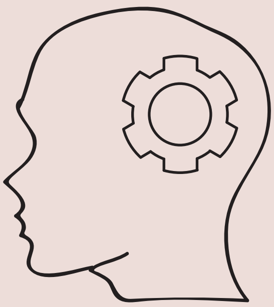
Knowledge shared in the literature often does not make its way back into the classroom

Brisco et al. (2019b) demonstrated that there are many gaps in students knowledge. Students at workshops across two institutions took part in workshops in 2016 and 2017. Participants were tasked with identifying the challenges of CSCD and solutions to these challenges. Solutions were identified for only half (9 out of 18) of the challenges. Similarly, solutions to problems were identified as good practices but students could not identify which challenge these solved. There seems to be a disconnect between publications on the topic which highlight challenges in CSCD or good practices for CSCD, and the knowledge which is being conveyed to students.

Students can best understand there digital literacy requirements and build on them in a safe environment

It has been identified that gaps in a students digital literacy with Web 2.0 technologies has an impact on the students ability to participate in distributed project work (Bohemia and Ghassan 2012). This also translates to the academic staff to support these types of classes. Then, there needs to be an understanding by students of there current digital readiness level and how they need to improve. This contributes towards a students future career, as greater emphasis is being placed on teamwork, technology and globalisation (Andert and Alexakis 2015).



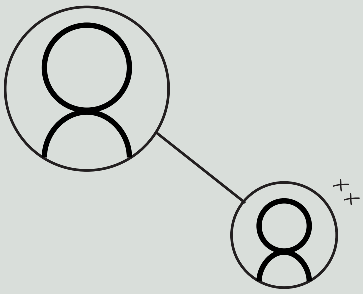


In addition to participation, students can meaningfully reflect on there interactions with other team members

Reflection is a large part of a good educational experience (Thornton, 2013). And a particular skill to be developed by students in reflective thinking and reflective writing (Grierson, 2010). Within a team, students have the ability to discuss and revisit topics which help to develop the design. But this is not only for an educational advantage but within real world engineering companies. Reflection is a major part of an engineers training within a company, as there is a relationship between reflection and design performance (Tang et al. 2012).

Support educational theories such as Active Learning considering skills building as well as subject knowledge building and sharing the responsibility for learning

Active learning strategies stem from a focus on how students learn in comparison to what they learn. The strategies active learning promote are useful during team activities to encourage self learning within a team environment. Engineering work tends to be multidisciplinary and then requires the skills to engage in these types of projects which an educational environment can prepare (Ledwith et al. 2017). When students are within a team environment they have to rely on self learning in research of the topic and this means they take a share of the responsibility to learn (Kinzie and Kuh. 2004).



Following the justification for an online class in CSCD, the requirements of the class were derived from the literature and developed through iterations of workshops with students on the challenges of global collaboration to identify gaps in student knowledge. Best practices were determined and an LMS was discovered which meets the requirements of the class.

Support the exchange and development of ideas, artefacts and documents

1.1 Capturing design work
1.2 Ability to easily switch between ideas
1.3 Ability to utilise artefacts to support ideation
1.4 To support the transformation of ideas into concepts
1.5 Ensuring conversations are complete
1.6 Allowing for the recoding of modifications to the artefact
1.7 Support understanding through annotations onto existing artefacts
1.8 Supporting problem solving activities

Gopsill et al. (2013) report on the importance of the ability to capture design work using CSCD technologies by collaborative engineering design teams. This must be the capture of the "right dimensions", meaning the work that is appropriate for the development of concepts. This requirement is linked with searchability, retrieval of design work and awareness of the work uploaded by design team members to CSCD technologies. These requirements are integral to CSCW research to ensure all team members have access to the information they need when they need it and in the correct format.

When engineering design teams engage in ideation tasks it is suggested that they need the ability to easily switch between ideas. This relates to the functionality of CSCD technologies used by engineering design teams and the awareness of teams as to the current topic of discussion. Herrmann et al. (2013), also discusses the role that individual and group thought has in the ideation process and how it should be easy for team members to frequently switch between these two states.

On the topic of ideation, the artefacts which have been captured on CSCD technologies must in some way be utilised to support ideation and drive the project progress (Gopsill et al. 2013). An artefact can be an image, video or a piece of descriptive text for example, which represents an idea, design change, or design decision. It can act as a focal point for aspects of the design allowing team members to discuss specific features of a concept aided by a visual representation. CSCD technologies have the potential to support ideation through iterative development using multi-threaded conversations and drive the project through greater awareness functionality. In addition, CSCD technologies must allow for artefacts to be modifiable (Gopsill et al. 2013) and allow for mark-up using annotations (Iacob 2011) both of which can be achieved with CSCD functionality of multi-threaded communication and tagging. Although the artefact acts as a focal point as stated before, it can be altered changed and updated iteratively to document the development.

Fruchter et al. (2010) suggest that problem-solving activities can be improved with the exchange and development of ideas using CSCD technologies as it builds a common ground for team members to share. Exploration of a problem as a group introduces common discussion and drives "convergent design thinking".

Hansen & Dalsgaard (2012), discuss a role of technology to support the transformation of ideas into concepts. This involves the generation of ideas and the use of design material to support this. In a typical design studio environment, work is completed synchronously with all available team members. CSCD technologies can connect team members asynchronous and the capability to allow design work to be conducted on the team member's terms. Ideas can be transformed at any time and with greater opportunities for input from all stakeholders.

When design team members discuss a problem, it is useful for that conversation to be marked as complete once decisions are made. This ensures that team members are aware of how the project intends to progress. Completed conversation act as an agreement of the work that needs to take place and an indication that no further action is required (Xie et al. 2010).

Support reasoning and discussion of design decisions

2.1 Encourage frequent decision making
2.2 Encourage opportunities to share opinions
2.3 Documenting the decision making process
2.4 Allow all to propose design change
2.5 Support the implementation of design change
2.6 Allow the asking of closed questions
2.7 Allow opportunities to negotiate
2.8 Provoke reflection on the design work
2.9 Allow ranking of ideas and concepts

Team members require a forum to allow them to share their opinions (Cho & Cho 2014). CSCD technologies can ensure team members are able to share their opinions in an easy way and inclusive of all team members' needs and confidence levels, without giving precedence to any team member. In addition, all team members must have the ability to use the CSCD technologies to suggest design changes (Hansen & Dalsgaard 2012).

During the design process, problems and solutions can come from any team member focusing on any aspect of the design, so it is important to give all team members the same importance. This includes the ability of the technology to support negotiation (Cho & Cho 2014; Fruchter et al. 2010) between team members.

Engineering design teams require the ability to rate and rank concepts (Iacob 2011). CSCD technologies can support this by ensuring it is easy for team members to engage in design meetings and activities including liking images and inbuilt voting mechanics.

In order to encourage discussion, Fruchter et al. (2010) suggest that it is important for engineering design teams to make frequent design decisions. This practice helps to build a common ground between team members who are aware of the current work and "accelerating the execution of action requests". In addition, it is important for design decision-making process to be well documented throughout (Hansen & Dalsgaard 2012) to ensure teams have access to all the information they might need and are aware of the progress of the project. Once decisions are made, it is important that the technology supports the ability of the team members to implement these changes (Hansen & Dalsgaard 2012). Teams need to have a system that can rapidly adapt and change depending on the needs of the project – the environment they use has a great impact on this.

Fruchter et al. (2010), suggests that the ability to ask closed questions is essential in design teams. Both for productivity to ensure definitive answers for the decision-making process, but also to progress the concept development and reduce future problems with miscommunication and misunderstanding.

When working in collaborative engineering design teams, it is important to take some time and reflect on the work. CSCD technologies have a part to play in supporting this (Hansen & Dalsgaard 2012) through awareness of conversations after the fact and notifications of updates to artefacts.

Supporting collaborative design activities

3.1 Support collaborative discussion within and out with the design team
3.2 Support co-construction activities
3.3 Integrate communications features within design software

Iacob (2011) and Gopsill et al. (2013) identify the role of technology in supporting collaborative discussion between design team members and stakeholders outside the core design team. It is important to include the right people in the discussion and CSCD technologies offer multiple communication methods and functionality to ensure this can take place. In addition, CSCD technologies offers opportunities to discuss issues in an informal and convenient way.

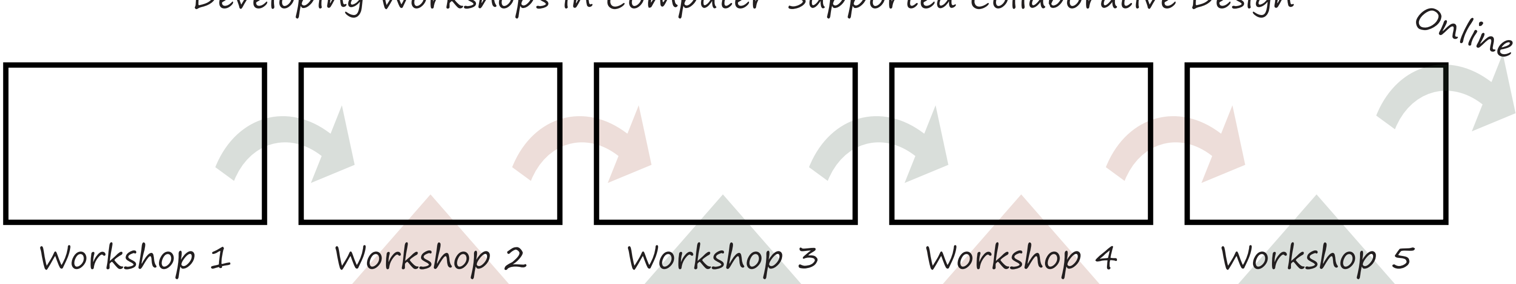
Rapanta et al. (2013) report on the capabilities of using technology to support co-construction activities. CSCD technologies can offer this by networking team members together and offer multiple communication methods to support discussion. This relates to the group's familiarity with the technology and willingness to adopt tools to ensure best practices.

Teams have demonstrated the benefits of having communication technology integrated within design software. This has been the case for example in studies integrating video-conference functionality within CAD software. Iacob (2011) and Horváth (2012) suggest this encourages more frequent discussions about specific design issues. Integrating CSCD technologies into design software has the capabilities to encourage this also.

The literature above formed guidelines for successful CSCD from literature featured within the diagrams. These were presented at the first of five workshops. As iterations of the workshops were conducted the guidance were updated. Where gaps in the knowledge were identified and reintroduced to the next cohort of students.

The workshop asked groups of students to consider the challenges of global collaboration and how they might use technology to overcome these challenges. After a short introductory lecture based on the guidelines found in literature, students were asked to form groups and pick there top three challenges and top three solutions to the challenges. The first , third and fifth workshop involved students of the Global Design Project class at the University of Strathclyde and the second and forth workshops include students of the global studio class at Loughborough University.

Developing Workshops in Computer-Supported Collaborative Design



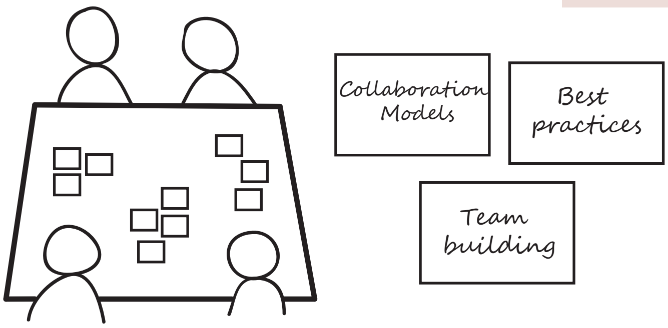
Current issues with Student distributed design projects

Expectations of the project and equal contribution
Encouraging debate and democratic decision making
Cultural differences
Sharing rationale
Choosing appropriate technology
Finding documents
A common understanding for the problem
Different levels of competence

File Type compatibility
Misunderstandings and misinterpretations
Clarification of requirements
Connection issues
Respect for others personal lives and work load
Information lost in translation
Team synergy

Building trust in a small amount of time
Lack of commitment
Skills gap
Lack of consequences
lack of leadership
Lost communications

Assessment of team member skills
Giving up control
Aligning to the strengths of the team
Different models of collaboration

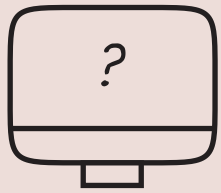


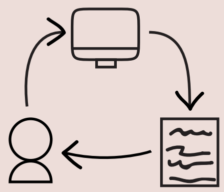
The top 10 best practices formed the basis for the online class Learning outcomes

1. Use an evaluation method to select best technologies, and not based on popularity.
2. Consider how collaboration challenges might be overcome ahead of the project.
3. Be critical of technologies and practices, test and change them as required.
4. Choose a limited number of technologies to keep communication simple.
5. Support all communication methods required and for all devices used.
6. Support for required functionalities throughout the project.
7. Awareness of other team members work to demonstrate competency and trust.
8. Team protocols of storing and sharing knowledge need to be agreed.
9. Team expectation need to be discussed and agreed.
10. Team roles should be assigned to ensure recording of data and regular communications.

Online class host

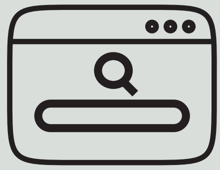
As the students involved with the Global Design Project class were studying at different institutions around the world (University of Strathclyde, University of Malta, University of Canterbury and University of Turku), there was a need to find a common educational platform or Learning Management System (LMS) where students could engage in the content.

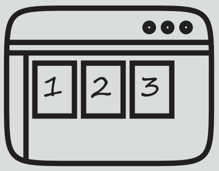




At the University of Strathclyde, the LMS is named Myplace and is a highly customised version of moodle. A first draft of the class was created using Myplace, and although it would be possible to add external students to the platform this would be a high administrative task for the staff of the class to manage. Instead external systems to the university were researched.

LMS such as Edmondo, Google Classroom, Moodle and Blackboard were tested to find out if they had the required features and functionality. Moodle and Blackboard require personal hosting and a major investment in setup. Edmondo and Google Classroom was not able to offer the ability to self enrol in a class and to create lessons which the user could engage in their own time. After further searching, NEO (neolms.com) was found and offered a simple setup and self enrolling features required. A class could be created for the Global Design Projects class and a link could be shared to self enrol reducing excessive administration.

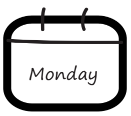




The features of NEO which made it suitable for the class were:

- The ability to have a self contained class with multiple lessons
- Self passed lessons which students could engage in their own time
- Functionality to support Wiki style forums for class discussions
- Advanced multimedia functions for video integration
- Surveys and Quizzes to poll student opinions and test recall

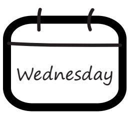
Format of the Online course

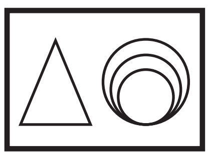


An Introduction to CSCD

In the first class students are encouraged to discover different technologies which may support there classes and engage in global communication.

- Introduction to the features and functionality of NEO through self exploration (Introduce yourself activity).
- Introduction to CSCD, typical CSCD technologies, their use and importance for education and enterprise applications.
- Posing questions about the use of CSCD in global design.
- Question "What are the challenges you may face during the project?"
- Link to ID cards for good communication (Evans et al. 2011)

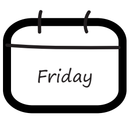


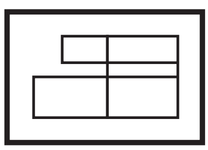


Collaboration Models

In the second class students are introduced to models of collaboration and are asked to reflect on successful collaboration endeavours.

- Models of Collaboration
- What is collaboration vs Cooperation, Communication, Coordination
- Examples of Successful CSCD projects
- Question "Which collaboration model might you use during the Global Design Projects and why?"



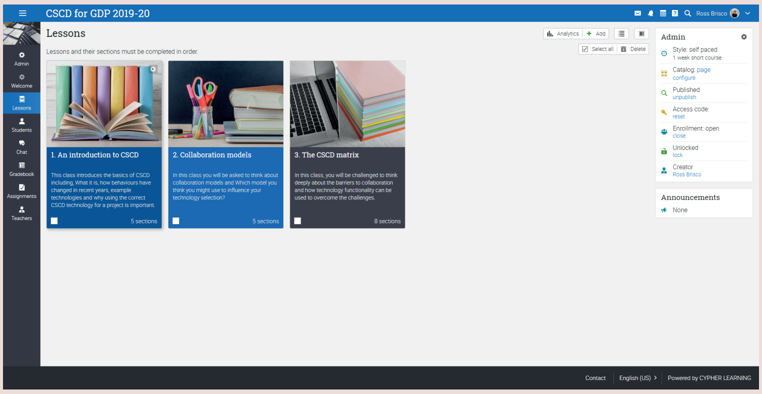


The CSCD Matrix

In the final class students are introduced to a matrix which supports technology selection for global collaboration projects.

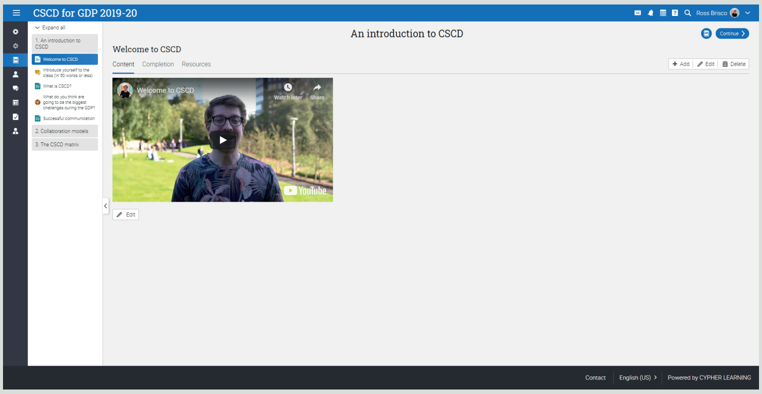
- Introduction to the factors which influence successful CSCD
- Introduction to the functionalities of technologies which support successful CSCD
- Introduction to the CSCD matrix tool for technology selection
- Best practices for global design
- Feedback on the course

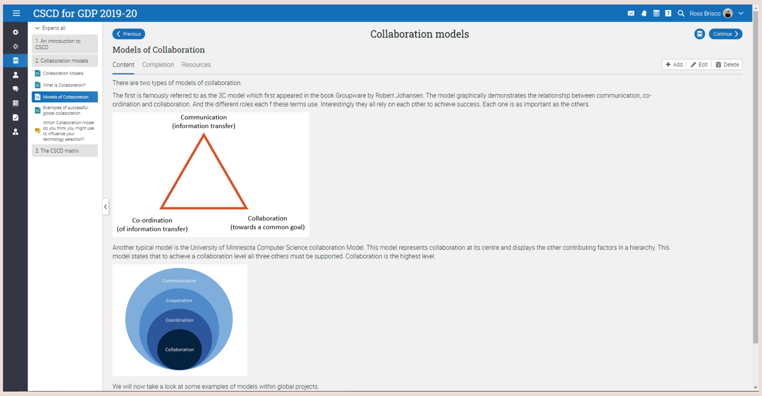
Screenshots from the class



Overview page displaying the three lessons as part of the class to be conducted in roughly 20 minutes on three separate days. Over the course of the week students are encouraged to revisit the previous classes and read the answers to discussion questions and make comments.

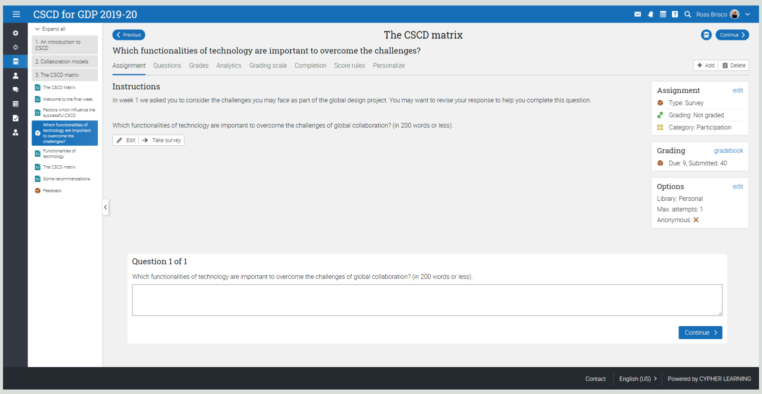
The first lesson of each day is an introduction to what will be taught during that section of classes. This is presented in the form of a video, medium shot, of the course coordinator explaining the lessons as part of that section. The video creates a sense of presence and connection where text based content does not.





During the second lesson, text articles and diagrams are used in place of a powerpoint slide to support learning of collaboration models. Links to further information can be included, such as academic papers for further reading, links to websites for further information on case studies, or animations to convey complex form relationships.

In the third lesson, a demonstration of the questionnaire forum is displayed. Students are encouraged to answer questions which tests their recall and to revisit the forum to view other students answers. Because others will be reading the answers, students spend more time revising their answer. Students also have time to reflect on their answer.



Conclusions

This visual paper conveys the development of an online course in CSCD. After establishing the need for such a course, literature was collected on best practices and developed into a workshop. The workshop was conducted with students of the Global Design project class at the University of Strathclyde and the Global Studio class at Loughborough University. Through iterations of these workshops, best practices for CSCD and the overall structure for the workshop was refined. Gaps in students knowledge were found and iterations of the course aimed to fill these. Once a reliable version of this workshop existed an online version was developed using NEO LMS. Students of the Global Design Project at four universities were invited to engage in the class. Where the workshops involved students from one institution, the online course allows all to engage. The online context of the course prepares students for group projects by giving them an experience of learning and collaborating online. The knowledge taught during the class includes known gaps in students knowledge based on previous workshops. The class encourages students to reflect on their answers to key questions about the challenges and overcoming challenges of global collaboration.

Future Work

The developed online week long class is independent of the Global Design Project. With minor modifications it can be developed for a more generic audience. This new class is being prepared for a higher education audience. Also, the knowledge in the class and tools are being further developed for an industry audience as part of a Continuing Professional Development (CPD) course offered to Small and medium sized companies in Scotland to promote digital transformation.

Acknowledgements

This work was supported by the EPSRC under Grant EP/M508159/1. Thanks to all the staff and students of the Global Design Project and the Global Studio who took part in the workshops.

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